Development of a New Integrated Student Agency to Increase the Number of Minorities with Advanced Degrees in Engineering: ATMO

Michel A. Reece, Carl White, Member, ASEE
Center of Advanced Microwave Research and Applications (CAMRA),
Morgan State University, Baltimore, MD, 21239, US

ABSTRACT

ATMO which stands for Academic, Training and Career Management Office within the Center of Advanced Microwave Research and Applications (CAMRA) is a new student agency developed at Morgan State University (MSU) whose goal is to integrate research and training into an academic curriculum to help increase the number of minorities to obtain advanced degrees in engineering. Currently, minorities have the lowest percentage of graduates who receive advanced degrees in engineering. By embedding advanced technical training during a student's freshmen and sophomore years of an undergraduate curriculum, students are not only motivated, but also have the skill sets needed to participate in research. After training, the student applies technical skills learned to an advanced research project provided by collaborative relationships with industry, the university, or faculty members. The integration of research and training increases the student's confidence to compete academically among fellow peers, improves graduate retention, and improves a student's academic performance. Because of the demands of these added components within the already demanding engineering curriculum, effective management and tracking of these students is paramount for successful matriculation. In order to assist students in managing the additional pressures within this unique academic environment, ATMO provides additional student support services to the clientele it serves. As a result, students are more likely to apply to graduate school and enter with higher GPAs. In 1999, a beta group of entering freshmen minorities were chosen, tracked, and monitored to determine the potential impact of integrating research and training within an academic undergraduate engineering curriculum. Initial results showed 100% retention and average GPA's greater than 3.5/4.0. This document will describe the potential impact of the initial results to future minority students. In addition, ATMO's infrastructure and the potential impact of ATMO's human resource management strategies on student retention and academic performance will be addressed.

I. INTRODUCTION

A key factor for motivating students to pursue advanced degrees and research careers in science and engineering is a productive research experience as an undergraduate.[1] However, how should the university create this productive research experience? Minority

research-based programs whose goals are to encourage students to remain in engineering programs and to obtain an advanced degree in engineering, involve faculty members who serve as mentors to participating students and collaborate with the university research center to supply research projects.[2] In addition, other minority research-based programs simulate an internship environment by allowing students to participate on advanced research projects during the summer.[3] However, these minority research programs inadequately address the following issues:

1. Utilization of methods for motivating students with varied learning styles
2. Inclusion of senior level students in the mentoring of junior level students in research
3. Inclusion of all undergraduate student types from the freshman to the senior level
4. Correlation of the summer research experience with the academic experience
5. Improved freshmen and sophomore participation in research
6. Intimate management and tracking of students who are involved in research programs
7. Maintenance of a pipeline of minority students who pursue advanced degrees in engineering

ATMO has created a unique environment that addresses current minority research program deficiencies and revolutionizes the minority research program paradigm. ATMO proposes to embed research and training within the academic curriculum by creating a series of ABET structured training courses that focuses on specific research areas to help increase the number of minorities to obtain advanced degrees in engineering. Having the training courses following an ABET criteria make for easier inclusion into an ABET accredited engineering curriculum.[4] The ABET structured training courses are taught by junior and senior level undergraduate students. Involving senior level students in the training process fosters positive peer-to-peer relationships, illustrates to lower level undergraduates the value-added benefits of training, and enhances trainers' understanding and implementation of fundamental engineering concepts. This paper addresses the methodology by which ATMO proposes to address current minority program deficiencies by integrating research and training within the engineering academic curriculum.

