Saudi Arabia Future Female Engineers Program

System Engineering Integrative Project
Loyola Marymount University
SELP 685

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Background
Saudi Arabia History

Early 1900

- One of the poorest countries in the world.

1930 (After Oil Discovery)

- It has become a competitive force in the global economy.
- Influx of foreigners and laborers came from western countries and poorer neighboring Arab states.
- Saudi Arabia is challenged with a workforce composition high in non-nationals.
- Declaring that they can't find qualified Saudis.
Background
Education in Saudi Arabia

Public expenditure on education as % of GDP.
("Abundant, Skilled Workforce").

Highlights:
- Education is the center of the kingdom's development
- Saudi Arabia is the highest spender per capita on education in the Middle East.

Root Causes of The Problem

1. High unemployment rate
2. High foreign labor
3. Limited qualified Saudi labor
4. Hiring mostly Saudi men
5. Cultural restriction on female education

5 Whys?

Due in part to the religious beliefs of the country, women are not expected to take part in the workforce the same as men. Therefore, the career paths that are available to women are significantly limited, especially in Engineering.
Problem Description

![Bar chart showing Saudi Male and Female Unemployment Rates (2001-2008)]

The irony is, [though, that] many of the unemployed are highly educated females...over 50% of unemployed females hold a university degrees. (Defteros, 2014)

Saudi Male and Female Unemployment Rates (2001-2008)

Ethical issues

The question then remains, what is to be done to utilize this untapped source of such highly educated female workers in a functional environment to address the country’s deficit in qualified Saudi workers, yet still protect the customs and traditions of the culture?

- Female equality.
- Government and education system’s responsibility regarding Saudi economy deficit.
The Golden Era for women’s education

“...I believe strongly in the rights of women. My mother is a woman, my sister is a woman, my daughter is a woman, my wife is a woman.” – King Abdullah of Saudi Arabia

- Educating Saudi women as his top priority.
- King Abdullah Scholarship Program (KASP) 25% out of 70,000 were women.
- King Abdullah University for Science and Technology (KAUST) first graduate-level research university.
  - Women are allowed to mix freely with men and to drive on campus and they are not required to wear veils in the coeducational classes.
- Princess Noura University (The world’s largest women university).

King Abdullah “RIP” AKA The founder of modern Saudi Arabia.

The Current Situation
The Cultural Restrictions for Female Education

Education Journal 2014; 3(2): 71-78

94% of Engineers in Saudi Arabia are Foreigners (Pinoy, 2014)

Women’s share of graduates in university education in Saudi Arabia in the years of 2008-2011 by fields of study

Current Situation

The development of female education

King Abdul-Aziz university first government university offers engineering programs for female students.

- First class included 50 to 60 students.
- Reasons to begin the program by the engineering faculty Dean, Aljunaidi:
  ✓ Studies showing that female students in Saudi Arabia perform better academically.
  ✓ 92% of the girls polled said that they would want to join an engineering faculty.
  ✓ 80% of the parents polled said that they would not mind if their daughters pursued engineering degrees.

("Jeddah to Host First Government Engineering Program for Women").

Taking a step

As this surge of reforms in women's education and even women's rights take place, the next step is to consider what needs to be done in order for this momentum to continue to build.
Project Objectives

Design a program that provides a means for Saudi Arabian female students in secondary education (high school) to not only have access to education in engineering and the sciences, but for them to collaborate with other Saudi Arabian girls from various parts of the country on significant and impactful engineering-based community projects for the betterment of the country.

Stakeholders Description

Each stakeholder has different interests and influences.
System requirements

Top level requirements

The system shall provide a program framework for high school female students in Saudi Arabia to learn about engineering and sciences.

The system shall provide a website for students and the public to access more information about the program.

The system shall provide a medium through which students can collaborate remotely.

The system shall be designed to accommodate a regular academic school schedule at most private schools in Saudi Arabia.

Second level requirements

- The system shall provide a website that provides detailed information about the program.
- The system shall provide a website that provides a method for new students who are interested to sign-up and apply to the program.
- The system shall provide a web application that launches a virtual workspace that students can use to collaborate.
- The system's virtual workspace shall provide a set of tools useful for collaborating with other students including a means to communicate with video and audio, chat box, an engineering draw box, and a web browser, all available within the workspace.
- The system's virtual workspace shall offer special features for each tool including a toggle on/off feature, a share screen feature, and a resize feature.
- The system shall provide a server that hosts the website and runs the web application.
- The system shall provide a database that stores all student information.

