
AC 2012-5131: IMPORTANCE OF UNDERGRADUATE RESEARCH IN ENGINEERING TECHNOLOGY PROGRAMS

Dr. Sidi Berri, New York City College of Technology

Sidi Berri is a professor and the Chairman of the Mechanical Engineering Technology Department of New York City College of Technology.

Dr. Andy Zhang, New York City College of Technology

Andy S. Zhang earned his master's in mechanical engineering from the City College of New York in 1987 and his Ph.D. in mechanical engineering from the Graduate Center of the City University of New York in 1995. Zhang's research areas include materials testing, composite materials, CAD/CAE, engineering animation, and mechatronics design.

Dr. Gaffar Barakat Gailani, New York City College of Technology

Gaffar Barakat Gailani received his master's and Ph.D. degrees in mechanical engineering from City College of New York of the City University of New York in 2001 and 2009 respectively. Gailani worked for industry for a few years before getting a Ph.D. Gailani has published many papers in biomechanics, poroelasticity, and engineering education. Gailani's work is sponsored by NASA and NSF.

Importance of Undergraduate Research in Engineering Technology Programs

Abstract

This paper talks about the importance of undergraduate research in the Associate of Applied Science (AAS) of Mechanical Engineering Technology (MECH), the AAS of Industrial Design Technology (IND), and the Bachelor of Technology (BTech) of New York City College of Technology (NYCCT). Enrolment and retention rates have been increasing steadily since the department received its first NSF ATE and NASA Cipair awards in summer 2010. The NSF ATE grant enabled the department to start undergraduate research in mechatronics by establishing a mechatronics center. The NASA grant helped the department modify some of its key courses in the AAS in MECH and send students to summer internships in NASA centers. Since the establishment of the new mechatronics center and the summer internship opportunities the number of new freshmen students has increased considerably in the department. Students are more motivated and retention rates are increasing. Students are more involved in undergraduate robotics research, team-work, and hands-on activities.

They participate in regional and national competitions and conferences. Students are more involved in team work, creativity, and extracurricular activities. The department's overall environment has changed categorically. Students are more active and interested in working with each other and learning the latest technologies related to their field.

Faculty members who mentor and advise students in their research receive three hours release time per semester. They use their three hours release time with students in the new mechatronics laboratory which was developed through the NSF/ATE grant.

Introduction

Undergraduate research is not a requirement at most US undergraduate programs. Students can graduate with an AAS (Associate of Applied Science), BS (Bachelor of Science), or BTech (Bachelor of Technology) by taking only courses with no research credits required. At the graduate level most institutions require at least three credits of research at the master level. At the MECH department of NYCCT research is becoming almost a required component of the AAS and BTech programs. Due to both NSF ATE and NASA Cipair grants the department received recently more students are involved with research. The NSF ATE grant opened the door for more collaboration between the MECH and the Computer Engineering Technology (CET) department.

Today, throughout the City University of New York (CUNY), colleges are stepping forward and conducting research at all undergraduate levels. One of the more effective ways to enhance the skills of students in STEM is conducting research as part of an internship or with a faculty member [1].

New York City College of Technology (NYCCT) or City Tech

City Tech is the designated senior college of technology within the 23-campus City University of New York, CUNY, the largest urban public university system in the nation. A federally designated Hispanic Serving Institution (HSI), City Tech has a student population of about 15,000. 34% of students identified themselves as Black (non-Hispanic), 31.7% as Hispanic, 18.5% as Asian/Pacific Islander, 11.0% as White, 0.5% as Native American, and 5.4% as other.

Sixty-eight percent are the first in their families to attend college. Students enter with widely disparate levels of academic preparation, professional goals, and personal circumstances. As an open access institution, City Tech's historic mission has been to offer opportunities for educational advancement to students regardless of financial circumstances or prior academic achievement. City Tech plays an important role nationally in the education of future scientists, engineers, technologists, and mathematicians as shown in Figure 1. The figure shows a clear recent increase in enrollment and the number of students who earn a bachelor degree.

In the Fall 2009 Fifty-two percent (52%) reported a household income of less than \$30,000. Seventy-six per cent (76.8%) of incoming first-year students and 60% of returning students received need-based financial aid. The student body, which is more than 15,000 members, reported more than 134 countries of origin; countries of origin of faculty also span the globe. Thirty-five percent (35%) of students reported working 20 or more hours per week.

