

## **AC 2007-2850: TEN YEARS OF STEPS SUCCESS: SIGNIFICANT IMPACT IN ATTRACTING GIRLS TO SCIENCE, TECHNOLOGY, AND ENGINEERING CAREERS**

### **Danny Bee, University of Wisconsin-Stout**

DANNY J. BEE is an Assistant Professor of Manufacturing Engineering since 1995 and the former Program Director for Manufacturing Engineering at the University of Wisconsin-Stout. He earned a B.S. in Mechanical Engineering at the University of Wisconsin-Madison and a M.S. in Manufacturing Systems Engineering at the University of Wisconsin-Madison. He has design/manufacturing experience in the aerospace and computer industries. In addition, he worked as a Quality Specialist in the Janesville/Beloit, WI region at Blackhawk Technical College. He is currently a Ph.D. student in mechanical engineering at Michigan Technological University, developing research in the area of environmentally responsible design and manufacturing.

### **Brenda Puck, University of Wisconsin, Stout**

BRENDA S. PUCK is a lecturer in the Technology Department at the University of Wisconsin-Stout. She teaches a variety of courses in support of the Technology Education and Engineering Technology programs. She received her M.S. in Technology Education from the University of Wisconsin-Stout. She has been on the “STEPS for Girls” faculty since the programs inception and will become the “STEPS for Girls” Camp Executive Director in the future.

### **Peter Heimdahl, University of Wisconsin-Stout**

DR. PETER D. HEIMDAHL is the “STEPS for Girls” Camp Executive Director and Associate Dean of the College of Technology, Engineering, and Management. He joined the UW-Stout faculty in 1992 after retiring from the U. S. Army in the rank of Brigadier General. Sixteen years of his military career were spent on the faculty of the United States Military Academy, West Point, New York, where he ultimately held the position of Professor and Head of the Department of Mechanics and later the Department of Civil and Mechanical Engineering. Dr. Heimdahl’s undergraduate degree is from the United States Military Academy. He completed his M.S. and Ph.D. in Theoretical and Applied Mechanics at the University of Illinois.

# **Ten Years of STEPS Success: Significant Impact in Attracting Girls to Science, Technology, and Engineering Careers**

## **Abstract**

The Science, Technology and Engineering Preview Summer Camp for Girls (STEPS for Girls) is a one-week summer camp initiated on the campus of the University of Wisconsin-Stout in the summer of 1997. The purpose of STEPS is to introduce young women to career opportunities in engineering, technology, and science and inspire them to prepare for these careers by selection of appropriate math and science courses in middle and high school. With the completion of the 10<sup>th</sup> year camp in 2006, 1600 young women have manufactured the components for and assembled their own radio-controlled model airplanes. A recent survey of early STEPS campers has revealed this summer camp has made significant impacts on their career pursuits. A young woman attending STEPS is 9.6 times more likely to pursue an engineering or technology degree and is 4.8 times more likely to pursue a natural science degree than her contemporaries. Inspired by the success of STEPS for Girls, the University created an Advanced STEPS camp for tenth grade girls during the summer of 2006. This paper will present the complete findings of the follow-up surveys administered to the first three years of STEPS campers and briefly outline the new Advanced STEPS camp. In addition to the significant impact in career pursuit, STEPS campers also indicate a greatly enhanced appreciation for impacts of technology within their non-engineering, technological or natural science pursuits.

