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A New Educational Approach towards Preparing Skilled Chemical Engineers for Special Assignments in the Energy Field

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1. Introduction:

Texas A&M University opened a branch campus in the Education City of Qatar Foundation in 2003 by offering Bachelor of Science degrees in four engineering majors: chemical, electrical, mechanical and petroleum. The curricula offered at Texas A&M University at Qatar (TAMUQ) are materially identical to the ones offered at the main campus in College Station, Texas and courses are taught in English in a coeducational setting. The reputation for excellence is the same, as is the commitment to training engineers equipped to lead the next generation of engineering discovery pioneers. Qatar has the world's third largest proven natural gas reserves, as well as some reserves of petroleum; it also hosts the most advanced existing plants and refineries in Gas-to-Liquid (GTL) technology, Liquefied Natural Gas (LNG), in addition to several chemical and petrochemical plants. The Chemical Engineering Program at TAMUQ and the Artie McFerrin Department of Chemical Engineering at main campus take full advantage of this unique environment to build a globalized education model that benefits the training of our students in both teaching and research. This model has generously been supported by the Qatar Foundation and by global corporations (e.g. ExxonMobil, Shell, Chevron, etc.) as well as Qatari government institutions (major oil company Qatar Petroleum, Ministry of Environment, etc.). Considering the urgent needs in these companies and global corporations for qualified chemical engineers, we developed a unique program that benefits all parties and supports our advanced education model. In this communication we will share the model we developed to prepare skilled engineers to the energy market in Qatar, the region and the world. Special research programs have been developed for both undergraduate and graduate students as part of this model. In addition, new elective courses were drafted and aimed at teaching the students the fundamentals behind the applied experiences they gained in the research programs. Furthermore, our study will discuss the potential for incorporating such a model as part of the curriculum of the engineering program to prepare the future engineers who will be leading technology development and operation in a different setup from the previous generations.

2. Qatar Foundation, Education City, and Training Models for Future Scientists and Engineering:

Under the umbrella of the Qatar Foundation for Education, Science and Community Development, both Education City and the Qatar Science and Technology Park operate. Education City is a campus comprising of several colleges, including Texas A&M University at Qatar. It has the three-prong mission of research, teaching and community service. These goals should be realized in the projects undergone by the universities. Qatar's work in facilitating research and innovation can be compared to studies based on the same issue in New York State. The Governor of New York assembled the Task Force on Diversifying the New York State Economy through Industry-Higher Education Partnerships. This task force studied the

interaction of New York's universities and companies and came up with several recommendations; central among them is the development of an "innovation ecosystem". The task force recommended that this ecosystem be developed through universities which place importance on entrepreneurship and the establishment of "long term relationships" with the universities. In addition, the report stressed the importance of "access to capital"[1].

Texas A&M University at Qatar has an excess of $120M dedicated to research work, much of which involves the participation of undergraduate students; concurrently, both industry and academia are investing heavily on training and development of those soon to be engineers. These efforts culminate in providing new opportunities for these students besides the research experience to participate in internship and co-op programs. Matter of fact, more than 88% of TAMUQ's student body participates in at least one internship before the date of their graduation, which is quite a remarkable figure, and many partake in more than one term. These experiences, alongside their interaction with faculty members within the university, allow students to gain knowledge in a vast array of engineering problems and technicalities which cannot be covered in the classroom environment; A survey summarizing more concrete qualitative and quantitative conclusions of these findings is currently being conducted, awaiting approval from Texas A&M University's Internal Review Board (IRB). This outcome of this survey is expected to give us clear assessment of the usefulness of this research experience in terms of the knowledge students gained in specific research topic, the skills they developed during the research course, whether this experience positively impact students' academic performance and help them to identify and find their future job. Furthermore, this survey will also be distributed to our graduates who are currently working in industry or in graduate school for the past five years to see whether this experience helped them in their career specifically at the start up. In order to ensure accurate feedback from

3. Industry and Academia Interface: A Case Study from Texas A&M at Qatar's Fuel Characterization Lab

Through a synergistic collaboration between industry and academia, our Fuel Characterization Lab (FCL) at the Texas A&M University at Qatar (TAMUQ) studies the relationship between the structure of Gas-to-Liquid (GTL) derived synthetic jet fuels and their properties. In a short time span our research team built a world-class lab, and generated a significant amount of reliable data. This data was subsequently subjected to advanced statistical analysis methods in order to visualize the trends and draw scientifically meaningful conclusions from this work. Our methodology was to systematically generate several series of synthetic fuel blends. A trained team of supervised undergraduate students were responsible for testing the fuel blends for their density, heat content, freezing point and flash point following strict safety and quality management regulations. The fuel blends were derived from specific classes of GTL products (*normal-*, *iso-* and *cyclo*-Paraffins) where the amount of each component varied. By doing this

and after non-linear statistical analysis we have been able to map how the hydrocarbon structure of a given GTL fuel blend influences its physical properties. We found that, within the sample space of these components, there exist areas where the fuel blend has optimum properties for use as aviation jet fuel. We also examined and mapped the influence of aromatic additives on the fuel blend properties; currently, a fourth phase of research is conducted where we're expanding our map to include new additives and component families in order to optimize the strategy of blending Qatar's GTL products and to increase their market value.

