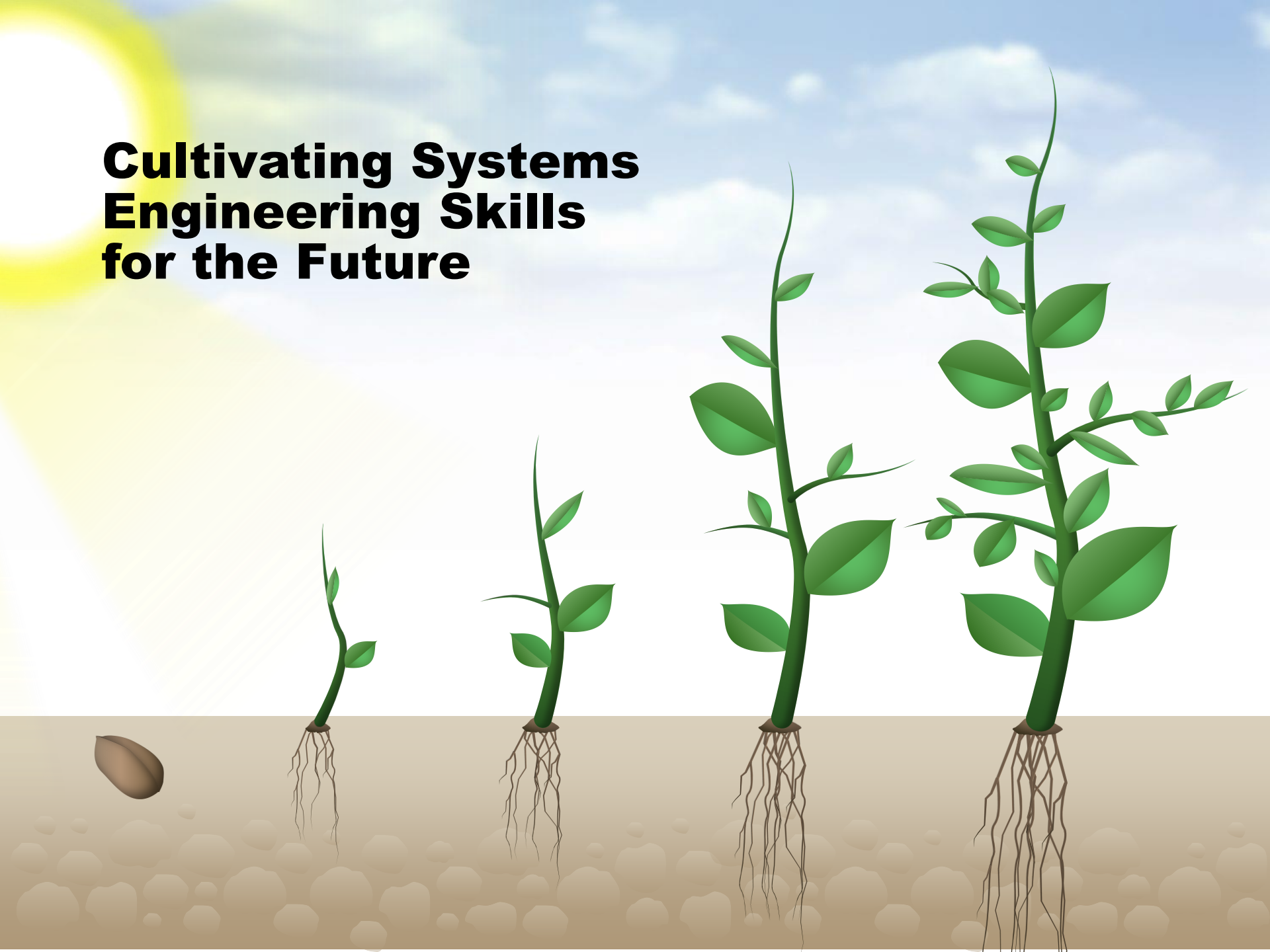
Cultivating Systems Engineering Skills for the Future