## **Introduction to Science, Technology and Engineering Preview Summer (STEPS) Camp**

In 1997, the University of Wisconsin-Stout, in partnership with the Society of Manufacturing Engineering Education Foundation (SME-EF), initiated an outreach program for girls entering the seventh grade. “STEPS for Girls” is a one-week introduction to the world of manufacturing. For ten years, the girls have manufactured radio-controlled model airplanes from raw materials. The components are fabricated in various laboratory activities using real production equipment. Each girl has an opportunity to fly her airplane with the assistance of skilled radio-controlled aircraft pilots. “STEPS for Girls” campers gain direct hands-on experience in math, physics, chemistry, packaging, computer aided design, rapid prototyping, computer aided manufacturing, CNC machining, metals casting, plastics processing, robotics, web-page development, and printing.<sup>1</sup>

Industry, University, and SME-EF support are keys to the success of this program. Initially free to all campers, the camp now charges a nominal \$325 fee for the week of activities. The seventh grade outreach program, which completed its tenth camping summer in 2006, now has 1600 female graduates. Twenty-five percent (25%) of campers receive donor supported scholarships due to low income status. On August 2, 2006, STEPS celebrated its tenth anniversary with a gala day of activities and events.

## **STEPS for Girls – A Brief Overview**

STEPS for Girls was designed to be an intense immersion set of activities that provides technical (process and production systems), developmental (personal development and leadership), and recreational experiences. From arrival of the campers on Sunday afternoon until departure on

Thursday afternoon, there are 52.5 hours of scheduled time other than routine meals. The following shows the balance among the various types of activities:

- Technical Activities 20.0 hours
- Developmental Activities 18.0 hours
- Recreational Activities 14.5 hours

Technical activities are designed around the manufacture of a radio-controlled model airplane. The aircraft is final assembled in the STEPS Production Lab after other lab activities produce parts as “subcontractors” or provide analyses and information as “consultants.” Several of the activities in the production of the airplane are described as follows:

*Subcontractors:*

Foundry	Casting aluminum nose weight
Plastics	Thermoforming clear plastic cockpit canopy
Packaging	Automated fabrication of fuselage and tail components

*Consultants:*

Physics	Theory of flight
Chemistry	How an internal combustion engine works, analysis of flight fuels using gas chromatography
CADD	Manipulation and modification of 2-D and 3-D CADD visualization renderings of airplane
Mathematics	Analysis of weight and balance
Flight Simulation	Computer simulation of RC model airplane flight

In addition to the activities surrounding the manufacture and assembly of the airplane, the campers also publish a daily newsletter and develop a weeklong website detailing some of their experiences. The websites can be viewed at <http://.edu/ctem/steps/>. These websites provide an interesting view of the excitement experienced during the week in many of the technical, developmental and recreational activities.

The culminating technical activity is the Wednesday evening flight night. Local RC Club pilots assist each camper in flying their own airplane up to magnificent heights. The campers then control their plane as it gradually descends back down in a glide. In 2006, the tenth anniversary of the camp, the 1600<sup>th</sup> plane was flown at a gala celebration flight night.

### **STEPS for Girls – A Significant Impact on College Program of Study**

The first camp graduates are now nearing college graduation. Follow-up surveys of the first three years of campers indicate significant impacts on their career pursuits. During the spring of 2005, a survey was conducted of alumni of the STEPS classes of 1997, 1998, and 1999. The survey was focused on determining their college program of study and sought to determine the influence STEPS had in their program of study. Additionally, optional written comments were solicited, and these comments can be seen in Appendix 1. Table 1 below summarizes the

programs of study from the three graduate groups. The table results also indicate the influence rank the graduates assigned indicating the influence they felt STEPS had on their career choice. A 0 indicates STEPS had no influence on choice and a 5 indicates STEPS had primary influence on choice. The percentages of graduates pursuing an engineering or scientific program of study vary from a combined sum of 33 to 45%. These percentages are even higher than the post camp exit surveys that indicate 25% of the campers would consider an engineering or scientific career.

