

# Addressing Low Enrollment in Engineering Schools Using the Segway HT as a Recruitment Tool

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**Abstract-Engineering colleges struggle every year to recruit engineering students to their freshmen program. In an effort to attract students to join the program at the University of Nevada, the College of Engineering purchased a Segway Human Transporter HT. The Segway HT is a self balancing electric mobility machine, which allows the operator to stand and steer the vehicle utilizing weight distribution and a hand control. The Segway HT combines many different engineering principles in the fields of computer science, electrical, and mechanical engineering. Not only does the Segway HT demonstrate engineering concepts, it is fun to ride and it creates much curiosity among students as to how it operates. The Segway HT indirectly helps with engineering recruitment because it provides a bridge between recruiters and future students. This allows future students an opportunity to learn about the school and the programs offered. This combination makes the Segway HT a valuable tool in attracting students to one of the engineering fields.**

*Index Terms*-Freshmen, Recruitment, Segway HT.

## BACKGROUND

### I. America Needs More Engineers

Technology, a mix of science and engineering, is the process of modifying nature to meet human needs and wants. The science part of technology aims to understand the “why” and “how” of nature while the engineering side seeks to shape the natural world to meet human needs and wants [25]. From this mix of science and engineering study, we obtain many products, facilities, and buildings, which make our lives better.

As society progresses, citizens need to increase their knowledge of science, technology, engineering, and mathematics (STEM) in order to compete with the rest of the world and to efficiently utilize the new technologies that are introduced. Wulf [26] believes that Americans are technologically illiterate: “I am very worried that Americans, entirely dependent upon technology, are poorly equipped to think critically about it...the United States is woefully lacking in technological literacy.” Most Americans use many high tech products without questioning how they operate or the consequences of their use. Americans need to learn how these products work so they can make a conscience decision about

the products benefit to society or possibly its future harm to society.

Some theorists believe that learning technology and engineering concepts is not only vital to Americans as consumers, but it is also vital to the nation’s prosperity and national security [6]. America needs to continue to produce engineers in order to keep up with the advancement of its international counterparts. Not only does America need to focus on increasing the number of engineers, but we also need to ensure that we are increasing the number of minority and women in the engineering workforce in order to remain competitive globally [5]. Diversifying the workforce will increase the breadth of ideas introduced to society.

### II. Enrollment in Engineering Colleges is Decreasing

Despite the continuing need for engineers in America, enrollment in engineering programs at American universities is decreasing. The number of American students earning bachelors degrees increased by 16% over the past 10 years, however, the number of bachelors degrees earned in engineering decreased by 15% [28]. These low enrollment numbers are probably due to the fact that only a small population of high school students find themselves attracted to engineering schools [26]. A recent study found that over the last 10 years, there was a 35% decrease in the number of high school seniors planning on pursuing an engineering career [20].

Possible ways to address the low interest of high school seniors in engineering careers and therefore low enrollment in engineering colleges is for engineering colleges to spark an interest in Engineering careers via outreach programs in secondary schools and also to try to recruit minorities into the engineering field [10].

### III. Minorities are an untapped source

Since American engineering schools are having difficulty keeping their student enrollment as high as other majors, they need to pursue to untapped populations of possible students. Female and minority students are an untapped source: “Underrepresented minorities and women are the largest untapped resources available to help maintain and/or increase engineering enrollments and to ensure a diverse engineering working force” [1]. The lack of women pursuing degrees in engineering, especially graduate degrees is often referred to as the incredible shrinking pipeline [12]. A study of graduates in 1996 that showed that women earned 27.5% of bachelors degrees, 26.7% of masters degrees, and

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14.5% of doctorate degrees in computer science [12]. Engineering schools could greatly increase their enrollment numbers if they can find a way to increase the interest of minority and women in engineering careers at a young age.