Overview

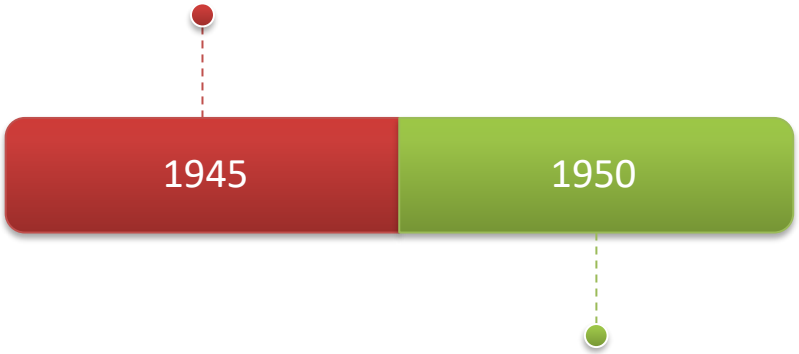
- Plan to Cultivate SE Skills for Future
  1. Raytheon influence in establishment of NSF goals and guidelines
  2. SE Summary using 5 P's of Progress
  3. Objectives for SE Training Projects
  4. Comparison of SE to STEM
  5. Sample SE Projects

Developing Scientific Talent

- In 1945, President Roosevelt asked Raytheon founder, Vannevar Bush, how to sustain engineering progress of WWII.
- "**Can an effective program be proposed for discovering and developing scientific talent** in American youth so that the continuing future of scientific research in this country may be assured **on a level comparable to what has been done during the war**?"

Vannevar Bush suggestions for developing scientific talent

Vannevar Bush offered suggestions in response to President Roosevelt's question in 1945

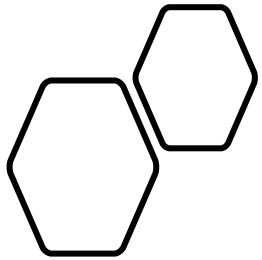


Bush's suggestions were implemented in the founding of the National Science Foundation (NSF) in 1950

Some of Vannevar Bush's Suggestions for Developing Scientific skills in 1945

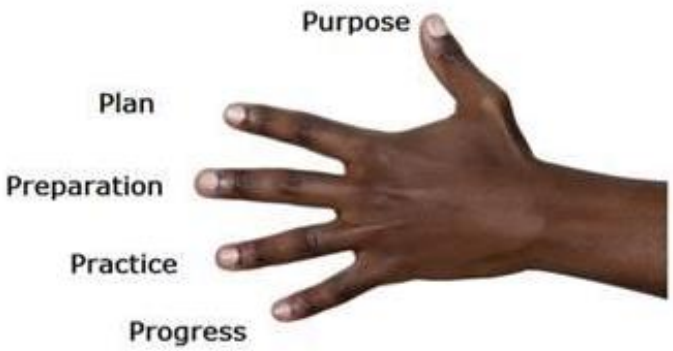
- "Scientific progress, on a broad front, **results from the free play of free intellects, working on subjects of their own choice**, in the manner **dictated by their curiosity for exploration of the unknown**. Freedom of inquiry must be preserved…"
- "**Remove Barriers**: Higher education in this country is largely for those who have the means. If those who have the means coincided entirely with those persons who have the talent we should not be squandering a part of our higher education on those undeserving of it, nor neglecting great talent among those who fail to attend college for economic reasons. **There are talented individuals in every segment of the population, but with few exceptions those without the means of buying higher education go without it.** Here is a tremendous waste of the greatest resource of a nation -- the intelligence of its citizens."

National Science Foundation Purpose 1950



- NSF formed to cultivate, incentivize, subsidize fundamental research in sciences for benefit of society

Five P's of Progress in Engineering



Purpose
Thumb is strongest finger
What is your main objective?

