1st-Year Engineering Students and Factors in Their Selection of a Major

Dr. Michael Elmore P.E., State University of New York at Binghamton

Mike Elmore is director of and a visiting associate professor in the Engineering Design Division in the Watson School of Engineering and Applied Science at Binghamton University, State University of New York at Binghamton, NY. He holds a B.S. in Electrical Engineering from the University of Vermont in Burlington, VT, a M.S. in Electrical Engineering from Syracuse University in Syracuse, NY, and a Ph.D. degree in Electrical Engineering from Binghamton University. He has worked for Lockheed Martin, IBM, General Electric, BAE Systems, and Celestica Corporation. He has 25 years of experience in these companies designing military and commercial power electronic circuits and as a systems engineer for airborne and land vehicle electrical systems. He is a licensed professional engineer. He also received a B.A in philosophy and a M.Ed. from the University of Vermont. Before becoming an engineer he was a high school mathematics teacher.

Mr. Koenraad E Gieskes, State University of New York at Binghamton

Koen Gieskes first joined the Engineering Design Division at Binghamton University as a graduate student in 2004, then, in 2009, he was hired on as a full-time lecturer, and in 2017 he became the Assistant Director. In this role, he serves as the engineering lab coordinator for the EDD 111/112 courses. Mr. Gieskes received both his B.S. and M.S. degrees in Mechanical Engineering from Binghamton University. In 2019, he received the SUNY Chancellor's Award for Excellence in Teaching.

Work-In-Progress: 1st-Year Engineering Students and Factors in Their Selection of a Major

Introduction

1st-year engineering students often are unsure which field of engineering they want to pursue. To track the impact of its 1st-year engineering program, students in the Watson College of Engineering and Applied Science at Binghamton University have been asked to complete a two-question survey in the first week of classes regarding their intended engineering major. The two, multiple choice questions are: (1) what is your intended engineering major? (2) how sure are you of your decision? Responses have shown that between a third and a half of the 1st-year engineering students express some uncertainty in their intended choice of engineering major, indicating that they are either very unsure, unsure, or neither sure nor unsure of the strength of their engineering major interest.

Out of programs that offer a combined 1st-year experience for engineering students, many do not require that students declare their major until the end of the first year or even second year of study. Until recently, Binghamton University students have declared their engineering major at the end of their second semester of study. Now, the declaration of major is done at the end of the first semester, although students are informed that they can still change their selection with no penalty until the start of their second year. The fall semester of engineering courses introduce students to the engineering majors offered at Binghamton University. There are guest lecturers from the engineering departments and industry. The engineering lectures, laboratories, and student projects represent all the engineering majors. These educational experiences are designed to give students a better understanding of the engineering majors, so they can make a more informed decision, when they declare their major.

The present study compares the intended engineering major of 1st-year engineering students in the first week of the fall semester to their actual declaration of major at the end of the fall semester. This study began in the 2016/2017 academic year with an anonymous survey each fall semester. The survey was not anonymous in the current 2020/2021 academic year for the first time. The authors wanted to better understand the correlation between the responses in the initial survey and the student's eventual declaration of major. A follow-up, non-anonymous survey was given when students declared their majors at the end of the fall 2020 semester in an attempt to understand what factors might have influenced their decision. The intent was to better understand how students, who are uncertain about their choice of major at the start of the fall semester, come to a decision about which major to declare. And why some students who are more confident of their intended major at the start of the semester end up changing their intended major. The primary question being asked is:

What can the 1st-year engineering program do to better aid students in their choice of major?

An estimated 40% of entering 1st-year engineering students are uncertain about their choice of major [1]. This was reflected in the number of 1st-year students at Binghamton University as reported in a survey they were given in the first week of class at the start of the fall 2020

semester. 37% of students reported that they were either unsure, very unsure, or neither sure nor unsure of their intended major. From 2016 – 2019 the uncertainty of entering 1st-year engineering students was about the same at Binghamton University, as shown in Table 1.

