



Forging Strategic Business Partnerships to Develop the 21st Century Workforce

A Case Study of the University of Houston's Undergraduate
Petroleum Engineering Program

The Business-Higher Education Forum

The Business-Higher Education Forum (BHEF) is the nation's oldest organization of senior business and higher education executives dedicated to advancing innovative solutions to U.S. education and workforce challenges. Composed of Fortune 500 CEOs, prominent college and university presidents, and other leaders, BHEF addresses issues fundamental to our global competitiveness. BHEF is committed to helping to drive better alignment between education and the workforce to create the innovation workforce necessary to keep regions, states, and the nation economically competitive.

For more information about the Business-Higher Education Forum, including links to current and completed BHEF initiatives, publications, and more: www.bhef.com

For more information about the University of Houston Petroleum Engineering Program:
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By all measures, the University of Houston has seen remarkable success in recent years. Each year we educate over 40,000 students in more than 300 degree programs. Our faculty and students conduct research in 40 research centers and every academic department. In 2011, as the result of a targeted and sustained strategy, we earned Tier One research university distinction from the Carnegie Foundation for the Advancement of Teaching, one of only three public institutions in Texas to be so recognized. These successes came about, in large part, because of our close ties to, and support from, the Houston community. We are Houston's university, and I believe an integral part of our mission is serving our city and our region.



As we look to the future, a key challenge will be ensuring a sufficient supply of workers who possess the knowledge and competencies to fit the demands of the 21st century job market. I am addressing these challenges, in part, through my membership with the Business-Higher Education Forum (BHEF), the nation's oldest organization of senior business and higher education executives dedicated to advancing innovative solutions to U.S. education and workforce challenges. BHEF is driving alignment between education and the workforce to create the innovation workforce necessary to keep regions, states, and the nation economically competitive.

To further its work, BHEF periodically examines exemplary "innovative communities" already in existence that have benefited from new and meaningful business and education partnerships. Profiled communities offer important examples of business and education collaborations, and contribute to a growing evidence base that BHEF shares with its national network of CEOs and university presidents. I am proud that the University of Houston's Undergraduate Petroleum Engineering Program is the latest in this series.

Founded in 2009, the UH Undergraduate Petroleum Engineering Program graduates much-needed petroleum engineers, blending regional business expertise and resources with the world-class research and intellect of UH. The program's strong ties with industry in Houston, the "energy capital" of the world, are seen throughout its curriculum, advisory board, and fundraising, ensuring that a high-quality education meets workforce demand. Today, nearly 400 undergraduates are enrolled in this program, which will graduate its first class the spring of 2013.

As this profile of the UH Undergraduate Petroleum Engineering Program demonstrates, such success would not have been possible without an intentional strategy that linked business and higher education expertise to build a world-class program. I hope you enjoy learning about our program as much as are we enjoying building it.

A handwritten signature in black ink that reads "Renu Khator".

Renu Khator
Chancellor, University of Houston System
President, University of Houston

The demands of the global economy have fundamentally increased the competitive challenges facing U.S. business, the economy, and the workforce. In response, we need a new model for strategic business engagement in education that develops education-workforce solutions in critical emerging fields such as data science and analytics, cybersecurity, water, energy and materials sciences, and engineering. Certain pockets of excellence, such as the University of Houston's Undergraduate Petroleum Engineering Program, are at the forefront of addressing this challenge.

BHEF employs a new model of Strategic Business Engagement in Higher Education which aligns key corporate “levers” to move from the traditional *transactional* engagement to a *strategic* business engagement that requires deep, sustainable participation by business in higher education to maximize impact. While each can have impact independently, aligning them in business’ engagements with higher education can have powerful synergistic effects. These levers include:



- **C-Suite executives** use their personal leadership to: (1) shape internal and external messaging to raise community awareness of 21st century workforce demands; (2) build a critical mass of peers focused on undergraduate education in support of workforce goals; and (3) guide corporate policy development to ensure the corporation's actions align with its strategic education and workforce goals.
- **Philanthropy Efforts** serve as vital catalysts for positive, lasting, and high-impact change in higher education if invested strategically. Examples include support for creating new undergraduate models, virtual course tools that integrate innovative classroom instruction techniques, and operating support as organizations bring new, evidence-based practice to scale.
- **Employee Engagement** deploys the hundreds or thousands of employees within an organization to support strategic education goals. These individuals represent human capital that can be mobilized to act both inside and outside the corporation, providing grassroots support for a company's investments in education and becoming major advocates for the work.
- **Core Competencies and Expertise** include intellectual capital and unique subject matter expertise that business can utilize to strengthen the education-to-workforce pipeline, collaborating with higher education to create new courses, programs, and student learning experiences.
- **Funded Research** at university labs can serve as platforms for early research experiences for freshmen and sophomores, which have been shown to increase student persistence.

