

# Better Collision Insurance

Russell L. Schweickart and Clark R. Chapman

In October 2001, we and 22 like-minded engineers and astronomers, including a few former and current astronauts, got together at the Johnson Space Center in Houston to discuss what we saw as a missing element in the space program: attention to the possibility of our planet being struck by a near-Earth asteroid. We knew of the accelerating rate at which such objects were being discovered. But no one, certainly no federal or international agency, was taking seriously the question of what exactly to do when an asteroid is found with our address on it. During that initial meeting, less than six weeks after the 9/11 terrorist strike, we decided that this threat from outer space needed to be dealt with seriously and that our group might just be able to move the process along. To facilitate our work, we formed the B612 Foundation, a non-profit corporation named after the home asteroid of the title character in Antoine de Saint-Exupéry's *The Little Prince*.

NASA has been spending about \$4 million a year to meet a 1998 Congress-

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*Asteroids smaller than those now being actively cataloged constitute a largely neglected natural hazard*

sional mandate to chart (by 2008) at least 90 percent of the near-Earth asteroids that are more than 1 kilometer in diameter. NASA's Jet Propulsion Laboratory has been overseeing the effort, called the Spaceguard Survey, which has to date discovered more than 790 of an estimated 1,100 or so of these huge, rocky objects. The impact of a 1-kilometer asteroid would release the same amount of energy as 70,000 megatons of TNT or, equivalently, as 1,400 of the largest thermonuclear weapons ever detonated. The subsequent Sun-dimming pall of debris lofted high into the atmosphere would envelop our planet for months, threatening all of human civilization.

The need to be on the lookout for such an immense catastrophe is clear enough, as more than one Hollywood blockbuster has made widely known. The capability of the current search effort, however, is inadequate to address the danger posed by the far more populous cohort of smaller near-Earth asteroids, those down to about 100 meters in diameter. Such objects can cause serious local or even regional destruction. The impact of a 100-meter-diameter body would release the equivalent of an 80 megaton bomb and thus could

devastate an area the size of a large city, for example. And a several-hundred-meter body could cause a tsunami rivaling or exceeding last year's great Indian Ocean tsunami.

Objects in this range of diameters are discovered only incidentally today by the modest equipment that has been dedicated to finding their larger siblings. A recent addition to the list of small asteroids that have a small but real chance of striking the Earth is a 330-meter-diameter asteroid named NEA 2004 MN4. It has a 1-in-32,000 chance of impacting in April 2035 and a 1-in-12,000 chance of striking in April 2036. So there's no need to become alarmed at this stage. Yet one of these smaller asteroids is far more likely than their larger counterparts to constitute a danger in the foreseeable future. They are also easier to deflect away from Earth using space technology. The problem is that today astronomers have discovered such a small percentage of the smaller near-Earth asteroids that a strike with no warning whatsoever is far and away more likely than our having enough time to undertake an effort at deflection.

## Hazard a Guess

In 2003, a NASA study team published a report that recommended deploying telescopes that could bring the detection threshold of near-Earth asteroids down to about 140 meters. Others believe that targeting 100 meters is a more appropriate goal. Below that size, the atmosphere largely protects us, although the best estimates of the object that caused the 1908 Tunguska explosion (which destroyed 2,000 square kilometers of Siberian forest) was about 65 meters. Unfortunately, no action has been taken to implement the recommendations made in that excellent report.

Whereas scientists in the United States have done most of the discovery work, many amateur and professional astronomers around the world make essential follow-up observations, which allow the orbits of the newly discovered asteroids to be refined and the probabilities of impact to be ascertained. Specialists at both the Jet Propulsion Laboratory (who operate the Sentry System) and the University of Pisa (who maintain the Near-Earth Objects Dynamic Site) do a fine job of making such information publicly available. But only the United Kingdom has begun to address the relevant policy issues. Unfortunately, precious little was done with the excellent recommendations contained in the report on the topic that Parliament mandated in January 2000. No government or international body assigned any agency responsibility for protecting life and property from this extraordinary kind of natural disaster.

The B612 Foundation has thus wrestled with this aspect of the problem virtually alone. In doing so, we have discovered that when you start paying attention to the details, both the engineering and the policy issues are far more complex than you might assume.