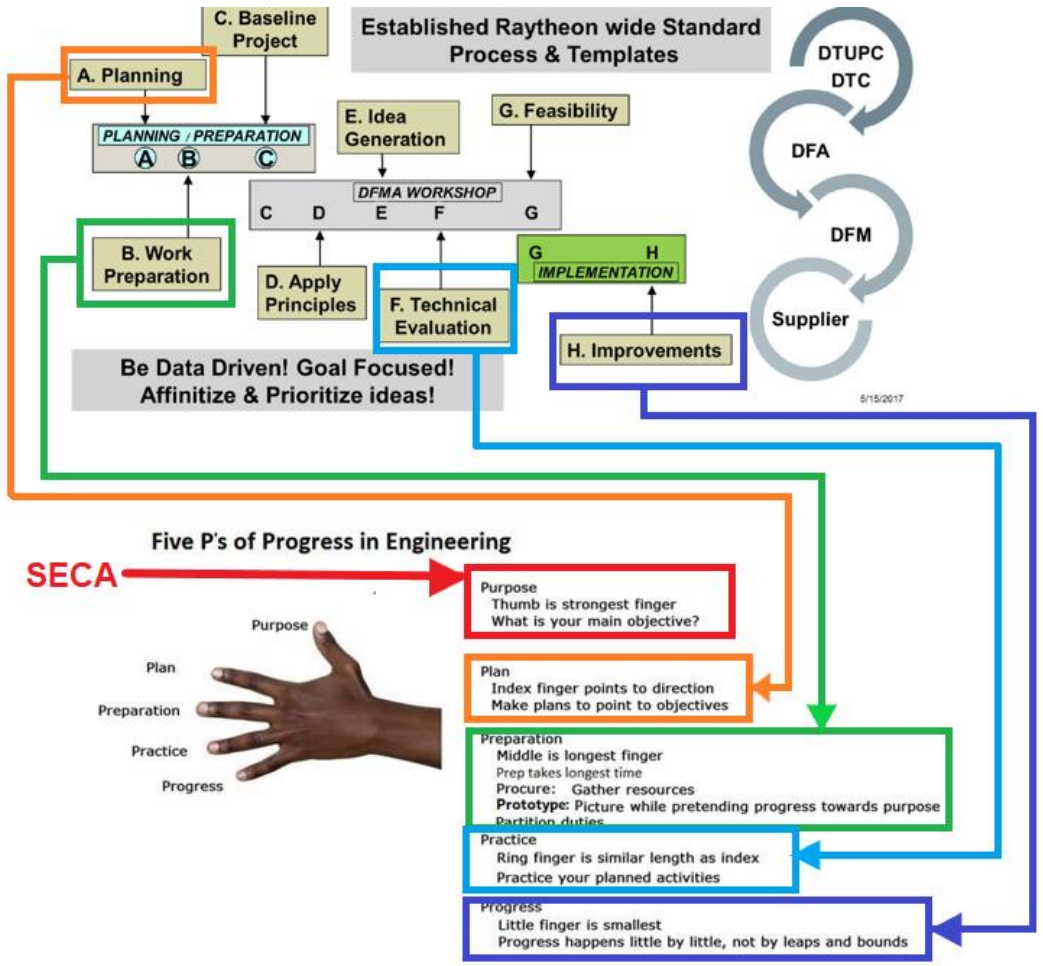
Plan
Index finger points to direction
Make plans to point to objectives

Preparation
Middle is longest finger
Prep takes longest time
Procure: Gather resources
Prototype: Picture while pretending progress towards purpose
Partition duties

Practice
Ring finger is similar length as index
Practice your planned activities

Progress
Little finger is smallest
Progress happens little by little, not by leaps and bounds

Summary of Systems Engineering (EIA 632, Mil-Std-499A)