Efforts such as University of Houston's Undergraduate Petroleum Engineering Program clearly demonstrate how strong, diversified business engagement strengthens new education offerings in high-demand fields. These exemplars of practice also serve as the backbone for BHEF's *Higher Education and Workforce Project*, through which business and higher education leaders across the country are mobilizing their organizations to improve education and workforce outcomes. We hope you will join us.

A handwritten signature in black ink, appearing to read "Brian K. Fitzgerald". The signature is fluid and cursive.

Brian K. Fitzgerald, Ed.D.
Chief Executive Officer

Executive Summary

The Business-Higher Education Forum (BHEF) is committed to aligning education and the workforce to create the talent and capacity for innovation necessary to keep regions, states, and the nation economically competitive. As part of that work, BHEF strives to analyze the factors that contribute to effective business and higher education partnerships that align education and the workforce.

To reach this deeper understanding, BHEF periodically examines exemplary “innovative communities” already in existence. One such center of innovation is in Houston, where leaders in the energy industry collaborated with the University of Houston (UH) to launch, and quickly grow, a highly successful undergraduate program in petroleum engineering.

The success of this partnership stands as a model of how business and higher education can collaborate to meet workforce needs. It both exemplifies a successful strategy for improved alignment between education and the workforce, and it demonstrates the value that is inherent in synergies among business, higher education, and the community.

One of the cornerstones of the success of the UH program is that it was created and shaped in consultation with an advisory board whose members are primarily executives in the energy industry. The process of creating this partnership between higher education and business produced insights that can be generalized to other partnerships, including these top-level findings:

- *New partnerships must address actual workforce realities and create college graduates who can enter high-demand fields.* One of the strengths inherent in the development of the UH undergraduate petroleum engineering program was that it was based on an urgent need for specific workforce skills in an industry with acute demand for relatively high skill levels.

- *Deeply engaged high-level industry support is a critical requirement for program development.* One critical factor in the success of the UH undergraduate petroleum engineering program has been that industry involvement has been deep, genuine, and ongoing. The industry partners were involved in many different and complementary ways over an extended period of time.
- *“Quick wins” can help keep business engaged.* Given the traditional difference in the pace of reform in business versus academe, a steady stream of incremental wins can keep business engaged in a partnership with a university.
- *Targeted interventions in education can help universities recruit and retain women and minorities.* By offering extra support and targeted programs designed to help traditionally underserved populations access and graduate from college, institutions of higher learning such as the University of Houston can help ensure a diverse pipeline of talent for business and industry.

The success of the undergraduate petroleum engineering program at the University of Houston exemplifies how business and education can effectively join forces to develop both curricular and co-curricular experiences that directly address regional workforce requirements. Given Houston’s leadership in this arena, BHEF believes that lessons drawn from the Houston experience can be scaled elsewhere — certainly in other BHEF member-led regional projects, but even more broadly in other communities that would benefit from closer collaboration between business and higher education.

Introduction

Education is often not in alignment with business needs. Academic achievement among high school graduates and enrollment in postsecondary education is too low, especially for low-income and underrepresented groups. There is high attrition in postsecondary education, particularly in the first two years of college and in the STEM fields. Not enough students earn degrees in high-demand fields, often causing a deficit of skills in particular communities.

One approach to meeting a community's pressing economic needs is for business and higher education leaders to jointly focus on a region's workforce requirements and execute evidence-based strategies to improve the alignment between workforce needs and educational outcomes. This strategy can spark systemic change and improvement in education, which can help drive regional economic growth.

An example of one such innovative community can be found in Houston, where local business leaders in the energy industry collaborated with leaders at the University of Houston to establish a program of undergraduate study in petroleum engineering.

In conducting this work, business and higher education leaders partnered productively to meet a workforce need in the nation's energy capital.

To better understand the complex matrix of factors that combined to shape the public/private partnership that resulted in the creation of the University of Houston undergraduate program in petroleum engineering—and to explore how the program might be a model for other communities—BHEF undertook a multi-pronged research project. First, it looked at the impetus for the creation of this strong public/private partnership. Then, BHEF reviewed relevant documents and spoke directly with many of the key stakeholders, interviewing a wide range of business executives and academics, members of the Petroleum Engineering Advisory Board, current students, and others. These interviews revealed the structure of the partnership and the strategies to support, advance, and sustain it over time. Finally, BHEF assessed outcomes of the partnership to date and analyzed lessons that could be drawn from the experience that might inform similar efforts elsewhere.



