Grand Challenges Scholars Program in Indian Context

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Abstract: Fourteen Grand Challenges were identified by National Academy of Engineers (NAE) for betterment of human race in the Twenty-first Century. It is believed to project a sustainable life if we overcome such challenges prescribed by NAE. NAE formulated a consortium of engineers and formulated the Grand Challenges Scholars Program (GCSP) for the need of futuristic engineers who can shape the world. This program spread across the globe across nearly 122 participating institutions and none from the Indian Sub-continent. The current work show cases on the approach of an engineering institution in India approaching towards the membership in Grand Challenges Scholars program. This paper briefs on the initiatives taken by the institution in meeting the Objectives of NAE.

Keywords: Grand Challenges Scholars Program, Learning Components, Assessment and Evaluation, Capstone Projects

1. Introduction

NAE-USA identified 14 Grand Challenges that are required for a sustainable future that humanity needs to come-up with. NAE empanelled a team of scientists, engineers and other philanthropists inclusive of founder of Google(Larry Page) and they nearly they dwell over an year to identify 14 Grand Challenges that are to be overcome to have an improved life on earth. Broadly these Grand challenges cover the important aspects like Sustainability, Health, Security and Joy of Living [1].

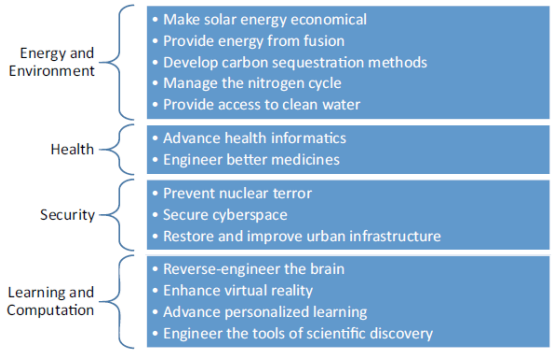

Fig 1.1 List of 14 GCSP Challenges in Engineering

Grand Challenges focused on the following: Sustainability: Due to growth in population, their needs, wants and desires the sustenance of human race, advances for comfort and providing quality life for the people. Health: Advent and use effective means to induce health and informatics together for the benefit of mankind. Engineer better medicine and prevent spread of diseases, epidemics and invent new medicine. Security: Fencing from nuclear wars, safeguarding from nuclear terror to mass population, cyberspace protection from threats and vulnerabilities. Joy of living: Taming the existing natural process for comfort of mankind like using fire for energy, snake poison for medicine and other top priority entities. The vision of NAE has been so framed as per Grand challenges and are listed in Fig 1.1.

Many of these themes and their efforts may span centuries and requires multi-disciplinary research for its solution. The mission of NAE is accomplished through the mission of producing futuristic engineers capable of taking up the challenges and attempting to propose solutions and solve them. The GCSP committee intends to solve them by spreading them across the future engineers and educate them of the opportunities. Since, 2009 it is spread across the different universities in USA and across reputed universities in the world. Different universities propose their solutions to problems that come under the 14 themes of GCSP [2].

It happened that proposal to join GCSP reached India in late November, 2017 and several institutions from India were invited for the event. These institutions were explained about the purpose of GCSP. They are encouraged to submit proposals to NAE for registering themselves as a prospective university or Institution equipped for attempting to solve the Global issues as specified under 14 themes of GCSP. Among several institutions that participated the conclave organized by NAE in India, only very few participants applied for the membership in NAE-GCSP initiative, Sree Vidyanikethan Engineering College was one amongst them. The proposal was submitted to NAE-GCSP in the prescribed format, where it was a free drive form, requiring creativity and passion for clearing the proposal for acceptance. The format was comprising of four items to state about Vision & Goal of institution in conformance with GCSP, about Scholar Selection proves, Execution/implementation of GCSP at parent institution and on assessment and tracking of progress of activity. The institutions drive was well supported by trust, the management of the institution, where it was taken as a challenge to participate for a global cause.