Comparing Raytheon DFMA and SECA Roadmaps

Objectives for SECA Training Projects

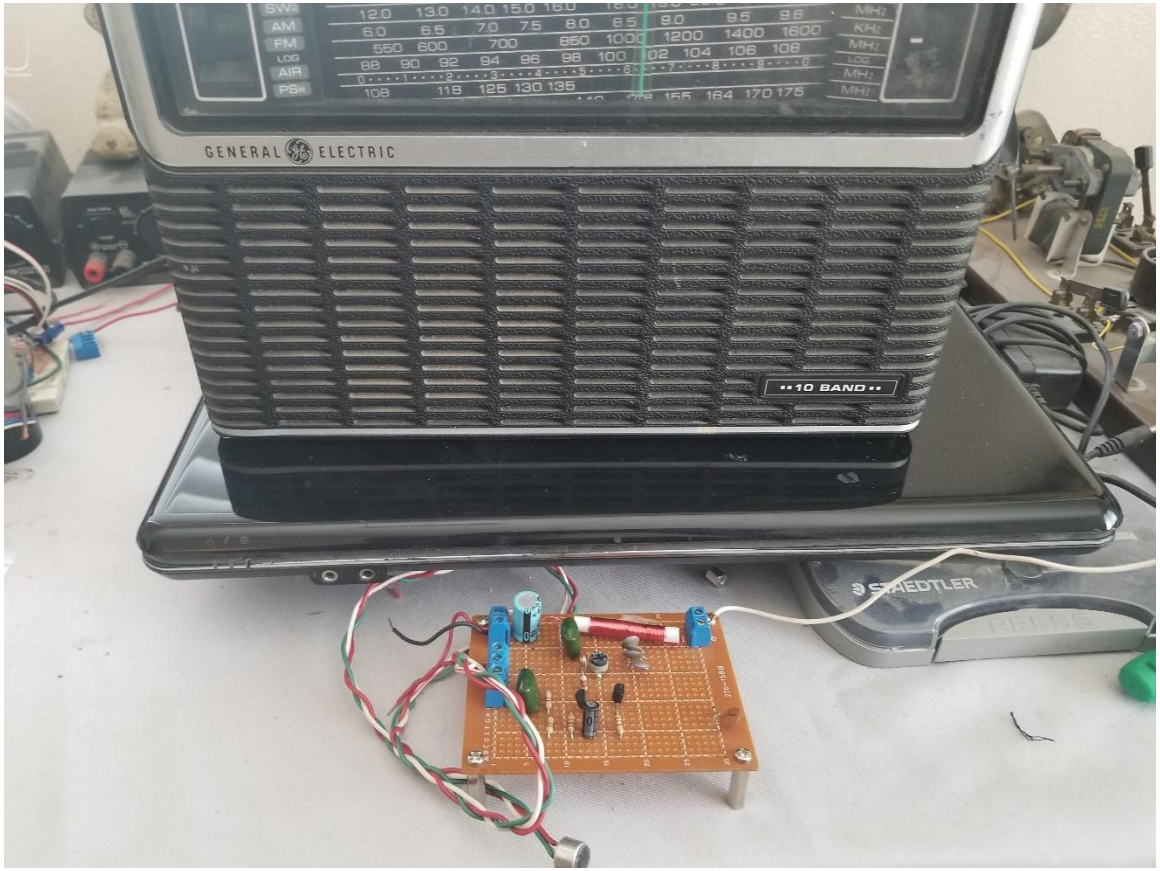
Comparing SECA to STEM Training Methods

Comparing SECA* to STEM Training Methods					
	PURPOSE	**PLAN**	**PREPARATION**	**PRACTICE**	**PROGRESS**
SECA*	Solves Societal Issues (National Science Foundation, NSF) Examples: Real-time Robot control Renewable Energy	· DFMA · COTS preferred o Low cost o Time to market o Quality · Specification development · Methodology well defined o Milestones/Tasks o GANTT charts/ o Balance cost, schedule, quality o Revolving Action Item list (RAIL) · Design Trade Study of options ● Design Synthesis: Computer Model ○ JPL Synthesis Example ○ Real - time robot Synthesis Example	· Round table, o Cross functional skills development o SME o Kaizen · Lab B4 Lecture prototype kits · Full spectrum of Mfg methods · Use of pre-existing similar solutions (bottom up)	Verify solution meets societal need (NSF)	· Meet needs of society · Encourages economic development · Supports teachers with SME, Kits · Builds infrastructure for next project · Teamwork/Networking skills. · Preparation for larger systems engineering role/entrepreneurship