II. ACADEMIC, TRAINING, AND CAREER MANAGEMENT OFFICE (ATMO)

ATMO is a special agency within MSU/CAMRA that creates a unique academic environment that aids in allowing a CAMRA student to successfully matriculate through a college curriculum to obtain advanced degrees in engineering. The goal of ATMO is to provide the following:

a. Total Academic Immersion

b. High End Supplemental Training for Engineers
c. Enhanced Retention and Degree Completion

ATMO is a combination of programs and services that are offered to MSU/CAMRA students. A team of dedicated staff members assist in minimizing potential academic barriers, interceding on the student behalf with university officials and departments, and supplying or acquiring appropriate counseling (academic or personal counseling) for participating students. The ATMO Office oversees the management of the outreach programs and uses these programs as a vehicle for early recruitment of potential entries into the student pipeline. Examples of such programs are the Pre-freshman Accelerated Curriculum in Engineering (PACE) and Saturday Academy.[5][6] Figure 2. below describes the ATMO infrastructure. Implementation of ATMO services are needed for the success of a research and training embedded curriculum. Thus, only ATMO services will be briefly highlighted here.

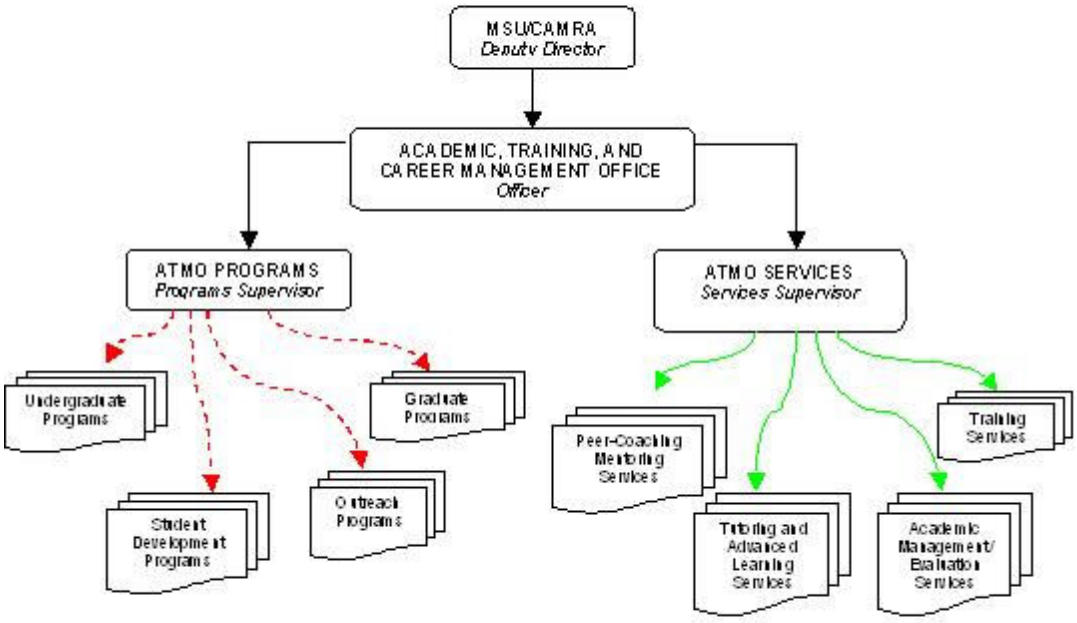

Figure 2. ATMO Infrastructure

ATMO services are designed to maintain an academic environment that combines academic advisement, peer coaching, tutoring, and research training for MSU undergraduate students. The goals of these services are to assist students in becoming more efficient and effective learners, improving academic skill sets, and increasing the students' ability to learn. ATMO services help a student maintain a good balance of research, training, and academic commitments. Various prediction tools will be

developed to evaluate students' progress on a real-time basis. In order to ensure the success of these services, the actions for implementation are listed below:

1. Provide structured tutoring and studying environment (including tutors)
2. Assist students with academic advisement
3. Create core research training programs to expose students to research early in their academic career
4. Maintain a database of student academic and personal progress
5. Identify, retain, and improve academically challenged students
6. Evaluate services based upon retention, academic success and growth

The ATMO services include the following:

A. Peer-Coaching and Mentoring Services

The peer-coaching service is designed to facilitate a collaborative relationship between student peers, professors, and peer coaching coordinators. The program is established such that MSU students are able to interact freely with their peers to address curriculum and instruction issues, observe and teach each other, and solve problems together. Peer coaching is a confidential process through which two student peers work together to enhance student performance, to create dedicated, energized professionals, and to create a stimulating academic environment that boost student's motivation for learning.