*IV. How do Engineering Colleges Recruit Students?*

Since enrollment in engineering schools is low, especially among women and minorities, the schools need to focus on recruitment techniques and evaluation of chosen techniques. One technique utilized by engineering colleges is to design outreach programs that teach engineering concepts to use in the local secondary school district. These programs typically reach a wide variety of students including minorities and females since they are often offered district wide in secondary schools. Ioannis Mialoulis, Tufts University Dean of Engineering, and Charles Lovas, associate professor of mechanical engineering at Southern Methodist University(SMU), designed a program that contains lessons that require students to “work together in engineering design teams as they explore mathematics and physics through a series of hands on, inquiry based learning activities” [10]. The program aims to increase interest in engineering amongst young students so they may want to pursue a job in an engineering field.

Tufts University and SMU focus on recruiting students at a young age via new outreach recruiting methods, while Arizona State University (ASU) focuses on studying the effectiveness of traditional recruiting techniques like campus tours, campus wide orientation programs, and introduction to engineering courses. ASU found the best recruitment technique for engineering schools is the new student orientation program with the exception of the Math/Science Honors Program for minority students, which was found to be a very effective recruitment event for underrepresented minority students [1].

Other engineering colleges like Iowa State University (ISU) are using new technology, like the Segway HT, to pique the interest of students about science, technology, and engineering. ISU purchased a Segway HT to educate students and teachers in schools around the community about science as well as to use as a tool to guide freshmen tours around campus [7]. Segway HT has a University program that suggests many uses for the Segway HT on campus including public safety supervision, guided tours, engineering classroom studies, and campus publicity [9].

**DESIGN AND METHODOLOGY**

The subjects surveyed were high school boys and girls from a suburban city that were at least 16 years of age. The majority of the high school students surveyed attend an upper middle class area high school. The students surveyed were attending Engineering Day at the University of Nevada, Reno

in either 2005 or 2006. Survey participants decided upon their own will to visit the Segway HT exhibit.

Students learned to ride the Segway HT indoors under the supervision of the researcher and an undergraduate engineering student assistant. The researcher gave students a brief description of how the Segway HT works and a short demonstration of how to operate the Segway HT. Students wore a helmet and received help mounting and dismounting the machine by the researcher and assistant to assure the safety of the participants. Each student rode the Segway around the room for 1-3 minutes depending on how many students were waiting for a turn to ride. Some students came back for a second ride, but they were only surveyed once.

The experiment is post test only, quasi experimental design based on a survey designed by the researcher. The first 6 questions were quantitative, and the final 2 final questions were qualitative. Some students were also interviewed by the researcher to clarify their answers to the qualitative questions. These students interviewed were chosen at random.

Some of the questions in the survey were adapted from a previous engineering attitude survey (Robinson & Fadali, 1998). The remaining questions were designed based on the researchers desire to study whether or not the Segway HT is an effective recruitment tool for engineering colleges.

The following questions were asked on the survey:

- Did you come to Engineering Day to ride the Segway HT?
- Are you interested in how the Segway HT works?
- Riding the Segway HT will increase my interest towards an engineering career.
- Engineering would be a highly interesting career for me.
- I am considering majoring in engineering in college.
- I would tell my friends to come to Engineering Day to ride the Segway.

Question 1 requires a yes/no answer while questions 2-6 are set up as a Likert scale. The survey was written by the researcher and than reviewed and edited by the Dean of the College of Engineering, a chair member on the grant that made the Segway HT purchase possible, and by a mechanical engineering professor.

All students that rode the Segway HT were required to fill out the survey. The researcher and the engineering student assistant were available to answer any questions concerning the survey.

Qualitative data was collected via the last 2 questions on the survey developed by the researcher. Qualitative questions included:

- Please share any thoughts about your ride on the Segway. Some ideas: Was it enjoyable? Does it make you want to be an engineer? Are you curious how it works?
- Why are you considering a career in engineering? Or why are you not considering a career in engineering? Students were encouraged to elaborate on the questions above. Some students were interviewed at random upon