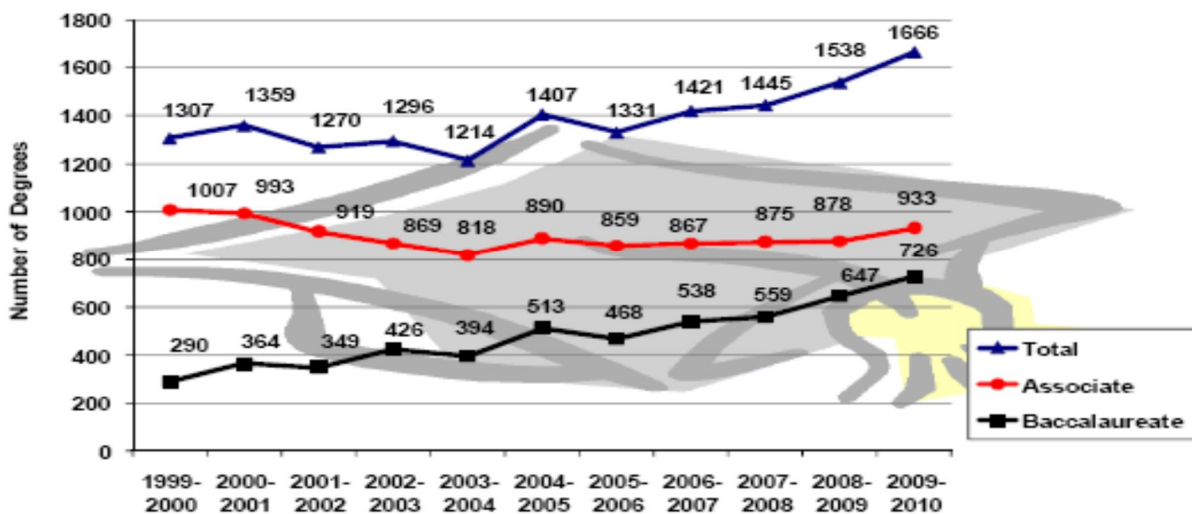


Figure 1: Number of degrees awarded at City Tech from 1999 – 2010. (Source: Office of Assessment and Institutional Research at City Tech)

The Mechanical Engineering Technology department (MECH)

The MECH department offers three degree programs:

- Associate Degree in Applied Science (AAS) in mechanical engineering technology
- Associate Degree in Applied Science (AAS) in industrial design technology
- Bachelor of Technology (BTech) in industrial design technology

The department's overall enrollment has grown from 200 students in 2002 to about 450 students currently. The department started offering a bachelor's degree program in Industrial Design in the fall 2010 semester. The increase in enrollment from Fall 2006 to Fall 2010 is 50.4%. Currently the department has about 450 students in both AAS and the BTech. Figure 2 shows the enrolment trend up to 2011. In the associate degree programs 28% of the students are African American and 27% are Hispanics and in the baccalaureate program, 28% of the students are African American and 12% are Hispanics. The data shows clearly a lower percentage of minority

students that continues to the bachelor degree level, despite the high population of minority students in the associate programs. The challenge for the department is to match this fast growth in enrollment with the quality of education in engineering technology that will help in retaining the students so that they continue to the bachelor level which will increase the department's graduation rate.