First, consider the technology-development front. It happens that NASA was, at least until recently, headed in just the right direction for building hardware that could deflect an object away from a collision with Earth. Prometheus is the NASA program to develop cost-effective deep-space propulsion capability by utilizing high-performance ion or plasma engines powered by a small nuclear reactor—just what would be needed to give a menacing asteroid the necessary shove. The nuclear-electric propulsion portion of the program now seems to be on hold with priority shifted toward developing a small reactor for future work on the lunar surface.

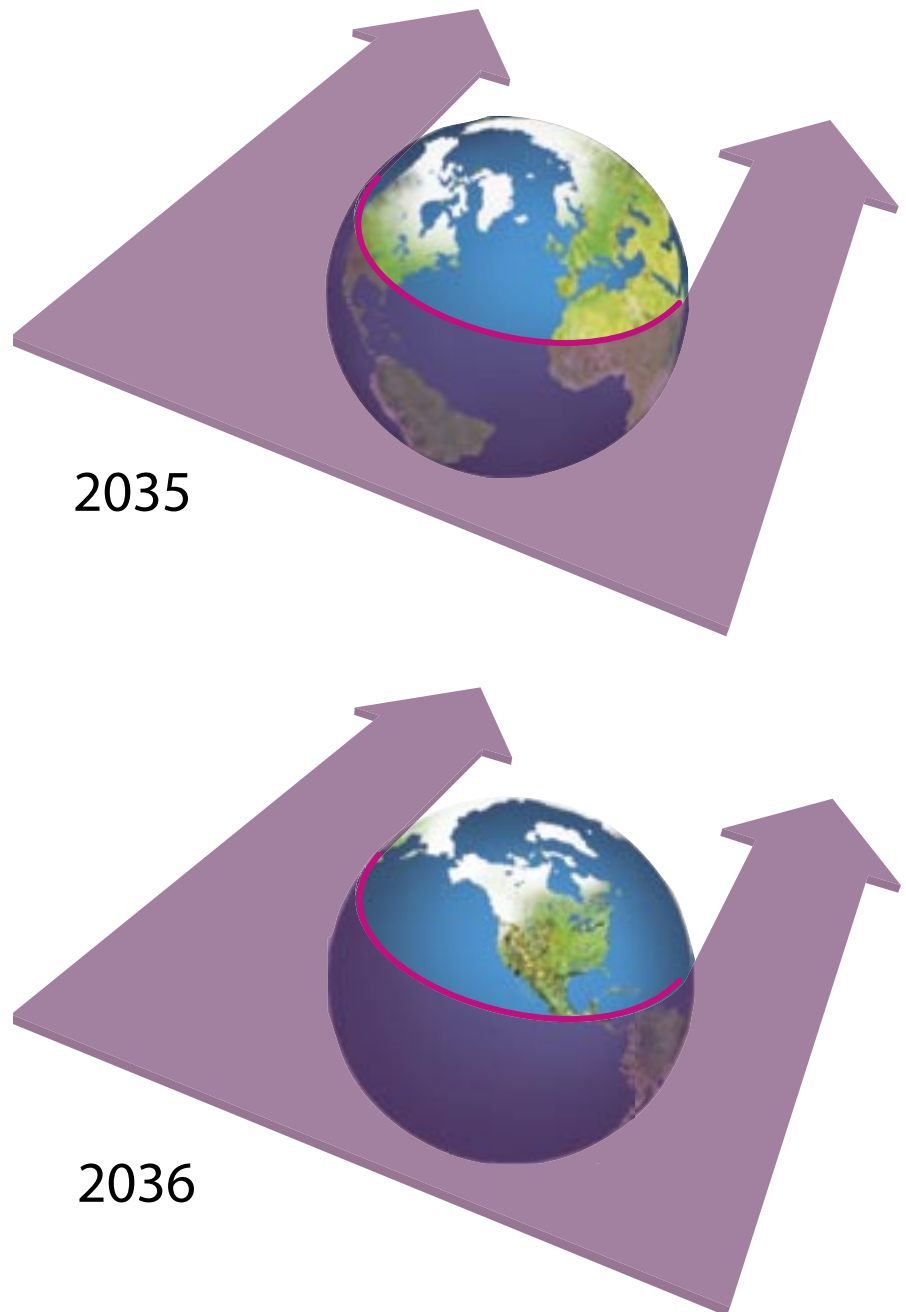
Just prior to the arrival of Michael Griffin as the new NASA Administrator, an asteroid-deflection mission was in the final throes of consideration as the first operational test of the Prometheus technology. This mission would have demonstrated the use of an “asteroid tugboat” to deflect near-Earth asteroids, a concept that we and two other members of our group spelled out in *Scientific American* in November 2003. However, this proposal, along with the Prometheus program,