Table 1. Programs of Study, 1997-1999 STEPS Graduates

	Number	Percent	Influence Rank
<b>STEPS 1997 [54 responses, 33.8% response rate]</b>			
Engineers	7	13.0%	4.3
Scientists	11	20.4%	2.4
Other	36	66.7%	1.8
<b>STEPS 1998 [42 responses, 26.3% response rate]</b>			
Engineers	5	11.9%	2.8
Scientists	14	33.3%	2.1
Other	23	54.8%	1.6
<b>STEPS 1999 [61 responses, 37.5% response rate]</b>			
Engineers	6	10.0%	3.8
Scientists	14	23.3%	2.5
Other	41	68.3%	1.7

In the United States, about 1.5 million girls graduate from high school every year.<sup>2</sup> Based on statistics of recent years<sup>3</sup>, about 1.2% of all U.S. female high school graduates enroll in engineering and technology baccalaureate programs each year. In addition about 5.2% of all U.S. female high school graduates enroll in natural science baccalaureate programs each year. These statistics equate to an extremely large proportion of highly qualified women not entering engineering, technology, or natural science career choices.

According to the follow-up survey administered to the STEPS graduates, 11.5% of the survey respondents have indicated a program of study in engineering and technology. This is an extremely significant finding. It indicates that STEPS graduates are 9.6 times more likely to pursue engineering or technology careers than their non-STEPS contemporaries. If the 1.5 million female high school graduates<sup>4</sup> enrolled in engineering and technology programs at the same rate as STEPS graduates, 173,000 of them would matriculate each year. Adding this number of additional female students to engineering and technology programs would more than double the current engineering and technology annual total enrollment, estimated at about 125,000 in 2000.<sup>4</sup>

According to the follow-up survey administered to the STEPS graduates, 25.0% of the survey respondents have indicated a program of study in natural sciences. This is also a significant

finding. It indicates that STEPS graduates are 4.8 times more likely to pursue a scientific career pursuit than their non-STEPS contemporaries.

### **Advanced STEPS – An Overview**

Advanced STEPS for Girls was conducted on the UW-Stout campus for the first time in the summer of 2006. The one-week camp, which was held June 24-29, was offered to alumni of the 7<sup>th</sup> grade STEPS camp of 2003. Tuition in the amount of \$350 was charged to each camper with ten spaces reserved for full scholarships.

The goals of Advanced STEPS camp are to:

1. Reinforce the career message of the 7<sup>th</sup> grade STEPS program in the minds of campers with continued interest,
2. Significantly influence the selection of science, technology or engineering as a participant's career choice,
3. Offer advanced design topical sessions and an advanced problem solving activity, and
4. Create an "army" of LEGO Mindstorms mentors for FIRST Lego League (FLL) teams.

The Lego Mindstorms RCX robotics kit was the vehicle upon which the technical activities of the 10<sup>th</sup> grade camp were based. As 15-year-olds, the advanced campers are much readier for a design experience than when they were 12. The week was spent teaching the concepts of robotics and controls to the campers in order for them to be able to accomplish a major project by the end of the week. Experience has shown that it is very important for the campers to bring things home with them, so each graduate took home her own Mindstorms RCX kit (a \$320 value) to take home with her.

There were four instructional staff (LEGO Professors) and four LEGO Team Mentors required to staff this week long summer camp. The LEGO Professors conducted the instructional activities, and the LEGO Mentors, all of whom were either current students or alumni of the manufacturing engineering program, were each assigned to one of the four teams. The mentors were responsible for guiding the teams through the brainstorming, problem solving, and technical matters of robot design and programming. Three of these four mentors were female, an additional aspect to demonstrate to the campers that women can be successful in engineering. The four teams, each having ten team members were responsible for developing their own solutions to the design project.

The design project, "Rube's Smart House", was introduced to the campers at the end of day 1. The project, created in true Rube Goldberg style, was a fun problem to be addressed autonomously by each of the four teams. The context for this problem was a family would be out of town for a full week and needed to have certain things occur within the house while they will be gone.

Each team had access to its own 4 x 8 foot table that remained from the FIRST Lego League (FLL) competition hosted by UW-Stout in December 2005. The tables were divided into two sections (2 x 4 and 6 x 4). In the smaller area, the teams needed to locate a mechanical mouse

from a random location and capture and dispose of it. In the larger area, the following tasks needed to be accomplished.