STEM	Competitions to encourage skills Examples: FIRST Robotics Competitions DARPA Robotics Challenge	· Competition goals and rules · Limited to Competition Scope · Siloed backgrounds · Methodology not well defined · Schedule driven decisions · Action Items ● No synthesis using computer models	· Gifted Student Isolation · Limited experience base on volunteers · Use of tools offered by sponsors · Makerspace o Solid models o 3D printer o Focus on custom design (top-down) o Lego structures	Test to competition goals and rules	· Limited reuse of results · Teamwork/ Networking skills · Experience in use of various development tools offered by sponsors ·

First Steps in Radar Science

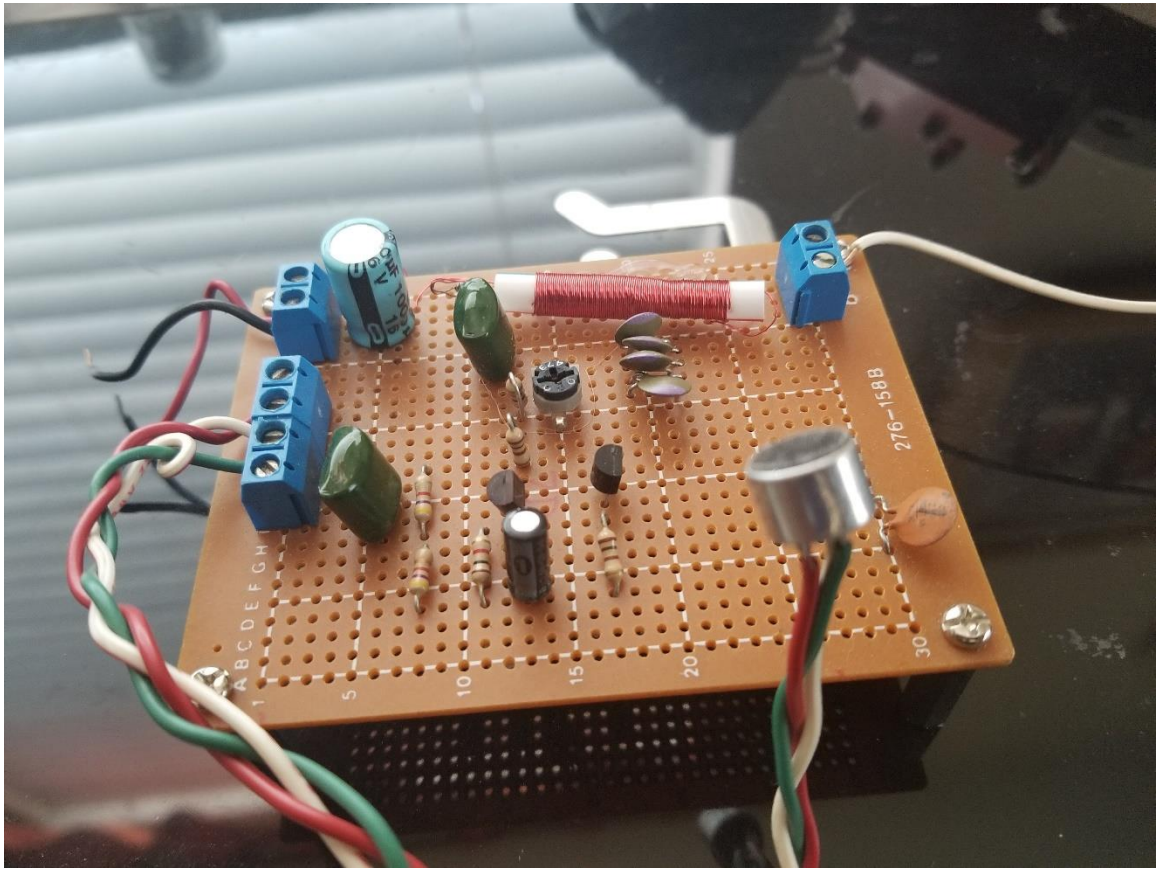
- “George Stimson became **fascinated with radio waves as a teenage amateur radio enthusiast**, designing and building transmitters and receivers…”
- Quote from “Introduction to Airborne Radar” , George W. Stimson, Second Edition

