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NORSTAR
Student Research Institute

***N**orfolk Public Schools **S**cience & **T**echnology **A**dvanced **R**esearch*

The NORSTAR Program: Space Shuttle to Space Station

by

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Abstract

Updating the development of G-325, the first high school student-run space flight project; and an overview of a new international program, which involves students from space station countries who will be utilizing GAS technology to cooperatively develop a prototype experiment for controlling a space station research module environment.

Part 1. The NORSTAR Student Research Institute

The NORSTAR project has developed at an incredible rate since last year, and the Get Away Special project has become an ongoing program. The original NORSTAR Project, which is the first high school student-run space flight project, has evolved into a major science development program in the Norfolk, Virginia Public School system. As a result of presentations made by NORSTAR students to various academic and professional groups, school officials witnessed the high level of skills attained by the students. Springboarding from the success of this GAS experiment project, a proposal was accepted to support the development of a creative, innovative, exciting, and highly visible community oriented program for the advanced sciences. The recommended program was designed to foster excellence in science education in the Norfolk Public School (NPS) system, by developing a student research institute evolving from the NORSTAR Project. It was an excellent time to develop the "NORSTAR Project - Space Shuttle Experiment" into the NORSTAR Student Research Institute. The absolute goal of the NORSTAR Program is to develop the full potential of the student, realizing the highest ideal of education. This program would be similar in some respects to a high technology magnet school within the NPS system, attracting the attention and support of world renowned scientists and researchers, and industries throughout the country.

The need and desire for superlative programs fostering excellence in science education has been established by a host of national educational committees. The original NORSTAR project was the dawn of a new age of excellence in science education utilizing community involvement. The new NORSTAR program represents the full sunshine in the development of one of the finest educational programs that a city could offer to its family of students, parents, teachers, administrators, and society. The program is, by its nature, open ended and flexible enough to adjust with the rapid changes in technology and society. Through this program, the NORfolk, Virginia public school system has become a STAR in education through innovation, enthusiasum, and interaction with the community.

NORSTAR division curricula incorporate a multidisciplinary, integrated approach which facilitates the most effective learning processes for areas of study including physics, mathematics, computer programming and applications, chemistry, and communications skills through a team approach to solve problems. The teaching environment becomes the actual work environment in which students develop important process/problem solving skills. Perhaps the greatest benefit of the program is the development of life-long process skills, learned in a practical, hands on, exciting experimental environment. Skills include communicating, analyzing, being constructively critical with a proper analytical attitude, receiving and utilizing criticism constructively, responsibility for real time tasks and schedules, and working as member of an integrated team. Students involved with the Student Research Institute are conducting meaningful scientific research for publication, in cooperation with professionals from NASA, the educational community, and industry.

The NORSTAR Student Research Institute currently includes the Space Shuttle Experiments, Robotics, SEER System, and Teacher Research Divisions. Projected programs include the Arts & Sciences Research, and Laser/Fiber Optics Divisions (see Figure 1).

CURRENT DIVISIONS

SPACE SHUTTLE EXPERIMENTS DIVISION

Current work in this division includes the original NORSTAR Project, which is the first high school student-run space flight project ever attempted. The project includes the definition, design, fabrication, testing, analysis, and publishing of the results of an acoustical experiment which will fly on a space shuttle as flight opportunities become available. The experiment has implications for the aviation and space industry in that it tests the process in which an ultrasonic sound field is used to detect flaws or weaknesses in solid structures such as the wing of a jet aircraft (see Figure 2). Future plans for GetAway Special experiments include further ultrasonic/acoustical tests; laser copolymerization studies, and robotics/artificial intelligence applications.

ROBOTICS DIVISION

This program allows students to develop the fundamentals of computer operations and programming, the operation and interface between computers and industrial robotic systems, and the applications and operation of industrial robots. Special projects include the development of space flight experiments in conjunction with the Space Shuttle Experiments Division, and work with mentors from NASA and other agencies on the development of space station robotics technology.

