

**Research, Academics and Mentoring Pathways (RAMP) to Success**  
Francis College of Engineering  
University of Massachusetts Lowell

Program Design and Outcomes Report for Summer 2018 Launch

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## Executive Summary

RAMP is a six-week summer program proposed for increasing the enrollment, retention and success of new female engineering students in the Francis College of Engineering at the University of Massachusetts Lowell. It was designed in the Spring of 2018 and launched during the second summer session from July 9 – August 16, 2018. Following an intensive recruiting strategy twenty-two students were accepted into the program. This represents thirty percent of the females who enrolled in the College of Engineering. Twenty students successfully completed the program. The program goals included academic success, psychosocial and department level goals. The objectives were to encourage research participation, improve student content knowledge in gateway courses such as Calculus, and improve their sense of belonging, preparedness and self-efficacy. At the department level, the goal was to increase the retention of females in Electrical, Computer, Civil, Mechanical, Plastics and Chemical engineering disciplines.

Participants got an early start earning six credits towards their degree by taking Calculus 1 and the Introduction to Engineering courses. They met a group of faculty who involved them in research and design projects in areas of biosensors, robotics, acoustics, materials processing and environmental engineering. Computing skills were introduced in each of these projects, providing them an early exposure to C, Python and MATLAB programming languages. The students networked with women engineers and scientists from industry at three on-campus panel sessions that addressed topics on Workplace Dynamics and Effective Communication Strategies, Computing in the Engineering Workplace and Careers in Engineering. They were invited to visit and see the operational structure of three different engineering companies: New Balance, BAE Systems and Autoguide Mobile Robots. They also met the University leadership at various social events. A detailed schedule of the six-week program is provided in Appendix A.

Faculty from the sociology department implemented a novel formative program evaluation using a participatory action research (PAR) model. The PAR framework prioritizes the views and participation of those who are directly affected by the problem or issue under investigation and provides an empowering context to the research process. All participants in a PAR project are valued and have the opportunity to have their voices heard. Online surveys and four focus groups involved the participants in topics on (i) what they were excited about doing and learning in RAMP; (ii) how to keep their engineering career in orbit; (iii) what was something they were surprised about during RAMP; and (iv) a tree values exercise that had them identify their core values and the skills needed to support and grow them.

Analysis of the evaluation data from the aforementioned activities showed that the students had set a combination of academic, social and professional goals for themselves and emphasized the need to have social connections to get used to life on campus. To keep their career in orbit, they expressed the need for guidance

or reference points and highlighted the value in developing connections with professors and establishing professional connections outside of academe. They maintained that a balanced life with time for family and friends as being very important to keep them in orbit in school. They were candid in expressing concerns about certain program elements such as the computing exercises and the long schedule that overlapped academic and research components. As core values, they identified in order of importance, happiness, growth, intelligence challenge, family and love. Several academic and non-academic portions of the RAMP program were then aligned as helping them anchor these values.

RAMP includes a longitudinal component of maintaining contact and involving the participants in collaborative activities during the academic year. The evaluation process will be on going and data will be collected at periodic intervals. Most all of the participants have been performing well academically and nearly half have identified research groups and faculty mentors. Their self-expressed narratives have been included in Appendix B. The results from these evaluation studies will continue to guide the refinement of the program for its second year implementation, scheduled for July 8 – August 15, 2019.

## 1.0 Introduction

RAMP is a new summer program designed in the spring of 2018 for incoming freshman female engineering students to become knowledgeable about the many opportunities that UMASS Lowell and the Francis College of Engineering [1] in particular have to offer during their ensuing years in the college. The program goal is to ensure that this new cohort is aware of the varied resources available to successfully navigate their academic coursework and have a better understanding of future educational and career pathways that they can begin to explore as early as possible. RAMP also highlights the importance of building skills in research, computing and technical communication. The program builds on studies that identify the specific barriers experienced by females and minority students in engineering programs and implements the necessary interventions that help students overcome such barriers. By providing a weekly forum for participants to candidly present their individual experiences in this program and identifying ways to alleviate their concerns was an important component of RAMP.

The Francis College of Engineering at the University of Massachusetts Lowell is the largest public undergraduate engineering program in the greater Boston area. In the Fall of 2017, the student population in the college included 2,943 undergraduate and 822 graduate day students and 166 undergraduates enrolled in the continuing education program. This includes an admitted cohort of 669 freshman day students and 208 transfer students. The percentage of female undergraduates and underrepresented minorities (URM) enrolled in engineering has however remained around 16% and 14% respectively since 2016. While these numbers reflect the trends observed nationwide [1] [2] in public higher educational institutions, the mission of the college is to buck this trend through implementation of evidence-based programs and allocation of resources to recruit, retain, train and mentor female and minority students in a supportive environment that includes formative evaluation of set goals and objectives. The RAMP program was launched to address this mission.

## 2.0 RAMP 2018 Program Description

### 2.1 Summer Bridge Programs Review

Summer bridge programs are being implemented at Universities across the nation with the goals to improve retention in Science, Technology, Engineering and Mathematics (STEM) disciplines and diversify the student population in these fields. Ashley *et al.* [3] provide a comprehensive review of published reports on STEM

bridge programs in the literature. Fifty percent of these reports address programs designed for engineering students. Examples of bridge programs that are designed for females include the Women in Applied Sciences and Engineering (WISE) program at Arizona State University, McDonnell Douglas Access to Engineering at University of Missouri-Saint Louis and Washington University and the Summer Bridge program at the University of New Mexico. Other programs target URM and academically underprepared population of students. The Meyerhoff Scholars Program at the University of Maryland Baltimore County, MA is a successful bridge program for highly academically prepared URM students across the STEM fields that has a well published record of its goals and achievements.

The bridge programs review by Ashley *et al.* [3], classifies the program goals as belonging to: (1) Academic Success (2) Psychosocial and (3) Department-level goals. Table 1 further delineates the program objectives under these broader goals of the program.

<b>Academic Success Program Goals</b>	<b>Psychosocial Program Goals</b>	<b>Department Level Goals</b>
Remediation: Providing students with foundational knowledge in a STEM domain	Increase interest in the major	Recruit students to major
Improving student content knowledge in a discipline	Improving student sense of belonging	Enhance diversity in the major
Maximizing student GPA	Increasing student sense of preparedness	
Increase research participation	Increasing student self-efficacy	
Increase student retention	Networking with students	
Increase student graduation	Networking with faculty	

**Table 1: General classification of bridge program goals**

The review shows that varied success across programs with respect to goals articulated in their published reports with the exception of the Meyerhoff program where set goals and the success in achieving them have been well documented. The

study concludes with important recommendations for future directions of summer bridge programs. These include: (1) A call to document and publish bridge program description, goals and outcomes; (2) Reporting lessons learned from prior (unsuccessful) iterations to guide the development of more successful future programs; (3) Reporting more information about the details of implementing bridge programs; and (4) Aligning Bridge goals and measured outcomes. The design of the RAMP program is guided by best practices identified in the successful summer bridge programs implemented at several higher educational institutions.