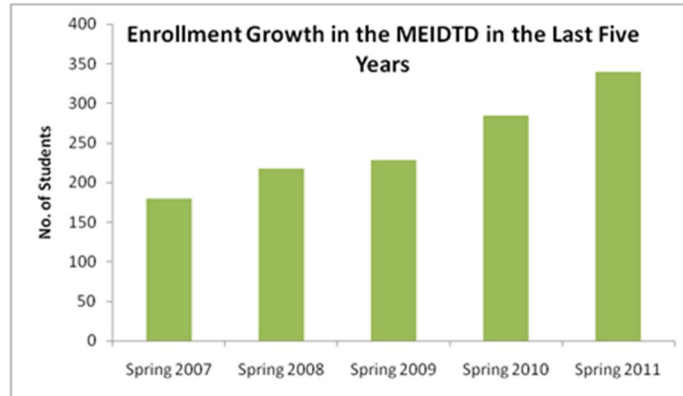


Figure 2: The growth of the MECH department from 2007 – 2011

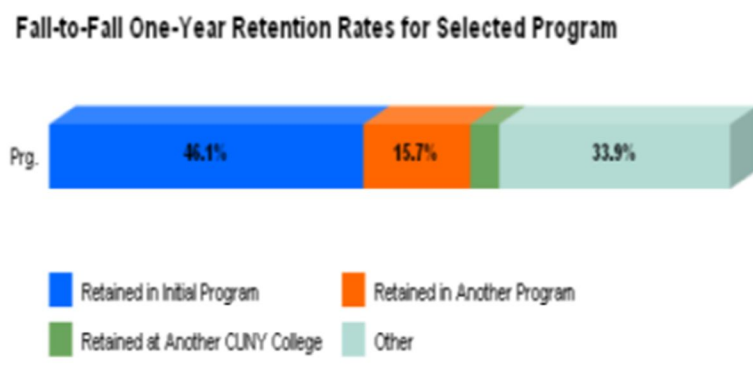


Figure 3: Fall to Fall one-year retention rates of the MECH department

Figure 3 shows retention rates of the MECH department. A rate of 46.1 % is much higher than other similar programs in the school of technology of design at City Tech. However, the department is aiming at higher retention rates in the next three years. The department's target retention rate is an increase of 2 to 3 % per year.

Undergraduate research and its impact on the department

The mechanical engineering department is including more research in its undergraduate programs. Students are required to work in teams and develop research projects in several courses. Collaborative work between the MECH department and other departments such as the Computer Engineering Technology (CET) department is growing. Students from both departments collaborate to design new products related to both fields. Students learn how to design, fabricate and evaluate mechatronic products. They learn 3D design and modeling,

manufacturing processes, material engineering, electrical design, computer control with embedded systems, interfacing and programming. Students from both departments are given mechatronic/robotic design projects that require them to use actual mechanical, electrical/electronic hardware and software that are currently being used by the industry. This enables the instructor to simulate real life product design activities inside the classroom and laboratory.

More freshman students are involved with weekly interdisciplinary activities of the new Mechatronics Technology Center (MTC). Junior students learn from their peers how to design, program and fabricate basic robots. They enjoy the hands-on aspect of mechatronics. Students are able to use the department's CNC and water jet machines under the supervision of a faculty member or a technician. They participate in regional and national robotics competitions. Some students have already published and presented some of their research work in conferences. Four students from the department have received awards to present their research work at national conferences in the last two years. In the summer of 2009 three students from the department worked with Dr. Gaffar Gailani (PI of the NASA Cipair grant), in a collaborative project with the department of Biomedical Engineering at City College (CCNY) and were able to publish their work [2]. Involvement of students in research and internships has proven to be very motivating.

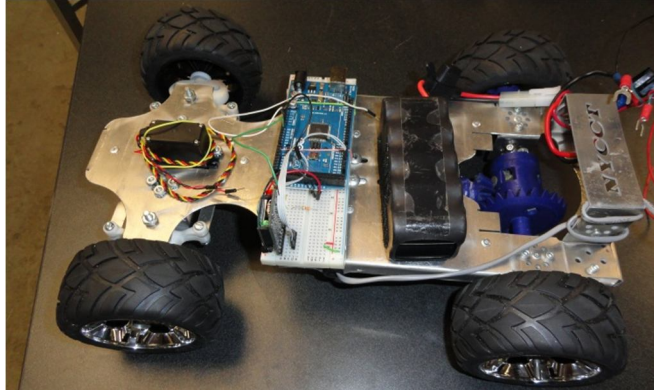
A good example of the impact of doing research at the undergraduate level is Mark Nelson, whose GPA was fluctuating between 2.5 and 3.0 during his first two years in the computer engineering technology program at City Tech and *he thought of himself as an average student. As soon as he joined the Louis Stokes Alliance for Minority Participation in STEM, LSAMP, his education experience changed for the better. He was named to the Dean's list every succeeding semester until graduating with honors in June 2010.* Today he has been accepted for graduate study in robotic engineering at Worcester Polytechnic Institute in Massachusetts. This tells us we can inspire this generation to move forward if we give them the opportunity.

The number of students doing undergraduate research has increased by about 10 % in the first year of both the NASA and NSF grants. Students are working with faculty members in research projects in fields such as aerospace, mechatronics, biomedical, renewable energies, and composite materials. Some students are presenting their research and findings in regional and national conferences. More than 15 students have already applied for travel funding to present their work and findings at conferences.

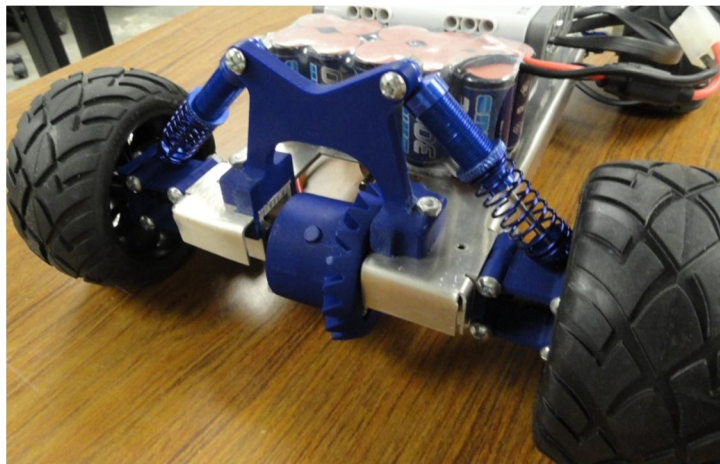
Examples of research projects

Students involved in research are first interviewed by faculty members. All students fill out surveys about team work and their expectations of the research work. Based on the interview students are selected and placed in teams.