The Need for Qualified Talent: An Imperative for Reform

The impetus for the University of Houston undergraduate petroleum engineering program was rooted in a confluence of factors. Foremost, the petroleum industry found itself in dire need of new talent. The aging of the workforce was bringing the energy industry to the verge of what was called “the great crew change” — a wave of impending retirements of experienced talent. At the same time, the number of students in university petroleum engineering programs had slowed, in part because of wariness about the field as a career path following a series of economic downturns that started with the energy crisis of the 1970s and continued into the 1980s and 1990s. Enrollments in such programs had contracted and the pipeline of students itself shrunk as over a dozen university petroleum engineering programs closed.

By the mid-2000s, however, demand had again grown for new talent in the energy industry. At the same time, too, the nature of petroleum engineering itself was evolving. The energy industry had begun to extract oil and gas in new ways, such as hydraulic fracturing and horizontal drilling, creating a strong demand for new technical skills in the field.



In the face of this evolving energy environment, civic leaders across Houston believed strongly that their community — considered by many to be the energy capital of the world, with roughly half its economy driven by the energy industry — should most certainly have a strong local undergraduate petroleum engineering program. In fact, there are

approximately 3,600 energy related companies based in Houston, including major operations of all the key oil and gas companies. Houston has almost 40,000 jobs just in oil and gas extraction, representing a third of such positions worldwide.

Hometown pride and a bit of friendly Texas rivalry also factor into this story. Two of the nation’s leading undergraduate petroleum programs were sited at other prominent Texas universities, the University of Texas-Austin (UT) and Texas A&M University. UT and A&M’s programs, however, had become fully subscribed with students, creating a political climate in which state authorities might be disposed to approving a new university program.

The University of Houston, meanwhile, was in the process of honing its reputation as a world-class provider of higher education. Already an established leader in energy-related education and research programs with 70 energy-focused faculty members and \$34 million in funded energy-related research, UH had launched a major initiative to expand all aspects of its energy programs, including education, research, and commercialization. Under leadership from a new chancellor, Renu Khator, who was appointed in 2008, UH was aggressively pursuing Tier One status as a research university by investing in the development of strong educational programs for these and other strategic areas.

In addition to a new undergraduate petroleum engineering program, the focus of this case study, the University also recently launched new energy-related programs in its Bauer College of Business, College of Liberal Arts and Social Sciences, and UH Law Center. Moreover, it has begun to develop a new energy research park to be the focal point of UH energy programs. The former headquarters of the Schlumberger Corporation, the 74-acre park includes some 15 buildings with 692,000 square feet of space to house academic, research, commercialization, and private business enterprises.

The University of Houston Undergraduate Petroleum Engineering Program

In the 1970s, oil production in the United States went into decline while production abroad expanded. Academic programs that served the energy industry felt the effect directly. At the University of Houston, an undergraduate program in petroleum engineering, in place during the 1960s, shriveled to extinction.

By the early 2000s circumstances had changed significantly. The energy industry was enjoying a boom cycle. The University recognized that demand for skilled talent in the industry was again on the upswing. The University's master's level program in petroleum engineering was thriving and conversations began that would eventually lead to a rebirth of the undergraduate petroleum engineering program.

As it weighed its options for starting such a program again, university administrators analyzed what went wrong with the earlier program. One clear takeaway was that the earlier program essentially existed in an isolated academic setting. Thirty years later, administrators at the University recognized that creating and maintaining a strong partnership with industry would be a critical cog in starting, and then sustaining, a new undergraduate degree in petroleum engineering.

Therefore, when the University of Houston officially announced on January 30, 2009, that it was launching a new undergraduate program in petroleum engineering, the debut was the culmination of more than half a decade of hard work by individuals from both academe and, importantly, business. Appropriately, therefore, the story of the program starts with its advisory board.

Advisory board

In February of 2001, Ron Harrell, a petroleum engineer who was then the chairman of the Ryder Scott Company LP, a prominent energy consulting firm, was invited by Christine Economides, who was then interim program director for the master's degree program in petroleum engineering at the University of Houston, to join her in creating a petroleum engineering advisory board. Harrell would eventually

“The University recognized that creating and maintaining a strong partnership with industry would be a critical cog in starting, and then sustaining, a new undergraduate degree in petroleum engineering.”

be joined on the board by other industry representatives, with university representatives serving an ex-officio role.