## **2.2 Ramp Program Goals**

The goals of the RAMP program included aspects of academic success, psychosocial and department level objectives. It was primarily driven by the psychosocial objectives identified in Table 1 that have been found to be key factors in helping broaden the participation of females in engineering and computing fields. Among the academic success goals, RAMP addressed the objectives of increasing research participation and improving the student content knowledge in a discipline. At the department level, the goal was to increase the retention of females in Electrical, Computer, Civil, Mechanical, Plastics and Chemical engineering.

As indicated by the program name, RAMP objectives are: (i) connecting participants to research opportunities; (ii) building skills for being successful in academics; (iii) identifying potential faculty mentors for each participant in the program. To accomplish these goals, participants while in the program enroll for six credits towards their degree requirements. This includes a four credit Calculus 1 and a two credit Introduction to Engineering course, both of which would typically be taken in the first semester of their freshman year. The Introduction to Engineering course was designed to provide exposure to research problems across different engineering majors and an introduction to basic computing skills.

## **2.3 Recruiting Strategy**

The program was first proposed mid-way through the spring of 2018. At this stage of the admission process, early action decisions had been made and admitted students data was provided by the UML admissions personnel. The RAMP website<sup>1</sup> was designed and an on-line registration form was made available for students to indicate their interest. Advertising began in April 2018 at the various open house events and at the Society of Women Engineers luncheon for admitted female engineering students. Post-cards were also mailed out to all eligible admitted students. In mid May 2018, personnel in the College of Engineering made telephone calls to each admitted female student who had chosen a major in Civil,

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<sup>1</sup> <https://www.uml.edu/engineering/RAMP>

Environmental, Electrical, Computer, Mechanical, Plastics, Chemical engineering or had not declared a major. This pool included 352 admitted freshman female engineering students. At final count, 84 students belonging to the RAMP eligible group had made deposits to join UMass Lowell. Each of these students was contacted by phone again to advise them of benefits to joining the summer program and encouraging them to register their interest on the web site. Twenty-eight students applied to join the program.

In the second stage of the RAMP recruiting strategy, an application form was sent out to each of the students who had registered online. The application provided a clear set of requirements for the attendees. These requirements included attending the Calculus class from 8 – 9:30 am, participating in research and design projects for the Introduction to Engineering class from 10 – 12 pm, followed by lunch and then being present for a variety of program activities ranging from panel sessions, workshops to industry visits in the afternoon. In addition, the application asked for a brief essay on the following questions: (i) Who or what has inspired you in your decision to become an engineer; (ii) What is your long-term goal? For example, what would you like to be doing professionally ten years from now? ; (iii) Tell us why we should select you for participation in the RAMP program. The deadline for returning the application was set to June 13, 2018. The application completion rate was 90%. Assoc. Dean Chandra and Michelle Smith, Senior Associate Director of Scholarships and Financial Aid, who provided advise on the financial eligibility for each student reviewed the applications. Approximately sixty percent of the students desired to stay on campus during the six-week session and their eligibility for support towards reduced housing rate was determined. Although all students had varying levels of financial need, forty percent of the applicants were found to deserving of full financial support for participating in the program. Twenty-five students were officially admitted into the RAMP program. Three students later indicated that they could not join due to the program dates coinciding with serving in the reserves, vacation with family or other conflicts.

#### **2.4 RAMP Program Personnel**

The RAMP program was directed by Assoc. Dean Chandra and supported by faculty members Prof. Susan Tripathy (Sociology, College of Fine Arts, Humanities & Social Sciences), Prof. Charles Thompson (Electrical and Computer Engineering), Prof. Gulden Camci-Unal (Chemical Engineering ), Prof. Yan Gu & Prof. Ioannis Raptis (Mechanical Engineering), Prof. Xiaoqi Zhang (Civil & Environmental Engineering) and Prof. Carol Barry (Plastics Engineering ). Post-doctoral associate Dr. Nicholas Misiunas from the Center for Advanced Computation and Telecommunications (CACT), served as the instructor for Introduction to



Engineering component of the program. Additional support in organizing the many logistical components of the program was provided by Ms. Leslie Ouellet, Program Coordinator in the Francis College of Engineering. Serving as peer mentors to the RAMP participants were a diverse group of six undergraduate and graduate students from the CACT. They assisted the participants during computing and research projects and also provided the new students their own perspectives and experiences on studying engineering at UMASS Lowell.

## 2.5 RAMP Schedule and Program Components

The program was designed to engage the participants in a diverse set of activities with the goal of providing a holistic view of opportunities on campus. In addition, the program aimed for each participant to reflect and voice their own aspirations so that the program directors could identify the appropriate resources to enable them to seek out their individual interests. A detailed schedule of the RAMP program implemented from July 9, 2018 – Aug. 16, 2018 is shown in Appendix A. A brief report of the program components is provided in the following sections.

### 2.5.1 Academics

Eighteen students enrolled in the four credit Calculus 1 class and two selected to enroll in Calculus 1A within two weeks after finding that they were not prepared for the material in Calculus 1. Two sections of Calculus 1 were offered and taught by two different instructors from the Mathematics department. The RAMP participants were part of a general student population in both sections. Dr. Chandra conducted sessions of Calculus support at various times as shown in the schedule. She collaborated with the instructors who shared the course material and homework assignments ahead of time. There was a wide range of proficiency in the mathematics background that the students had gained while in high school. As a result, these sessions had differing levels of impact on the students. Approximately 30 – 40 % of the students needed a higher degree of support. All but one student successfully completed the Calculus requirement. In the next implementation of RAMP, a redesign of the Calculus support hours will be required to ensure that all students are equally occupied during this period.

### 2.5.2 Research, Engineering Design and Computing Experience

The research, design and computing experience was built into the Introduction to Engineering course. Six



faculty members designed modules aligned with their research and engaged the participants in small projects. During week one, Prof. Gulden Camci-Unal, Assistant



Professor of Chemical Engineering introduced students to ideas on low cost bio-sensors and their application to point-of-care diagnostics. Students built a sensor using paper and the folding principles of origami. They tested the channel properties of the sensor and studied concepts of wicking through hydrophilic channels and capillary action.