Table 1. Entering First-Year Engineering Student Uncertainty About Major at Binghamton University

Year	Very Unsure	Unsure	Neither Sure nor Unsure	Total
2016	2%	10%	28%	40%
2017	2%	13%	24%	39%
2018	3%	11%	22%	36%
2019	2%	12%	20%	34%

The data in Table 1 was previously published by Gieskes and Elmore [2]. The data was taken in blind surveys, unlike the present study in which the responses of individual students were identified. Other studies have looked at the factors influencing the choice of engineering major. Zahorian, Elmore, and Temkin, gave a 10-question survey just before major declarations at the end of the first year [3]. It looked at factors, such as labs, lectures, guest presentations, perceived difficulty of a major, and job prospects. However, there was no survey given at the start of the first year, so it was difficult to understand the changes students underwent over the course of the first year in their decision process. Theiss et al. gave surveys at three different points in the first year of engineering, similar to the current study in the years shown in Table 1 [4]. Students were asked their current intended major and what their confidence level was in their choice of discipline. The study saw that students who initially intend to major in either biomedical or mechanical engineering were the most likely of all the engineering majors to shift to another major. This has also been observed at Binghamton University. Some previous studies have looked at the sources of information that students value in choosing a major. Kelly, Maczka, and Grohs reviewed existing survey data to determine how students' perceptions of identity and motivation constructs change over their first year of engineering [5]. It concluded that student identity and motivation constructs are not significant predictors of changes in major. Griffin and Griffin had students read about different engineering majors and attend "open house" sessions in the evening conducted by various engineering programs at their university [6]. The research questions posed were: (1) which majors were the engineering students originally interested in pursuing? (2) did the 1st-year engineering program provide them with sufficient introductory courses and information sessions to assure them of their major choice? (3) what other information sources helped them in forming their choice of major? The research approach was in these respects similar to the approach Binghamton University has taken.

Several other studies have also looked at the sources of information students use in deciding their engineering majors. One study concluded that "Self-Led Exploration of Engineering Disciplines" (SLE) is the single most important source of information that students use in deciding on an engineering major [7]. While SLE is rather a broad and poorly-defined term, the study did develop a quantitative method to study how students do a SLE. Mohammadi-Aragh et al. took a

broad look at several different categories, such as parents' educational achievement, timing of the desire to study engineering, and current engineering major in order to develop a survey instrument that could be used by universities to collect information concerning the choice of engineering major [8]. Some other studies describe 1st-year engineering programs that are designed in part to provide students with engineering experiences that will aid in an informed decision on their selection of major [9], [10], and [11].

All of these studies are informative and helpful to the present study. However, they do not address the central concern of the present study, which was stated previously as the primary question. The 1st-year engineering program at Binghamton University wants to know specifically what it can do to continuously improve the experience of its 1st-year engineering students and help them to select a rewarding and satisfying major.

Study Approach

The 1st-year engineering program at Binghamton University consists of two engineering courses in both the fall and spring semesters. In the fall semesters students take an introduction to engineering design course that consists of a twice-weekly, one-hour lecture and a two-hour laboratory. The Monday lecture mostly focuses on engineering topics relevant to the two hands-on engineering projects student work on in teams. The Wednesday lectures are given by guest lectures representing the engineering majors offered at Binghamton University. The laboratories are taught by some engineering instructors and graduate engineering students. Students also take a weekly two-hour course in which the focus is on writing and oral presentations. This course instructs students on how to write reports and give oral presentations about their projects. Both courses use undergraduate course assistants, who have been through the 1st-year program, to assist the instructors. Engineering students choose from one of five engineering disciplines at Binghamton University, when they declare their major at the end of the fall semester.

A two-question survey was given to the 1st-year engineering students in the first week of class in the fall semester. Two multiple choice questions were asked: (1) currently, what engineering major do you intend to declare in December 2020? (2) how certain are you of your answer to Question 1? The possible responses to each of the two questions are given in Table 2.

Table 2. Semester Start Two-Question Survey

Engineering Major Interest	Strength of Major Interest
Biomedical	Very Sure
Computer	Sure
Electrical	Neither Sure nor Unsure
Mechanical	Unsure
Industrial & Systems	Very Unsure
Undecided	

Near the end of the semester students declared their majors. They were also asked again how certain they were of their decisions and three additional questions: (1) was their declaration the

same as their expressed major interest at the start of the semester? (2) who helped them make their decision? (3) what activity helped them with their decision? The five questions and possible responses are shown in Table 3.