Application was submitted in the month of March, 2018 and it was after two-three revisions that the proposal was accepted by its mentors of USA and Malaysia. A simple

reason may be for the fact that there was a strong technical scrutiny from the reviewers as it was the first such proposal from Indian sub-continent. The proposal was reviewed twice and then it was accepted to approve the conduct of GCSP for students of Sree Vidyanikethan Engineering College in India. Having achieved this fete, the institution could not offer this course for I year Engineering undergraduate students straight away, it was offered for III Year students to start with, but a hectic scrutiny was underway to select its first set of Seventeen students who opted to take up five challenges envisaged under NAE-GCSP for the very first time.

Director and the members of the GCSP program at the parent institution supported students with required exposure about the nature of program and its implementation. The program involved evolving learning components and teaching methods to make students ready to take up Global Challenges and be future ready

2. Existing Programs and participating institutions:

Engineering career prepares students towards career in the traditional requirements of the country. After the advent of 21st century all the engineers believe that Engineering career and jobs have now become global and they realize the potential to work together understanding every other's needs. The GCSP was first proposed at the summit by NAE for Engineering at Duke University. The program was proposed to enhance the reach of Engineering to global community. GCSP is added as a supplement to existing engineering program. GCSP never dictates any courses for the engineering programs. The idea is to propose five competencies and ponder upon how to achieve them while solving globally re-known-problems. Every institution is provided with a chance to support or supplement its own approach and attempt few (atleast five) among GCSP proposed 14 challenges. The five competencies that the problems chosen by the students should possess include: Research, Multi-disciplinary, Entrepreneurship, Multi-cultural, Social consciousness. Addressing these global challenges generally spans across several disciplines, they are implemented across the globe solving or targeting their own problems at their own constraints. It is not just attraction but shear interest drives the students approaching towards the student participation in the program.

Students come out with proposals with their mentors and try to solve themes their effort, build models, propose solutions, conduct experiments, model products, design innovative solutions and many more all these happen during their course of under-graduate course of study during engineering. The program as such doesnot attract additional requirements on the administrative side for the academic institution. The institute has its own autonomy to create its supplement courses to fulfill the requirements if not available. The idea is that all five competencies are not directly available in engineering curriculum and these have to be supplemented additionally by the parent institution or university to its students. Home institution proactively implements the program and no other pushes it up through its regulatory requirements. The focus is on social empathy with the engineering curriculum that drives students solve typical society problems.

Nearly 122 universities or institutions are part of this program in US and broad. Nearly 33 institutions internationally beyond US are members. The rate at which institutions are adopting since inception represents a phenomenal growth. Currently, the program span across many institutions and K12 school curriculum around USA. Financial support for many institutions is either from parent institution or from alma matter.

Every institution constitutes it own team, members, facilitators, supervisors based on its students and competencies. NAE acts as a facilitator for the event and acts as a mutual collaborator. NAE assists individual students and their problems to broaden their understanding of the problems and deepen their experience. The NAE personal sends an appreciation letter congratulating students on their achievements at the end of their program [3].

3. Preparation of Proposal:

The format of proposal for GCSP participation is very versatile and yet thought provoking which fits to any university/institution without any barriers or requirements neither from NAE nor from parent or participating institutions. The format comprises of four components that the parenting institution shall start preparing with and they are as follows: Alignment of Vision & goals of NAE and the participating institute, Selection of GCSP scholars and available support, Implementation of GCSP program and supplementary course components, Assessment and Evaluation of student performance and tracking. Any institution, with intent to participate shall submit its proposal covering the above items mentioned. It is worth mentioning that all participating institutions have taken their time and efforts to submit their proposals in their own style.