The role of the board was originally envisioned as a sounding board of executives that could offer industry insights to help strengthen the curriculum for the University's graduate program in petroleum engineering. Economides wanted to be sure the master's program aligned with needs of the energy industry at the time. She also wanted advice on how the program could engage adjunct professors from business and how it could best integrate distance learning, which was growing in importance as a mode for delivery of education. Certainly, too, Economides and her colleagues at the University hoped that the industry representatives would help the program become better connected throughout the Houston energy community, help secure financial resources for the program and the University, and help open doors for students in the form of internships and scholarships. The group was somewhat informal, in the sense that it did not have an official charter and members served open-ended terms, but it met regularly. With one exception — a prominent local CPA Carl Glaw — members of the advisory board were all from the energy industry.

While the advisory board's initial role was to advise UH on its graduate programs, by 2006 its members realized that undergraduate petroleum engineering programs at UT and Texas A&M were filling up,

“The curriculum responded to evolving needs, combining fundamentals of petroleum engineering with the study of geosciences, as well as training in economics, energy law, and business.”

creating an opportunity for the University of Houston to have a role in preparing more undergraduates for work in the energy industry. The possibility that the University would open an undergraduate program in petroleum engineering appealed highly to both local industry and community leaders, who believed strongly that UH should have such a program. Indeed, the decision to move forward with the program sparked enthusiasm across the community and inspired more business leaders to join the advisory board.

That collective enthusiasm in turn provided the motivation — and expertise — to help the University secure state approval for the undergraduate program. The influence of business also extends to the program’s administrative leadership: two of its past program directors have backgrounds in the industry. Ali Daneshy, who served as director from 2004 to 2007 (and continues today as an adjunct faculty member) had a long career with Halliburton Energy Services. He is widely credited with helping to develop the program’s curriculum and ensuring that it reflected the opinions of industry experts. The current director of the program, Thomas Holley, spent 28 years as a geophysicist with Shell Oil Company in Houston. He retired early specifically to move to the University to head the program. (Between those appointments, from the fall of 2008 until April 2010, Raymond Flumerfelt, a former Dean of the Cullen College of Engineering at the University of Houston, who was also instrumental in helping to start the undergraduate program, held the post.)

Program launch

The University of Houston Bachelor of Science in Petroleum Engineering was approved by the Texas Higher Education Coordinating Board early in 2009. The first students enrolled in fall of that year.

At the time of the launch, UH Chancellor Renu Khator said “already, more than 28,000 students at UH are pursuing degrees with ties to the energy industry. This is the right industry, the right time, and the right city for this kind of program.”

In announcing the undergraduate program, the University noted that “perhaps more challenging for the petroleum industry than finding new ways to extract hard-to-reach resources may be locating the people to do it.” One dimension of the promise of the new program was that it would help replenish the energy industry’s aging workforce. Moreover, the curriculum responded to evolving needs, combining fundamentals of petroleum engineering with the study of geosciences — an increasingly important tool in energy engineering — as well as training in economics, energy law, and business.

Curriculum

Through countless discussions, the advisory board helped the University shape a curriculum that strongly reflected industry’s needs and desires. The curriculum is designed to cover the broad fundamentals of what is known as the “upstream” component of petroleum engineering, including drilling, petrophysics, production, and reservoir engineering. In addition, students can focus their degrees in three areas of specialized engineering: reservoir, production, and chemical. The program blends geosciences with the technical aspects of petroleum engineering, a new focus that reflects the evolution in the industry toward new technologies that allow engineers to access previously unreachable energy sources (these innovations include horizontal drilling and hydraulic fracturing).

The program consists of 127 credit hours. Of that total, 44 credits are courses required of all university students in Texas, and 35 credits constitute an “engineering core” of additional mathematics,

science, and fundamental engineering courses. In addition, students earn 24 credits in fundamental petroleum engineering and 18 credits in an engineering specialty of their choice. The remaining 6 credits are earned in electives drawn from an approved list of courses on creativity, data mining, leadership, and entrepreneurship — emphases added at the urging of industry advisors, reflecting the need for employees who can solve problems and work effectively with a significant flow of data.

Program administrators and members of the advisory board know that graduates need more than just technical skills to succeed. Program Director Thomas Holley challenges students in some technical courses do more than just memorize facts. He specifically focuses on developing students' ability to solve problems, work effectively in teams, communicate well with colleagues from diverse backgrounds, practice safety, and utilize other competencies beyond content knowledge necessary for success in the 21st century economy.

The region provides ample opportunities for students to have internships with industry, many of which also serve as springboards to employment. This robust pipeline of work opportunities serves several purposes. For employers in a field where competition for talent is fierce, internships help industry find, field-test, and train potential new hires. For students, internships provide an opportunity to test their affinity for and abilities in particular types of jobs, perhaps find a mentor, and connect with future employers. All of the students interviewed for this report gained extensive internship experience through the program — and all have job offers waiting for them when they graduate.