Table 3. Semester End Survey Questions

Question	Response Choice
Question 1 Major Declaration or Intention to Transfer	Biomedical
	Computer
	Electrical
	Mechanical
	Industrial & Systems Engineering
	Computer Science
	Internal Transfer
	External Transfer
Question 2 How sure are you of your answer to the 'Major Declaration or Intention to Transfer' question?	Very Sure
	Sure
	Neither Sure nor Unsure
	Unsure
	Very Unsure
Question 3 Is this the same Major Declaration or Intention to Transfer you made in the two question survey at the start of the semester?	Yes
	No
	I do not remember
Question 4 What activity helped you decide on your answer to Major Declaration or Intention to Transfer Question? (Select all that apply.)	One or more of the Wednesday EDD 111 Engineering Department Presentations?
	One of the other Wednesday EDD 111 presentations?
	One or more of the Monday EDD 111 lectures?
	One or more of the EDD 111 Labs?
	The EDD 103 Arduino Project?
	The EDD 103 Reverse Engineering Project?
	Other
Question 5 Who helped you decide on your answer to the Major Declaration or Intention to Transfer Question? (Select all that apply.)	One of your engineering instructors?
	One of your adjunct instructors?
	One of your engineering lab instructors?
	One of your undergraduate course assistants (UCA)?
	A 2^{nd}-, 3^{rd}-, or 4^{th}-year engineering student other than your UCA?
	A fellow 1^{st}-year engineering student?
	Other

Results and Discussion

Figure 1 shows the1st-year student engineering major interest at the start of the fall 2020 semester. The responses are similar to responses in previous years. Figure 2 shows the actual major declarations made at the end of the of the fall 2020 semester. The declarations are different from previous years. The number of students declaring the Industrial & Systems Engineering (ISE) major was only about half the number of previous years. It is believed that one reason for this is that students were not able to meet in-person with the ISE faculty as they have in previous years, because of the coronavirus pandemic. In previous years the ISE department would hold a large in-person event to recruit 1st-year students into their program. This had to be done on-line in the fall 2020 semester and it is believed to have not been as successful.

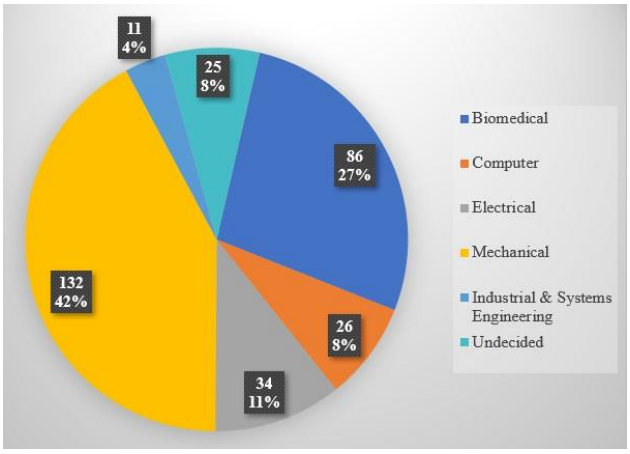

Figure 1. Class of 2024 Semester Start Major Interest, Response Rate: 93.7% of 335

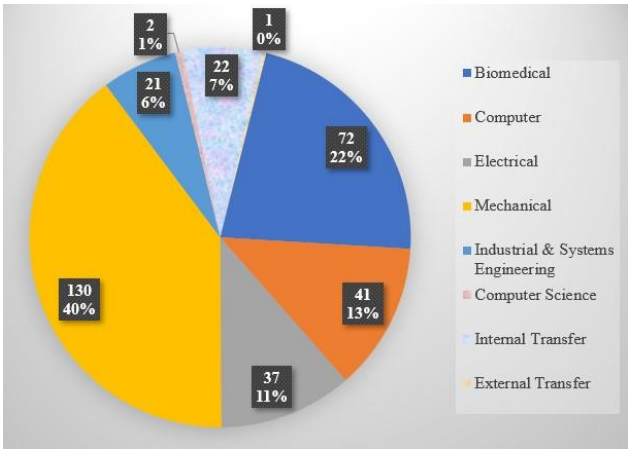

Figure 2. Class of 2024 Semester End Major Choice, Response Rate: 97.6% of 334

Figure 3 shows the perceived strength of their engineering major interest at the beginning of the fall 2020 semester. Figure 3 shows that 37% of students were either very unsure, unsure, or neither sure nor unsure of their engineering major interest. Note that unlike the data in Table 1 the undecided students at the start of the semester are included in Figure 3. Figure 4 shows the perceived strength of their major declarations at the end of the fall 2020 semester. Figure 4 shows that 23% of students were still either very unsure, unsure, or neither sure nor unsure of

