USRA White paper on Educating the Next Generation of Space Scientists and Engineers

"Our policymakers need to acknowledge that the nation's apathy toward developing a scientifically and technologically trained workforce is the equivalent of intellectual and industrial disarmament and is a direct threat to our nation's capability to continue as a world leader." (The Report of the Commission on the Future of the U.S. Aerospace Industry, November 2002)

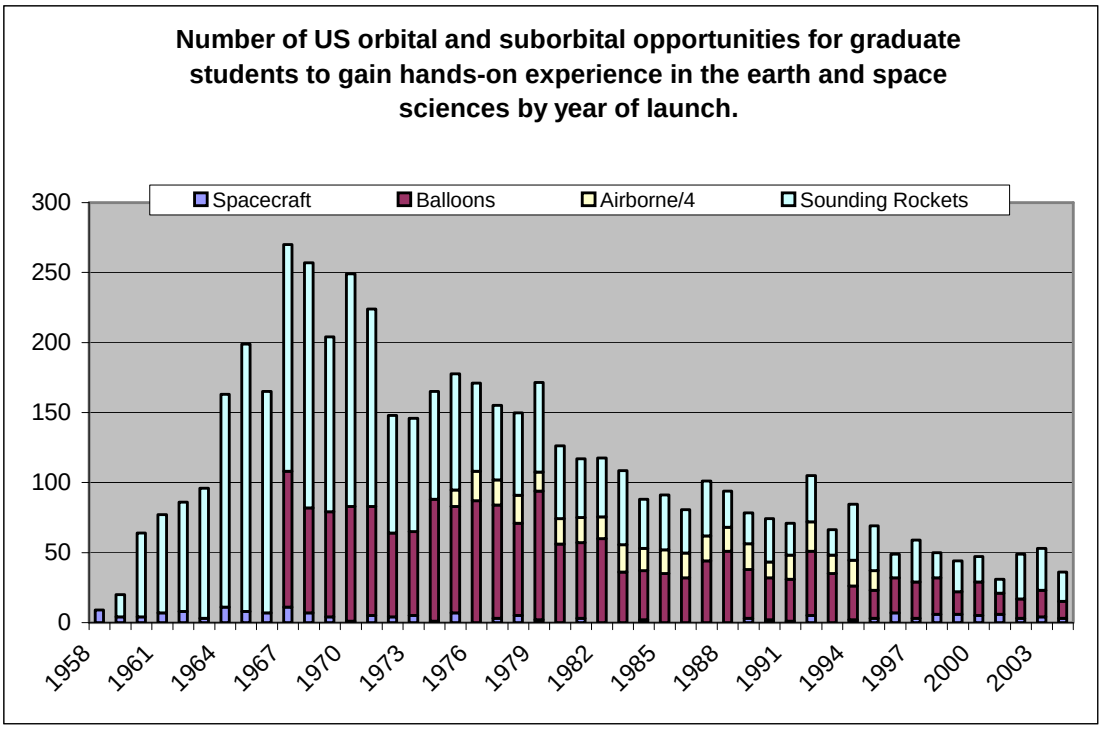
"At present, there are insufficient methods for students to acquire hands-on experience in the scientific and technical disciplines necessary for space commerce and exploration." (Commission on Implementation of United States Space Exploration Policy (the Aldridge Report), June 2004)

There is a significant deficit of scientists and engineers in the United States with meaningful hands-on experience with space instrumentation and space systems, which is jeopardizing the ability of the nation to maintain a vigorous presence in space into the future, regardless of whether we are in space for reasons of commerce, exploration, national defense, or scientific research. This deficit leads not only to a loss of capability, but also to escalating costs of many of the space systems vital to the nation's security and industrial competitiveness.

Space scientists and engineers are trained at universities, particularly in the science and engineering graduate programs of those research universities active in space research. To attract good students into these fields requires sufficient funding for graduate stipends from either research projects or graduate fellowships, and projects or research opportunities that excite students so that they choose space research over other possible areas. These projects or research opportunities must also provide the students with the range of experiences they need to become fully trained scientists and engineers.

The scientists and engineers who learned their trades during the first decades of the space age have reached or are nearing retirement. These were exciting years for a young person to enter space research, and space attracted many of the best young scientists and engineers. These years were marked by frequent launches of smaller missions many of which were led by university-based teams that included graduate students. These students got plenty of hands-on experience, and learned first hand the difficulties of designing and constructing an experiment or engineering system that would operate reliably in space. Many students also learned from designing and building experiments for smaller, suborbital flights on rockets or balloons, or by observing with an airborne telescope.

The chart shows that the number of these opportunities peaked in 1968, at the height of the Apollo program. Since then the number of student opportunities provided by spacecraft missions, rocket and balloon fights and airborne observatory sorties has diminished from over 250 per year to consistently less than 50 per year. Most graduate students now never have an opportunity to do hands-on science. Instead the vast majority of science PhD students analyze data obtained from instruments they have never seen and thus have only a vague idea of how they work or how they might malfunction. They certainly don't learn the important skills needed to conceive of, and to help design and construct a space experiment.



The chart hides another phenomenon. As space missions have, necessarily, become more complex, they also take longer to design and construct. The increasing complexity means that fewer universities have the resources and capabilities of managing the complexity, so increasingly missions are being run by non-academic laboratories and research centers. The mission time scale is now significantly longer than a typical graduate student remains in school. Both of these effects significantly decrease the likelihood of graduate student involvement, exacerbating the problem.

This is a national problem. It affects not only space science, but also human space exploration, global climate prediction, commercial ventures in space, and national security uses of space. All these enterprises require space engineers able to design and construct reliable space hardware, and space scientists who understand the space environment and the rigors of conducting any activity, robotic or human, in space.

What needs to be done?

These critical needs are addressed by a proposed hands-on, rapid cycle flight program of moderate risk that focuses on inexpensive system development for suborbital and orbital applications. This program should provide multiple flight opportunities involving graduate and undergraduate students from science and engineering disciplines, and should provide the excitement of discovery to attract those who will become leaders of the future U.S. space enterprise. The program should permit a four-fold increase of hands-on experiences over present levels to return to the peak levels of the 60's and 70's. The proposed level of activity should allow an average of two launches per month or more.