In week 2, students explored computing in robotic design using the robotic operating system (ROS) environment and its associated simulation capability. Guided by Prof. Raptis, Prof. Thompson and Ph.D student Lejun Hu, they learnt how to design a simple control algorithm to move a robot on given trajectory.



During week 3, students explored issues related to the environment through the research of Prof. Xiaoqi Zhang. The topic of study was wastewater processing and associated chemical processes. Students undertook a trip to the wastewater processing plant in the City of Lowell with Prof. Zhang. During this week, students also explored with Prof. Yan Gu of the mechanical engineering department the motor selection for a soft exoskeleton project through a simple dynamic modeling of balance in a human body. The project was motivated by the application of robot-assisted human walking. Students explored associated mathematical models using MATLAB computing.



In week 4, the focus was on research problems related to Plastics Engineering. Guided by Prof. Carol Barry, students had opportunities to run a sequence of experiments on machines that involved extrusion, blow and injection molding. They collected data and learned how to conduct a statistical analysis of the observations.





The fifth week presented examples of audio signal processing with students learning to record segments of voiced and unvoiced speech and comparing the features of corresponding spectrograms. MATLAB functions were applied in this task. During this week a few students who were interested in building their own computer were directed on sourcing the components, building and configuring a personal computer.



During the final week of the RAMP program, participants were engaged in designing and presenting a poster that documented their own goals and objectives for pursuing an engineering education. They were provided guidance on creating a hybrid technical and aspirational presentation. By going through iterative practice sessions with their peers, they received feedback, refined their talks and gained confidence in their work. The posters were presented on the



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final day of the program during the industry panel session on engineering careers.

### 2.5.3 On-Campus Panel Sessions with Industry Participants

Three panel sessions addressing different themes were held on-campus. The theme of the first session was entitled *Workplace Dynamics and Effective Communication Strategies*. The panelists were Dr. Ellen Ferraro, Director Research and Technology from Raytheon Integrated Defense Systems, Ms. Susan Peckham,



Director, Hardware Technologies, BAE Systems and Ms. Stephanie Livsey, Manager, Engineering Development, BAE Systems. They addressed topics ranging from the diverse engineering work environments, acquiring optimal skill set for success in the workforce and ways to diversify the

engineering workforce.



The second panel was charged with a more technical topic related to *Computing in the Engineering Workforce*. The panelists were Denise Dumas from Red Hat Enterprise, Roxann Broughton-Blanchard and Laura Fegley from Analog Devices Corporation. They addressed not only the technical aspects of their work with respect to computing skills but also the ways in which they had to acquire new skills as technology directions evolved in their industry.



The third panel was held on the concluding day of the RAMP program. The theme was *Careers in the Engineering Workforce*. The panelists were a diverse

group of nine women from Red Hat Enterprise (Anaga Vijayakumar, Doreen Alongi, Courtney Pacheco, Whitney Chadwick, Catherine Robson, Pallavi Ravishankar and Denise Dumas), Skyworks Solutions (Michelle Lewis) and United Technologies (Kimberly Kinsley). They provided not only perspectives of their own careers as product, marketing and user design experience managers, quality and performance engineers, vice-presidents and directors but also how they work across teams with multidisciplinary expertise.



The panel sessions were noted by the participants as being very helpful in understanding the dynamics of the engineering workplace. It was observed that whereas the level of interaction of the students with the panelists was somewhat limited during the session, there was a high degree of one-on-one engagement within smaller groups after the formal panel discussion ended. During these interactions, the participants engaged the panelists on several questions and concerns pertaining to their own future career options.



#### 2.5.4 Industry Visits

RAMP participants were invited to visit three companies in the local area. The first visit was to the New Balance manufacturing facility and factory store in Lawrence, Massachusetts where the students came to understand the variety of roles that engineers can be involved in the design and manufacturing process of sports shoes. The visit to BAE systems at their Nashua, NH facility gave students a close-up view on the stages involved in the design of high-technology systems and the opportunities available for engineers to contribute in this field. Finally, the visit to Autoguide Mobile Robots in Chelmsford, MA., showed a close-up view on the design of robotic systems for manufacturing facilities such as automobile industry. In all of these visits, the companies provided access to their engineers, scientists and business managers some of whom were alumni from UMASS Lowell and generated a great sense of community that participants can be part of in the future.



#### 2.5.5 Meeting UML Administrators, Staff and Faculty



One of the highlights for the RAMP participants was meeting several administrators and staff who came to the program location and met with the students in informal settings. This included meeting Chancellor Moloney, Provost Vayda, Vice



Provost Julie Nash, Dean of Enrollment Management Kerri Johnston and Dean Hartman. Additionally leaders in Financial Aid (Michelle Smith), Centers for Learning (Kristen Rhymer), Career and Co-op Center (Wendy Hyatt) visited and provided an overview of the services offered in their departments. The students also met with associate co-chairs of their respective



departments and got great advise on planning their freshman year and learnt of the varied opportunities across the departments. Additionally, students learnt about the role of mentors, expectations of the mentoring process and best practices for students to benefit in a mentoring relationship through a lecture given by Prof. Thompson.

#### 2.5.6 Social Events



The intensity of the RAMP program required that a balance of social events be well integrated to allow students to relax and get to know each other. To

accommodate this once a week, an afternoon social event was created using the British afternoon tea as a model. A kayaking trip on the Merrimack river was also a welcome respite at week three of the summer session. In the next design of RAMP, careful consideration should be given to create a more balanced experience that can help energize the participants during the rigor of the academic and research sessions.



## **2.6 RAMP Evaluation Process: Key Goals and Methods**

RAMP incorporated a novel evaluation process that was motivated by the following three goals:

- 1) To provide an opportunity to listen and learn from student perceptions, experiences, values and goals, and use this knowledge to inform and make changes in the RAMP program as it unfolded, as well as assess accomplishments at the end, thus incorporating both formative and summative evaluation.
- 2) To create an empowering, self-reflective learning and evaluation process for engineering students, helping them to identify personal goals and action steps they can take to improve their own learning and personal well-being. This goal requires foregrounding issues such as communication skills, voice and values, as well as creating opportunities to forge strong connections with other students, all of which are often left out of an engineering curriculum. The ultimate aim here is to provide students a degree of self-sufficiency so they have the skills to navigate and seek out resources proactively throughout their engineering education and career.
- 3) To assess academic accomplishments by collecting quantitative data such as attendance and completion rates and scores on Calculus exams.