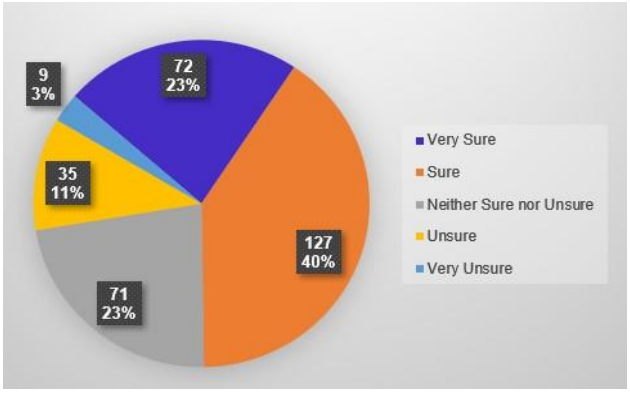

Figure 3. Class of 2024 Semester Start Strength of Major Interest, Response Rate: 93.7% of 335

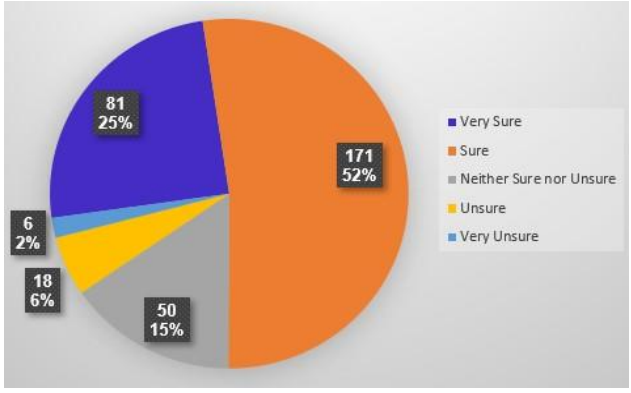

Figure 4. Class of 2024 Semester End Strength of Major Choice, Response Rate: 97.6% of 334

their major declarations.

Table 4 shows the changes students made in their major selections from the start of the fall semester to the end, when they formally declared their majors or decided to transfer out of the engineering college. The largest number of changes in major intent occurred with biomedical engineering (BME) and mechanical engineering (ME). 19 students who had indicated an interest in majoring in BME at the start of the semester made a switch. 8 BME students selected ME at the end of the fall semester and 9 BME students transferred out of the engineering college to another college at Binghamton University. 2 BME students selected an electrical engineering (EE) major. 27 students who had indicated an interest in ME at the start of the semester made a switch. 8 ME students transferred out of the engineering college to another college at Binghamton University and 19 students switched to another engineering major within the college.

Table 4. Major Change From Semester Start to End

Start Major	**End Major**								
	BME	CE	EE	ISE	ME	Int. Tran.	Ext. Tran.	Com. Sci.	Total
Biomedical Eng. (BME)	**0**	0	2	0	8	9	0	0	19
Computer Eng. (CE)	1	**0**	1	0	0	2	0	1	5
Electrical Eng. (EE)	0	2	**0**	3	2	0	1	0	8
Industrial & Systems Eng. (ISE)	0	0	0	**0**	1	0	0	0	1
Mechanical Eng.(ME)	3	6	5	5	**0**	8	0	0	27
Undecided	0	4	2	2	11	2	0	0	21
Total	4	12	10	10	22	21	1	1	81

Table 5 gives the total number of responses to questions 4 and 5 in Table 3 for all students who either expressed an interest in a particular major at the start of the fall 2020 semester or were undecided. These questions were asked of students at the end of the fall 2020 semester when they declared their majors. The numbers in Table 5 are the sum of all the responses in Tables 6 – 11 in the Appendix. Some patterns are noted. For students who indicated they were ‘Unsure’ of their intended major at the start of the semester the EDD 111 labs and the two EDD 103 projects had very little impact on whether students stayed with their initially intended major or switched their major. For students who were ‘SURE’ of their intended major at the start of the semester the EDD 111 lab and the two EDD 103 projects were mentioned much more often in question 4 if they stayed with their originally intended major, than those who switched their intended major. The Wednesday EDD 111 presentations had little impact on whether students stayed with their intended majors or switched, if they were ‘Unsure’ of their intended major at the start of the semester. On the other hand, if they were ‘Sure’ of their intended major at the start of the semester, then the presentations seem to have reinforced that initial intention.