1. Feed Fifi the cat
2. Feed the expensive exotic tropical fish in the fish tank. (Fifi must be distracted when the fish come to the surface as she likes to eat them and can get at them too easily when they are fed.)
3. Water a precious plant.
4. Clean Fifi's litter box.

These tasks had to be completed sequentially. In other words, once the first robot is started, the other robots must be triggered from previous task actions. The super teams were only allotted five minutes to accomplish the tasks and could use up to five of their LEGO Mindstorms robots to accomplish the tasks. The five minutes simulated a "day" and the completion of the last task had to trigger the first one to repeat.

During day 1 of the camp, several instructional activities, conducted by the LEGO Professors, helped the campers learn how to program the RCX unit, function as a team in creative problem solving, utilize sensors available on the RCX unit, and build mechanical mechanisms utilizing LEGO building sets. After this initial day of activities, the super teams were turned loose on designing their solutions to "Rube's Smart House" for the remainder of the design time. The energy and excitement of the teams was contagious. The culminating design experience was judged by panels of industry and experienced judges that reviewed the overall robotic designs, the program designs, and the teamwork. This format is modeled after the FIRST LEGO League (FLL) tournament structure.

In addition to the judging of teamwork, programming, and design, the teams' best performance in solving "Rube's Smart House" was factored into the judging process. Awards were given in the following classifications: Director's Award (the strongest overall in all categories), Programming/Design Award, Judge's Award (most improved team over the course of the camp), Teamwork Award, and Gracious Professionalism Awards (given to one member of each team that exemplified the spirit of gracious professionalism).

As in the STEPS Camps previously discussed, adequate time is spent in recreational activities, including the ROPES team skills course, swimming, recreation centers, and movie times. It is important to provide a fun experience along with the creative design experience provided through the project.

The week focused on an unstructured design experience for the Advanced STEPS participants. The design activity of "Rube's Smart House" was deliberately designed to be messy, as all design experiences are, with multiple solutions possible. Based on the success of Advanced STEPS in 2006, the camp will be continued in 2007. The new LEGO Mindstorms NXT kit will be utilized which will include new enhancements of a 32 bit processor, servo motors (with 1 degree sensitivity), ultrasonic sensors, sound sensors, improved color recognition sensors, and improved touch/release sensors. Plans for 2007 will also improve the training for the LEGO Team Mentors to ensure they function as true facilitators of the design process and only step in

with technical assistance when the teams require it. Less time will be spent in actual training, and the teams will be turned loose on open design/problem solving time sooner in the week.

## Conclusions

STEPS for Girls is a success. The University of Wisconsin-Stout and the Society of Manufacturing Engineers, through their national franchise efforts with the STEPS Academy<sup>5,6</sup>, will continue to offer this excellent program. Advanced STEPS for Girls builds on the success of the 7<sup>th</sup> grade camp and provides a 10<sup>th</sup> grade design experience. Advanced STEPS will further solidify the career choices into engineering and technology. Both of these summer camps will continue to achieve the primary goal of attracting and encouraging women to pursue engineering and technology careers. In addition, STEPS for Girls has developed an overall appreciation of engineering, science and technology in participants, even if they choose other career pursuits.

Through pre- and post-camp surveys, STEPS for Girls and Advanced STEPS participants have shown that they leave STEPS for Girls with a high level of appreciation for the kind of work a scientist or engineer performs, and this knowledge is retained when they return for Advanced STEPS. The survey results also indicate that STEPS for Girls doubles the interest in pursuing an engineering or scientific career. The Advanced STEPS surveys indicate that the group of selective students participating is better than 50% likely to pursue an engineering or scientific career. Table 2 summarizes the pre- and post-camp survey responses to these two items.

