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ABSTRACT

A laboratory summer workshop in materials engineering for high school seniors is discussed. Held at North Carolina State University, the workshop is designed to enlighten university-bound, science-oriented high school students to materials science and engineering, and to construct communication links with high school faculty. The workshop consisted of two-hour experiments which maximized student physical involvement. Seven experiments are described. (MLH)

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CAREER GUIDANCE IN MATERIALS ENGINEERING: THE SUMMER WORKSHOP CONCEPT

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CAREER CUIDANCE IN MATERIALS ENGINEERING: THE SUMMER WORKSHOP CONCEPT

For the past three years, the Materials Engineering Department of North Carolina State University has conducted a laboratory workshop for rising high school seniors. Approximately 10% of the students who attended have matriculated in the department just prior to or during their freshman year. The goals, philosophy, preparation, structure and results of this endeavor form the substance of the remainder of this paper.

The motivation for the workshop stemmed both from declining departmental enrollments during the early nineteen seventies as well as the desire to achieve two long-standing and complementary goals of our department: the enlightenment of university bound science oriented high school students and their mentors to the existence and opportunities in Materials Science and Engineering, and the construction of academic bridges of rapport with pertinent high school faculty. It is important from a historical viewpoint to note that techniques such as televised films on materials oriented topics, direct consultation with teachers, etc., in which the materials department had presented its case within the boundaries of the high school environment and its constraints simply had not been effective vehicles to increase the enrollment. This was our first effort to introduce high school students to the subject of materials on a laboratory basis with an extended allotment of time in an university environment not unlike that encountered by the college student.

The prevailing philosophy and thrust of the workshop have been the utilization of various types of concurrently running two-hour experiments in which the students physical involvement is maximized. Furthermore the initial brochure encourages, and the faculty assumes, that the students will have taken at least one course in the physical sciences prior to the workshop. The experiments are therefore specifically designed such that the concepts and procedures draw from and supplement this existing knowledge for their understanding. Finally, the experiments are to be moderately short with plenty of time for the more serious students to discuss the complete laboratory in greater depth with a particular faculty member.

Our initial efforts followed the scenario of 1) the preparation and mailing of announcement brochures to principles and guidance counselors already known or selected from forty high schools of varying size and geographical location within the state, 2) the reservation of space in a dormitory nearest the workshop area, 3) the planning and implementation of the workshop program, and 4) a student-faculty critique of the entire program. The brochures explain the philosophy of the workshop noted above, describe the various experiments and scientific concepts involved and note other essentials such as who should attend, cost of workshop and other expenses, and contain an application blank to be returned by a certain date. Letters of acceptance with registration details are subsequently sent to each applicant.

The students reside in a coeducational setting without supervision (other than the dormitroy counselor) and are allowed to bring automobiles. The "registration fee" represents the cost of the dormitory room rental and linen fee. No student expenses are underwritten by the department; however, a free "get acquainted" dinner is held in the beginning for both students and faculty. Each student is assigned a faculty advisor in case of an emergency and as an identifiable person to whom questions may be directed concerning any aspect of university life. Certificates of completion are awarded at the close of the workshop.

The critique noted above has informed the faculty in a positive way of the strengths and weakness of the various experiments, and has alerted the workshop coordinators to desired changes necessary for a better program. As a result of this critique, several experiments were modified and the workshop was expanded from the initial 3-day period to a 5-day period with registration on Sunday afternoon. This latter change allowed both an increase in the number of experiments as well as more free time for the students to meet with individual faculty and to explore the campus and city. Topics of the experiments currently conducted and their scientific and engineering relationships are shown in Table I below:

TABLE I.
LIST OF EXPERIMENTS USED IN MATERIALS WORKSHOP

1. MECHANICAL PROPERTIES AND FAILURE ANALYSIS - Science: Hardness, strength, toughness, stress, strain, fracture, wear and abrasion.
2. FABRICATION AND TESTING OF GLASS AND A CERAMIC SEMICONDUCTOR - Science: Chemical and thermal reactions, glass structure and properties, measurements of the electrical properties of a semiconductor ($SrTiO_3$).
3. THE MICROSTRUCTURE OF METALS - Science: Chemical reactions in the solid state, principles of microscopic examination, microstructure of metals and alloys, physical alteration of microstructure.
4. THERMAL SHOCK OF MATERIALS AND ENAMELING OF METALS - Science: Heat transfer, strength, thermal expansion, microstructure. Rheology of enamels, chemical reactions, interfacial bonding.
5. CRYSTAL STRUCTURE OF MATERIALS AND COMPUTER APPLICATIONS IN MATERIALS SCIENCE - Science: Unit cell, atom arrangements, defects in solids. Computer analysis of the electrical data of Experiment 2.
6. CORROSION OF METALS - Science: Chemical reaction, oxidation, reduction, electrochemical processes.
7. PHASE TRANSFORMATION IN METALS - Science: Allotropy, structural and thermal changes, diffusion of atoms, nucleation, equilibrium, kinetics.

The major change from the initial regimen has been in the method of student recruitment because of the heterogenity of student interests in the initial group (biology, chemistry, zoology, etc) and because

of the recalcitrance of high school officials to provide the proper teachers with the workshop information and brochures. Although our initial cooperative contacts are still solicited for help, the bulk of our enrollment (now approximately 80) comes from direct mailings to students whose names and addresses are provided by the Princeton Testing Service. This service (entitled the spring search), for a nominal fee, will provide a participating university with an alphabetical list and mailing labels imprinted with the names of students within specified scholastic limits (ours are 85% and above), the geographical boundaries and other student characteristics defined by the university department, and who have indicated engineering as a career choice on the PSAT and NMSQT tests. This service has eliminated considerable work and frustration, and allows workshop personnel to work with students who are very likely to enter the field of engineering.

The single most important factor in the success of any endeavor of this type is a cooperative departmental faculty willing to spend a portion of their summer recess or research time in a somewhat repetitive time-consuming exercise. The coordinators have learned from experience that a week is the optimum time for a workshop of this nature, that placing the students on more than one floor of a dormitory increases the potential for disturbance, and that a buffet dinner on registration evening with the students and their respective faculty advisors grouped together is better than a picnic in which people (including the faculty) arrive, eat and leave without really meeting each other. The above dinner also allows a one day advancement of

introductions and opening remarks which normally come just prior to the frist experiment and are addressed to students who may have had approximately four hours of sleep their first night. The authors have also found that a scheduling compromise may be necessary between those faculty who want a lunch break after the first experiment and those who wish their afternoons free, that the presence of automobiles is not deleterious to the workshop environment, that two hours is an optimum time for each experiment if the group is comprised of 8-10 students each and that students do provide very helpful criticisms and ideas for planning subsequent workshops.

It is very important for the faculty to present an atmosphere of concern for the students enlightenment in the subject of materials rather than their departmental enrollment. The experiments themselves should be the primary subliminal magnet which later may attract the students' matriculation into the field of study. Sympathy with and discussion of a students' vocational search as well as complaints about food, hot rooms, uncomfortable beds, noise and lack of equal percentages of the opposite sex may, in many cases, be a better vehicle of recruitment than all the experiments combined. Finally, encouraged and even scheduled visits to other attractions on campus such as a nuclear reactor are also a vital part of the overall program.

The enrollment results of our program have been 5% from the first year and 11% from the second which in relative terms will evoke different reactions from different people. One rather important spinoff of this project has been the solicitation of our help in presenting talks and

science demonstrations by the faculty members to one of the senior high schools in the Raleigh area. The attitude of the departmental faculty members toward this endeavor as a vehicle of recruitment has remained positive. This is in part catalyzed yearly by the enthusiasm of the students chosen to attend. If nothing else, the workshop endeavor provides many lessons in the art of dealing with students who are openly and sometimes desperately trying to chose between career alternatives.

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