SEER SYSTEM DIVISION

The SEER (Space Station Environmental Expert Research) System Division represents an international, cooperative program including the Space Sciences Academy, Stanford University, NASA Langley Research Center, NASA Ames Research Center, and the Norfolk, Virginia Public Schools. This program currently involves students and teachers from the United States, Norway, and France. Science and educational groups have been approached to develop student teams in Canada, Great Britain, W. Germany, and Japan. Students are developing an artificial intelligence expert system to monitor experiments in remote environments. The development of a telescience operating system is being developed through the guidance of Stanford University. Students will be working with scientists and college students from the various supporting institutions throughout the entire development process of the experiment, including flight and post flight analysis. A flight opportunity for the student developed experiment is being sought after through various

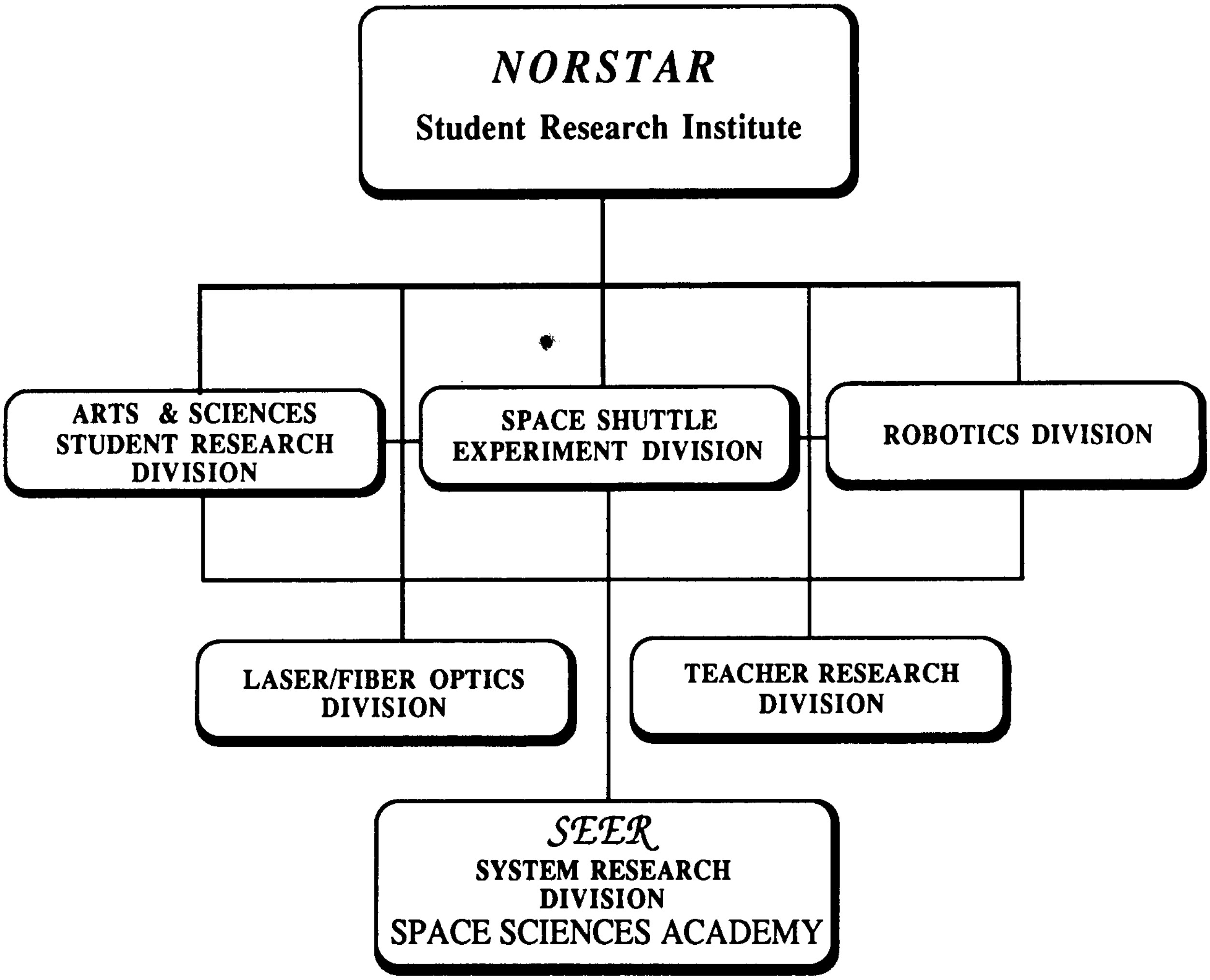


Figure 1. NORSTAR Student Research Institute Divisions

organizations. The SEER project is discussed in more detail later in this article.