Elaborative discussions on filling items which shall be of help to other participating institutions include the following:

3.1 Alignment of Vision & Goals: This section requires the description on Describing the vision and goals of institutional GCSP program with an explanation of how they fit with the institutional and contextual values and mission. Suggestion: As per the information on GCSP website and submission of details by different institutions to GCSP, it discusses the Vision, mission, Core values of the institution and it should elevate the Vision, Mission and the Goals of the proposing institution in correspondence with its GCSP program it is planning to start. The vision can generally comprise of the broad areas that the GCSP envisages and mission may comprise of the core strengths/challenges that the institution may likely taken up by the students of GCSP.

3.2 Selection of GCSP scholars: The selection of young undergraduate scholars and learned scholars or mentors is the secret behind success of the proposal and program. A structured, un-biased and competent scholar groups adds the strength to the proposal and for successful completion of the program. This is discussed elaborately in this section. The proposing institution has reviewed the various practices followed by different institutions and formulated a stringent

plan involving the following stages: Scholar Motivation, selection process based on competency and interests, Motivation & Problem customization and formulation of learning models, Course Work, Preparatory activity, Review of activity, Submission of Outcomes. If we observe carefully, it is a customized approach that can be well designed to suit the needs of the participating institution. There cannot be or need not be hard-fast rule for the same.

3.2.1 Orientation Session and Survey: An Orientation session is undertaken for students before anything else and it is the event where all prospective students are made aware of the NAE-GCSP at large and in detail for a duration of atleast one hour per group of students. This is an eye-opener session for Senior and Young research Scholars (undergraduates). It discusses on GCSP themes, challenges and prospective research that shall be undertaken. This survey is across the young graduates normally during the I Year of their program. A sample survey covers the following items: Student details, Important problem to be addressed in India in several aspects, Need and applicability of Grand Challenges Scholars program in Indian context, Need for participation of Parent institution in GCSP for local & global cause, Curricular requirements for GCSP, Number of issues that can be attempted by students of parent institution, Challenge of GCSP that the student shall attempt if given a chance to participate.

3.2.2 Screening test on Student Competency: This brings him to a stage where he can plan for the challenge he would likely take up. Also, few students are given a choice to opt out of the program because of lack of interest. The students are then categorized based on the challenges they are willing to accept for their future prospect, here option is student driven completely. Then the learnt scholars are identified through their competency via publications, specializations, certifications, Job profiles and designations to choose a challenge to guide or supervise. They are also requested to prepare an elementary Evaluation form of 25 Questions per Challenge to assess the student interests or foundation knowledge and skills. All the students shall take up their screening based on the choice given by the student during the survey. All the students take the evaluation and based on their grades and grades in the assessment, they are chosen. Students' across disciplines are allowed to take any GCSP Challenge Assessment of their choice (but only one test per student).

3.2.3 Scholar groups and meetings: The GCSP steering committee selects the students based on their performance in the screening test and other factors and also allocates a mentor to supervise them. The Steering committee comprising of Director, Coordinator and mentors decides the time and venue for a meet-up. For a case, in a given year out of nearly 1400 graduates in First year of engineering course, students opted for Eight challenges and overall Twenty students were identified as toppers in the screening test. A meeting is called upon by the Director with the newly selected scholars to spread across the word on Grand Challenges scholars program and their corresponding challenge they have taken up and nature of Problem statement they are to take up keeping in view of high standards set by NAE-USA. Mentors are advised to guide them accordingly. Internally the scholars along with supervisors corresponding to theme met-up regularly and decide upon the problem that are likely to take up satisfying the GCSP competencies as specified in NAE-GCSP website. The corresponding GCSP-Theme team formulates the problem and refines it as per their requirements and constraints. They also decide upon the extent to which the marked problem shall be solved.