Sample SECA Project: Radio Science



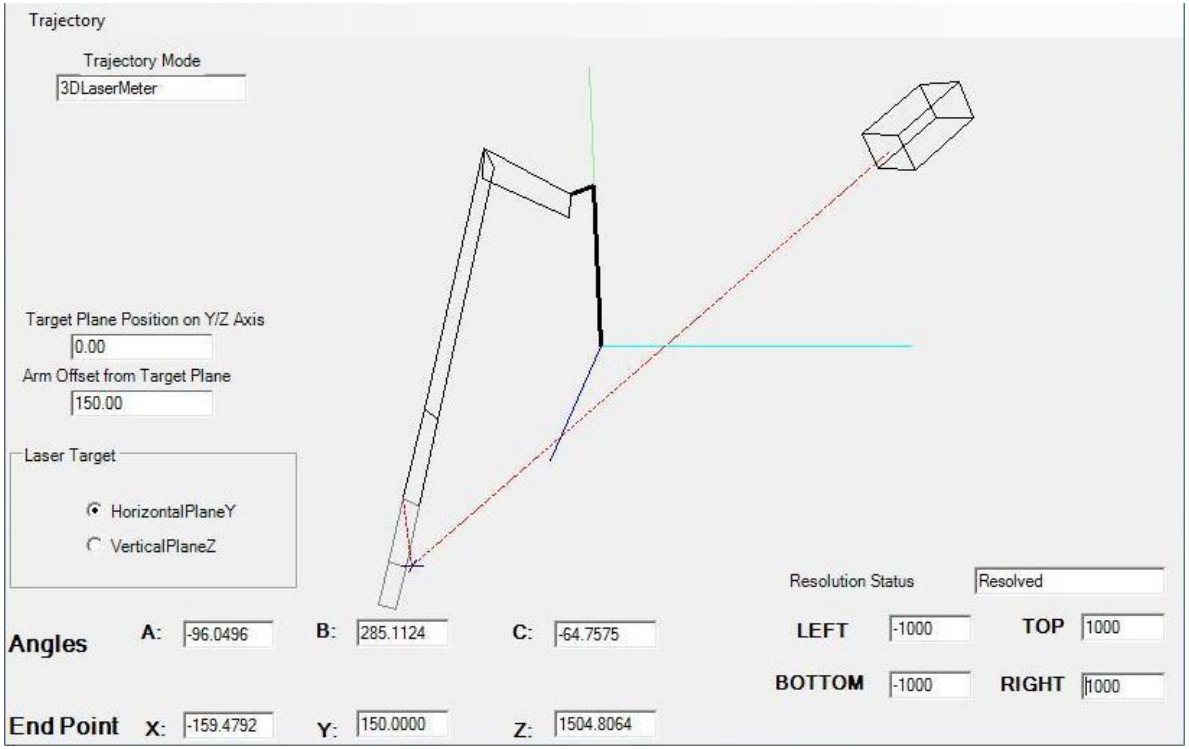
- [Forrest Mims Communications Projects]

Sample SECA Project: Voice Transmitter



- Forrest Mims "Getting Started in Electronics"
- 3-minute video of voice transmitter for outreach to schools