Faculty, Facilities, and Fundraising

Yet another contribution from the advisory board has come in the form of suggestions of industry experts who might teach in the undergraduate program. Indeed, many members of the board themselves are among the program's current and past adjunct faculty. Advisory board members were also instrumental in recruiting John Lee, a member of the National Academy of Engineering and arguably the most widely known petroleum engineering academic

Navigating Political Waters to Gain State Approval

The process of securing state approval for the University of Houston's undergraduate petroleum engineering program holds potential lessons for other institutions that need to garner similar approval. State politics in Texas can be rough-and-tumble, and challenging political realities defined the environment in Austin when UH sought approval for its program through the Texas Higher Education Coordinating Board. The existing programs at UT and Texas A&M had strong political support, and might not want more competition in-state.

To help them make their case, representatives relied on prominent voices from industry on the advisory board who had the right expertise and influence in Texas politics. It helped especially, for example, that the UH Petroleum Engineering Advisory Board was able to recruit former Texas Governor Mark White to its ranks. White would prove extraordinarily effective in helping to steer UH's proposal for a new program through the necessary channels at the state level. The takeaway? The right kind of support and influence can create just the right fulcrum to enable institutions to get the approval needed at the state level.

in North America, as a faculty member. Formerly a professor at Texas A&M University who had served since 1977, Lee was named the first tenured faculty member in the UH petroleum engineering program in 2011. He holds the Hugh Roy and Lillie Cranz Cullen Distinguished University Chair. For his part, Lee says he relocated to UH because he welcomed the chance to help shape a program that was in its early years. In addition, he was motivated by the chance to help young people in Houston, many of whom are underprivileged, earn an education and do so in an environment where they would have regular direct contact with the energy industry.

The University has been strongly committed to supporting the petroleum engineering program. Ramanan Krishnamoorti, Chair of the Chemical and Biomolecular Engineering Department, and Joe Tedesco, Dean of the Cullen College of Engineering, have provided constant guidance, support, and administrative resources for the



program. Additionally, the University has committed to hiring top faculty for the program. The program's first five-year plan called for the hiring of six full-time, tenure-track faculty. Of those slots, three have been filled and two more have been approved for recruiting. Each faculty appointment requires a substantial financial commitment in start-up funding from the University — as much as \$500,000 — to help the faculty member establish a research program at Houston, a critical factor in the recruiting of faculty in a highly competitive field. In addition, the University supports an administrative infrastructure for the program that includes Professor and Administrator Thomas Holley, as well as an academic advisor, Anne Sturm, and a new program manager, Milagros Lugo-Amador. Without

these staff, in particular Anne Sturm who has served since 2010, the growth in students could not have been properly accommodated.

The advisory board was also instrumental in outfitting a home facility for the petroleum engineering program. In the beginning, the program was housed in the University's department of chemical and biomolecular engineering. By 2011, however, the University had found a new site for the program, in building 9A at the University's energy research park. There, the program has three teaching laboratories, three classrooms, a computer lab, faculty offices, and a student lounge — facilities funded in part by support from business.

In addition to political clout, the advisory board served other important functions — not the least of which was financial. The companies represented on the board, and their friends in the industry, contributed significant sums of money to jumpstart the undergraduate program. University alumni and the companies represented on the advisory board have been extremely generous in providing scholarships for students in the program. In the academic year ending August 31, 2012, for example, nearly 50 students had been awarded scholarships.

Among important specific donations, in July 2008 the University announced funding totaling \$1.6 million from Fortune 500 oil companies Devon Energy Corporation and Marathon Oil Corporation for general support, scholarships, equipment, and facilities. In 2010, the Beth Madison Foundation gave \$1 million for classrooms. In June 2011, ConocoPhillips gave \$1 million to the University and its emerging energy research park, where many of the University's preeminent energy research and education programs are clustered. ConocoPhillips donated another \$1.125 million to the University in 2012, \$1 million of which was earmarked to support the building that bears its name. Overall external support for the program would ultimately total about \$6 million, from a number of companies.

Developing the program

University leaders opted to administer the new undergraduate petroleum engineering program

through UH's chemical engineering department. A flagship program at the University, the chemical engineering program provided an already established infrastructure to buttress the petroleum engineering program as it prepares to graduate the first class in the spring of 2013. That milestone offers a fitting juncture at which to assess the program's success.