TABLE 1: THIS TABLE SHOWS RAW DATA TAKEN FROM THE SEGWAY QUESTIONNAIRE

| TOTALS 2005 and 2006: N=38   |                                |                  |         |                       |                                  |
|--|--------------------------------|------------------|---------|-----------------------|----------------------------------|
| Questions  | Student Response               |                  |         |                       |                                  |
|  | Yes                            | No               |         |                       |                                  |
| 1. Did you come to Engineering Day to ride the Segway HT?                        | 6                              | 32               |         |                       |                                  |
|  | Strongly Agree/Very Interested | Agree Interested | Neutral | Disagree Low Interest | Strongly Disagree/Not Interested |
| 2. Are you interested in how the Segway HT works?                                | 8                              | 16               | 12      | 2                     | 0                                |
| 3. Riding the Segway HT will increase my interest towards an engineering career. | 2                              | 7                | 24      | 3                     | 2                                |
| 4. Engineering would be a highly interesting career for me                       | 10                             | 14               | 10      | 3                     | 1                                |
| 5. I am considering majoring in engineering in college.                          | 9                              | 7                | 10      | 8                     | 3                                |
| 6. I would tell my friends to come to Engineering Day to ride the Segway.        | 11                             | 12               | 12      | 2                     | 0                                |

TABLE 2: THIS TABLE SHOWS THE DESCRIPTIVE STATISTICS FOR THE SEGWAY QUESTIONNAIRE DATA.

| N=38   |        |         |       |        |            |
|--|--------|---------|-------|--------|------------|
| Questions  | Mean   | Std Dev | Range | Median | Confidence |
| 1. Did you come to Engineering Day to ride the Segway HT?                        | 19.000 |         |       |        |            |
| 2. Are you interested in how the Segway HT works?                                | 2.189  | 0.845   | 3.000 | 2.000  | 0.282      |
| 3. Riding the Segway HT will increase my interest towards an engineering career. | 2.895  | 0.831   | 4.000 | 3.000  | 0.273      |
| 4. Engineering would be a highly interesting career for me                       | 2.237  | 1.025   | 4.000 | 2.000  | 0.337      |
| 5. I am considering majoring in engineering in college.                          | 2.711  | 1.271   | 4.000 | 3.000  | 0.418      |
| 6. I would tell my friends to come to Engineering Day to ride the Segway.        | 2.132  | 0.906   | 3.000 | 2.000  | 0.298      |

completion of their survey. When time was available between participants, the researcher reviewed their answers and used probes to initiate a conversation that would lead to a deeper understanding of the students experience on the Segway HT, their education and career goals and aspirations, and what factors affected their educational and career goals

**RESULTS**

This results in this study are preliminary. Table 1 displays the raw data taken from questions 1-6. All 38 subjects that learned to ride the Segway HT at engineering were surveyed and the results were used in the study. Every person surveyed answered every question on the survey. Question 1 required a yes/no answer, questions 2 and 3 required that students circle a choice regarding interest level on a 5 point likert scale, and questions 4-6 required that students circle a choice regarding agreement level on a 5 point likert scale.

Table 2 displays the sample size, mean, standard deviation, range, median, and the confidence intervals calculated using Systat Software. Table 2 provides valuable information in interpreting the survey results. Question 1 asked students if they came to engineering day to ride the Segway HT. The majority of students said that they did not come to ride the Segway. Question 2 asks about interest level in learning how the Segway HT works. On average students showed an interest level of 2.189, which correspond with having interest in how the Segway HT works. Question 3 asks

if riding the Segway HT has increased their interest toward an engineering career. Most students responded with agreement to question 3. On average students were in agreement that students agreed that engineering would be an interesting career for them and that they may consider a career in engineering. In question 6, students were asked if they would tell their friends to come to Engineering Day to ride the Segway HT. The majority of students were in agreement that they would tell their friends to ride the Segway HT at Engineering Day.

After the 6 quantitative questions, students were asked two open ended qualitative questions. Some students were interviewed after filling out the survey as well. The first quantitative question asked students to share any thoughts about their ride on the Segway HT (Was it enjoyable? Does it make you want to be an engineer? Are you curious how it works)? Some examples of student responses included:

- “It was really neat; I am kind of curious how it works.”
- “It was strange at first, but I thought it was really cool. I actually understand the basics of how it works.”
- “Fun. It would be interesting to find further applications.”
- “Cool. Yes [it makes me want to be an engineer]. Yes [I am curious how it works].”
- “Sensitive, Possibly. Yes, It is very interesting.”
- “I don’t know, I guess, yes.”
- “It was enjoyable. Not really. Yes.”
- “It rocks my socks.”