Table 5. All Engineering Majors

Activity That Played a Role in Student Decision of Major Choice	Sure		Unsure	
	Stay	Switch	Stay	Switch
One or more of the Wednesday EDD 111 Engineering Department presentations?	96	8	33	25
One of the other Wednesday EDD 111 presentations?	37	4	13	18
One or more of the Monday EDD 111 lectures?	20	4	7	8
One or more of the EDD 111 labs?	79	10	28	28
The EDD 103 Arduino Project?	49	10	13	17
The EDD 103 Reverse Engineering Project?	49	6	19	18
Other	26	7	6	6
Person Who Played a Role in Student Decision of Major Choice	Sure		Unsure	
	Stay	Switch	Stay	Switch
One of your engineering instructors?	64	6	22	17
One of your adjunct instructors?	9	3	4	2
One of your engineering lab instructors?	36	4	19	11
One of your Undergraduate Course Assistants (UCAs)?	10	1	2	3
A 2nd-, 3rd- or 4th-year engineering student other than your UCA?	30	6	14	11
A fellow 1st-year engineering student?	41	5	15	17
Other	69	12	15	24

The impact of people on major selection can also be seen in Table 5. The full-time EDD 111 engineering instructors are mentioned often by students who were ‘Sure’ of their intended major at the start of the fall semester. Students who were ‘Unsure’ mentioned their full-time instructors about equally whether they stayed with their originally intended major or not. Lab instructors show a similar results as the full-time instructors, but with about 64% of the responses. Student peers: one of the UCAs, a fellow 1st-year student, and a 2nd, 3rd, or 4th-year student, have nearly 50% more response than the full-time faculty. Most of the instructors who teach the writing and oral presentations course are not mentioned very often in the survey.

Tables 12 and 13 in the Appendix show a representative sampling of the responses to 'Other' in both the 'Activity' and 'Person' questions, respectively.

Conclusions

This study is labeled as a 'Work-In-Progress' even though the current academic year, 2020-2021, is the sixth year of the study. This is the first academic year in which individual student responses were tracked both at the start and the end of the semester. However, this year marks the first year in which the surveys were given during a pandemic. Much, although not all, of the fall 2020 semester at Binghamton University was on-line. The EDD 111 Monday lectures and Wednesday presentations were on-line the entire semester. The EDD 111 lab and EDD 103 instructors were sometimes in-person and other times on-line. This unusual academic structure may have impacted the survey results, as well as, the major declarations. Consequently, the study will continue at least one more year, perhaps longer if the academic environment does not return to its previous, non-pandemic status in the fall 2021 semester.

Nevertheless, two conclusions have been drawn from this study: (1) More could be done to involve the Undergraduate Course Assistants in student decisions of engineering major. The UCAs are 2nd-, 3rd- or 4th-year engineering student and represent all the engineering majors in the college. There is one UCA in each EDD 111 laboratory and on in each EDD 103 class. It is somewhat surprising that 1st-year engineering students do not mention them in the survey as often as they mention other 2nd-, 3rd- or 4th-year engineering students; (2) At the end of the fall 2020 semester 23% of our 1st-year engineering students were still very unsure, unsure, or neither sure nor unsure of their chosen majors. While this is better than at the start of the semester, when 37% of our students were very unsure, unsure, or neither sure nor unsure of their choices. Could it be lower? Perhaps. We have an obligation as engineering educators to help students make major decisions they are pleased to have made and feel very sure or sure of their decisions. However, there will always be some number of students who will want more time, perhaps much more time, to feel more confident in their choice of major and career.

One step our program has already taken is to move the declaration of majors back to the end of the spring semester of the first year of engineering study, as it once was. The engineering topics of the fall semester mostly focus on ME, EE, and CE with less of a focus on ISE and BME. Declaration in the spring semester will provide a greater exposure to BME and ISE. Our program spends significant time on topics of some importance to ISE students in the spring semester, for example the writing and verification of requirements in design. And some of our spring semester projects involve BME. A survey will still be done at the end of the fall semester to determine if students have changed their intended majors since the start of the fall semester. The fall survey will also be used by the engineering departments to plan their 2nd-year course capacities, when they accept transfer students from other schools, but the actual declaration of majors will be done at the end of the following spring semester. The survey will be given a final time, when students make their declarations at the end of the spring semester.