3.3 Implementation of GCSP program:

3.3.1 Scholarly learning and demonstrations: The most important factor is enabling the learning among students amidst their tight academic schedules and they are pre-occupied with 32 weeks of class work in a given academic year. The crux is identifying the courses accordingly so that they have ample time solving the problem altogether. The courses all the students irrespective of their challenge they have chosen are as follows: Core Engineering courses relevant to the problem, Advanced Engineering core courses, Interdisciplinary courses, Professional Ethics, Entrepreneurship course followed by a Seminar and Project work. Students are allocated credits after completion of the course as per GCSP regulations (as fixed and approved by Steering committee). Learning components include, Project Based Leaning, Research courses, Internships, Fundamental and advanced Engineering core courses, Interdisciplinary courses, Seminars, Senior Thesis for reference, Design contests and competitions, Industry visits, Workshops, Expert Sessions, Outreach activity and Capstone Project. Students shall complete their courses of study through special courses offered for them or through regular curriculum making it a twinned supplement for the students with flexibility (can vary from specialization to other and from institution to other). As part of their curriculum they are required to demonstrate their problems and progress in solution design to a review committee which monitors the progress from time-to-time.

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3.4 Assessment and Evaluation of student performance and tracking:

3.4.1 Review Committee: Review team is comprised of steering committee members, external expert corresponding to the Challenge (other than the Supervisor) and corresponding supervisor of challenge. Progress of their wards is evaluated and results are announced as part of satisfactory or unsatisfactory. The team strives to achieve satisfactory grade always. In case of unsatisfactory grade for two times, they are given time to prove themselves after a short span of Three months to get their work reviewed again. Students and supervisors present on the following during their review by steering committee: Theme of work, Literature, Proposed work, accomplishments, demonstrations, observations, improvements, schedules and progress of activities. Evaluators are the members of GCSP steering committee formed at the start of the program along with an external expert to judge the progress of the activities.

3.4.2 Final Submission: The works once attaining completion status are presented at various venues like conferences, Design contests, Symposiums and other platforms to seek feedback from the leant community. Work is evaluated against the achievements of students as part of objectives and accomplishments set at the start of the program and further revisions thereof. Work is certified to be accomplished only when significant outcomes in terms of product or software or demonstratable activity and/or research publications in relevant domain that was attempted by the group.

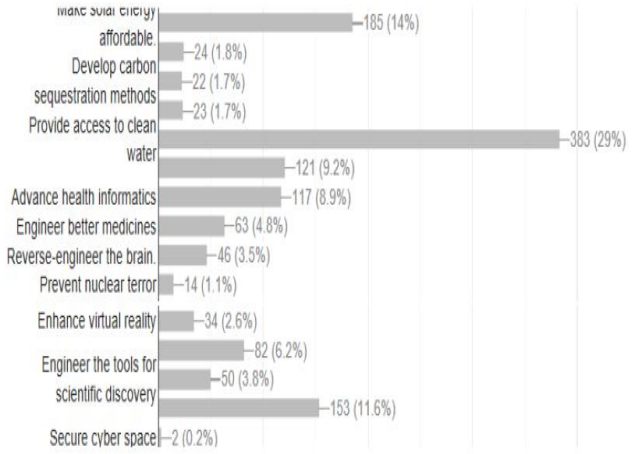
4. Results:

GCSP at the participating institution is a flavor of research in societal context for undergraduate students of an university or institution. Following are few samples taken from a batch of 2017-18.

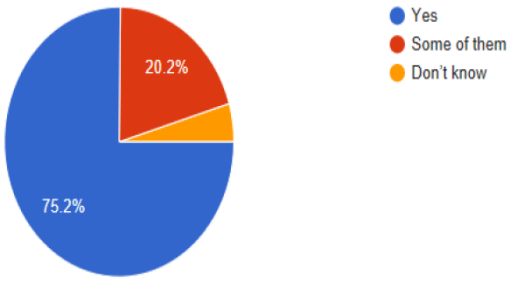
Sample survey form:

https://forms.gle/HVJyZTFrXg5tUemWA

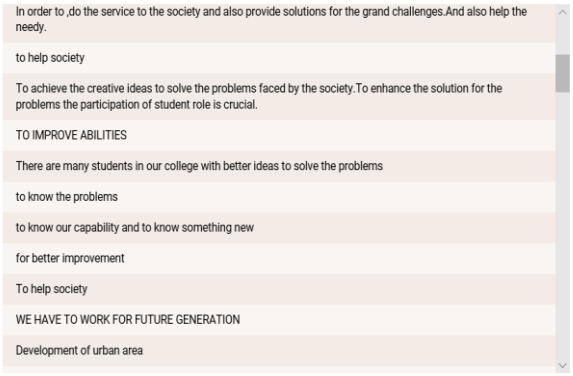
1. What is the most important problem to be addressed in India



2. Is Grand Challenges applicable to India in the present context

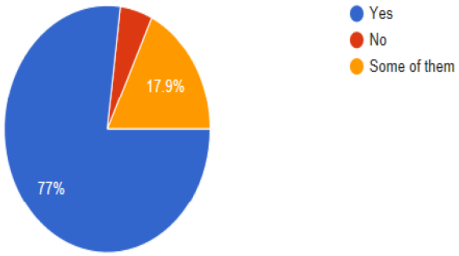


3. Why SVEC has to participate in GCSP (Specify Reason briefly in TWO sentences)

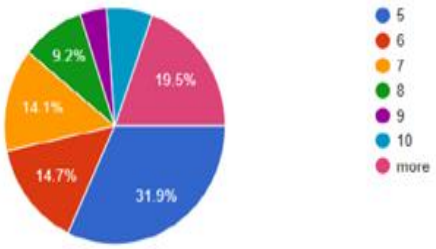


(Sample only)

4. Do you feel that the requirements of GCSP to be considered as curriculum requirements for the students



5. How many problems can SVEC address in GCSP



Sample Research issues undertaken by students pursuing GCSP program for a given batch are as follows:

S.No	Topic	Problem Identified
1	Securing Cyber Space	Intelligent Threat Monitoring Framework For The Internet Of Things (IoT)
	Objective/Outcome	**Objective:** Classify the IoT based networks based on the architectures and handle threats encountered by them. **Outcome:** Provide a Unified Intelligent Framework based on architecture that focuses on providing Threat monitoring for different IoT based networks

S.No	Topic	Problem Identified
2	Making Solar Energy Affordable	Harvesting Energy Form Wide Range Frequency Signals.
	Objective/Outcome	**Objective:** To harvest the energy available from wide range of frequency signals and increases the yield of solar parks. **Outcome:** Provides a viable approach for power harvesting which will increase the energy generation capabilities of the solar parks.

S.No	Topic	Problem Identified
3	Making Solar Energy Affordable	Harvesting Radio Waves:
	Objective/Outcome	**Objective:** To increase the solar power storage efficiency using efficient battery systems. **Outcome**: Provides cost effective and enhanced energy storage batteries for solar energy conversion and storage systems.

S.No	Topic	Problem Identified
4	Enhance Virtual Reality	Speech Training For Hearing Impaired Children Using Virtual Reality Articulation
	Objective/Outcome	**Objective**: Convert given Text input into three-dimensional visual speech.

		Outcome: An audio-visual 3D virtual articulation system for visual speech synthesis used for training hearing impaired children.

S.No	Topic	Problem Identified
5	Providing Access To Clean Water	Water Quality Monitoring Through Cloud Computing And Treatment By Using Herbal Materials
	Objective/Outcome	**Objective:** To inform the public (stakeholders) about bacterial contamination of water whenever occurred and provide treatment solutions using herbal materials. **Outcome:** People get to know the water quality and they can treat water by themselves with mixing natural herbal materials.

S.No	Topic	Problem Identified
6	Restoring and Improving Urban Infrastructure	Designing and Monitoring Automatic Plantation System For Eco Friendly Environment In Smart Roads Using ICT And IoT Technology
	Objective/Outcome	**Objective:** Monitoring of plants which affects environmental conditions and which influences human health issues in urban road plantation. **Outcome:** Provide an automatic plantation system for eco-friendly environment in smart roads.