### **2.6.1 Evaluation Model: Participatory Action Research & Surveys**

With the aforementioned goals in mind, the evaluation process utilized a mixed-methods approach, combining approaches commonly utilized in Participatory Action Research (PAR) with online surveys.

PAR is a research framework that prioritizes the views and participation of those who are directly affected by the problem or issue under investigation. Because these stakeholder views are being prioritized, PAR provides an empowering context to the research process; rather than being treated as “subjects” to be analyzed by “experts,” all participants in a PAR project are valued and have the opportunity to have their voices heard.

PAR has been used successfully in many different contexts worldwide, from health to education, especially in situations where inequities exist and change is required to bring about a desired outcome. This approach has also been applied to address problems and inequities in engineering education. For example, Denson, Avery & Schell (2007) [4] used PAR to illuminate urban African-American students' perceptions of engineering, and Hahn & Werpetinski (2010) [5] used PAR to study student learning and collaboration with faculty members in Engineers Without Borders. Both of these studies comment on the ability of PAR not only to facilitate research, but to empower participants as well:

“A purpose of many, often quantitative studies is to justify pre-existing programs based on pre-determined criteria . . . In contrast, PAR is characterized by an emergent process that empowers students to engage in discovery, reflection, and action that can lead to self determined improvements as well as contribute to generalized knowledge” (Hahn & Werpetinski, 2010) [5].

For RAMP, the problem being addressed is the low rate of participation by women and minorities in engineering degree programs, and subsequent low rate in engineering careers. A related issue is the lower level of active participation in classroom discussions by women as compared with men [6](Nayee, 2015). By using PAR, we intend not only to learn more about the perceptions and experiences of women in engineering programs, but also to create empowerment strategies that will help them to succeed academically and foster overall well being, thus increasing the likelihood that they will stay in an engineering pathway well beyond their undergraduate degrees.

In addition to organizing focus groups using PAR approaches, online surveys were administered during the middle and end of the program, to gather a variety of data from RAMP students, including demographic characteristics, interest in engineering, and reactions to the program. Dr. Susan Tripathy, from the Sociology department at UMASS Lowell facilitated the evaluation.

### **2.7 RAMP Participant Demographics**

Twenty-two students began the RAMP program in July 2018. Two dropped out within the first few weeks due to lack of transportation and workload related issues. The remaining 20 completed the program. The RAMP students were all women who were entering first year students in eight different engineering majors at UMass

Lowell. Table 2 captures the distribution across the seven majors and those enrolled with an undeclared major.

**Table 2: Demographics and Characteristics of the RAMP Participants**

\*Total number of respondents was 20; three participants chose more than one race/ethnicity.

	<u>Quantity</u>	<u>Percent</u>
Total participants	20	100.0
<u>Engineering Major</u>		
Electrical	5	25.0
Chemical	2	10.0
Plastics	2	10.0
Environmental	1	5.0
Computer	3	15.0
Civil	3	15.0
Mechanical	3	15.0
Undeclared	1	5.0
<u>Race/Ethnicity*</u>		
Latina	1	5.0
Asian/Pacific Islander	8	40.0
White	8	40.0
Black/African American	4	20.0
Native American	1	5.0
Haitian	2	10.0
Other	1	5.0
<u>Highest level of parent's education</u>		
High school	4	20.0
Community College	1	5.0
4 year College or University	7	35.0
Masters	3	15.0
Doctorate	5	25.0

The participant group was racially diverse. The educational attainment of their parents or guardians ranged from twenty-five percent completing high school and community college degrees, to 50% with a four-year college degree and 25% with terminal degrees.

## 2.8 RAMP Survey 1

In a survey conducted with 18 RAMP participants several weeks into the program (July 20-27), their level of interest in an engineering career was queried. Table 3 captures their responses to the following statements:

- (1) Would like to have a career in engineering.
- (2) Their family encouraged them to study engineering.
- (3) Engineers make a meaningful difference in the world.



**Table 3: Survey 1 Results**

	Strongly agreed	Agreed	Somewhat agreed	Neither agreed nor disagreed	Somewhat disagreed
1	83% (15)	11% (2)	-	6% (1)	-
2	33% (6)	28% (5)	17% (3)	11% (2)	11% (2)
3	78% (14)	22% (4)	-	-	-

So overall, the majority of RAMP participants is positive about the value of engineering and have a strong desire to work towards a career in this field, in most cases with their family's encouragement.

### 2.9 RAMP Focus Groups Summary

Four focus groups were designed and implemented at bi-weekly intervals, each organized around a different theme. Some of the models were drawn from effective practices and suggestions from staff at agencies such as Ekjut, a NGO located in Jharkhand, India that uses PAR methods extensively<sup>2</sup>.

The RAMP cohort was split into two different groups, with 8-10 students in each group, resulting in eight focus group meetings during the six-week program. The discussions centered on the following questions or exercises:

- (1)*Focus Group One*: Introductions and what is the one thing you're excited about learning/doing at RAMP?
- (2)*Focus Group Two*: How can you keep your engineering career in orbit?
- (3)*Focus Group Three*: What is something that surprised you about RAMP?
- (4)*Focus Group Four*: "Tree" values exercise: Roots, Trunk and Leaves.

#### 2.9.1 Focus Group One: What is one thing you're excited about learning/doing at RAMP?

The first focus group was organized to get to know each other and explain the main purpose of these groups: to listen and learn from student experiences during RAMP. After having each student talk with a partner and then introduce each other, the facilitator asked students to think of one thing they are excited about learning and/or doing at RAMP.

The responses emphasized academic, professional, and social goals, and as two students commented, "getting a head start on everything" was an overarching

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<sup>2</sup> <http://www.ekjutindia.org>

theme. **Academic skills** students hoped to learn and/or accomplish included programming, completing Calculus credits, mini-projects, working with other majors in projects, and coding. **Social skills** connected with academics included getting to meet and connect with professors and mentors. **Professional goals** included visiting companies such as New Balance, meeting environmental engineers, meeting inspiring people such as panel participants drawn from several local companies, and improving communication skills. Finally, several responses emphasized **social connections and getting used to life on campus**, such as making new friends, finding their way around campus, meeting roommates and going kayaking.

### 2.9.2 Focus Group Two: How can you keep your engineering career in orbit?

Focus group 2 was organized around the question, “How can you keep your engineering career in orbit?” To prepare for this exercise, students were asked to choose a card with a photo of one of the planets in the solar system. They were then asked the question: Just as these various planets are all in orbit around the sun, what will help you stay in orbit along your engineering pathway?