This one research project is an example of how the FCL has been used as a training ground for our students in order to develop their technical and soft skills that are much needed for success in their future careers in local and regional industries. Several elective courses that targeted the fundamentals behind this project has been developed for the students involved in this research work. Besides the theoretical and the technical experience the students get the opportunity to work in a professional environment, report scientific data and draw conclusions from this information in order to make decisions on the next phases of the research work. Furthermore, they experience working as a team, teaching, leadership and holding joint responsibility for meeting deadlines and reaching the highest quality standards that our lab demands.

The industry partners made a large contribution to the undergraduate students' research experience through sharing of expertise and advice, as part of advisory committees. These partners had an interest in the project as the fuels would provide them a way to comply with new environmental regulations. Issues of safety, quality control and feasibility are more relevant to industry, and they were therefore able to give advice on them extensively. Shell scientists, for example, assisted in these aspects as well as orchestration of activities, while Rolls Royce scientists assisted with the combustion aspect of the project. Qatar Science Technology Park (QSTP), as well as Qatar National Research Fund (QNRF), which falls under Qatar Foundation umbrella, provided the funding for the project, besides Shell Qatar. All of which contributed to its aim of facilitating academia-industry collaboration with main focus on enhancing the engineering students skills and knowledge about gas processing technologies.

The real success of the project must be assessed by actual feedback from members of the research group from Texas A&M Qatar who participated in this consortium. Overall the group felt that there was a "fruitful" and very successful experience highlighting the benefits they gained from the partnership between the Texas A&M Qatar group and its partners. Shell Qatar specifically was cited as a great supporter, providing advice, consultation, lab chemicals and training in a "very smooth" manner. However, this model represents a win-win situation as Shell Qatar recruited more than five of these students to the world largest Gas-to-Liquid technology plant the world (the Pearl GTL plant in Qatar). Group members said they had a lot of interaction with the partners, through board meetings, visits, as well as conferences. This applied even to the undergraduate student researchers, who felt that even their seemingly small contributions had an impact. Many of the other partners conducted lab tours frequently. They also sponsored trips to conferences where the group could present their work in international conferences such as the

annual meetings of the American Chemical Society and the American Institute of Chemical Engineers. Though the partnership was cited as “amazing” overall, it was still plagued with the usual problems associated with collaboration between academia and industry. These include a lack of understanding of the pace and aims of academia, as well as some difficulty in communication. However, it was ultimately essential as it “gave the research applied nature” and the students the right skill to sell themselves to both national and global energy corporates. The students who joined this program and garnered experience in this project are currently of equivalent projects either in world leading industrial entities (such as Shell, Maersk Oil, Total, Qatar Petroleum and others) or pursuing a higher degree in a graduate program in esteemed schools. This presentation will provide more details on the importance of such programs in the future career of engineering students.

More importantly the undergraduate students participated received several awards and recognitions as part of the research team including.

- Qatar Foundation’s Research Excellence Award for the Best Energy & Environment Research Program of the Year during the Joint Qatar Foundation Annual Research Forum and Arab Expatriate Scientists Network Symposium.
- The First Place Award (US$6,000 Award) in the Fourth Scientific Visualization Competition sponsored by Qatar Foundation & Texas A&M Qatar University for developing 2-Dimentioanl (2-D) and 3D visualization models to identify optimum composition of synthetic jet fuels obtained from natural gas via GTL (May 2012).
- The First Place Best Poster Prize in the Third International Gas Processing Symposium held in Doha on March 2012for their project titled "A path to formulate new generations of synthetic jet fuels derived from natural gas via GTL." The research is sponsored by Qatar Science & Technology Park (QSTP) and Qatar National Research Fund (QNRF).
- The Chemical Engineering Program Best Research Team of the Year (April 2012).
- Recognition from the Fuels and Energy Division of the American Chemical Society for the “High Quality Research Contribution” for a poster presented during the Spring Meeting of the American Chemical Society in San Diego, California (May 2012).

4. Conclusion

In conclusion, Texas A&M Qatar model of developing research program for its undergraduate students in collaboration with local and global industry is proved to be quite successful overall. It is comparable to successful models in other institutions, and it has proved satisfactory to those involved. In addition, the group has been able to work in accordance with the goals of Education

City, to provide teaching, research and community service. It has also acted in accordance with the overarching guidelines of the Qatar National Vision, aiding in both Human and Economic Development. Therefore, according to all criteria, the project has been a great success to prepare the university graduates for industry and graduate programs. The model of engaging undergraduate students in advancing GTL technologies and participate in the Fuel Characterization Lab confirm this outcome as almost 95% of the participated students (out of 25 undergraduate students worked in this project in the last four years) found jobs in global energy corporate or joined a reputable graduate program.

Reference:

[1] Skorton, David. *Task Force on Diversifying the New York State Economy through Industry-Higher Education Partnerships Final Report*. Presented by Johnson & Johnson and the New York Academy of Sciences (2010).