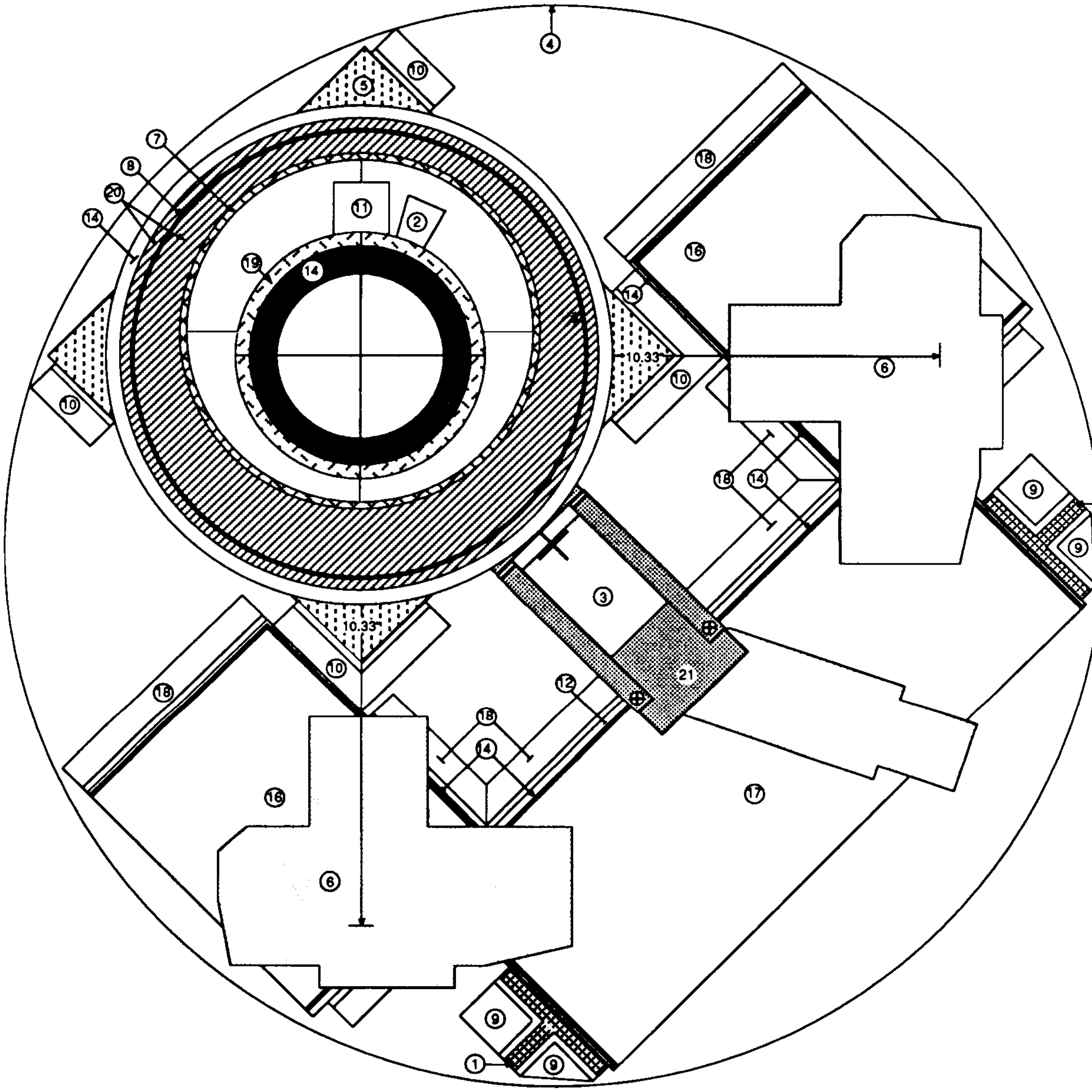
TEACHER RESEARCH DIVISION

This division gives teachers an opportunity to conduct their original research in all fields of study, including research for advanced degrees. The teachers have access to all NORSTAR Program facilities, including equipment, databases, and community resources.

PROJECTED DIVISIONS

LASER/FIBER OPTICS DIVISION

Laser and fiber optics technology will be the focus of this division. Students will study the science of state-of-the-art laser and fiber optics technology, while special projects will include the development of a space flight experiment in conjunction with the Space Shuttle Experiments and Robotics Divisions.



TOP VIEW NOTES

1 T-bars (28.25"L)
2 Expansion device
3 Strobe
4 Outer diameter of mounting plate (19.75"D)
5 Electronics box (8.0"L x 8.0"W x 4.0"H)
6 Camera (see camera mounting drawing)
7 Retaining cylinder(inner radius = 6.25", outer radius = 6.50"; 22.625L)
8 Test Cell wall (inner diameter = 8.125", outer diameter = 8.1875"; 22.875"L)
9 T-bar mounting brackets
10 Electronics box support
11 Sphere containment system
12 Main battery support plate (18.4375"L; 0.125"W; 15.35"H)
13 MSC (inner diameter = 8.625", outer diameter = 9.125"; length = 27.75")
14 Insulation and sound absorbing material (RTV rubber)
15 Test Cell wall (inner diam. = 8.125"; outer diam. = 8.1875"; 22.875"L)
16 4-Pack of batteries (Duracell industrial alkaline ID9260 : 4.565"L;5.5875"W; 15.35"H)
17 8-Pack of batteries (Duracell industrial alkaline ID9260: 12.0375"L;4.5025"W; 14.0125"H)
18 Battery mounting brackets
19 Test cell (Diam.=4.5"; 19"L)
20 Injected foam insulation (A & B foam)
21 Strobe support

Figure 2. Top View of GAS-325 (1:3)

ARTS & SCIENCES RESEARCH DIVISION

Original research performed by students with practical applications to community problems is the focus of this division. Experiments providing real local benefits include water sampling and analysis, atmospheric particle sampling and microscopy for the Tidewater waterfront and outfall areas, anti-fouling paint studies, traffic flow study, and survey and marketing studies. Advanced research will also be conducted in research fields related to visual arts, lasers and holography, music, artificial intelligence software development, creative writing, speech/voice synthesis, marine sciences, and materials characterization.

