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The Dynamic Greenhouse Challenge for Gifted Students

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(Adapted from an article originally published in The Technology Teacher)

Introduction

Greenhouses are marvelous devices, allowing one to enjoy the flower spectacle of summer all year-round. At night, greenhouses use supplemental heat to keep the fragile plants warm. Usually a greenhouse has a large volume above the plants that is generally not used. Could this volume be somehow utilized? The idea here is to envision a multi-level arrangement of greenhouse plants that are exposed to the sun during the mid-day warmth by having the greenhouse structure itself unfold, roll-back, or somehow transform its shape so all the plants inside experience sun on a warm day….then re-fold back up during the night into a compact energy saving arrangement. This is what I mean by a dynamic greenhouse.

Technology Background

Over the last 30 years, greenhouse technology has undergone many changes, with the structures being automated, monitored, and low cost plastic structures emerging as a serious challenge to traditional glass greenhouse designs. Low cost greenhouses use plastic sheeting instead of expensive glass, and also employ various energy saving devices to keep the heat of the day retained as much as possible at night, using only a fraction of the supplemental heat. This design challenge is about developing an idea for a new type of greenhouse, one that opens (perhaps like a flower or some sort of opening structure) and closes at night…..effectively increasing the volume of plants under protective cover at night, through an efficient packing process.

Our first stop is to search the Internet and the library/school media center for an update on where greenhouse technology is today. There are plenty of greenhouse builders and designers out there to get some basic information about what is currently being offered. A variety of colleges with agricultural programs are also places to learn about greenhouse design and innovative practices. It may also be worth a road trip to a nearby greenhouse or greenhouse complex to get a tour and first-hand look at the state-of-the-art.

Time should be taken to delve a bit into the math and science surrounding greenhouse design. How is heat loss from the structure calculated by design engineers? What technologies are now being used to retain the heat that is captured during the day to minimize the need for supplemental heating? Some greenhouse designs use artificial lighting to stretch out the growing time for the plants. How is this accomplished and why does it work? What are its limitations?

Your gifted students will find quite a variety of concepts and ideas for innovating greenhouse design, from new low cost materials through unusual ways to provide supplemental heating to the structures. This is all grist for their creative mills when trying to fulfill the design charge as I have described above.

Designing a Dynamic Greenhouse

I suggest you consider this activity as a team-based one where gifted students have plenty of time to brainstorm and interact, bouncing ideas around and building and combining them. Lots of diagrams and illustrations are welcome to enhance the understanding of what it is your students are envisioning.

There should be no limits as to how dynamic the greenhouse may be designed. Their greenhouse may:

- Rotate
- Open
- Unfold
- Re-shape Itself
- Fold Down
- Slide Apart
- Or any combination of the above.

Gifted students are the masters of their own design. To the extent possible, they should have sound reasons for doing this and justifying it as a means for increasing the packing density of the greenhouse. Careful attention should be given to how much area is required for the greenhouse design both closed and in its dynamic outstretched form.

- Can this dynamic state be reasonably achieved?
- Is the technology proposed available?
- Will the dynamic action be performed by humans or automation?
- When during the time of day and season does the dynamic greenhouse operate?
- Are there specific areas of the country that limit the daily dynamics of the greenhouse by season?
- Can the greenhouse remain in the dynamic mode during the summer?
- Are there any special conditions for the foundation or floor of the dynamic greenhouse?
- What happens if bad weather persists for an extended period, and the greenhouse cannot be opened?
- With many plants packed so close together, how would disease infestations and break-outs be handled?
- What technologies might the greenhouse employ to stimulate greater plant growth?
- Are there certain plant species that might grow best within this dense or concentrated volume greenhouse?

These are but a few quick ways to challenge student-team thinking. They should be thinking about how the greenhouse will operate as much as how they can design and build it. If the class is able to visit a greenhouse and talk to someone experienced with greenhouses, make sure that person discusses the daily and seasonal routines that typically occur in a greenhouse, and why. Also learn about the kinds of skills and manpower normally employed in a commercial greenhouse, and what can and cannot be automated.

Cardboard models should be allowed so concepts may be envisioned in three dimensions. To the extent that your class has access to computerized modeling software, graphic representations of their concepts are another excellent way to get ideas across to other class members.

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It is now popular to have small greenhouses attached to a home. Could some of the ideas generated by your gifted students be employed on a smaller scale in these add-on greenhouses?

Have a sunny time with this design challenge!