In a welcome message, program director Thomas Holley says that this is an exciting time for the program as it grows and implements its strategic plan. Noting that the program's motto is "World-class Petroleum Engineering in the Center of World Petroleum," the program is working hard to live up to that moniker. Specifically, he says, the University is looking to build a community of petroleum engineers, one that is small enough for students and faculty to know each other yet large enough to have the industry contacts students need to succeed professionally. Among other highlights, he notes that the program is remodeling its physical plant, recruiting full-time tenure-track faculty, seeking additional funding, and actively recruiting the best students from Houston high schools who can meet the program's standards, which are gradually becoming more competitive.

Markers of recent success

Several milestones measure the program's success.

Student enrollment. Starting with an initial enrollment of just 20 students, the program ballooned in just three years to currently enroll nearly 400 undergraduates. Many of the program's students started their undergraduate education in other fields, often at other schools, sometimes even other countries. Many current students also hold jobs and have families, making their success in a rigorous academic program all the more remarkable.

Industry support. Interest in the program on the part of industry, exemplified in the form of financial support and valuable advice from industry leaders, is another strong signal of accomplishment and an important endorsement of the program's value to the energy industry and the Houston community.

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University progress. The program's success can be viewed in the context of a strategic campus-wide effort, led by Chancellor Khator, to raise the University's stature among research universities. In January 2011, the University joined the ranks of other top research universities in the nation with the announcement by the Carnegie Foundation for the Advancement of Teaching. The designation makes the University of Houston one of only three public Carnegie-designated Tier One research universities in Texas, along with the University of Texas and Texas A&M.

Altogether, the University is developing a reputation for innovation, one example of which is its development of a subsea engineering program. With the University expansion to the energy research park, at least one member of the advisory board sees an opportunity for UH to build programmatic and research emphases around solar, wind, tidal, geothermal, and other forms of energy.

Markers of future success

Going forward, the undergraduate petroleum engineering program is aggressively pursuing several important opportunities.

Create a separate department. Both the industry representatives and the University ultimately envision the petroleum engineering program as its own department. While starting the program in the chemical engineering department provided the infrastructure that enabled it to hit the ground running, both the advisory board and the University recognize that if it is to realize its full potential and develop a reputation as a leading program in petroleum engineering, the program

needs to move from under the chemical engineering umbrella. Apart from helping the program establish its own independent reputation and stature, such a move would give the program its own academic structure and more autonomy.

Expand the research agenda. Creating a separate department is tied to the broader goal of expanding the department's research agenda in order to compete with the existing flagship undergraduate programs in petroleum engineering. Widely viewed as an indicator of a university program's depth, a strong research component can help the program attract funding, grow its reputation, enhance its prestige, and attract more students. Toward this end, for example, UH is actively seeking to develop a Ph.D. program in petroleum engineering to complement its master's and undergraduate degrees. In the near term, the program envisions having 12 to 15 tenure-track faculty, and 50 students earning bachelor's degrees each year, in addition to 20 earning master's degrees and 6 earning Ph.D.'s.

Add faculty. Expanding the research portfolio requires adding faculty. Currently, the program relies on a faculty base of just a few full-time professors, augmented by valued contributions from many adjunct faculty members who bring industry experience to the classroom. But administrators at the University and members of the advisory board recognize that if the program is to be truly competitive, it needs a critical mass of full-time professors and researchers.

Especially in a field which business can pay higher salaries than academe, recruiting top-quality professors is a true challenge. Competition for faculty also comes from other petroleum programs, many of which are older and have more established reputations. Still, the program is aggressively seeking to expand its professoriate. For example, two new faculty positions were announced in November 2012.

Raise student academic standards. In alignment with the University's successful push to become a Tier One research institution, the petroleum engineering program — and, indeed, the entire

college of engineering — is pushing to raise standards for undergraduate admission.

Manage growth. In what might be characterized as a good problem to have, the program's remarkable growth in enrollment has spawned the perhaps predictable challenges associated with trying to deliver quality education to a growing student cohort, such as crowded facilities. One significant plus in this equation is that the program's popularity enables UH to steadily increase the quality of the students it enrolls, an important goal for improving the program's reputation overall. Future success will be measured by how well UH is able to handle the rapidly growing numbers.

Expand facilities. Just four years old, the undergraduate program is already outgrowing its physical home. Additional financial resources will be needed to help the program expand into a new physical plant and develop facilities that will keep pace with rapidly developing technology in the field.

Secure additional funding. At an even broader level, sustainability and expansion of the program on the whole will depend on new and larger contributions from corporations, individuals, and philanthropies. The program like the one at the University of Texas, for example, benefits from a funding base that is significantly larger than the one currently at UH. Houston needs to expand its resource base to help fulfill its goal of competing with the top petroleum engineering programs.