Table 2. Pre- and Post-Camp Survey Data from STEPS for Girls and Advanced STEPS Participants. (2006 camp data: all 160 STEPS participants surveyed and all 40 Advanced STEPS participants surveyed)

<b>STEPS for Girls: "I know what kind of work a scientist or engineer performs."</b>			
Pre-camp survey:	Yes – 37.2 %	Post-camp survey:	Yes – 82.4 %
	Not Sure – 60.2%		Not Sure – 16.3%
<b>Advanced STEPS: "I know what kind of work a scientist or engineer performs."</b>			
Pre-camp survey:	Yes – 84.6 %	Post-camp survey:	Yes – 100 %
	Not Sure – 15.4%		
<b>STEPS for Girls: "I would like to be an engineer or scientist someday."</b>			
Pre-camp survey:	Yes – 14.1 %	Post-camp survey:	Yes – 25.0 %
	Not Sure – 57.7%		Not Sure – 57.4%
<b>Advanced STEPS: "I would like to be an engineer or scientist someday."</b>			
Pre-camp survey:	Yes – 56.4 %	Post-camp survey:	Yes – 54.8 %
	Not Sure – 38.5%		Not Sure – 38.7%

While the quantitative data presented indicates the worthiness of STEPS for Girls, the best evidence in support of this program is qualitative. The following unsolicited quote came to us from a parent:

“My daughter attended STEPS for Girls two summer ago in 1999. She has gained so much from it I can’t put it into words. Her self-confidence has skyrocketed to the moon. Her grades have followed. Old grades were 2.5 – 2.7 range. Since STEPS, 3.7 – 4.0. Yes, straight A’s a couple times. Our entire family attributes the change to the STEPS for Girls Program. She is a real leader and go-getter the last couple years. She always tells us that “she found out that she wasn’t dumb” at the camp. No other changes in her life. She has surrounded herself with great friends and consistently gets high remarks from her instructors in school. Truly an amazing life change for her.

The University of Wisconsin-Stout deems this program to be exceptional and encourages all universities to consider developing an outreach activity modeled after STEPS for Girls and Advanced STEPS.

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## Appendix 1 STEPS Alumni Follow-up Survey Comments

### *STEPS 1997 Graduate Survey Comments*

- I was planning on engineering. But I studied abroad for a year in Mexico my junior year of high school. I switched it after that experience. STEPS definitely helped with a choice of engineering. Would not have thought of it otherwise.
- STEPS is a great program but my calling is nursing.
- Thank you!
- Even though STEPS has not influenced my major, I really enjoyed the experience and it has influenced other aspects of my life. Thank you for the opportunity.
- I really thought about going into plastics for a while. I also learned a lot about teaching by being a counselor. Thank you Pete!!
- I loved the STEPS program! I have a continued passion for technology and engineering. Although, I am not pursuing a profession in engineering, I enjoy using and applying it in my tasks daily. Thank you so much.
- I entered college undecided. Most of my college influence came from my family life and college environment.
- Even though I decided not to pursue a science career, I still feel the STEPS program was an amazing experience and something I will always treasure and keep with me.
- Opened my eyes to science and I considered an engineering/science career...realized women's rights was my passion. Good camp though.
- While STEPS didn't influence where I went to school or what I plan to pursue occupationally, I still really enjoyed the program and hope it continues!!
- I loved the STEPS program. It was a great learning experience.
- I really enjoyed the program and think it is a great way to get young women interested, but I found engineering not to be my interest.
- Very good program, must continue.
- STEPS encouraged choices. I took Math and Science beyond the required courses for my major.
- Even though I chose an unrelated field, I still look back at STEP camps with fond memories. It was a very valuable experience.
- Great program!
- It was a lot of fun then. I can only guess how much it has improved! I hear many great things about it. Thanks for the opportunity to have experienced it.
- I had a great time at STEPS. You guys taught me so much. I think back on how lucky I was that I was in the first group of STEPS girls. I will remember that experience for the rest of my life.

