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# **THE MARYLAND GEMSTONE PROGRAM**

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## **ABSTRACT**

The Maryland Gemstone Program is a unique four-year honors program in which undergraduates from all majors are teamed together in groups of 10-15 students and challenged to address some aspect of a major societal problem containing technological, social, ethical, and business elements. At the conclusion of the program, each team submits a team thesis, which is reviewed by academic, corporate, and governmental representatives. Upon successful completion of the program, Gemstone students receive their undergraduate degrees with a special Gemstone Citation. The process of curriculum development, research project management, and particular lessons learned from the first cohort to complete the program are summarized.

## **INTRODUCTION**

The Maryland Gemstone Program was conceived with the goal of addressing two perceived shortcomings in current undergraduate programs. The first is the failure of undergraduate programs to provide any kind of meaningful intellectual thread linking the students' program from start to finish. In too many cases, an undergraduate degree program is perceived by those enrolled as a degree completion process in which they take so many courses from area A, so many from area B, and so forth. Course sequences, when they exist, rarely comprise more than two sequential offerings, and even in those cases many students are not entirely convinced that the second course is related to, and should therefore follow, the first. The second problem which the Gemstone Program is intended to address is the failure of our undergraduate programs to provide meaningful intellectual contacts between students in engineering and the sciences and those in the social sciences, the humanities, and business. Even traditional Science, Technology, and Society programs, as valuable as they are, are usually designed to expose students with strengths in the humanities and social sciences to technology issues and vice versa, rather than to engage students from the various majors together in an intellectual process in which each brings his or her own talents and interests to the task in a complementary manner.

A further motivation for the program arises from the author's belief that society has not been as effective as it might be in utilizing the assets available across a broad intellectual spectrum in addressing societal issues. The evolution (or devolution, perhaps) of nuclear power in the United States is a clear example of a situation in which the development of applicable technologies would have greatly benefited from the input of social scientists, including economists, sociologists, and psychologists.

The Maryland Gemstone Program is intended to address each of these concerns. In summary, it is a unique four-year honors program in which undergraduates from all majors are teamed together in groups of 10-15 students and challenged to address some aspect of a major societal problem containing technological, social, ethical, and business elements. At the

conclusion of the program, each team submits a team thesis, which is reviewed by academic, corporate, and governmental representatives.

The program was conceived in 1994, and funding was quickly garnered from the GE Fund and the A.T.&T. Foundation to support a four-year experiment in which a program was to be developed and a single cohort recruited and tracked through the program to determine if the concept was viable. In order to identify a cohort to start the program in the fall of 1995, a group of students already admitted to the University of Maryland Honors Program was selected and formally invited to participate in the program. Using the usual yield figures for honors admittees, the number of invitees was chosen with the goal of achieving a first cohort of 60 students. Surprisingly, 113 students accepted the invitation with an average SAT score of 1420, effectively doubling the yield rate of such academically gifted admittees to the University. As a result, the University, in something of a leap of faith since at that time Gemstone was more of a concept than a program, immediately embraced the concept and pledged institutional support for a continuing program so that students could be recruited during the next, and subsequent, academic years. Since the author was dean of engineering at the time, the Institute for Systems Research, a cross-disciplinary research and education institute within the Clark School of Engineering at Maryland, was chosen as the administrative home for the program, and a team of faculty from across the campus was recruited to begin putting the program together.

Although the program was not initially planned to be a living-learning program, first year admittees to the program were invited to live together in Ellicott Hall, and nearly 100% exercised this option. Ellicott is an older-style residence hall with double rooms, but first- and second-year students enjoy the easy social interaction and the ready access to team members for meetings, etc. In academic year 1998-99, the basement of Ellicott was renovated to provide a number of specially equipped team meeting rooms with installed computers and audio-visual equipment. Since that time, student enthusiasm over the benefits of living together has resulted in most Gemstone program participants opting to live together in Ellicott for their first two years at the University. The University is currently constructing an upper-class residence hall for Gemstone students with apartment-like amenities not available in Ellicott. It has been our experience that upperclassmen prefer such facilities, although the Gemstone junior and senior students still usually wish to live together with their team members or other Gemstone students.

In each subsequent year, the Gemstone Program has shown itself to be an extraordinarily attractive program to talented applicants to the University. At the present time about 700 students are enrolled in the program with an average SAT of about 1430, by a wide measure the most talented cohort ever attracted to a single educational program at the University of Maryland.

## **THE CURRICULUM**

Although several of the Gemstone courses meet core curriculum requirements for an undergraduate degree at the University of Maryland, it is important to note that all Gemstone students complete all regular degree requirements for their major. This was an important factor in obtaining the support of all of the Deans of the various colleges for the program, since no curriculum compromises were required from any of their programs.

The initial curriculum for the program included a special version of Maryland's freshman engineering design course to introduce teaming concepts in the first semester, a 1- credit course in the second semester in which possible research projects were explored and teams were

formed, and three core academic 3-credit courses centered on technology from historical, social, and business perspectives. In addition, starting in the third semester, each team met weekly with a designated faculty mentor in a 1-credit team project seminar. Progress reports were presented by each team at the end of each semester, including a final team thesis presentation at the end of the eighth semester to a review panel composed of academic, corporate, and government representatives.

