Biotechnology: Gearing up to Manufacture Biofuels Including Ethanol and Biodiesel

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Abstract

With global demands recently causing United States (U.S.) gasoline prices to exceed $4.00 per gallon, and the average price of diesel fuel to sell at approximately $4.70 per gallon, renewable alternative auto fuels, or biofuels, have not only become feasible but desirable. The "corn rush" is creating a tremendous shortage of factories and trained factory workers to convert natural resources into usable fuels. The Apollo Alliance and the Urban Habitat Institute have reported that "an average ethanol plant produces about 40 million gallons of ethanol a year and employs around 35 people in the following types of jobs: general manager, plant manager, maintenance supervisor, plant operators, purchasing manager, lab manager and technicians, craftsmen, laborers, and instrument technicians. Biodiesel plants employ fewer people; around 28 workers for an average plant making 30 million gallons per year" [1].

One could ask the following questions: How does a biofuel manufacturer obtain the qualified personnel required to operate a biofuel factory? And, what is the nature of collaboration between the biofuel industry, other higher education institutions, and government to train workers?

This paper proposes a solution to the biofuel personnel education shortage problem by describing how one education program establishes collaboration between departments in a school of technology at an institution of higher education to establish a master's degree program in biotechnology. This master's degree program would establish a source of trained biofuel graduates to help meet state, national, and global demand for educated, technology-trained workers to manufacture biofuels. One specific department in that school of technology, the Manufacturing Systems department, seeks to determine whether the personnel needed to operate biofuel factories can be traditional higher education students, retrained misplaced factory workers, or a combination of the two.

This paper, which describes an interdisciplinary-designed graduate program geared specifically toward the needs of the technologists, managers, and laborers employed in biofuel manufacturing plants, is designed primarily by collaboration between four departments in the School of Technology at North Carolina Agricultural and Technical (A&T) State University and various other disciplines across the campus. The proposed curriculum for the manufacturing systems program provides three integrated segments: traditional four-year higher education students, community college transfer students, and displaced factory workers. The proposed curriculum is based on manufacturing needs with respect to the knowledge base (skill sets) and application requirements of the biofuel manufacturing companies. Most biofuel companies in the region are suppliers of biodiesel fuel to the automotive industry, with ethanol only beginning to establish a market.

Introduction

A graduate program geared specifically towards the needs of biofuel manufacturers of ethanol and biodiesel fuels is being designed by collaborative efforts of a blue-ribbon focus group composed of administrators, faculty, and students from each of the four departments in the School of Technology at North Carolina A&T State University. As part of curriculum development, administration, faculty, and students involved in this effort meet with other schools and colleges across this campus. Members of this focus group plan to attend alternative biofuel conferences and seminars, such as the one attended by two members of this focus group recently. The seminar was sponsored by the North Carolina Community College Systems (NCCCS). “College that really works” is the motto of NCCCS, the state’s 58-campus community college system [2]. The BioNetwork, which began in 2004, is a system of community colleges that banded together and formed NCCCS BioNetwork, which is a statewide initiative that connects community colleges across North Carolina, providing specialized training, curricula and equipment to develop a world-class workforce for the biotechnology, pharmaceutical, and life sciences industries. Our purpose for attending this seminar is to gain further insight into the NCCCS’ biotechnology seminars to aid our initiative to develop an interdisciplinary biotechnology graduate degree program at North Carolina A&T State University.

Industry and Collaboration

To meet U. S. demand, major oil companies say that easily attainable global oil supplies are nearing exhaustion, forcing them to explore drilling deeper or drilling in areas that have been termed ecologically off limits, i.e., the Arctic National Wildlife Refuge (ANWR). Environmentally, the Environmental Protection Agency (EPA) has declared methyl tertiary butyl ether (MTBE), which was touted by industry experts earlier, to be unsafe because of its propensity to contaminate underground water [3]. Corn, soybeans, sugar cane, switch grass, wood, crop residue, and other renewable biological energy products have now become viable alternative fuel sources. Together, these and other factors open the door for ethanol, biodiesel, and other renewable fuels to become America’s alternative fuels of choice. Renewable energy sources have become viable alternatives to our nation and the world’s growing energy problem. This paper also uses the collaboration between Columbia Basin

College, Washington State University Extension, and Port of Walla Walla as an example to demonstrate how three entities successfully collaborated to build and staff a biofuels manufacturing facility. When this graduate project is complete, it will provide tremendous insight into how universities and industries collaborate to maximize the potential of both entities.