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Appendix

Tables 6 – 13 show the answers to the survey questions at the end of the fall 2020 semester. Tables 6 – 11 are organized by the intended choice of major at the start of the fall semester. The 'SURE' columns indicate the number of students who replied with very sure or sure to the two-question survey at the start of the fall 2020 semester. The 'UNSURE' columns indicate the number of students who replied with very unsure, unsure, or neither sure nor unsure to the two-question survey at the start of the fall 2020 semester. Under each of the two columns the number

of students who chose to ‘Stay’ with the major or ‘Switch’ is indicated. It bears repeating that students could select more than one activity and more than one person in the end-of-semester survey.

Table 6. Biomedical Engineering

Activity That Played a Role in Student Decision of Major Choice	Sure		Unsure	
	Stay	Switch	Stay	Switch
One or more of the Wednesday EDD 111 Engineering Department presentations?	38	0	8	5
One of the other Wednesday EDD 111 presentations?	11	1	1	5
One or more of the Monday EDD 111 lectures?	3	1	0	2
One or more of the EDD 111 labs?	14	2	0	11
The EDD 103 Arduino Project?	7	2	0	5
The EDD 103 Reverse Engineering Project?	7	0	0	7
Other?	7	2	2	3
Person Who Played a Role in Student Decision of Major Choice	Sure		Unsure	
	Stay	Switch	Stay	Switch
One of your engineering instructors?	19	0	3	2
One of your adjunct instructors?	5	0	0	0
One of your engineering lab instructors?	10	1	0	3
One of your Undergraduate Course Assistants (UCAs)?	4	0	0	0
A 2nd-, 3rd- or 4th-year engineering student other than your UCA?	12	0	3	3
A fellow 1st-year engineering student?	8	1	4	3
Other?	23	4	3	8

Table 7. Industrial & Systems Engineering

Activity That Played a Role in Student Decision of Major Choice	Sure		Unsure	
	Stay	Switch	Stay	Switch
One or more of the Wednesday EDD 111 Engineering Department presentations?	3	0	3	1
One of the other Wednesday EDD 111 presentations?	2	0	0	1
One or more of the Monday EDD 111 lectures?	1	0	0	0
One or more of the EDD 111 labs?	3	0	1	0
The EDD 103 Arduino Project?	1	0	0	0
The EDD 103 Reverse Engineering Project?	1	0	0	1
Other?	3	0	0	0
Person Who Played a Role in Student Decision of Major Choice	Sure		Unsure	
	Stay	Switch	Stay	Switch
One of your engineering instructors?	1	0	2	1
One of your adjunct instructors?	0	0	0	0
One of your engineering lab instructors?	0	0	0	0
One of your Undergraduate Course Assistants (UCAs)?	0	0	0	0
A 2nd-, 3rd- or 4th-year engineering student other than your UCA?	0	0	0	1
A fellow 1st-year engineering student?	0	0	1	0
Other?	5	0	1	1

Table 8. Mechanical Engineering

Activity That Played a Role in Student Decision of Major Choice	Sure		Unsure	
	Stay	Switch	Stay	Switch
One or more of the Wednesday EDD 111 Engineering Department presentations?	39	5	17	6
One of the other Wednesday EDD 111 presentations?	19	1	9	4
One or more of the Monday EDD 111 lectures?	11	1	4	3
One or more of the EDD 111 labs?	43	5	21	7
The EDD 103 Arduino Project?	22	5	8	6
The EDD 103 Reverse Engineering Project?	34	5	18	4
Other?	8	1	3	2
Person Who Played a Role in Student Decision of Major Choice	Sure		Unsure	
	Stay	Switch	Stay	Switch
One of your engineering instructors?	33	4	15	4
One of your adjunct instructors?	3	2	2	1
One of your engineering lab instructors?	20	1	14	3
One of your Undergraduate Course Assistants (UCAs)?	5	0	1	2
A 2nd-, 3rd- or 4th-year engineering student other than your UCA?	10	2	8	3
A fellow 1st-year engineering student?	27	1	8	5
Other?	22	3	7	6