GCSP Learning Components & Assessment:

GCSP Proposed Learning Components	Assessment
Team & Individual Project based Learning	YES
Research courses	YES
Internships (Technology/Marketing/ Charity)	NO
Senior Thesis	NO
Design Contests/Competitions	NO
Engineering minor courses	YES
Non-Engineering Courses/Ethics/Patenting	YES
Seminars	YES
Industry visits	NO
Entrepreneurship & Innovation courses	YES
Curricular Courses	YES

Chosen Research problems and complete proposal is available at the following link**:** **https://bit.ly/2VInJdU** [4]. GCSP program enthuse interest among faculty and student fraternity and inculcates the sense of societal need for the hour among futuristic engineering students.

Sample Theme:

Theme: SECURING CYBERSPACE

Title: INTELLIGENT THREAT MONITORING FRAMEWORK FOR THE INTERNET OF THINGS (IOT)

Proposed Courses:

- Professional Ethics
- Computer Networks
- Network Security
- Cyber Security & Laws
- Entrepreneurship Development
- Internet of Things – I Semester
- Intelligent Computing Techniques
- Thesis

Securing Cyber Space (Courses)	Rubric
Design and Develop using knowledge acquired in Computer Networks & Network Security/ Internet of Things	a. Formulation of Research problem relevant to the Theme selected b. Design of approach for an optimal solution c. Implement with a support for a range of applications

	d. Test for conformance to requirements as well as for performance
Cyber Security & Laws Internet of Things	a. Conduct a contact course work for atleast 30 hours per subject and refresh with relevant knowledge b. Conduct mid-term course and final course end assessments to observe the performance (Pass/ Fail as per the prevalent regulations of SVEC)
Internships in Industry to understand real-time problems	NO Assessment
M.Tech./B.Tech./Ph .D Theses	NO Assessment
Internet of Things	NO Assessment
Entrepreneurship Development	a. Conduct a contact course work for atleast 30 hours per subject and refresh with relevant knowledge b. Conduct mid-term course and final course end assessments to observe the performance (Pass/ Fail as per the prevalent regulations of SVEC)
Professional Ethics	a. Conduct a contact course work for atleast 30 hours per subject and refresh with relevant knowledge b. Conduct mid-term course and final course end assessments to observe the performance (Pass/Fail as per the prevalent regulations of SVEC)
Internal Seminars/Presentations	Conduct Review on a chosen topic relevant to Theme and assess based on a. Knowledge in the subject b. Presentation skills c. Practical knowledge d. Conclusion
Visit to CISCO CoE division for IoT/ RV College of Engineering, Bengaluru/ PSG College of Technology, Coimbatore/ ERT Tech, Bengaluru	NO Assessment
Entrepreneurship Development	a. Conduct a contact course work for atleast 30 hours per subject and refresh with relevant knowledge b. Conduct mid-term course and final course end assessments to observe the performance(Pass/Fail as per the prevalent regulations of SVEC)
Computer Networks, Network Security Internet of Things	a. Conduct a contact course work for atleast 30 hours per subject and refresh with relevant knowledge b. Conduct mid-term course and final course end assessments to observe the performance(Pass/Fail as per the prevalent regulations of SVEC)
Cognixia /Course ERA/TEDx etc..	As per Online Evaluation pattern of the service provider and provide a certificate

Details for all other projects are available in NAE-GCSP portal.

5. Conclusion:

GCSP was first of its kind proposal submitted to NAE-USA from India. Thorough study was done in this regard for effective implementation. It has been a breakthrough at SVEC to involve diverse student community from different discipline and encourage them to take up Grand Challenges. SVEC has been promoting the initiative to many other institutions in India to participate in GCSP.

Acknowledgement

We profusely thank management of SVEC for consistent encouragement and support towards our participation in GCSP. Hope our students will make the best use of it.

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