FUTURE DIVISIONS

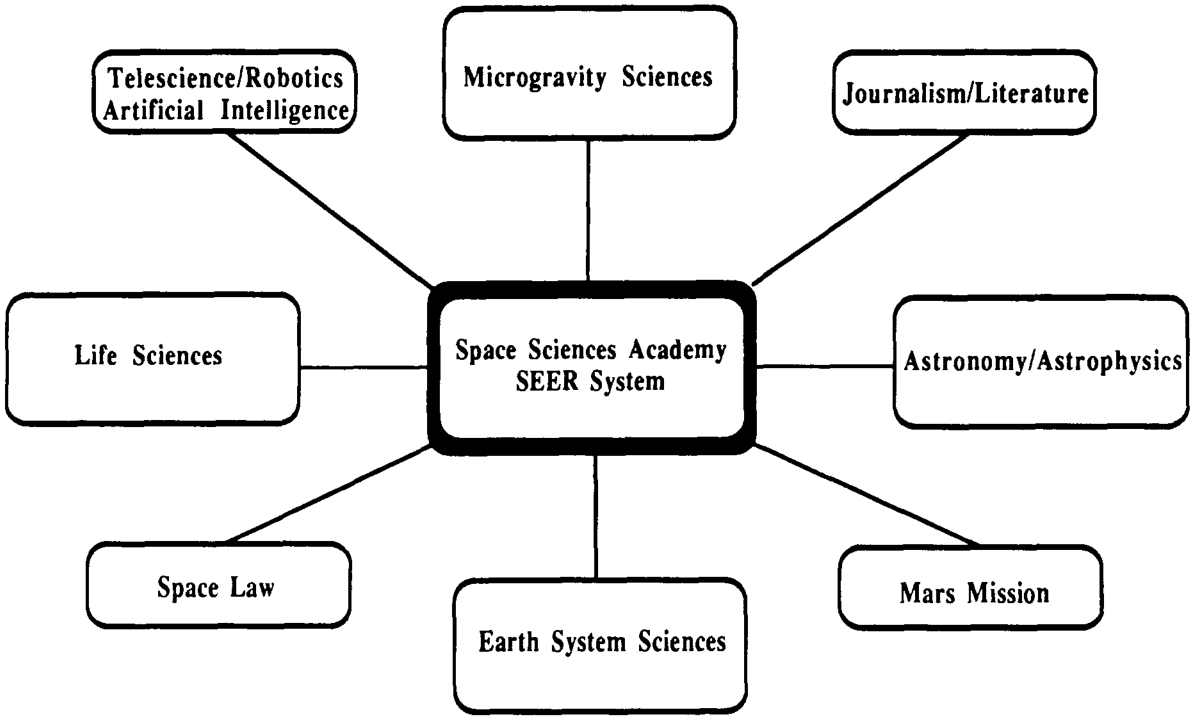
Future divisions of the NORSTAR Student Research Institute are in the developmental process.

Part 2. The SEER System Project

The SEER (Space Station Environmental Expert Research) System Project is an exciting, innovative student project designed to promote international cooperation. If high school students from around the world could learn to work cooperatively on an experimental project, then we would truly be preparing them for the space station era. The SEER Project was developed at an intensive four week Space Sciences Academy held at Stanford University during the summer session. The multidisciplinary, integrated curriculum of the academy was developed by NASA Teacher In Space finalists, utilizing space science and technology . A full range of disciplines were taught, including astrophysics, computer programming, robotics, creative problem solving, space law, bioflight, journalism, communications, etc.
(see Figure 3). All subject areas were related to space sciences, and integrated into a coherent curriculum for the most efficient transfer of understanding to the student. The program taught by Ron Fortunato (NASA Teacher In Space finalist, Virginia) was to teach the students how to develop a space flight payload, similar to the NORSTAR program in Norfolk, Virginia, where students are working on a GetAway Special payload. An international team of students was formed into a space flight project organization, and professional mentors were sought after for the students, from NASA, space station contractors, and academic institutions, covering the broad range of expertise necessary to develop a payload. A communications network was established under the sponsorship of CompuServe, which allows students and mentors from all over the world to send messages, files, and hold live conferences in the Space Education Forum. This way, any student with access to a computer and modem could participate in the project, even after the Stanford academy was completed. Currently, students from all over the United States, France, and Norway are linked to the computer network. Educators, scientists, and interested professionals are currently being approached to form student teams in Canada, Japan, England, West Germany, and Denmark. A flight opportunity to send the student experiment into space has been requested from the NASA Langley Research Center, in the form of an additional Get Away Special canister, or to have the payload added to an existing NASA payload (LITE - LIDAR In Space Technology Experiment).