Main themes that emerged from the discussion included academic skills and personal attitudes, professional connections, financial support, balanced life, dealing effectively with male dominance, and giving back to future RAMP students.

#### A. Academic Skills and Personal Attitudes

For academic skills, the discussion divided broadly according to what students need to do, such as studying, asking questions, etc., and what teaching faculty and advisors should provide.

Using tutoring services, working hard, having people to study with, staying after class to ask questions, studying daily and having a goal to achieve were all mentioned as ways students can help keep themselves “in orbit.” In addition, personal attitudes connected with academic success were also noted – such as being positive, self-motivated, ambitious, passionate about one’s major, open-minded, and willing to make mistakes.

Several students mentioned the importance of study groups and tutoring for difficult subjects, especially Calculus. During RAMP, many of the students did form strong connections in study groups, especially those who were living on campus. Acquiring academic skills along with the rest of the group was considered crucial for staying on track – as one student explained, “I think one of the reasons students decide to change major is when they (find) out they are left behind from others.”

As for what faculty should provide to help keep students in orbit, having interesting/relevant materials to study, portraying engineering topics across a broad spectrum, offering opportunities to explore different facets of engineering, and including hands-on activities were emphasized.

Several students also mentioned providing opportunities for good mentoring and forming strong relationships. For example, one student described the need for “guidance or reference points so you don’t feel lost or overwhelmed and know that you’re on the right path.”

Overall, students were very aware of the value of developing connections with professors prior to fall semester, “so we have that background to stand on.”

At the same time, along with this recognition of the need for clear guidance, at least one student noted her desire for “freedom to be my own person, learn the way I need to . . . make my own choices and the freedom to grow, fail and succeed.”

With regard to what is taught in the classroom, students felt faculty should be careful to provide the overall context and relevance of what was being learned, as well as provide more opportunities for “hands-on” work.

### *B. Professional Connections*

Students stressed the value of networking, opportunities to learn from other women in engineering, internships/co-ops, and exploring different facets of engineering as important to keeping them in orbit. Providing these types of opportunities was seen as a key strength of the RAMP program.

As one student suggested, “Get in touch with people that are involved with what you want to do. Get their feedback, and try the things they recommend.” However, another student also stressed the need for a sufficient level of knowledge to take full advantage of some networking opportunities.

### *C. Financial Support*

Financial support was cited as being critical, but only mentioned by a few students. Work-study and scholarship opportunities, as well as meeting with financial services counselors were all discussed. One international student commented how important scholarships were, “. . . because whenever I realize how much more international students have to pay and how hard the opportunities are, I tend to get discouraged.”

#### D. A Balanced Life

Apart from their personal attitudes, study habits, the contributions of faculty and professional connections, and financial support, students emphasized the need for a *balanced life* to keep them on their pathways--in other words, not focusing solely on academics, but interacting with family members, friends, and pets. In one student's words, ". . . you have to find a balance between (academics and social life), especially being an engineering major, because it's very heavily academic."

Students also felt it would be helpful to "have friends in (their) classes," "do more team building activities like kayaking," and have "free time for ourselves, we need to be away from academics sometime." Personal health – "emotionally, spiritually, and physically" was also stressed, including the need to go to the gym and exercise a few times each week.

Finally, communicating with family and friends regularly was considered crucial, "because they love you," and students noted the need to be "more appreciative of their impact." The importance of pets such as dogs and guinea pigs was also mentioned.

#### E. Dealing Effectively with a Male-Dominated Field

When we discussed how women should deal with male domination in classes, one student quickly responded: "Fight back!" Several students commented on the value of having a "community of women" to provide help and support.

On the other hand, two students mentioned that they had enjoyed working with male engineering students from another summer program on campus (the Bridge Program), because they were doing some interesting "hands-on" work that involved making underwater submarine devices.

#### F. Giving Back to Next Year's Group of RAMP students

While most of the points above focus on what the RAMP students can do themselves to help stay in orbit, or how they can receive help from others, this last point focuses on how they can "give back" to the UMass Lowell community and specifically, to next year's group of RAMP students. Several students were very eager about the value of creating a connection with these new students, coming up with ideas such as writing a group letter welcoming them to the program and offering helpful suggestions, or having a panel discussion.

In this way, RAMP students recognized their own potential power to forge

helpful connections and share knowledge with students less experienced than themselves, thus extending a helping hand to the next group of women entering engineering majors at UMass Lowell.

### **2.9.3 Focus Group Three: What is something that surprised you about RAMP?**

For this focus group, students were given time to think silently about the question, “What is something that surprised you about RAMP?” After this, each person shared their response with the group and offered comments for discussion.

Some students commented on personal successes that were surprising to them, such as getting a good grade in Calculus. Students also reflected on their experience in RAMP as compared with their experience in high school, noting especially how greater opportunities in RAMP for studying with friends helped to alleviate stress.

Other aspects of the program students found surprising were stories told during the panel presentations regarding personal educational and career opportunities –especially “how they continued to grow and find new opportunities,” and new insights about the “many facets” of engineering careers gained on fieldtrips to industry sites such as New Balance.

### **2.9.4 Focus Group Four: “Tree” values exercise: Roots, Trunk and Leaves**

For the final focus group, students were presented with a large sketch of a tree on several large pieces of paper taped on the wall. They were then given a list of over 120 different core values, such as “ambition, humor, intelligence, power, resourcefulness, and zeal,” and asked to write down 10 values from this list that resonated with them (This exercise utilized the value list and modified instructions from “Live Your Core Values: 10 minute Exercise to Increase your Success” (Carr, 2013)<sup>3</sup>.

After making this list, students were asked to choose three values they felt were most important, write them on sticky notes and place them in the “roots” portion of the tree. For the trunk of the tree, students were asked to write skills they were learning at RAMP that connected with these core values (i.e., roots). Finally, for the leaves, they were asked to write dreams and aspirations, and for the sun

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<sup>3</sup> Downloaded from <https://www.taproot.com/live-your-core-values-exercise-to-increase-your-success/>)

helping the tree to grow, to make notes about people who inspired and supported them.