System Organization

SAFFE Program OV-4 Organizational Relationships Chart
### Proposed Alternatives Research and Analysis

The Most Recognizable Institutions that Offers Pre-College Engineering Program

<table>
<thead>
<tr>
<th>University</th>
<th>Program</th>
<th>Length</th>
<th>Goal</th>
<th>Offered for</th>
</tr>
</thead>
<tbody>
<tr>
<td>John Hopkins University</td>
<td>Engineering Innovation</td>
<td>4 weeks (credited)</td>
<td>The objective of this course is to introduce engineering ideas, thoughts, and problem-solving to potential engineering students and help them answer the question: Is engineering for me? If so, what field?</td>
<td>Both genders</td>
</tr>
<tr>
<td>Massachusetts Institute of Technology</td>
<td>Women's Technology Program</td>
<td>4 weeks</td>
<td></td>
<td>Females</td>
</tr>
<tr>
<td>University of Michigan’s</td>
<td>Summer Engineering exploration camp</td>
<td>One week</td>
<td>Discover the possibilities of Engineering</td>
<td>Females</td>
</tr>
<tr>
<td>Carnegie Mellon University</td>
<td>The Summer Academy for Mathematics and Science (SAMS)</td>
<td>One week</td>
<td>rising high school juniors and seniors with a strong interest in math and science and who may be considering a career in engineering.</td>
<td></td>
</tr>
</tbody>
</table>

http://collegeapps.about.com/od/extracurricular/tp/summer-programs-engineering.htm

### The Most Recognizable Institutions that Offers Pre-College Engineering Program

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<thead>
<tr>
<th>University</th>
<th>Program</th>
<th>Length</th>
<th>Goal</th>
<th>Offered for</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Illinois - Youth in Science and Engineering</td>
<td>Exploring your options</td>
<td>2 weeks</td>
<td>Campers have the chance to interact with engineering students and faculty, visit engineering facilities and research labs at the university, and work together on hands-on engineering projects.</td>
<td>Both genders</td>
</tr>
<tr>
<td>University of Maryland - Clark School of Engineering</td>
<td>Pre-college summer programs</td>
<td>1 week</td>
<td>Designed to help students develop their math, science and engineering skills and decide if engineering is right for them.</td>
<td>Both genders</td>
</tr>
<tr>
<td>University of Notre Dame</td>
<td>Introduction to Engineering program</td>
<td>2 weeks</td>
<td>The opportunity to further explore potential career paths in engineering.</td>
<td>Both genders</td>
</tr>
<tr>
<td>University of Michigan</td>
<td>Summer Engineering Academy</td>
<td>2 weeks</td>
<td>To increase the engineering workforce.</td>
<td>Both genders</td>
</tr>
</tbody>
</table>

http://collegeapps.about.com/od/extracurricular/tp/summer-programs-engineering.htm
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<th>Program</th>
<th>Length</th>
<th>Goal</th>
<th>Offered for</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Pennsylvania</td>
<td>Summer Academy in applied science and technology (SAAST)</td>
<td>3 weeks</td>
<td>The opportunity to explore engineering at a college level.</td>
<td>Both genders</td>
</tr>
<tr>
<td>University of California San Diego</td>
<td>California State Summer School in Mathematics and Science (COSMOS)</td>
<td>4 weeks</td>
<td>Motivate the most creative minds of the new generation of prospective scientists, engineers and mathematicians who will become leaders for California, the nation, and the world.</td>
<td>Both genders</td>
</tr>
<tr>
<td>University of Kansas</td>
<td>Summer Engineering camp - Engineering Discovery</td>
<td>5 intensive days</td>
<td>receive a hands-on introduction to engineering principles and the various career opportunities within the field of engineering, to find out if engineering is a good career choice for you</td>
<td>Both genders</td>
</tr>
</tbody>
</table>

http://collegeapps.about.com/od/extracurricular/tp/summer-programs-engineering.htm

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### Pre-college Engineering Programs Similarities:

- 9th and above graders
- Residential programs
- Leadership focused
- Increase Engineering workforce
- Seek to attract a diverse population of students to engineering, and then to ensure that these students are fully included in the college experience and that all students have the opportunity to experience success within a diverse college.

### MIT

- Females Only Program
- 4 weeks
- Top 5 Engineering School in the US.
- Similar motive:

WTP was created by MIT students in EECS in 2002 who were concerned about the fact that many young women do not consider engineering or computer science majors in college, despite having strong math and science backgrounds and analytical abilities. Research into this issue identified some key pipeline barriers:

- Lack of pre-college computing or engineering experience.
- Negative stereotypes about what engineers do and how they work.
- Lack of confidence in their potential to pursue engineering.
- Lack of female role models.
Analysis of Alternatives

**MIT’s WTP**
(Women’s Technology Program)

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**SAFFE program**

Design a program to allow female secondary students entering the 11th or 12th grade, who are interested in pursuing engineering as a topic of study at the university level, an opportunity to get a head start.

