Running CREST Projects

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CREST Awards are organised by the British Association for the Advancement of Science in order encourage young people to get involved in "stretching extra-curricular research projects". There are several levels of award, each level requiring increasing amount of work and sophistication. I have mainly been involved with mentoring the Silver and Gold awards which are usually undertaken between Years 10 to 13.

I have been involve over several years in mentoring teams of yr 10/11 girls aiming for Silver CREST, helping more than 200 to get awards. Each student should expect to do about 30 hours of independent work for a Siver award. They require a fair degree of commitment. (Gold awards require at least 70 hours of work and involve significantly more challenge – often real research. I have known high ability yr 11 teams with exceptional commitment tackling Gold projects, but these are normally more suitable for yr 12/13 who have previously done a Silver and know what might be involved.)

I believe that they provide excellent experience if the project is carefully chosen, since they are probably closer to the type of challenge they will experience in professional working life than anything they will see until after university.

A carefully chosen project needs, in my opinion, to have the following characteristics:

- It should have some relationship to their academic studies. (Ideally, the students will need to find out how the science, technology or maths they study is applied in a real World situation, and/or they will need to read beyond the syllabus to find the knowledge they need.) I am a physicist so I like to see projects which require the application of the basic principles of the subject.
- The project should engage their imagination and motivate them, either because of the gee-whiz nature of the science, or the obvious relevance of the outcome to important contemporary problems.
- The project should require sufficient work that it is impossible for any one person to complete it on their own. They should find that they *have* to work as part of a small team, learning how to divide and coordinate their work. (In my experience 3 to 5 members, with 4 being ideal.)
- It should have real challenge: it does no harm if in the early stages the teams realise that they have taken on something that they do not know how to complete. (It is the mentor's job to provide suggestions at critical points, keeping them moving in the right direction, without telling them how to solve the problem.)
- The problem should be open-ended in the sense that there are a number of possible solutions. None should be considered as the "right" solution. Part of the challenge is for the team to argue that *their* solution meets the original specification.
    - Although there is no right solution, proposals must respect known science and engineering practicality. Some teams produce excellent projects based on interesting applications of of-the-shelf component. We should, however, also encourage “blue-sky” thinking, for example, based on assumptions that cutting-edge technology now being tried in university labs will turn out to work as hoped. (“Soft robotics” is a good example. In the past we have found that “off-the-wall” ideas from some students are turning into reality three or four years later.)
- Although it would be highly desirable for project to have a practical aspect, this can cause difficulties with access to resources, especially if dealing with more than one or two teams at a time which to take part. (Grants to fund equipment are available from time to time from professional societies, and some companies may be prepared to sponsor teams with real money and equipment. However, this does take significant administrative effort from busy teaching staff

and is not always very practicable.) We have found that it is possible to specify challenging paper-based design exercises, allowing groups of up to 40 students (8-10 teams) to work in parallel. Note that this is really very similar to industrial practice, where a number of alternative solutions to a problem are scoped and assessed on paper by different teams. We point this out to students.

Effective support by a mentor external to the school is, in my opinion, valuable. It is essential at Gold level (to deal with technical challenges), and desirable for Silver projects. An industrial mentor brings attitudes, insights, suggestions and knowledge not available to teachers. I am now retired, so no longer an employed industrial engineer. (However, I do not think that my insights and knowledge will decay immediately.)

In the Silver projects I have mentored (usually in cooperation with other industrial colleagues) we usually made several visits. Of course in the pandemic years of 2020 and 2021 things have to be somewhat different, but we are all used to Zoom or MS Team meetings by now, and they can mean that it is easier to find industrial mentors who can take a hour out of their schedule for video meetings, but would find it had to justify travel time for an in-person visit. They are probably here to stay.

- An initial project brief - 30 minutes to 1 hour. I also provide a written project specification and a short written guide on "How to Do a CREST Project" (which is just guidance that I would also give to young professional colleagues running small industrial projects.) By the end of the project most teams admit that they would have saved themselves grief if they had read it more carefully - part of the learning experience!
- The project runs over several months. (The school with which I cooperate sometimes starts the project in April/May of yr 10 and schedules the assessment for the October of yr 11. This includes time over the summer vacation for independent research, and ensures that everything is complete by the time "mock" GCSEs start to figure on the horizon.) We have also scheduled Silver projects to run entirely within the yr 10 academic year. (The truth is that not a lot of team work tends to get done over summer vacations.)
- The teacher in charge could hold weekly sessions in which teams can meet together and the teacher can look out for signs that one or more teams is stuck (or having inter-personal difficulties).
- The mentors need to meet with each team separately for about 20-30 minutes.
    - The first visit gives a push to the teams to get them off the starting block. (Usually at this stage they are struggling to see what to do next).
    - A visit towards the end of the project helps the teams bring their material together for the report.
    - At least one visit in between gives teams chance to talk through technical problems. I have found that they often need a little encouragement to move the project forwards, dropping ideas that are not working and focussing on those which are likely to prove viable.
    - The mentors should also be prepared to answer questions from the teams forwarded by email (via the responsible teacher).
    - Mentors with a day-job often have pressing work commitments and they may not always be able to make themselves available at the right time. Hence, if the school is cooperating with an industrial organisation, it is best if two or three people form the mentoring team to spread the load and give a good chance that someone can be available when required.
    - When mentoring girls it is of course very useful to have a female role model on the team. However, given the shortage of women in STEM employment, this can be difficult to arrange.

- The mentors should if possible comment on draft reports and attend the final assessment presentations by the teams.

Here are a couple of examples that we have used in the past, just to give you an idea of the type of project we have found workable. These two challenges provide good opportunities for teams to extend their GCSE learning and discover the excitement of engineering based on science.

Since we developed the proposals below, some years ago, it is now possible to find *real* example of the kind of solutions that some of our early teams proposed!

Debris Recovery from a Nuclear Reactor

Locate, characterise, pick-up and bring out the suspected debris (all without causing any further damage to the reactor).

Design a method of recovering an irregularly shaped object from the bottom of a nuclear reactor. Access is difficult, through a restricted channel with bends. The environment is hostile (fatal to people and challenging even for electronics). Furthermore, certain materials often used when building robots cannot be taken inside a nuclear reactor.

Students will need to investigate the effects of radioactivity on people and electronics, and how robots can be designed to navigate in difficult confined space, pick-up awkward shapes and survive hostile environment. They might wish to research soft-robotics and bio-mimetics for novel solution approaches.

Extending Human Senses for Working in Dangerous Zones

In parts of the Russia there are old submarine naval bases that are now contaminated with radioactivity and hazardous chemical pollution. They need to be cleaned up – but how are the people who enter such zone to know where there is danger, and where they may walk safely? Can we use devices such as flying drones and autonomous robots to map danger and feed this information to humans in a “live” view using modern technology such as VR head-sets.