Assessing success over time

What markers will measure the success of the program over time? The number of graduates the program produces will be one tangible proof of its success, especially assuming the program continues to grow at a similar pace. How successful those graduates are finding jobs will be another sign of success, although that marker may not be as relevant given the high demand for new talent in the industry. Whether the program is able to attract the faculty it needs — and additional financial support — will be other critical signs of success, as well as development of

new facilities to accommodate a program that is already nearing capacity.

Given higher education's focus on institutional prestige, the program's reputation will ultimately matter as well. The exercise of reputation building cannot be emphasized enough — as one practical consideration, for example, there are companies in the industry that insist on recruiting only at the handful of petroleum engineering programs that have the highest reputation in the field, a hurdle that the University of Houston will have to surmount.

The most notable marker of success will be the impact that the graduates from the program ultimately have in the energy industry. At the most basic level, it means ensuring a pipeline of talent to help the industry meet fundamental needs for skills in the field. At another level, however, members of the advisory board anticipate that

the program will also produce graduates who will distinguish themselves as leaders in the energy industry and thus help the UH program increase its reputation among peer programs. Observing students currently in the program, for example, Thomas Holley sees a number who have the capacity to move up the ranks as innovators and leaders. Recognizing, too, that many of the students in the program are from abroad, Holley expects the program's impact will be measured by the influence it has in the energy industry around the world. Ron Harrell, a long-standing member of the advisory board, believes that new graduates in the petroleum field will also have to distinguish themselves with extraordinary productivity — a prerequisite for true competitiveness in today's fast-paced world—and an entrepreneurial spirit that will drive them to invent innovative new solutions for the industry.



Lessons Learned: Insights for Other Communities

The success of the undergraduate petroleum engineering program at the University of Houston, particularly its foundation of a robust partnership between business and higher education, offers a number of insights that can be generalized to other partnerships. In that spirit, we present findings that propose ideas to help inform other efforts:

New partnerships must address actual workforce realities and create college graduates who can enter high-demand fields.

One of the strengths inherent in the development of the UH undergraduate petroleum program is tied to the urgent need for specific workforce skills in an industry with acute demand for relatively high skill levels. Regional employers encouraged UH to develop the program to replace a large number of anticipated retirements in the field. Such efforts were further bolstered by industry's need for a curriculum that trained future employees for emerging technologies and by the university's interest in expanding its programmatic offerings in strategic areas.

Deeply engaged high-level industry support is a critical requirement for program development.

Industry involvement is a critical factor in the success of the UH undergraduate petroleum program. That is, industry representatives on the advisory board have been genuinely involved in the development of the program from its earliest stages, when it was just being conceptualized, and have contributed considerably in terms of time, ideas, and advice. High-ranking leaders from the energy industry identified the need for the program and remained persistently engaged in its development over several years, helping the university not just shape the program, but also secure the necessary financial resources to get it started. Industry representatives even assisted in recruiting faculty with corporate experience for the program.

Thomas Holley, director of the UH petroleum engineering program, has said that collaboration between industry and the university was absolutely

vital in the program's development. "The thought of starting such a program without industry support — I just don't know how the university would do that," he says. Occasionally consulted by institutions interested in starting similar programs, especially in countries outside the United States, Holley says that he advises them not to even start unless and until they have industry support. "That partnership," he says, "is absolutely critical."

The role of business in the development of the Houston program has extended to include outreach by industry leaders to influence important decision-makers. One practical benefit of such engaged leadership was realized, for example, when well-connected representatives of industry were able to help facilitate the program through the challenging landscape of Texas politics en route to ultimately securing approval from state authorities.

Yet another important factor is that industry engagement with the program has been sustained over time. Many of the same companies that were involved in starting the program at the onset are still involved in the program today, creating invaluable continuity and consistency around the business-higher education partnership that is fundamental to the program's success.

"Quick wins" can help keep business engaged.

Anyone who works with public/private partnerships that engage business and academe quickly finds that those partners move at different speeds. Business tends to undertake reform efforts at a fast pace and make decisions unilaterally, while academe typically takes a more deliberate approach and seeks consensus. That discrepancy often creates cultural chasms between the parties and sometimes makes it difficult for the parties to work together. Ensuring a steady stream of incremental wins toward a larger goal can be instrumental in bridging that gap.

For example, in the development of the UH petroleum engineering program the fact that a new program could be developed within an administrative framework that already existed — i.e., the chemical engineering program — enabled the

project to exhibit signs of progress early on, creating positive momentum that helped keep industry partners involved. The challenge of getting the program approved at the state level in a political climate that could have favored other larger and more well-established petroleum engineering programs proved an enticing contest for Houston's energy industry community to engage in, and their ultimate victory provided another incremental win that helped keep stakeholders engaged in the program's overall development. The program's rapid growth in student enrollment, evidenced early on, was another positive trend that helped maintain the industry's commitment.