During the third year of the program, input from the Gemstone Student Advisory Group, an elected group established to provide continuous student feedback on the program, resulted in significant curriculum changes. Students reported that they felt that the three core courses on historical, social, and business perspectives on technology were limiting their own core elective choices and taking student time away from the multi-year team research project, which was always intended to be the heart of the Gemstone Program. They also requested more attention to team dynamics and research methodology. As a result, the curriculum was changed in the fall of 1999 and the three core courses were replaced with a single core course, combining essential elements from the three previous offerings, to be taken in the second semester. In addition, the special version of the freshman engineering design course for Gemstone students was replaced with a course on team dynamics and research methodology offered in the third semester. In the first semester, students were required to enroll in a one-credit honors seminar on the responsibilities of a liberally educated person. This course is intended to provide an early introduction to ethical issues associated with scholarly research. An elective course on leadership issues was also introduced. The remainder of the program, including the 1-credit team project seminars and the research project exploration seminar in the second semester, was retained.

## **FINDING TEAM MENTORS**

In a program which, in steady state, involves 40-50 student teams, identifying appropriate faculty mentors is a significant challenge. This is a primary responsibility of the Gemstone Program Director, Prof. Christopher Davis, who is a highly respected senior faculty member who, among other significant campus duties, has been Chairman of the College Park Senate and therefore is well acquainted with the faculty across the intellectual spectrum. As an incentive to those faculty willing to serve as team mentors, Dr. Davis can offer either modest overload compensation during the academic year, partial summer salary support, or partial support for a graduate student working under the supervision of the faculty mentor. Nevertheless, faculty agreeing to serve as mentors to Gemstone teams are making a three-year commitment, which in many cases can be difficult in the face of sabbatical plans, etc.

Despite these obstacles, faculty who have signed on as team mentors have in most cases become enthusiastic promoters of the program and have found their interactions with these exceptional students to be as gratifying as any experiences they have had in academia.

## **STUDENT RETENTION**

Student retention was a matter of considerable concern from the outset of the Gemstone Program. The challenge of keeping student teams at work on research projects for more than three years was seen as the biggest obstacle to the success of the program, and concerns were raised over such issues as how to maintain critical mass within a team if a number of team members dropped out, how to deal with the loss of particular expertise if critical individuals left

the team, etc. Initially, some ideas were proposed for allowing limited numbers of upperclassmen not originally admitted to the program to join teams to fill critical vacancies, but that has not proven necessary, as student retention has exceeded expectations

### **Gemstone Program Student Retention AY96-99**

	1996	1997	1998	1999
Initially Enrolled	113	171	159	199
% Retained to date	69% (Graduated)	84%	86%	93%

As is evident from the retention data, Gemstone Program retention is apparently improving as the program matures, with the predicted retention rate of those in the 1997 class graduating in the spring of 2001 at greater than 80%. The actual graduation rate of students admitted to the Gemstone Program as freshmen is even greater, since most of those students who drop out of the program do so to concentrate on their major and end up graduating with their Gemstone classmates.

### **TEAM ACCOMPLISHMENTS**

To date, Gemstone student teams have tackled a wide variety of societal issues and problems, including flexible manufacturing, the psychological impact of long-term computer use, personal genetic testing, nuclear and other waste disposal, desensitization to violence through youth education, antibiotics and resistant bacteria, improvement of the national K-12 curriculum, urban mass transit, privacy and security in the internet, information technology and medicine, biological computing, affordable public housing, prisons: rehab or storage, manned mission to Mars, reclamation of the Chesapeake Bay, managed health care, life at all costs, innovative power sources, and the nation's crumbling infrastructure. Many of these teams are still at work, but a number of them have already achieved notable results; for example:

1. The Urban Mass Transit team designed a GPS-based tracking system to allow bus travelers waiting at any stop to see the location of any bus on their route on a graphic display at the bus stop. This concept was developed to counter the frustration of mass transit users generated by their inability to know when, if ever, a bus will arrive to pick them up. This concept was tested on the University's extensive shuttle bus system.
2. The Nuclear Waste Disposal Team presented a paper detailing an integrated approach to nuclear waste disposal, including both technological and social factors analysis, at the 2000 annual meeting of the American Chemical Society and received the "Best Paper" award at the conference.

3. The Mission to Mars team was one of five teams nationally chosen by NASA to develop an exploration program for Mars, and presented their findings at NASA's Houston Space Flight Center.
4. The Beacon project team developed a GPS-based tracking system employing ankle bracelets to allow law enforcement agencies to track prisoners on work release or home-detention programs. This group is currently forming a startup company to exploit this technology commercially.
5. The Flexible Manufacturing team presented a paper at the 1998 Artificial Intelligence & Manufacturing conference in Albuquerque.

As expected, however, team accomplishments are uneven in quality and depth and remain crucially dependent on the quality of team mentorship provided. In general, students are told that reasonable team outcomes should normally include empirical research with appropriate findings and conclusions, the production of a scholarly paper to be published or presented at an appropriate conference, prototype construction and testing where appropriate, and possibly the initiation of appropriate legislation at the local or national level.

## CONCLUSIONS

The Gemstone Program is still too new to allow definitive conclusions to be drawn, but the initial results of this very ambitious educational experiment are encouraging. The Program has proven to be exceptionally attractive to talented students and has been instrumental in raising the profile of the University of Maryland's undergraduate student body. Student retention in the program has exceeded expectations, and only one team to date has failed to carry their project to completion.

Students involved in the program continue to be enthusiastic (and a bit elitist) about their involvement, and the successes of some of the graduating teams are proving to be a powerful motivating factor for the underclass teams. Campus support for the program continues to be strong, and current institutional support for the program is about \$500,000 annually.

A more conclusive evaluation of the program should be possible in 2-3 years, when several Gemstone classes will have graduated and information on their subsequent employment and/or further education is available.

For more information on the Gemstone Program go to our web page at [www.isr.umd.edu/gemstone](http://www.isr.umd.edu/gemstone).