Figure 1. Bio-Diesel Project Walla Walla County, Washington (2006)

Quick Facts

- $40 million investment.
- 100K metric tons or 31million gallons of biodiesel annually.
- 20 FTE—Average wage $40K+ benefits.
- 2003: The Washington State Legislature approved legislation that provides biodiesel plants with a six-year property tax exemption, sales tax exemption for equipment and new construction, and reduction in the Business and Occupation (B&O) tax rate.

Quick Facts

- $150 million Investment.
- 100 million gallons of ethanol annually.
- 35–50 FTE—Average wage $35K+ benefits.
- 2003: The Washington State Legislature approved legislation that provides biodiesel plants with a six-year property tax exemption, sales tax exemption for equipment and new construction, and reduction in the B&O tax rate.

The Program Kickoff

This program started with an interdisciplinary meeting of various departments from across the university campus. Personnel as diverse as the chairpersons from the nursing department and the department of agriculture to engineering and technology faculty, as well as undergraduate and graduate students in the school of technology were all present to kick off the collaborative degree effort. Agricultural engineering made it clear that they were not interested in manufacturing biofuels. The nursing department asserted that there is definitely a divide between safety and first-aid. Undergraduate and graduate students wanted to be included in the research arm of biotechnology. During the week following the initial kickoff meeting, two faculty members traveled to Clayton Community College (near Clayton, NC) to attend a one-day conference on the biodiesel industry in North Carolina.

Table 1: Curriculum Content Courses for the Masters of Biotechnology Program

MANUFACTURING SYSTEMS
Introduction to Manufacturing Processes (3)
Industrial Materials and Processes (3)
Introduction to PLC and Robotics (3)
Manufacturing Planning and Management (3)
Statistical Processes/Quality Control (3)
Production and Control (3)
Six Sigma (3)
Lean Manufacturing (3)
Problem Solving in Industrial Technology (3)
Concepts of Technological Innovation (3)
Leadership Development Seminar (3)
Manufacturing Organization and Management (3)
Statistical Research in Industrial Technology (3)
Industrial Productivity and Management (3)
Strategic Concepts in Quality (3)
Advance Automation and Control (3)
Advanced Manufacturing Processes/CNC (3)
Applied Computer Integrated Manufacturing (3)

Program Coordination with the Companies

Even though the committee is currently identifying private companies with which it plans to collaborate and coordinate the master's degree curriculum, thus far no biofuel manufacturing companies have been contacted. Several community colleges and biodiesel companies were present at the April 2008 biodiesel seminar in Clayton, NC. Several of the community colleges were receptive to an articulated degree program with North Carolina A&T State University in the biodiesel program. Several companies expressed interest in working with North Carolina A&T State University to develop curriculum, as well as in hiring graduates of the biotechnology master's degree program.

The Collaboration on the Final Projects

Collaboration on the final projects will involve input from biofuel industry experts not only from across North Carolina but the U.S. and around the world. The program at North Carolina A&T State University will be a premier program, using the most current ideology and cutting edge technology.

The School of Technology's contribution:

- A Master of Biotechnology degree program, identifying course curriculum, scheduling, and all requirements toward receiving a master's degree from the School of Technology.
- The school would provide core courses in each discipline, much as it already does for other undergraduate and graduate programs.
- The degree curriculum would be designed so new freshmen, community college transfer students, and displaced factory workers could join the program at any time.
- All classes would be coordinated from the North Carolina A&T State University campus. Community college classes would be conducted at the partnering institutions. Displaced workers could attend the first two years of classes at the community college or North Carolina A&T State University. After the first two years, the remainder of the degree would be completed at North Carolina A&T State University.
- The department would allow students to base their class projects on projects that they were involved in at their current company. Departmental class projects would need to be related to the biofuel manufacturing initiative. However, they could be work related if they meet the above criteria and are approved by departmental faculty.

The Manufacturing System Department's contribution:

- This department would house the Master of Biotechnology degree.
- The Manufacturing Systems department would provide access to faculty and students working on projects, completing class projects, or for the student's final project to participating community colleges and companies.

- The department, along with the School of Technology, would also raise money to build a traveling operations display model for conferences and seminars at various sites. This joint association would raise money to build a stationary working model on the North Carolina A&T State University campus, which would actually manufacture fuel to help supply fuel needs for the campus motor fleet.