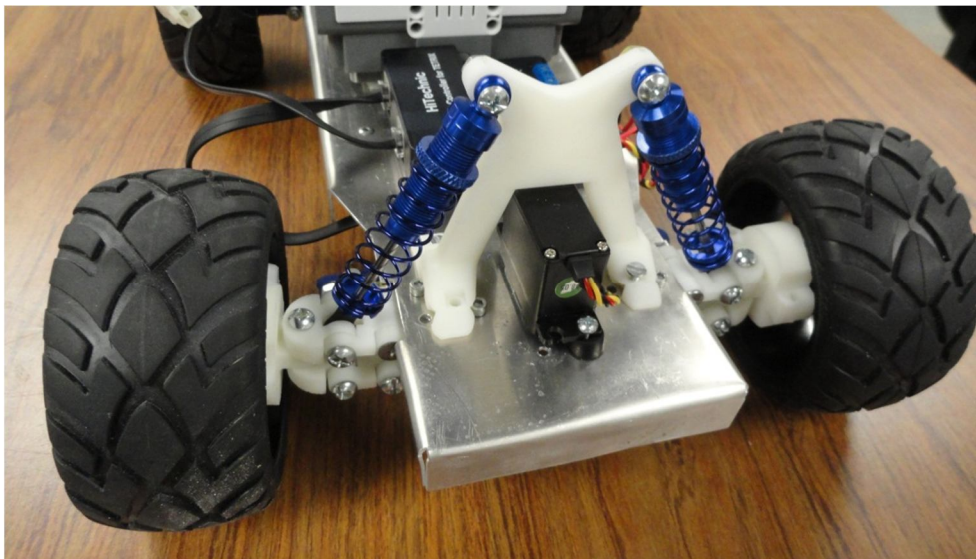
Pictures below show examples of research projects from the new mechatronics laboratory. Each team learns to follow a time line and the team leader submits a progress report every week.



Picture 1: A Robot Prototype Controlled by Custom Made Arduino Micro-controller



Picture 2: Rear Suspension System and Differential System



Picture 3: Front Suspension System and Steering System

Summary

The mechanical engineering technology department at City Tech is one of the leading departments in engaging students in undergraduate research. Students are involved with team research work in areas such as mechatronics/robotics, biomedical, aerospace and product design. They are able to learn from their peers at the department, work in teams, enhance their creativity skills, and apply what they learn in the department to hands-on applications. Students are able to design and fabricate new products using the department open lab facilities such as the CNC lab, water jet machine and the 3D modeling and prototyping lab. Capstone courses at both the AAS and the B.Tech levels incorporate multidisciplinary research projects. Students publish and present their achievements in regional and national conferences. More students are able to start internships with the local industry. Some have been able to obtain challenging positions in the field after graduating with an AAS in MECH or IND or while finishing their BTech.

This new direction of the MECH department has also increased both enrolment and retention rates. Students spend more time at the department doing extra-curricular projects. Undergraduate research is an excellent tool to attract more and better quality students to enroll in the department. More faculty members are starting to get involved with students doing their own research. The department has applied for more grants and was recently awarded a manufacturing grant from the department of labor in collaboration with the continuation education department at the college. This influx of funds from the different awards received is helping the department build better design and fabrication facilities. Undergraduate research represents the most critical, logical step in the department's long-term plan to transform itself to a model in education. It will make graduated students more relevant to current industry needs and will create curriculum and learning experiences for students that would enhance their theoretical and hands-on skills.

Acknowledgment

The work is funded by a grant from NASA CIPAIR NNX10AU73G and a grant from NSF ATE No DUE-1003712.

References

- [1] Boyd, M., and Wesemann J., 2009. "Broadening participation in undergraduate research: fostering excellence and enhancing the impact." Council on Undergraduate Research (CUR)
- [2] Ranglin, S., Das, D., Mingo, A., Ukinamemen, O., Gailani, G., Cowin, S., and Cardoso, L., 2009. "Development of a mechanical system for osteon isolation". Proceedings of the ASEE Mid-Atlantic Conference, PA, Oct. 2009.