B. Tutoring and Advanced Learning Services

The Tutoring and Advanced Learning services are offered to all MSU/CAMRA student types. The objective of these services are to increase MSU/CAMRA students' knowledge and academic performance in engineering and general college courses, to help MSU/CAMRA students maintain a 3.5/4.0 overall grade point average, and to prepare MSU/CAMRA students for the academic challenges of graduate school. Students and tutors will link with professors, peer coaches and the tutor coordinators to monitor and to help students maintain academic success.

C. Training Services

Training services are provided to maintain technical competency for future endeavors in research. MSU/CAMRA core training will support the objectives of participating research centers. MSU/CAMRA training staff works cooperatively with each participating research center to maintain quality training, monitor students' progress, and evaluate the program's effectiveness.

D. Academic Management Services

The Academic Management services provide monitoring and tracking of each MSU/CAMRA students' academic and research progress. This service provides a checkpoint for each MSU/CAMRA student where data collection and student assessments are maintained. This service assists undergraduate students in maintaining a balance between academics, training, and research. The data collected is maintained, stored, and can be transferred to other departments within

MSU/CAMRA. This data is utilized as a tool to help assess ATMO's success and effectiveness.

A coordinator is assigned to manage each service and participates on an active board that develops "daily" action plans for participating students. The daily action plans are developed and updated periodically during the semester by each coordinator. The action plans outline issues that may affect the student and actions for implementation to improve student academic, training, and research performance.

III. Research and Training Embedded within the Academic Curriculum

For years freshmen, have been denied the esteem privileges of participating in advanced research programs. However, by including research and training within the academic curriculum, all students, particularly freshmen and sophomore undergraduate students, can participate in the research experience. ATMO recruits its students from the summer bridge program, PACE (Pre-Freshman Accelerated Curriculum in Engineering).[5] The research or training activities that occur each summer can either be a paid research position at the university or an internship with an industry sponsor. Based upon a MSU electrical engineering curriculum of 130 credits, the track below describes the path a student will follow in this proposed curriculum. [7]

Freshman Year
Minimum of 30 academic credits
Minimum of 10 hours of training per week for 20 weeks
Training type: Level 1

The objectives of Level 1 Training are to:

- Encourage and promote an atmosphere of learning and higher order thinking
- Provide learning on general engineering concepts
- Encourage team/ group learning

During the summer at the end of the freshman year, each student is required to remain at the university to continue general learning and development. Each student participates on a summer research project that incorporates the general fundamental engineering concepts. The project goals are clearly outlined and well developed. Although the research may have been previously completed, the project provides the opportunity for students to apply the engineering concepts that they learned. The students receive significant guidance from both upper level undergraduate students and faculty. At the end of the summer, the students will select an active research center to further continue training and participate in research activities.

Sophomore Year
Minimum of 32 academic credits
Minimum of 10 hours of training per week for 20 weeks
Training type: Level 2

The objectives of Level 2 Training are to:

- Give the students exposure to application specific software tools or hardware equipment
- Provide advanced learning on fundamental ***research specific*** concepts
- Reinforce higher level thinking in order to solve problems
- Encourage team/ group learning
- Identify students with management potential

During the summer at the end of the sophomore year, the students are expected to participate on a summer research project that reinforces concepts learned during the academic year. This research project may be provided by the research center or it may be an effort in collaboration with a research center and industrial partner. The summer project has goals that are clearly outlined and developed. The students work with a senior level undergraduate student in assisting with a senior or a contractual research project. The student will require moderate guidance from the senior level student, faculty, and or industrial mentor.