SEER project development is twofold, consisting of an artificial intelligence/expert system, and an experiment payload to test the computer system. Students are working on both aspects simultaneously, with student teams responsible for the development of certain components, and ground-based experimentation to build a control database. The basic definition of the SEER system is:

1. To program an Expert System to control the environment of a simulation of a (telescience) experiment flying in the Space Station Laboratory Module. The program should maintain an optimum environment under normal conditions. It should be able to handle emergencies such as puncture by a



Workshops

Flight Operations/Mission Planning
Bioflight
Entrepreneurial/Economics
Creativity
Space Studies Institute
Careers & College Planning

Figure 3. Space Sciences Academy Curriculum Organization

micrometeor, sudden changes in heat flow, and disrupted water flow.
2. To dynamically expand the knowledge base and capabilities of the AI program, making possible control of the environment of diverse experiments with a minimum of special programming; non-environmental concerns will be taken care of by a dedicated controller or by telescience.
3. To design real-world interfaces for the AI system, enabling the environmental control of actual experiments rather than simulations.
4. To design user-friendly methods of supplying the AI system with experiment specifications, so that a layman can modify it to interface with a variety of experiments.
5. To design and construct a set of experiments for flight on a Space Shuttle experiment pallet, testing the control systems of the AI system in space.

Once these steps are successfully completed, we will have a system capable of "intelligent" control of the environment in a space flight payload, or perhaps a Space Station Laboratory Module. This type of system could replace supervision by a mission specialist or technician in cases where experiments are too hazardous for direct supervision, yet decisions must be made immediately in case of a malfunction.

The experiment that will test the SEER system has been named V-GER by the students. V-GER, an acronym for Variable Gravity Aeroponics Research project, refers to the Voyager probe in the first Star Trek movie. The V-GER experiment will make plant growth observations of an expert system controlled aeroponics experiment in a variable gravity environment. The experiment will monitor the effects of different gravity levels on the following plant growth aspects: growth rate (in height and mass over time), oxygen and carbon dioxide production/use (atmospheric breakdown over time, average respiration per plant unit mass), fluid and nutrient transport (using a dye in the nutrient solution, pattern of stained water in leaf, tissue analysis), cell division rate (root tip densities of dividing cells, other tissues), cellular mutations (tissue analysis), chemical content of plants (plant nutritional values and lignin amount checked through bioassay), morphology, stem/base/mesh growth angles of the root systems, and germination percentage. Since it is probable that more than one kind of plant will be tested, the success rates of different plant species will also be observed. A future experiment may actually deal with testing the plants for vulnerability to diseases (microorganism resistance).

The canister on a larger scale would represent the greenhouse which will meet the agricultural needs of the Space Station. The knowledge gained in the variable gravity aeroponics experiment would be quite relevant in designing a plant growth facility for a Space Station - at the least, the data could be used to confirm the findings of other experiments. Multiple gravity levels would be applied in order to develop data pertaining to different space ventures: zero-gravity for space flight, one-sixth gravity for the moon, one-third gravity for Mars, earth gravity for control, and possibly one-hundredth or one-thousandth gravity for an asteroid mining operation or small moon (see Figure 4).

The critical aspect of the project is the expert system which will control the experiment environment. This computer system will change the environment if necessary to ensure maximum plant growth. Like an aeroponics expert, the system must react to each and every detrimental situation. This program may be modified for use in other microgravity experiments. The Space Sciences Academy students are developing this artificial intelligence expert system to control and maintain the following environmental parameters: atmospheric gas concentrations, temperature, pressure, humidity, lighting, and nutrient spray intervals. Environmental requirements include: atmospheric concentrations - 78.9% nitrogen, 20.8% oxygen, 1000 parts per million carbon dioxide; temperature - 25°C ± 2°; pressure - 1 atmosphere; humidity - 80%-90%; lighting - 1/4 to 1/5 full sunlight.