The core value that was mentioned the most was happiness (5 times), followed by growth (4 times) intelligence (3 times), challenge (3 times), family (3 times) and love (3 times). RAMP activities that were perceived as supporting these values were as follows:

Happiness:

- Being able to solve computing problems on different platforms
- Friendship
- Lunch
- When not coding

Growth:

- Learning how to handle life and adjust to being more independent #adulting
- Taking chances and challenges. To grow and be successful you have to challenge your limits

Intelligence:

- Being challenged
- Learning how to build study habits by an accelerated Calc course

Challenge:

- Coding!
- Stepping out of our comfort zones
- Coding and Calculus

Family:

- The bonds I've made with the girls I've met
- More prepared before the school; decreased dropping, increased be an engineer, increased to earn more money to take care of family

Love:

- Making new friends

As can be seen from this list, several of these values and linking activities overlapped with each other, and included both academic and non-academic portions of the RAMP program. The word "challenge," in particular, is used to describe linking activities for the core values of intelligence and growth and is also mentioned as a separate core value, and friendship is linked with three different core values: happiness, family, and love. Interestingly, the most commonly mentioned core value, "happiness," is linked with activities that include a break from academics ("lunch" and "not coding") as well as one centered on academic work ("being able to solve computing problems on different platforms").

Dreams and aspirations mentioned most frequently referred to career, personal and community goals, and connected with the following themes: gaining personal knowledge, doing well in school, and graduating; being involved in engineering projects and jobs; earning a lot of money, helping to inspire other girls/women to be engineers and giving back to the community; maintaining happy and healthy families and relationships (including pets), having a good overall work environment, and traveling.

The most frequently cited category of people RAMP students felt inspired and supported them were family members (including parents, grandparents, siblings, etc.), which was mentioned 26 times, followed by professors (12 times), and friends (9 times).

## 2.10 Final Survey Results

For the final online survey, RAMP students were asked to rank aspects of the course on a scale from “not helpful” to “very helpful.” Aspects of the course considered most unhelpful were: Introduction to Engineering (5), calculus support (4), and focus groups (4). Aspects of the course considered most helpful were: Calculus class (14), studying with classmates (14), industry visits (13), and panel presentations (11).

In addition to this ranking, students were asked to respond to three open-ended questions:

- 1) What do you feel could be improved about the RAMP program?
- 2) What was most challenging for you during the RAMP program?
- 3) What did you accomplish during RAMP that you are most proud of?

For the first question, what do you feel could be improved about the RAMP program, students responses emphasized the following: 1) the daily program should be “shorter and more focused” with “more structure” and the whole day shouldn’t be spent in one classroom; 2) more hands-on projects should be included; 3) the Introduction to Engineering Class should be reorganized to have a clearer structure and perhaps combined with another major-specific engineering course, and 4) “no more focus groups.”

As for the second question, what was most challenging for you during the RAMP program, the most common responses mentioned difficulties with coding, calculus, time management, and becoming tired from the long days.

When asked about what they accomplished during RAMP that they are most proud of, student responses were diverse and included the following: finishing Calculus and receiving a good grade, transitioning from high school to college and making friends, connecting with women in industry, networking at engineering places and with professors and peers, improving communication skills, learning more about programming, and figuring out challenging engineering problems.

### **3.0 Conclusions and Future Directions**

The program coordinators (Chandra and Tripathy) have continued to meet with the RAMP participants once a month during the last Fall 2018 and current Spring 2019 semesters. The call to meet as a group has been optional but we have seen participation by 60 – 70% of the participant group. However, at the individual level, participants have been in contact with Dr. Chandra as and when they have needed direction or resources with respect to their academic and research pathways. The registrar has enabled the program coordinators to observe the academic performance of this cohort. We are pleased to report that 85% of the students are currently in good academic standing with several qualifying a spot on the Dean's list. We requested the participants for a summary of their experience during their freshman year and received the ten narratives that are included in Appendix B. Several students have already connected with a faculty mentor and are beginning to explore research problems. With the help of professional advisors who work with freshman students, we have also been able to identify those few students experiencing difficulties in their courses and remedial actions have been proposed.

As determined by the results of the surveys and focus groups there are a few areas of improvement that need to be considered for the second implementation of the RAMP program in summer of 2019. These include: (i) creating a more focused and structured experience for building computing skills; (ii) focusing on one unique engineering design and research project that builds the required skills across the six-week session; (iii) changing the venue of the program for the different program components to afford location diversity; (iv) integrating more social events for students to network with faculty and peers.

The chancellor has directed that the program double in capacity for 2019. This will require not only a more structured program but also one that can share certain program elements between two or more bridge programs being run on campus. It will also require the involvement of a group of faculty members who can commit their time and expertise towards the mission of making a significant



improvement in the participation and success of women in engineering. The support from industry partners will also be sought out earlier in the planning stages of this year's program through the formation of RAMP advisory board that can provide direction for integrating program components that help young women better understand how engineers can thrive and be successful in a multidisciplinary workplace.

### Acknowledgements

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## Appendix A: RAMP Daily Schedule of Events

	Time	Monday 7/9/18	Tuesday 7/10/18	Wednesday 7/11/18	Thursday 7/12/18	Friday 7/13/18
<b>W E E K 1</b>	8-9:50	Calculus 1	Calculus 1	Calculus 1	Calculus 1	Calculus 1
	10:15 - 11:15	Program Orientation	Intro to Engineering: Research Project Prep	Intro to Eng. Computing 1.0	Computing 2.0	Computing 3.0
	11:15-12:15	Computer Readiness				
	12:15-1:15	Lunch	Lunch	Lunch (Focus Group 1)	Workplace Dynamics & Effective Communications Panel & Lunch	Lunch (Focus Group 2)
	1:15 - 2:00	Research Project 1: Chemical Eng.	Research Project 1: Chemical Eng.	Research Project 1: Chemical Eng.		Communications Practice 1.0 (Writing)
	2:15-3:15	Eng. Design (ChE)	Eng Design (ChE) & Dean Hartman	Eng Design (ChE)	Eng Design (ChE)	Workshop 1.0: Strategies for Success at UML
	3:30 - 4:30 pm	Assessing Math & Computing Background	Calculus Support	Networking & Social Hour & Julie Nash	Calculus Support	Weekly Debrief

	Time	Monday 7/16/18	Tuesday 7/17/18	Wednesday 7/18/18	Thursday 7/19/18	Friday 7/20/18
<b>W E E K 2</b>	8-9:50	Calculus 1	Calculus 1	Calculus 1	Calculus 1	Calculus 1
	10:15 - 12:15	Research Project 2: ME (ROS)	Research Project 2: ME (ROS)	Research Project 2: ME (ROS)	Research Project 2: ME (ROS)	Computing & Data Analysis 5.0
	12:15-1:15	Lunch	Lunch	Lunch	Computing in the Engineering Workforce Panel & Lunch	Lunch(FG2)
	1:15 - 2:00	Engineering Project Design (ME)	Engineering Project Design (ME)	Engineering Project Design (ME)		Communications Practice 2.0 (Project Readouts)
	2:15-3:15	Intro to Engineering Lecture	Intro to Engineering Lecture	Intro to Engineering Lecture	Intro to Engineering Lecture	Workshop 2.0: Accessing resources at UML & Social Hour
	3:30 - 4:30	Calculus Support	Computing & Data 4.0	Calculus Support	Kayaking	Weekly Debrief