Table 2: List of Various Projects at Different Companies and Universities

1. "Biotech Develops Formula That Nurtures Job Growth," BusinessNC.com.
2. "Community Jobs in the Green Environment," Apollo Alliance and Urban Habitat.
3. "Biofuels Summit I," Columbia Basin College, Port of Walla Walla, Washington.
4. "Building an Innovation Economy," The University of Rhode Island.
5. "Industrial Biotechnology and the Future of Ethanol Production," Biotechnology Industry Organization, Washington, D.C.
6. "North Carolina Ethanol Plant Creates New Market for Corn," Southeast Farm Press, North Carolina.
7. "Switchgrass Profile," Iowa State University, Iowa.
8. "One-Step for American Biodiesel, Inc. DBA Community Fuels," State of California.
9. "O.H. Kruse Family Makes $2 Million Commitment to Kansas State University Pilot Feed Mill," Kansas.
10. "Biotechnology Curriculum Units," Iowa State University, Iowa.
11. "Is Indiana Ready to Be an Emerging Leader in the Biofuels Industry?" Indiana.
12. "Using All the Corn and Making Ethanol," Iowa.
13. "Mercedes Wants to Eliminate Petroleum from its Lineup by 2015," Germany.
14. "Research into Desert Plant Could Help Development of Energy Crops for Arid Regions," Liverpool, UK.
15. "Biodiesel Products," Extreme Biodiesel-Corona, CA.
16. "Biofuels for Oregon," Oregon.

Conclusion

The impending global crisis created by depleting energy supplies and petroleum reserves has enlarged the market for renewable energy. Converting biological matter to much needed energy requires a workforce trained in biotechnology. The Biotechnology master's degree program at North Carolina A&T State University is expected to educate potential biofuel industry employees who are able to step into all roles of biofuel manufacturing processes with minimal on-the-job training, while bringing immediate substantial contributions to the biofuels manufacturing industry. All of this helps reduce America's dependence on foreign oil and provides a much needed boost for American manufacturing work forces. "What started out to be a large ethanol producing plant in Aurora, NC, recently became a huge ethanol producing plant with the announcement that the facility will be doubled in size from 54 million gallons per year to 108 million gallons per year" [4].

Figure 1: North Carolina corn

“Speaking at a recent meeting to introduce the plant to eastern North Carolina corn growers, Terry Ruse, vice-president for Agri-Ethanol Products, who will operate the Aurora plant, noted that the facility will be good for farmers, good for the environment, and good for consumers” [4].

“For every 42 gallons of ethanol we produce, we will eliminate 17 gallons of foreign oil, he notes” [4]. This exemplifies one of multiple ways America can reduce its dependence on foreign oil.

References

[1] Apollo Alliance and Urban Habitat, “Community Jobs in the Green Economy,” 2007.

[2] North Carolina Community College System, “Preparing North Carolina's World-Class Workforce - Celebrating 40 years of "College That Really Works" for North Carolina,” http://198.85.71.234/alsbrookls/itn160/ncccs/ncccs2.html, September 7, 2008.

[3] “Methyl Tertiary Butyl Ether (MTBE): Overview,” *MTBE in Fuels*, http://www.epa.gov/MTBE/faq.htm, September 7, 2008.

[4] Roberson, R., “North Carolina Ethanol Plant Creates New Market for Corn,” *Southeast Farm Press*, June 13, 2006, http://southeastfarmpress.com/news/061306-Aurora-ethanol/, June 16, 2008.

Biographies

ALTON KORNEGAY is currently an assistant professor and graduate coordinator in the Manufacturing Systems Department in the School of Technology at North Carolina

Agricultural & Technical (A&T) State University. Dr. Kornegay brings to the academy four years of military avionics technician experience and more than 30 years of work experience in corporate America. He served corporate America as an aerospace engineer (3.5 years), production supervisor (17 years), and facilities engineer (10 years). Upon retirement from the John Deere Corporation in 2001, Dr. Kornegay enrolled in a doctoral program at Iowa State University, where he graduated with a Ph.D. in Industrial Education and Technology in 2003. He then embarked on a career in higher education. Dr. Kornegay is a Certified Senior Industrial Technologist (CSIT) in the National Association of Industrial Technology (NAIT). He is the immediate national Past President of the Industry Division of NAIT.

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