Strategy for Space Science

Criteria for a Successful Strategy

The following are a set of four criteria for success against which the strategy should be judged.

1) **The opportunities for success are available and not currently dominated by some other organization.** The purpose of this strategy is to excel. We will be unlikely to excel by copying what others, such as CU and UCB, are doing.
2) **The opportunities for recognition are available; in particular adequate funding is available.** In today's environment, this requires diversification from NASA funding sources.
3) **Support and encouragement is available from the College of Engineering and the University of Michigan**. Our educational mission has to satisfy the College's needs, and our activities need to be recognized and rewarded by the University.
4) **The strategy needs to be compatible with other strategies in the department.** Such compatibility enables cross-disciplinary collaborations across the diversity of the Department. The Department's mission is understandable if the various approaches are common.

Strategy for Space Science and Applications

The proposed strategy for the space activities of the Department has three components, leading from basic research to applied knowledge:

1) **Fundamental research to understand the space environment of the Earth, the planets, and elsewhere.** The purpose of this task is to develop breakthrough research to enhance our understanding of the fundamental physics of the environments in question. Success criteria are given by publication and citation records, and the amount of paradigm-shifting knowledge obtained. Such breakthroughs can happen through experimental work, data analysis, and theory/modeling.
2) **Integrate this research into a system-level understanding with the goal of developing prediction capability.** Large models play a crucial role for this second part. This integration task should take advantage of computational technologies developed at the CoE.
3) **Apply this knowledge to flight programs by NASA, DOD, and the U.S. aerospace industry.** The purpose of this aspect is to respond directly to engineering needs arising from space flight or other industrial challenges, taking full advantage of the CoE environment. Success criteria should be defined by the usefulness of our approaches to customer needs, patentable technologies, and spin-off technologies.

The accompanying educational thrust of the space strategy is:

1) **Focus education on excellence in the PhD program, the Space Technology Masters program, and student design and experimental work.** The crucial emphasis here is on hands-on work of students of multiple engineering disciplines. Such work could be encouraged in a classroom setting, as well as an independent project setting. This emphasis also enhances the AOSS undergraduate program and does not preclude participation through classroom teaching and experimental classes.

Comparison of the Strategy to the Success Criteria

A comparison of the Strategy with the four success criteria, listed in order:

1) The application-motivated theme put forward in topic (3), and also (2), are not found in other Universities. It takes advantage of the CoE environment and its breakthrough technologies. It focuses on environments and their relation to engineering in the relevant environments. These drivers are needed for space missions, near-Earth spacecraft from all agencies and industry, communications effects from space weather, and many more applications. Our major competitors have a science focus exclusively, perhaps with the exception of the Air Force Academy, which has a very different purpose.
2) This approach does not preclude the funding sources we have now. Moreover, it broadens our scope sufficiently to attract interest from DOD, NOAA, and the aerospace industry. In addition to traditional science disciplines, we can compete for funds that are focused on technology. This diversity has precedents, of course. The programs currently most successful in AOSS have that character, including work by Gombosi and Clauer. A strategic underpinning of these developments would enhance their impact and breadth. A stronger technology focus will also increase the likelihood for major wins of space instrumentation; a situation that is not currently likely in the absence of a strong technology effort.
3) This aspect can only be assessed once we understand the change of leadership in the College and the strategy the University of Michigan is planning to implement. There are good reasons to assume, however, that the CoE would be enthusiastic about the initiative. First, it links AOSS closer to traditional engineering disciplines. Second, AOSS would take leadership in design and systems of interest to the broader industry and government labs. The educational role stressed in the strategy has an important history in AOSS through successful classes, such as AOSS 450 (JPL, Aerospace Corporation), AOSS 582 (GOOGLE, JPL), and AOSS XXX (S3FL, ICARUS).
4) The compatibility of the strategy can only be assessed in coordination with the other strategies being developed in the Department. However, there are very promising parallels between this strategy and successful programs in atmospheric chemistry and regional climate modeling, and with important system-integration and data-assimilation tasks that are of National importance.

Possible Tactical Implementation

The following tactical steps are to illustrate the implementation of the strategy. The strategic imperatives could be pursued through other possible tactics:

- Hire to develop and run a Space Weather center similar to the SEC/NOAA, with focus on real-time weather forecasting. Encourage hire through modest startup funds to develop a distributed array of FPIs to analyze global space-environment characterization.
- Hire to develop near-Earth radiation analysis and test laboratory, with the task to develop models and tests for radiation environments. Hire to focus on breakthrough radiation-belt physics, and the Mars environment.
- Have an open search for all subsequent position with the emphasis on strategic thrust (3).
- Develop a strategy for future hires to address strategic thrusts (2) and (3).
- Develop student labs to enable and foster educational opportunities. Make these flagship facilities for our department.