Time	Monday 7/23/18	Tuesday 7/24/18	Wednesday 7/25/18	Thursday 7/26/18	Friday 7/27/18
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W E E K  3	8-9:50	Calculus 1	Calculus 1	Calculus 1	Calculus 1	Calculus 1
	10:15 - 11:15	Research Project 3: Env. Eng.	Research Project 3: Env. Eng.	Research Project 3: Env. Eng.	Industry Visit (New Balance) and Lunch	Research Project 3: Env. Eng.
	11:15-12:15					
	12:15-1:15	Lunch (FG1)	Lunch	Lunch		Lunch (Focus Group 2)
	1:15 - 2:00	Research Project 4: Mech. Eng.	Research Project 4: Mech. Eng.	Research Project 4: Mech. Eng.	Research Project 4: Mech. Eng.	Computing & Data Analysis 8.0
	2:15-3:15	Intro to Engineering Lecture	Intro to Engineering Lecture	Intro to Engineering Lecture	Intro to Engineering Lecture	Communications Practice 3.0
	3:30 - 4:30 pm	Computing & Data Analysis 6.0	Calculus Support	Computing & Data Analysis 7.0	Calculus Support	Networking & Social Hour

	Time	Monday 7/30/18	Tuesday 7/31/18	Wednesday 8/1/18	Thursday 8/2/18	Friday 8/3/18
W E E K  4	8-9:50 am	Calculus 1	Calculus 1	Calculus 1	Calculus 1	Calculus 1
	10:15 - 11:45	Calculus Support	Instrumentation /Measurements 1.0	Instrumentation /Measurements 2.0	Instrumentation /Measurements 3.0 - Freshmen Advisors	Calculus Support
	11:45-12:45	Lunch (FG1)	Lunch	Lunch	Lunch	Lunch ( FG2)
	1:00 - 3:00	Research Project 4: Plastics Engineering	Research Project 4: Plastics Engineering	Research Project 4: Plastics Engineering	Research Project 4: Plastics Engineering	Communications Practice 4.0 - Work on Presentations
	3:30 - 4:30	Why learn computing?	Calculus Support & FA - Michelle Smith	Problem Solving using Computing	Quiz on building flow charts and computing	I want to be an engineer because .. Weekly Debrief
	Time	Monday 8/6/18	Tuesday 8/7/18	Wednesday 8/8/18	Thursday 8/9/18	Friday 8/10/18
	8-9:50 am	Calculus 1	Calculus 1	Calculus 1	Calculus 1	Calculus 1
	10:15 - 11:15	Research Project 5: ECE	Research Project 5: ECE	Research Project 5: ECE	Industry Visit (BAE)	Research Project 5: ECE - 11 -12

W E E K 5	11:15-12:15				& Lunch	Freshman advisors
	12:15-1:15 pm	Lunch with Alumni (Razia)	Lunch FG1	Lunch FG2		Lunch with faculty Maureen Howley
	1:15 - 2:00	Computing 11 (Signal Processing)	Computing 12 (Signal Processing)-Autoguide visit	Computing 13 (Signal Processing)	Intro to Engineering Lecture	Computing 14 (Signal Processing)
	2:15-3:15	Intro to Engineering Lecture	Intro to Engineering Lecture	Intro to Engineering Lecture		Communications Practice 5.0 & Provost Vayda
	3:30 - 4:30 pm	Engineering Design	Calculus Support - Wendy Hyatt	Networking & Social Hour Chancellor, Kerri Johnston	Calculus Support	Weekly Debrief

	Time	Monday 8/13/18	Tuesday 8/14/18	Wednesday 8/15/18	Thursday 8/16/18
W E E K 6	8-9:50 am	Calculus 1	Calculus 1	Calculus 1	Calculus 1
	10:15 - 11:15	Final Project discussion	Final Project Discussion	Poster Preparation	Poster Presentation
	11:15-12:15	Program - Survey Reflections	Program Reflections		
	12:15-1:15 pm	Lunch	Lunch	Lunch	Careers in Engineering Panel & Lunch  Red Hat, UTC, Skyworks
	1:15 - 2:15	Calculus Support	Dean Hartman	Workshop 3: Mentoring	
	2:15-3:15	Intro to Engineering Lecture & Project Design -Wendy Hyatt	Intro to Engineering Lecture & Project Design	Intro to Engineering & Project Design	
	3:30 - 4:30				

## Appendix B: RAMP'18 participant experiences in their own words

### Freshman Year: Fall 2018 & Spring 2019

#### Adriyanna Albert (Environmental Engineering)

These past two semesters I have been focusing on school and getting used to college life. The only eventful thing I have done so far is help the office of sustainability by volunteering for one of their events revolving around recycling at the Tsongas Center. I also plan on helping them for their next event that involves cleaning up the dorms. Through my freshman year, I have understood the amount of work that is required in order to go on with my major and how much more work I need on my time management. This summer, I am going to be taking Calculus 2 and do some research with a transportation engineer, which is in itself very exciting. I am hoping to use what I have learned so far to further ensure my success now and in the years to come.

#### Salwa Alhawi (Chemical Engineering)

The RAMP program affected all aspects of my life – making me a better student, individual, and leader. Academically, the program prepared me for the environment I would be experiencing in the Fall. Socially, the program helped me form strong friendships with like-minded, hard-working women interested in engineering. One of my favorite aspects of the program was how we were able to meet with current engineers in our fields, visit their companies, and learn what it was like to be an engineer. Professor Chandra encouraged and pushed us to get interested in a topic and learn more about it. Her influence led me to dive into research in my first full semester at UML. Currently, I am a member of a chemical engineering research lab. In my lab we experiment on Chinese hamster ovary cells to test out therapeutic proteins that are used for pharmaceutical production. I believe that RAMP has helped me to realize that I can achieve great things if I work hard. Currently I am receiving very high marks in class while doing research and holding a job of campus. Additionally, I, along with a fellow RAMP member who is now my best friend, participated in a backpack hackathon competition in the fall. We won an award and prize money, were featured in an article for UML news, and got to meet many interesting and influential mentors. We were very proud of our accomplishments because we were one of the smallest groups (with only two members) and one of the youngest and least experienced groups. I enjoy spending time with the friends I made at RAMP, doing work in Cumnock Hall Marketplace, and being a member of the Society of Women Engineers. My goal is to graduate with a chemical engineering degree and spend a few years after graduation gaining experience in this field. Then, I would like to further my knowledge by going to a graduate school.