Table 9. Computer Engineering

Activity That Played a Role in Student Decision of Major Choice	Sure		Unsure	
	Stay	Switch	Stay	Switch
One or more of the Wednesday EDD 111 Engineering Department presentations?	9	1	1	1
One of the other Wednesday EDD 111 presentations?	2	0	1	1
One or more of the Monday EDD 111 lectures?	4	0	0	1
One or more of the EDD 111 labs?	10	1	1	2
The EDD 103 Arduino Project?	12	0	2	3
The EDD 103 Reverse Engineering Project?	4	0	0	2
Other?	4	0	1	0
Person Who Played a Role in Student Decision of Major Choice	Sure		Unsure	
	Stay	Switch	Stay	Switch
One of your engineering instructors?	6	0	1	0
One of your adjunct instructors?	1	0	1	0
One of your engineering lab instructors?	3	0	2	0
One of your Undergraduate Course Assistants (UCAs)?	0	0	0	0
A 2nd-, 3rd- or 4th-year engineering student other than your UCA?	5	1	1	0
A fellow 1st-year engineering student?	4	1	0	4
Other?	8	0	2	1

Table 10. Electrical Engineering

Activity That Played a Role in Student Decision of Major Choice	Sure		Unsure	
	Stay	Switch	Stay	Switch
One or more of the Wednesday EDD 111 Engineering Department presentations?	7	1	4	3
One of the other Wednesday EDD 111 presentations?	3	0	2	2
One or more of the Monday EDD 111 lectures?	1	0	3	0
One or more of the EDD 111 labs?	9	0	5	2
The EDD 103 Arduino Project?	7	1	3	1
The EDD 103 Reverse Engineering Project?	3	0	1	0
Other?	4	2	0	0
Person Who Played a Role in Student Decision of Major Choice	Sure		Unsure	
	Stay	Switch	Stay	Switch
One of your engineering instructors?	5	1	1	2
One of your adjunct instructors?	0	0	1	0
One of your engineering lab instructors?	3	0	3	2
One of your Undergraduate Course Assistants (UCAs)?	1	0	1	0
A 2nd-, 3rd- or 4th-year engineering student other than your UCA?	3	1	2	0
A fellow 1st-year engineering student?	2	1	2	0
Other?	11	1	2	3

Table 11. Undecided

Activity That Played a Role in Student Decision of Major Choice	Sure		Unsure	
	Stay	Switch	Stay	Switch
One or more of the Wednesday EDD 111 Engineering Department presentations?	0	1	0	9
One of the other Wednesday EDD 111 presentations?	0	2	0	5
One or more of the Monday EDD 111 lectures?	0	2	0	2
One or more of the EDD 111 labs?	0	2	0	6
The EDD 103 Arduino Project?	0	2	0	2
The EDD 103 Reverse Engineering Project?	0	1	0	4
Other?	0	2	0	1
Person Who Played a Role in Student Decision of Major Choice	Sure		Unsure	
	Stay	Switch	Stay	Switch
One of your engineering instructors?	0	1	0	8
One of your adjunct instructors?	0	1	0	1
One of your engineering lab instructors?	0	2	0	3
One of your Undergraduate Course Assistants (UCAs)?	0	1	0	1
A 2nd-, 3rd- or 4th-year engineering student other than your UCA?	0	2	0	4
A fellow 1st-year engineering student?	0	1	0	5
Other?	0	4	0	5

Table 12. Typical Other 'Activity' Responses

Formula SAE
Lego and RC-Nitro
I saw mechanical engineers working on a go kart outside and I knew that was for me.
Building my own computer
A science textbook when I was in 8th grade
Google program
High School Class Experience
Learning about electrochemistry and circuits in high school
Research and peer conversations
Course taken over the summer and another taken in high school.
Volunteering at Upstate Medical University
Presentations given during the open house and other prior experiences in high school.

Table 3. Typical Other 'Person' Responses

Watson College Advising
Faculty and other engineers
My high school teachers/ guidance counselors
Father
Mother
High school biology teacher
High school engineering teacher
A friend from high school
Cousin
A 2nd year friend in other college at Binghamton University
Brother came through Binghamton University with a master's degree in EE
Engineers I job shadowed previously