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MIT’s Women Technology Program OV-1c

SAFFE Program OV-1c
Measure of effectiveness of the proposed alternatives

<table>
<thead>
<tr>
<th>MOE</th>
<th>MIT WTP</th>
<th>SAFFFE Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication &amp; Coordination</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>System Reparability</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>System Reliability</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>System Robustness</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>System Upgradeability</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>System Safety</td>
<td>Moderate</td>
<td>High</td>
</tr>
</tbody>
</table>

**Table Legend**

- **High**: Highly Effective
- **Moderate**: Moderately Effective
- **Low**: Not Effective

Proposed Solution

The proposed solution is called the Saudi Arabia's Future Female Engineers program, a program intended for private secondary schools in KSA to adopt in partnership with other private secondary schools, but eventually to be adopted also by all KSA public secondary schools.
Quality Engineering Education

Learn
- Learn through IEC and daily classes through their academic year.

Create
- Create their own project ideas.
- Must address a problem or situation challenging the student's local community.

Apply
- Apply and practice their newly learned knowledge to labs and activities.

Engineer
- Engineer the projects.

Proposed System Architecture
System Functional View

SAFFE Program SV-4: Systems Functionality Description
Proposed System Architecture
Data Flow

SAFFE Program SV-4 - Data Flow Description

Proposed System Architecture
System Overview

SAFFE Program OV-5 Operational Activity Model
Proposed System Architecture

Selected Technology for the system
- Virtual Workspace

SAFFE Program OV-1c

SAFFE Program OV-1d – Virtual workspace
Selected Technology for the system

- Virtual Workspace Cells

Video chat Cell  Text chat cell  File Sharing cell

SAFFE Program– Virtual workspace Cells

Selected Technology for the system

- Virtual Workspace Cells

Draw box cell  Advisor help cell

SAFFE Program– Virtual workspace Cells
Selected Technology for the system

- Virtual Workspace Cells

![Browser cell](http://www.google.com)  
![Screen sharing Cell](image)

SAFFE Program—Virtual workspace Cells

System Interfaces

- Video Chat/Advisor Help Cell → VSee
- Text Chat Cell → TokBox
- File Sharing Cell → Google Drive
- Draw Box Cell → Microsoft Visio
- Browser Cell → Google Chrome
- Screen Sharing Cell → Screenleap
Proposed System Architecture

Applied Heuristics

- We don’t really know what works until we try it.
- Systems need to be built to tolerate change and expansion beyond current stakeholders needs.
- Don’t ever try to build it all at once - evolve the system based on highest value early and rapid learning about realities.
- The most critical requirements and critical designs are probably soft, not hard. And most ‘engineers’ are not social engineers.

The proposed program does not exist in Saudi Arabia, and there is no sure way of testing it other than to actually try it.

The proposed program intends to have sustainability and upgradability intrinsic to the system.

The Proposed system embraces this evolutionary project management style.

User Friendly and Interesting.

Gilb, Tom. Some Powerful Systems Engineering Heuristics. 8 Oct 2006. 1 April 2015

Operational Needs

- SAFFE staff capable of handling internal processes including application processing, verification, admissions, university interactions, and private school interactions.

- SAFFE IT that will manage the website, interface, database, server, and information exchange with schools and the Qiyas.

- A website that hosts all information about the program including student profiles.
Operational Needs

- A GUI interface linked to a server and database that can withstand all applicant information.

- A server and database with sufficient processing power and storage space.

- Universities outside of KSA that can host the SAFFE IEC.

Operational Needs

- Private school curriculums that incorporate the SAFFE program schedule.