was put into limbo in a reshuffling of NASA priorities.

#### Political Moves

On the policy side, it became obvious to us that asteroid deflection raises a host of critical issues, many of them international in scope. Intentional deflection of an asteroid bound to hit a specific location on Earth transforms an

“act of God” (in legal parlance) into an intentional act of humankind. During deflection, the point of impact is shifted from its original location along a “path of risk” to a point where the asteroid barely grazes the Earth’s atmosphere. In the process, populations and property not initially threatened are placed at risk. If, for example, the propulsion system were to fail before deflection



The orbital plane of a 330-meter-diameter asteroid designated NEA 2004 MN4 (purple) intersects with where the Earth will be in April of 2035 and again 12 months later. The object’s trajectory within this plane is not currently known with precision. The asteroid will most probably pass to the left or right of the Earth (arrows), missing by many times our planet’s diameter. However a slim possibility exists that this object will strike Earth in 2035 (a 1 in 32,000 chance) or 2036 (1 in 12,000), impacting somewhere along the “path of risk,” shown above in red according to the authors’ estimation.

was fully achieved, the asteroid would then be headed for a new ground-zero, which might, say, fall on the other side of an international border. Shifting the point of impact might also reshape the potential and nature of a subsequent tsunami, redistributing the risk from what it had been before. Who then is liable? These concerns are just the tip of one large and messy policy iceberg, but they exemplify very significant matters with which no nation on Earth is currently dealing.

The B612 Foundation recently called this absence of government involvement to the attention of the U.S. Congress. We suggested that responsibility for protecting the Earth from impact hazards be analyzed and assigned to some agency of the U.S. government. Most people who are aware of the danger probably think that NASA already has this duty, but in fact it doesn't. The scientists of NASA have done an excellent job in discovering and cataloging these objects, but their work, and to a large extent their thinking, has stopped there. But thanks in large part to Texas Congressman John Culberson, who has taken a strong interest in this issue, this vacuum is about to be filled. As

of this past June, NASA has been instructed to assess what actions would be necessary to protect our planet from asteroid impacts.

This recent Congressional action is a welcome development. We hope that NASA will take its new charge seriously and examine the many elements involved in full depth. Now might be an excellent time for NASA to request that the National Academy of Sciences (which has been silent on the issue) weigh in and recommend the proper steps to take to integrate the management of this threat into the wider array of responses to natural and human-caused hazards to society.

Although the task of providing an early warning has gotten off to a good start, it is just a start. It's fine to know about the possibility of infrequent civilization-busters, but it is well past time to look systematically for the much more numerous 100- to 200-meter objects. Furthermore, once astronomers have reported their data and made their calculations for the likelihood of an impact, other professionals need to assess the hazard and inform the public—both about the potential for damage and about the practical op-

tions available to eliminate, or at least mitigate, the risk.

In addition, we believe that it is critical that the technologies necessary to deflect a near-Earth asteroid be developed beyond the current sketchy plans and that an actual demonstration be executed within the next decade or so. After all, you always learn best by doing.

Perhaps most challenging, but vitally important, is to bring together the institutional players, both domestic and international, who must ultimately make the difficult choices about when and under what circumstances we should attempt to deflect a threatening asteroid—and what risks and costs we are willing to accept in the process. Right now no one has any inkling about how these decisions would be made.

Although the frequency of asteroid impacts is very low compared with most other natural hazards, none has the same enormous potential for devastation. Conversely, a catastrophic collision with an asteroid, unlike any other major natural disaster, can be avoided entirely—provided that we do our homework in time and with diligence.