Junior Year
Minimum of 34 academic credits
Minimum of 15 hours of research per week for 20 weeks OR
Minimum of 5 hours of training and 10 hours of research per week for 20 weeks
Training type: Level 3

The objectives of Level 3 Research/Training are to:

- Allow the students to participate in semi-independent research
- Provide advanced training, specific to research project (if needed)
- Link research project completion with graduate school participation
- Encourage individual learning and development
- Encourage students to transfer knowledge learned to lower level students

The junior level student is now prepared to participate in semi-independent research. The research can begin during the academic semester or during the summer. The academic semester can be used as an opportunity for the student to obtain highly advanced research training that requires understanding of multiple and complex concepts. Although the research goals are not clearly outlined, the students participate in developing research goals with assistance from a graduate student. The junior level student still requires moderate guidance from the graduate student.

Senior Year
Minimum of 30 academic credits
Minimum of 15 hours of training per week for 20 weeks
Training type: Level 4

The objective of Level 4 Research/Training is to:

- Allow the students to participate in independent research with minimal to no guidance from a graduate student
- Allow the students to participate in independent/ self-motivated training (if needed)
- Link research project completion with graduate school participation
- Encourage individual learning and development
- Encourage students to train lower level students
- Assist student with graduate program selection

At this level, students become full participants in independent research. The students' research at this level can be utilized as a senior capstone project or can be developed into a future master's project. Figure 1 summarizes the research and training embedded curriculum. This research and training embedded curriculum will require participation of high caliber and highly academic potential students to complete the rigorous program within four years. An initial test of the program was initiated in 1999 and outcomes of assessments of program in 2003 illustrate the program's potential for future success.

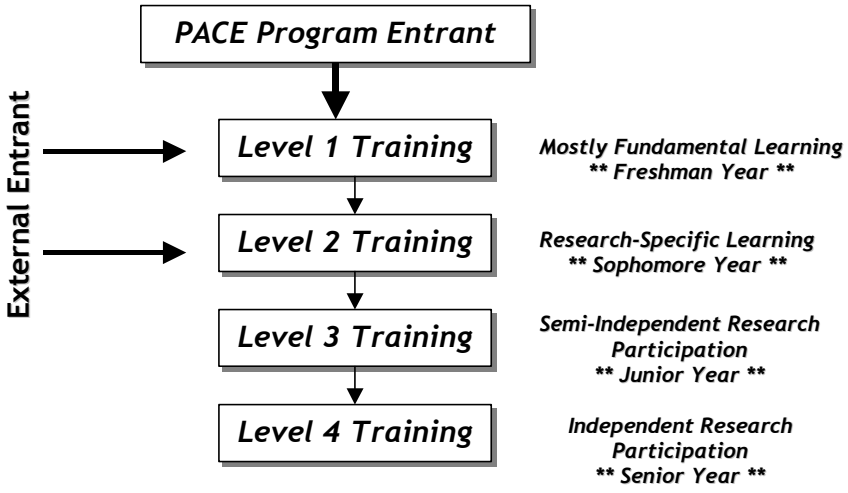

Figure 1. Summary of Research and Training Embedded Curriculum

III. BETA TEST RESULTS

In 1999, a small beta group of students were assigned to the MSU research center COMSARE (Center of Microwave, Satellite, and RF Engineering). COMSARE is a multidisciplinary research center that specializes in active device characterization and modeling, investigation and implementation of intelligent systems, circuit and system design and characterization, and software development and integration. COMSARE accepted the beta group of 6 students from the PACE program.[8] The beta group of six students were chosen based upon the following criteria:

- Academic performance in the PACE program
- Placement into Calculus I
- Recommendations from PACE tutors, teachers, and counselors
- Status as a full MSU honor or a partial MSU honor awardee