Sample SECA Project: Model Based Engineering Project



- [Beacon Engineering Consortium Blog]

Motor Control using a Graphical User Interface (GUI)

Summary

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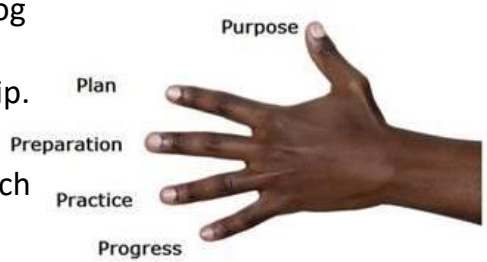
Backup Slides

Background and Purpose

- 1982-40 years (PSGA)
- George Floyd
  - UCLA HSSEAS Townhall
  - Overcome evil with good
- Raytheon assignment to cultivate strategic skills for future by influencing college curriculum
  - Send email to Katrina.b.Hiramoto@Raytheon.com to say you heard about 5P's of Progress
- Beacon Engineering Consortium Blog presents challenges and opportunities with entrepreneurship.
  - Dates back to 1989
- 5P's of Progress is a thumbnail sketch of how products are developed.
  - EIA-632 Processes for Developing a System
  - Any system whether electronic, software, mechanical, electrical etc

THE BEACON ENGINEERING CONSORTIUM

Five P's of Progress in Engineering



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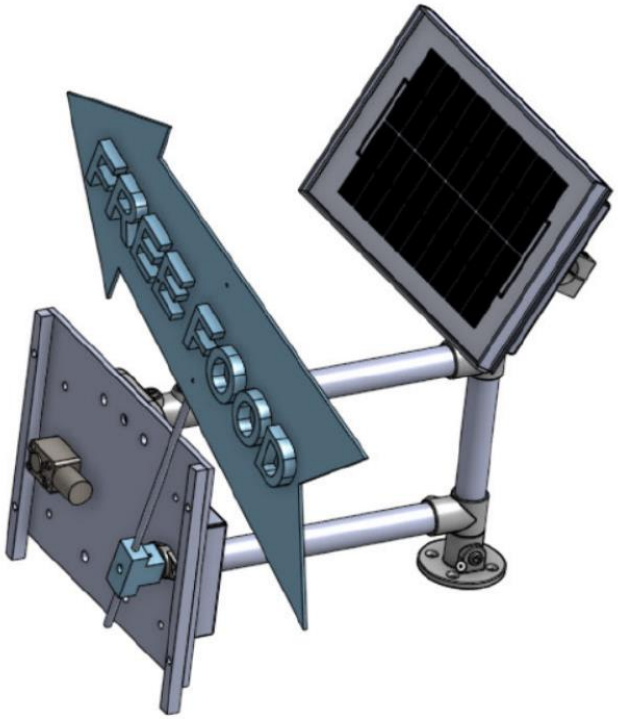
Developing Entrepreneurship Locally

Local Entrepreneurship

- When compared to Art, Math Ed stops at artist's palette
  - Coding CANVAS suggests prewritten composition like English and Music training
- Networked Improvement Communities (NICs) suggest partnering with industry
  - Lab before Lecture suggests using pre-assembled kits to teach technology
  - White paper suggests systems approach in classroom to develop skills for future with robot example
  - 5P's at NASA shows virtual reality programming in industry
  - Sign Spinner shows example of NIC

Sign Spinner Project



Developing Entrepreneurship Globally

- Developed screen printing carousel and dryer in USA
  - Taught screen printing at orphanage in Malawi, Africa
  - Brought solar water pump kit as suggested training at orphanage
- Challenges and Opportunities abound in Malawi, Africa
- Stunning need for economic development
- High water table
  - Lake Malawi covers 20% of Malawi land mass
  - Aquifers only 50 ft below surface
- Irrigation is a major issue in continent

Irrigation Challenges in Malawi