- The STEPS program was such a great experience. Do you think when you get all of this info. back you could send out a list of where people are and what they are doing? It would be really fun to see where people are and maybe contact people that may be at the same school as each other.
- I always planned to study manufacturing engineering. However, UWEC provided a generous scholarship for music, and UW-Stout did not match it. In the future, scholarship funding should be available for girls to study engineering.
- I am currently participating in a research experience for undergraduates at the University of Florida-Gainesville. Thank you to the STEPS program for opening the door to such awesome experiences in science.
- But it was still an amazing experience that I've never forgotten.

### ***STEPS 1998 Graduate Survey Comments***

- I am pursuing a career in either medicine or genetic counseling. The STEPS program helped me become more interested in the math and science fields.
- The camp was awesome and I have a lot of great memories from it. It also made me realize how much I would probably not succeed in engineering.
- This program helped me learn how much fun science can be.
- STEPS gave me the opportunity to be a junior counselor, contributing to my love to work with children of all ages.
- STEPS helped me to realize how interested in science I really am. Great program.
- I had a lot of fun and learned some cool stuff, but in general I am more interested in service and helping people with my own hands – I might do Peace Corps!
- STEPS was a great program, but I decided on the other route of college and am now going for Pre-Pt.
- I received a scholarship from the Wisconsin Space Grant Consortium which is sponsored by NASA.
- I feel successful, and used the skills from group work towards my program.
- STEPS was a great opportunity and it really helped motivate me to a science related career.
- Great program but it really did not influence my decision on a college or major. Thanks.
- Science and engineering didn't really fit my personality.
- Although I probably will not choose physics as my major I have played around with the thought. I am currently a tutor for a lower level physics class so I am still interested and involved in the department. I believe STEPS has a major influence in my involvements as well.
- Even though my interest is not in engineering, STEPS was a great experience!

- Although STEPS did not influence me in the major I chose, I think it was a great opportunity and a wonderful learning experience.
- Even though the camp did not influence me in any way, it has always been worth it and still have many wonderful memories. Thanks.

### ***STEPS 1999 Graduate Survey Comments***

- It was a good program that geared me more into science, it helped me develop a passion for it.
- I loved STEPS. I found confidence and knew I was able to do what I wanted to.
- I did enjoy the program very much but chose another field.
- I'll let you know when I decide!
- STEPS was a great experience and I learned that engineering has many fun elements. I just have a far greater interest in my areas.
- STEPS helped me to think critically. I am going to nationals in debate June 12<sup>th</sup>! Thank you once again.
- I really enjoyed the STEPS program and the insight into the fun side of engineering that it gave me. My younger sister will be attending this summer and I'm sure she will be equally impressed and intrigued. Thanks!
- STEPS continued by interest in science, but didn't capture any interest in technology.
- Helped me realize that my true interests were in the medical field.
- Looking for counselors?
- I enjoyed STEPS! It is a great program.
- I wouldn't say that STEPS had a huge influence on my career decision, but it did make me experience making new friends in a place that I didn't know anyone. And it gave me a taste of campus life for a week which is an experience that made me really kind of know what I was looking for in a college or university. So, thank you for the opportunity you have provided me with. It has, without a doubt, changed my life.
- I had a blast! Thank you for the wonderful opportunity. I'll never forget it.
- Thank you for allowing me to participate!
- STEPS gave me the confidence to take all the science classes that I could. STEPS also helped show me that science classes can be (and are) fun!
- I did really enjoy the program. It was a lot of fun and learned a lot. Although, I decided to major in nursing, Stout offers programs different than I'm interested in.
- I decided engineering wasn't for me, but I had a blast! It was a great experience that I wish every girl could have.
- The camp was inspirational and helped me when taking tech classes in high school.
- STEPS was a great experience and introduction to science and engineering.

- The influence STEPS has on my major is not as much as the influence it has had on me as a person.
- It (STEPS) did influence our choice in UW-Stout. I feel my catholic school greatly influenced my major.