#### Ivette Alvarez (Electrical Engineering)

After participating in the RAMP program, I began freshman year with a work-study at CACT. I have been involved in research on acoustic streaming. This research, as well as the guidance of Professor Chandra and Professor Thompson, has helped me in developing my math and management skills. These skills have been mirrored into my performance in classes, as now I am more comfortable with working with others in developing methods to solve problems and manage a group towards an end goal. Other than the research, I am involved on campus. I am currently a member of a local sorority called Alpha Omega. I currently hold a position as fundraising chair. Essentially, I plan events and work with local businesses to earn money for the active chapter and meet our quota. The past two semesters have been evidence on how much I have grown as a leader through my communication with others and my networking circle. I am hopeful that the coming years will allow me to continue to learn and grow as a student, person and hopefully achieve my goal of becoming an academic.

#### Sakshi Jeena (Computer Engineering)

After RAMP, I have been taking courses which I found to be easier since RAMP gave me a head start over the summer. I am doing fine academically. As for research, I joined the team at the CACT with Professor Chandra and Professor Thompson, but due to scheduling conflicts the second semester I was unable to proceed. I also joined SWE, which helped me cope professionally with my major, and provided me with many hands-on opportunities through workshops and volunteering work. Overall,

RAMP helped me start out my freshman year smoothly by helping me excel academically, and by showing me the many opportunities that my major holds for me.

Annie Kelley (Mechanical Engineering)

Since RAMP, I have learned to better code in MATLAB which helped me in my Intro to Mechanical Engineering project. The project was to build and move multiple CNC machines to perform a task. My partner and I built a Screen Cleaner machine and we pitched our idea to Difference Maker. Our idea did not win anything, but it was a good experience. Later in the Fall semester, I was inducted into Pi Tau Sigma, the International Mechanical Engineering Honors Society. Finally, this Spring semester I have secured an Immersive Scholars research opportunity for Fall semester 2019 with Professor Chris Hansen.

Jade Man (Civil Engineering)

I am a civil engineering major at the University of Massachusetts-Lowell. The summer before I officially became a freshman, I participated in the RAMP program which allowed me to explore engineering, and build up connections. Although I am just a freshman this year at UML, I was honored to join Prof. Tzuyang Yu's Structural Engineering Research Group. I am participating in one of the projects where we are trying to use SAR image to detect defects in concrete. I also became one of the ambassadors of the Francis College of Engineering which helps promote the development of relationships with the university's current and potential students, alumni, staff, faculty, and the campus community.

Samusha Naijuuko (Computer Engineering)

After the RAMP session, I continued with my education at UMass Lowell. My classes have been going well so far and I also made it to the Dean's list last semester. I received the Chancellor's scholarship award, which was very exciting and very helpful financially towards my academic expenses. I joined clubs outside of school work such as HASA and the international dance club. These clubs are interesting and help me cope with the school activities and help me make friends in general. I currently work with Mrs. Linda Barrington on the SLICE project for my work study which is about service and learning integration in the community of engineers. I also study basic research skills at the Center for Advanced Computation and Telecommunications with Professor Chandra and Professor Thompson. Currently, my time at UMass Lowell has been very interesting and I am very anxious for more activities to come along the way.

Flore Norcéide (Computer Engineering)

After finishing the RAMP program, I started utilizing some of the skills I learnt throughout the six weeks in the program. Almost all the classes I took during the fall semester required me to use MATLAB, C, or Python. Since I had been exposed to these subjects in the summer, it made it easier to adapt. During my first semester at UMass Lowell, I joined the Center for Advanced Computation and Telecommunications (CACT) where I started exploring research topics such as acoustic streaming and acousto-fluidics. I have not done much yet but it has taught me a lot about what undergraduate research entails, in which I hope to eventually dive in more. I was also one of 6 first recipients of the inaugural Oprah Winfrey Inaugural Scholarship where I got to meet her in person. I am currently part of the Honors College, secretary of HASA (Haitian American Student Association), member of NSBE (National Society of Black Engineers), and the IEEE (Institute of Electrical and Electronics Engineers) where I applied to be the Vice-President.

Grace Remillard (Electrical Engineering)

After RAMP ended, I have continued my education, and with the help of the program, I am now a semester ahead in my studies. I am on the Dean's list and a part of the Honors college. Between studying, hanging out with friends, and classes, I do research in a group in CACT on passive transducers and plan on having my name published by the end of the school year on a paper about said transducers. Over the summer, I will be interning at custom MMIC, who have given me, not only an internship, but a highly generous scholarship for my studies at UML.

Katherine Vail (Mechanical Engineering)

During my first semester of school after attending RAMP I was able to accomplish a lot, aside from just focusing on my classes. I joined the Design Build Fly (DBF) team, which is part of the American Institute of Aeronautics and Astronautics Chapter at the school and was later appointed Vice President. We are designing an airplane, which can complete certain tasks during flight and will compete at a competition in Arizona in the upcoming weeks. During my second semester I have continued with the DBF Team and have also received an Honors Fellowship, which has allowed me to conduct research under Dr. David Willis, Associate Professor of Mechanical Engineering and Associate Chair for Undergraduate Studies. This research project assesses the viability of using Soft Robotics to create a bio-inspired wing. Right now, I am working on designing a McKibben actuator which will be able to control the shape of the wing during flight using custom braid biases on the outside of the actuator that promote elongation, twist and combined elongation and twist. I am researching, prototyping, and testing this theory and will complete the Fellowship by writing a paper on the project as well as presenting my work in front of the Honors College staff, my mentor, and members of the Mechanical engineering department. I have also been invited to present my research at the America East Conference Research Symposium in April. This Fellowship has helped me learn how to plan and structure a research project and carry out the experiments and writing involved. I have learned amazing things through all these opportunities and am very grateful to have been able to be a part of them. This summer I will continue working towards my degree in Germany as part of the "Engineers Made in Germany" program. I will be taking three classes and exploring the country with our mentors while I am not studying. When I return, I will continue to work on my research project under Dr. Willis to create a working prototype and test it in the Wind Tunnel at the university.