The second quantitative question asked why are you (or why you are not) considering a career in engineering. Some examples of student responses to this question included:

- “I have other interests”
- “Because I enjoy science and math. Computer science engineering looks particularly interesting.”
- “I could be interested in engineering if I had more information.”
- “This did make me think more about engineering, but I have never thought about a job in this.”
- “For the money.”
- “I am considering one, but I am just not sure yet.”
- “Just want to, I like math and science.”
- “I like engineering because, while good at math, I see little value in abstract mathematics, and more value in the applied math and study sciences, like mechanics or civil engineering.”

The qualitative answers to question 1 on the survey varied greatly in the group. The majority of the students surveyed enjoyed their ride on the Segway HT and were curious about how it worked, but only a small number actually stated that the Segway HT may influence them to become engineers. The answers to question 2 almost all fell into two categories. One group had decided that they wanted to be engineers, while the second group mentioned other interests such as English.

Upon probing random students with extra questions, the researcher was able to further understand whether or not the Segway HT was helpful in recruiting engineering students. Two students showed particular interest in learning how the Segway HT works and how the inventor came up with the idea. The researcher explained the various design aspects of the Segway HT and the different engineering disciplines involved in its creation to the students. The researcher then asked the two students if they had an interest in designing new products like the Segway HT. One student wanted to create a machine that made beds, while the other wanted to design a new video game. They started brainstorming ideas of how to create the bed making machine as well as the details of the video game. After the brainstorm, the researcher mentioned that senior engineering students invent and build an original product in one of UNR’s engineering design classes. The students showed much interest in taking a class that allows them to invent a new product. This is an example of the Segway HT creating a bridge between recruiters and high school students. The bridge allows recruiters to connect with prospective students so they can give prospective students more information about the engineering program as well as provide a personal perspective of the program, which can lead to enrollment.

Another conversation initiated as a student asked how the Segway HT is able to balance itself and not fall over. The researcher mentioned that it is a control system that you learn about in engineering classes, sometimes in your freshmen year. The researcher mentions that in the introduction to mechanical engineering class, students are asked to build a self balancing LEGO Robot, which operates similarly to the Segway HT. This provides an example of the Segway HT creating an

interest in engineering concepts, which also may lead to student enrollment.

The researcher asked another group of students what they thought of the other exhibits at Engineering Day. One boy responded, “The other exhibits are OK, but the Segway is by far the coolest!” His friends agreed. This shows that the Segway HT is interesting to high school students and may be useful in attracting students to learn more about engineering school.

### DISCUSSION

The research attempted to address two main questions including will riding a Segway HT increase student interest in studying engineering in college and why does the Segway HT increase student interest in engineering.

Quantitative survey results showed that riding the Segway HT helped pique student interest in how the machine works. It also showed that students found the Segway HT fun to ride and they would suggest that their friends come to engineering day to ride the Segway HT. The results showed a neutral student attitude toward interest in engineering and also toward a ride on a Segway HT increasing their interest in engineering. Using these results alone, researchers conclude that the Segway HT does not directly inspire high school students to become engineers.

Although the quantitative questions did not show that the Segway HT directly encourages engineering recruitment, the qualitative questions and interviews indicate that the Segway HT does help with engineering recruitment. From the qualitative results, researchers determined that the Segway HT indirectly helps with engineering recruitment because it provides a bridge between recruiters and future students. When future students come to ride the Segway HT, they are greeted by current engineering students. This provides them with an opportunity to learn about the school, the programs offered, and the students attending. High school students are provided with a personal experience to connect them with the school. Hopefully high school students will ride the Segway HT, learn how it works, ask questions about engineering school, and leave with a perspective friend or mentor. Researchers believe that this is the answer to the second research question, which asks why the Segway HT increases student interest in engineering. The increased interest may be due to the personal connection they have with the engineering school. In conclusion, the Segway HT may indirectly become a valuable recruitment tool in the near future.

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