The SEER Project is sponsored by the Norfolk Public Schools Gifted Program and seeks comments from those in the space and educational community who would be interested in this experiment and wish to collaborate. Any correspondence with the NORSTAR Student Research Institute is welcomed, and may be addressed to:

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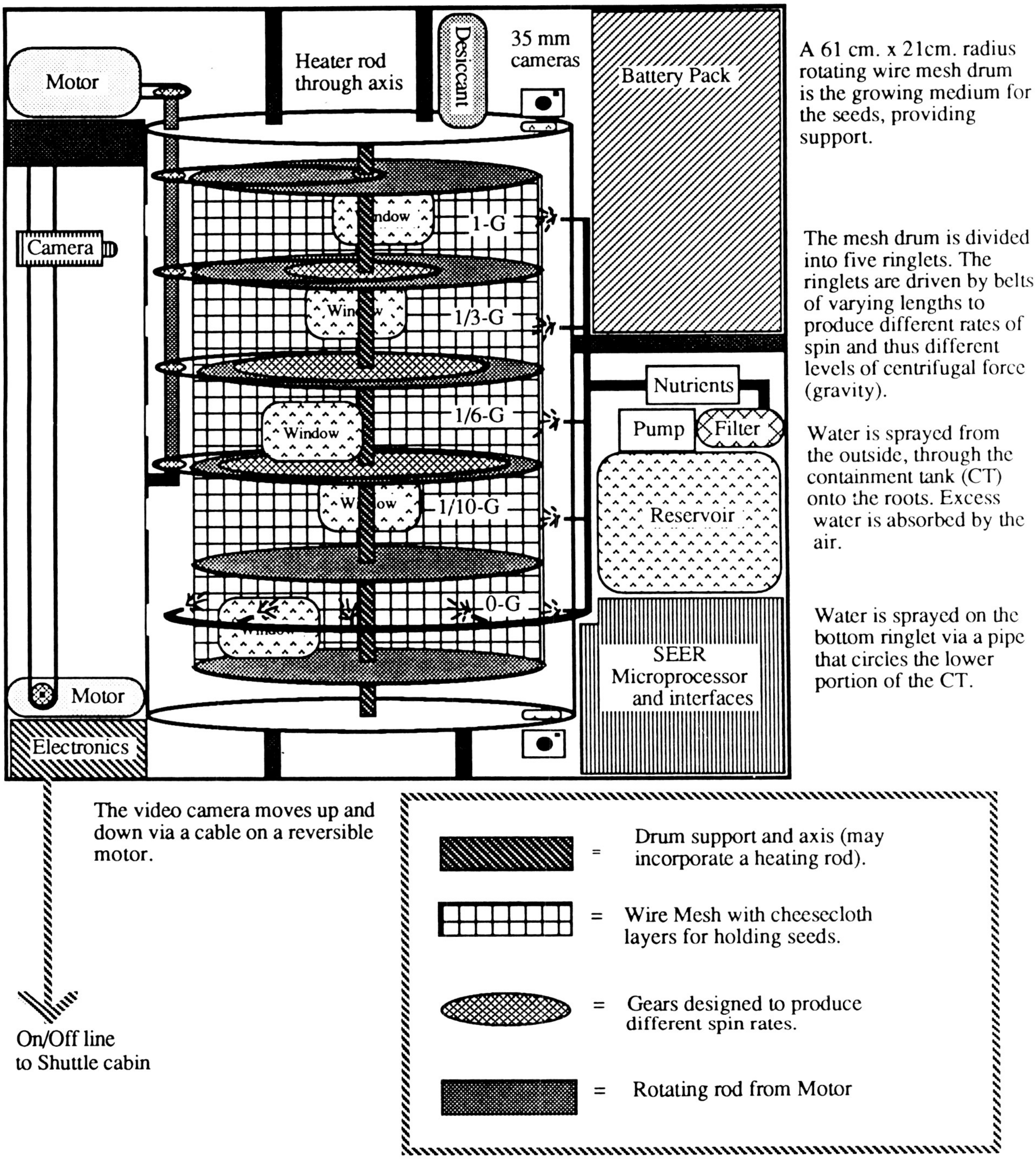

Figure 4. V-GER Experiment Schematic