- Private schools staffed with teachers who can teach about engineering according to what was taught during the IEC

- Private schools facilitated with sufficient internet bandwidth and equipment that can operate the VW smoothly.
Cost Analysis

<table>
<thead>
<tr>
<th>Administrative</th>
<th>IEC</th>
<th>Project Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admissions and Abroad Committee</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Staff: $1,800 / month</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Program</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o 6 Class Rooms Rental: $8000/class $800 * 6 classes = $48,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Staff</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Instructors: $15/hr. * 8 hrs./day = $120</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$120 * 5 days/week = $600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$600 * 4 weeks = $2400</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Administration: $2,000/1 employee 2,000 * 5 employees = $10,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Project Material</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Specialty Software License:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Engineering Materials: $5,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation: 4 field trips</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Bus Rental: $610</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Admission: $10/person</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Social Activities: Team Building &amp; Leadership Training</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Staff: 2,000/Instructor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Instructors: $2,000 = $4,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Room &amp; Boarding/Cafeteria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Room/2 students = $600/month</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o In campus Food = $300/student/month</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Staff</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Instructor: $1,450/Teacher</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Administration: $1,200/Employee</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Highest Risk Scenario

**Scenario:** A student enrolled in the project course during the academic year drops out.

**Handling the risk**

1. Identify whether the student exits before or after the first month of the beginning of the program.
   - A. If before, they are not penalized.
   - B. If after, they receive an F for the course.

2. Mark group member profile(s)
   - A. If one student leaves a group, mark the abandoned group member profile within a database as 'OG' for Open Group.
   - B. If two students leave a group, mark the abandoned group member profile within the database as 'FA' for Free Agent.

3. If the student drops out prior to the two-month mark since the start of the project course, the database will immediately recommend matches for OG students with FA students available at the time.
   - A. If no FA students are available until the 2-month mark, OG students will permanently work alone to the end of the project course using a rubric designed for groups with two students as opposed to the typical rubric designed for groups with three.
Highest Risk Scenario

4. In a rare situation where two students drop out of the same group prior to the two-month mark since the start of the project course, the database will immediately recommend matches for the FA student with OG students available at the time.

   A. If no OG students are available and until the 2-month mark, the database will attempt to group three FA students together to form a completely new group.
   B. If the databases can only pair two FA students, they will use a rubric designed for groups with two students as opposed to the typical rubric designed for groups with three.
   C. If the database cannot find any FA or OG students, an advisor will identify a group with which they can work in a group of four.

5. All students successfully grouped or paired will be unmarked 'OG' or 'FA' on their profiles.

5. If the student drops out after the two-month mark since the start of the project course, the abandoned students will be required to speak with an advisor that will guide them on how to proceed with the project without having to do three people's worth of work.

Risk Management

<table>
<thead>
<tr>
<th>No.</th>
<th>Risk</th>
<th>Likelihood</th>
<th>Impact</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Student dropping</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Follow standard procedure, reassign team</td>
</tr>
<tr>
<td>2</td>
<td>Rejection of program</td>
<td>Moderate</td>
<td>High</td>
<td>Work with program to change image</td>
</tr>
<tr>
<td>3</td>
<td>Human Error</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Identify issue, modify program by a meeting or replace employee</td>
</tr>
<tr>
<td>4</td>
<td>Network Failure</td>
<td>Moderate</td>
<td>High</td>
<td>Setup multiple backup networks and allow developers to provide support</td>
</tr>
<tr>
<td>5</td>
<td>Software Bug</td>
<td>Moderate</td>
<td>Low</td>
<td>Debug and fix algorithm</td>
</tr>
<tr>
<td>6</td>
<td>Difficulty to implement code</td>
<td>Student</td>
<td>High</td>
<td>Ask government for developers/consultants</td>
</tr>
<tr>
<td>7</td>
<td>Engineering teaching coding</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Train current staff and science students to teach S&amp;T Ed</td>
</tr>
<tr>
<td>8</td>
<td>Student level/subject difficulty</td>
<td>Low</td>
<td>High</td>
<td>Provide student with S&amp;FE support line</td>
</tr>
</tbody>
</table>
Verification and Validation

Verification

- Inspection
- Demonstration
- Similarity

Validation

- Ministry of education
- Public opinion acceptance
Future Lean state

Future Lean Thinking (Future State)

Going Lean

The Cultural Restrictions Creating a Push System for Female Education

Education Journal 2014; 3(2): 71-78

Women’s share of graduates in university education in Saudi Arabia in the years of 2008-2011 by fields of study

Lean Thinking

**Lean Principles**

- Value
- Value Stream
- Flow
- Pull
- Perfection
- Respect People

Lessons Learned

- Limit the scope
- Cultural Challenge
- Looking at a problem from different perspectives
- Learning experience

*Girls Can't WHAT?*
Conclusion

- Obligation to engage our kingdom in discourse that opens minds to the importance and values of education equity between both sexes.

- Saudi Arabia is now in its heyday and making progress everywhere.

- Now women are finally being recognized, so it is now time to prepare our young girls for opportunities that they never once dreamed of.

- SAFFE reaches them at proper age and gives them opportunity to learn Engineering in a modern way.

Bibliography


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Thank you