Targeted interventions can help universities recruit and retain women and minorities.

One of the great strengths of the UH petroleum engineering program is its diversity. The program attracts students from all over the world, some of whom intend to return to their home countries to work in the energy industry there. The program has a good track record in recruiting minority students, although administrators are quick to note that more work is needed to recruit more women to the field. (In part, the dearth of women in the program — they now constitute just 20 percent of students — is linked to the overarching absence of women in the STEM fields in general.) By offering extra support and targeted programs designed to help traditionally underserved populations access and graduate from college, institutions of higher learning such as UH can help ensure a diverse pool of talent.

Still, the opportunities in the energy industry make study in the field attractive and, in turn, help the university recruit a more diverse student body. (Overall, the UH student body today is approximately one-third white, one quarter Hispanic, 19 percent Asian, 12 percent black, with the remainder of students drawn from other groups.) Recruitment is aided by the fact that the Houston area itself is quite diverse. The program consciously ensures that its local recruiting efforts include high schools with diverse student populations.

The University also offers extra support for traditionally underrepresented populations once they arrive on campus. In 1974, the university's Cullen



College of Engineering established the Program for Mastery in Engineering Studies (PROMES, pronounced "promise"), which originally offered support for recruitment, retention, and academic development to Hispanic, African American, and Native American students. Now open to all students, PROMES also offers academic advising, workshops, scholarships, and job opportunities, all designed to help undergraduate students succeed and thrive.

As the most recent affirmation of its diversity, the University was recognized in 2012 as one of just three Tier One public research institutions in the nation designated as a Hispanic-Serving Institution by the U. S. Department of Education Office of Postsecondary Education. In 2010, the University was recognized by *U.S. News & World Report* as the second most racially and ethnically diverse university in the nation.

Implications for BHEF's National Higher Education and Workforce Project

The insights gleaned from the Houston experience confirm the power of strategic business engagement with higher education to meet workforce needs in high-demand fields. Indeed, the University of Houston has successfully leveraged multiple dimensions of business engagement — such as the use of adjunct faculty directly from industry, a curriculum co-created by business and higher education, the opportunity for students working alongside practitioners to gain content knowledge as well as 21st century workplace competencies, and the corporate financial support to meet programmatic needs — to fuel the innovation workforce in petroleum engineering. This partnership model is evidence that will drive the national network of regions within BHEF's *National Higher Education and Workforce Project* that are tackling country's pressing workforce challenges.

BHEF's *National Higher Education and Workforce Project* utilizes the resources of strategic partnerships to expand the capacity for colleges and universities to increase the persistence of undergraduates,

particularly women and underrepresented minorities, in high-demand fields. These regional projects promote a new model of strategic business engagement in higher education that moves from a the “transactional” — a one-dimensional relationship limited to interactions that address tactical business needs, such as support for applied research related to company's production processes and products—to a strategic engagement model that mobilizes five corporate “levers” — c-suite leadership, philanthropy, employee engagement, core competencies, and funded research — in a multidimensional feedback loop with higher education to effect deep, sustainable change in undergraduate learning.

As we look to the future, learning from successful business and higher education partnerships, such as the University of Houston Petroleum Engineering Program, will better enable us to scale these highly effective practices. BHEF members will continue to lead this work, and demonstrate to the country the power of these new models for strategic business engagement for improving higher education outcomes.



Acknowledgements

BHEF members are committed to building the innovation workforce we need to keep regions, states, and the nation economically competitive. As part of that work, BHEF examines exemplary “innovative communities” that can serve as role models for business and higher education collaborations. We would like to thank the University of Houston (UH) community for serving as the site for our most recent inquiry, and for opening its doors and giving us the opportunity to learn about its successful Undergraduate Petroleum Engineering Program. The lessons learned from this engagement will support a national network of business and higher education leaders shaping an actionable agenda to meet regional workforce demands.

Our deepest thanks go to those who took time to share their insights with us, including members of the Petroleum Engineering Advisory Board, UH department leadership, faculty, staff, and students. We hope we captured all of your enthusiasm, passion, and commitment to this very important field. BHEF would like to extend a special thanks to Ramanan Krishnamoorti, Dow Chair and Department Chair of the UH Chemical & Biomolecular Engineering Department, and Thomas K. Holley, Director of the UH Petroleum Engineering Program, for their willingness to serve as ambassadors for the program and for BHEF as we developed this case study. Your dedication and wisdom inspire us to emulate your work.

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As we look to the future, and the scaling of those innovative programs that help address our country’s workforce needs, efforts such as UH’s will continue to lead the way.

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