In addition to maintaining high academic performance, these beta groups of students were exposed to technical training and research activities. As a result, these students have surpassed performance in academics and developed technical skills that are directly applicable to obtaining a graduate degree. Table 1 shows that by incorporating research into a curriculum of highly motivated and high caliber students, these students will have improved academic performance. Out of the 20% of the PACE 1999 student population that graduated in May 2003, 60% of that population were the students (small beta group) who went into the research center (COMSARE). 100% of the small beta group population graduated in May 2003. In addition, 60% of the population that graduated from COMSARE in 2003, 100% of the students is currently pursuing advanced degrees in engineering at accredited colleges and universities. Although the beta group achieved great initial results, it is suggested that the following factors attributed to the program's success:

a. A small highly selective group of students
b. Peer-to-peer development through training and skill transfer
c. Faculty endorsement
d. Student participation on contractual research opportunities
e. Encouragement of team/group and individualized learning during appropriate times within curriculum
f. Student hands-on experience and exposure to research throughout undergraduate years
g. Correlation of research participation and academics

These factors are based upon feedback from participating faculty, research director and the student beta group participants. Initial results are based upon only GPA performance and graduation rate, currently, additional data is being collected and new tools are being incorporated to better evaluate and assess program goals.

Table 1. PACE 1999 vs. COMSARE 1999 GPA Performance

	1st Semester GPA	*2nd Semester GPA*	*1st Year GPA*
PACE 1999	2.93/4.0	2.89/4.0	2.91/4.0
COMSARE 1999	3.58/4.0	3.83/4.0	3.70/4.0

Because of the demands of this program on a student's time, it is essential that the student utilizes ATMO to help balance training, research, and academic commitments.

V. CONCLUSION

In conclusion, research and training embedded into an engineering curriculum has the potential to have a great impact on improving minority students obtaining advanced degrees in engineering. An initial study showed high retention and high percentage of students who applied and were accepted into graduate engineering programs. This paper illustrates that students will experience a higher success of degree completion within a 4-yr college curriculum. To maintain the program's success an integrated student agency, ATMO has been created and defined within this paper. Thus, instilling research has a great impact in inspiring students to achieve advanced degrees.

REFERENCES

[1] May, G., "An Evaluation of the Research Experiences for Undergraduates Program at the Georgia Institute of Technology," ASEE 1997 Frontiers in Education Conference, pp. 1132-1136.

[2] Numbere, D., Riordan, C., "SURE: A Research-Oriented Program to Increase the Number of Minority Engineering Students in Graduate Schools," 29th ASEE/IEEE Frontiers in Education Conference, November 1999, pp. 30-35.

[3] Freeman, R., "Undergraduate Research as a Retention Tool," 30th ASEE/IEEE Frontiers in Education Conference, October 2000, F1F-21.

[4] ABET 2003-2004 Criteria for Accrediting Engineering Programs

[5] White, C., Curtis, M., and Martin, C., "Pre-Freshmen Accelerated Curriculum in Engineering (PACE) Summer Bridge Program," Proceedings of the 2001 ASEE Annual Conference and Exposition, Session 1653.

[6] White, C., Curtis, M., and Martin, C., "An Evolution of a K-12 Pre-College Program through Student Leadership Development, Proceedings of the 2001 ASEE Annual Conference and Exposition, Session 2270.

[7] Morgan State University Department of Electrical and Computer Engineering Undergraduate Curriculum Guideline 2003-2004.

[8] Richardson, N., White, C., "Combining Research and Education Through COMSARE," Proceedings of the 2001 ASEE Annual Conference and Exposition, Session 2370.

Dr. Michel A. Reece holds a Bachelor of Science in Electrical Engineering from Morgan State University (1995), a Master of Science in Electrical Engineering from Penn State University (1997), and a Doctor of Engineering degree from Morgan State University (2003). Currently, she serves as the Academic, Training, and Career Management Officer (ATMO) for the Center of Advanced Microwave and Research Applications (CAMRA) at Morgan State University.

Dr. Carl White has been at Morgan State since 1987. He earned his B.S.E.E. and M.S.E.E. degrees from Howard University and his Ph.D. in Electrical Engineering from Cornell University. Dr. White is a tenured professor is now the director of CAMRA, a new 6 million dollar NASA sponsored research center. He has graduated the highest number of advanced electrical engineering degrees and produced the first female doctoral degree at MSU.