

# DEVELOPING A NEAR EARTH OBJECT OBSERVATORY AND ITS ROLE IN EDUCATION

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## Abstract

This paper will trace the evolution and development of ideas, serendipitous encounters, and dead ends that have led to the realization of a Near Earth Object Observatory having the dual functions of astronomical research and education.

Emphasis will be placed on the history of this particular Near Earth Object Observatory. Reasons for choosing the telescope make, type, and size will be discussed in detail. Selection criteria for CCD cameras versus photographic cameras, software, and auxiliary hardware will be discussed in more general terms. Observatory site selection will be outlined and the general pitfalls and good ideas highlighted associated with the entire process will be included in a question and answer period at the end of this presentation.

The astronomical research side of a Near Earth Object Observatory is fairly obvious to most persons. Given the term 'observatory', we at once envision a stark building of sorts next to or supporting a huge white domed structure housing a large telescope poised against the night sky, ready to make discoveries and measurements of celestial bodies and events. Of course it goes without saying that the observatory must be perched atop a mountain or highest point to ensure an unobstructed view of the whole sky.

The education side of a Near Earth Object Observatory is not so obvious. The term 'education' evokes ideas of classrooms, children, blackboards, and chalk. Education should not just be the memorization of facts from dusty antiquity, real education involves discovery and engaging the minds, hands, and imaginations of the student. The discovery aspect for the student is also a major focus of the Near Earth Object Observatory. The Near Earth Object Observatory will be utilized for both classroom instruction and informal science education for pre-school through college students and the public at large.

## Introduction

If you look hard enough at any idea, there is usually a single event which can be traced back in time that may be called 'The Key Event'. This Key Event

contains the primordial essence of the idea and is important to any telling of the idea and its history. In the case of the development of this particular near Earth object (NEO) observatory, there is such a Key Event. I would like to relate a series of layered ideas and their Key Events in the hopes that those of you reading this account and interested in developing your own NEO observatory may benefit.

The very first Key Event for the development of a NEO observatory for me occurred when I was five or six. I do not actually remember the story I am about to tell, it has been related to me over the years by family members older than I.

In 1963, my family owned and operated a ski lodge just outside of the old Colorado mining town of Breckenridge. One of my regular morning chores was to go around to all of the breakfast guests and take their meal orders and deliver their meals. Two of the guests were in hot debate about something, and I kept interrupting them to eat their food before it cooled. Exasperated, one of the guests said 'OK young man, we will eat our breakfast when you have settled our argument'. I said that I would help if I could. One of the guests asked me if I knew what the Moon was. I excused myself and ran to my room and brought back my treasured four inch plastic Kellogg Moon globe I had recently received for eating enough cereal and sending in box tops. Both guests laughed, and the other guest asked me if I knew what the bumps and dents on the surface were. I said that they were mountains and craters. Both guests grew excited, and to the now hushed rest of the guests I was asked 'To solve our argument maybe you could tell us if the craters are produced by volcanos or large rocks falling onto the Moon'. 'Oh is that all', I said, 'Let me show you'. Supposedly I led all of the guests outside to the pond in front of the ski lodge where a small stream fed the pond. The area was kept free of ice. Selecting a large stone, and nodding to a low snow sprinkled muddy spot along the bank, I said 'Watch'. I tossed the stone high into the air and down it came into the slush and mud. Pointing to a large crater on the plastic Moon globe, I said 'See, looks the same'. The debate was settled. All of the guests, now satisfied returned to breakfast.

Later, armed with a new confidence in such matters, I asked my first grade teacher why the Moon

was so full of holes and the Earth (evidenced by the class globe) was not. She did not have the answer to my question. I have been searching for this answer and the related answers to the questions that were raised with this original question ever since.

These events were to be the beginning of my interest in the potential threat to the Earth by asteroids and comets more than a third of a century ago.

Time passed. My enthusiasm for astronomy and what caused those holes in the Moon and why the Earth lacked them seldom wavered. I found more answers in science fiction at that age than in science and mathematics. In 1974, the science fiction novel Rendezvous With Rama<sup>1</sup> by Arthur C. Clarke came into my hands. The very first chapter of Clarke's book in less than two pages - provided the answer to a question that I did not know that I had been subconsciously asking since 1963 - 'How do you prevent these rocks from hitting the Earth?'. Clarke's answer was elegant and simple. Just look for them. Clarke called this space survey for cosmic interlopers with a potential of being Earth impactors - Project SPACEGUARD. I knew now what I needed to do. Start a Project SPACEGUARD.

All through high school and college, I watched the available technology needed to detect NEOs. The development of high speed photographic film in the mid-1980s held some promise as a NEO search tool/technique for small aperture telescopes. Even high speed film, however, is slow, expensive, and labor intensive. The advent of personal video cameras using Charge Couple Devices (CCD) in the late 1980s led to a huge reduction in price of consumer CCDs and an accelerated research and development of large scale format CCDs. It was obvious that the use of the CCD method to detect faint light in the astronomical setting would one day be a reality. The only draw back was that CCDs were still state-of-the-art, and astronomical quality CCDs were astronomical in price.

The *Spaceguard Survey*<sup>2</sup>, the report of the triad of NASA International Near-Earth-Object Detection Workshops in 1991, was published in January 1992 (NASA publication) and suggested the use of CCD cameras for the search of near Earth objects (NEOs). At the time of this study (1991), the cost of a CCD camera exceeded the cost of the research telescope.

In the (fall / spring) of 1993, I founded the *k-SkyWatch Survey* with the hope of garnering business and industry support for the search, discovery, and orbital determination of NEOs. 'Detection (knowing that a threat exists) is the first step in averting disaster' was the motto used. Then something quite remarkable occurred. A comet was detected in orbit around Jupiter

that would impact the planet in the summer of 1994. This was a chance in dozens of lifetimes. It was hoped that the public reaction to and awareness of the comet fragments of Comet Shoemaker / Levy 9 that were scheduled to impact the planet Jupiter would initialize the funding support for the *k-SkyWatch Survey*. Quickly I drafted funding requests to be mailed to the top 300 companies listed in the 1994 issue of *Fortune 500* - listing the highest grossing companies in the United States.

Certainly if there was a celestial event that would galvanize the world as to the potential threat of NEOs, it was witnessing the planet Jupiter being repeatedly hammered by multiple objects, any one of which could cause a world wide catastrophe on the Earth. Had Earth, rather than Jupiter been the target, the resulting catastrophe would devastate our planet's biodiversity for millions of years, alter the Earth's climate for decades, and would end civilization as we know it.

An in-person conversation in the spring of 1994 with David Morrison (NASA Ames), Chair of the NASA International Near-Earth-Object Detection Workshops, verified the NEO threat as a REAL threat. David Morrison indicated that amateur-organized NEO search programs may be extremely useful by filling in the gaps missed by government funded NEO search programs as political and fiscal interests change.

The Comet Shoemaker / Levy 9 media and science frenzy arrived on schedule. Jupiter was heavily impacted during the week of July 16-22, 1994, and quickly the public forgot. Few people really listened or paid attention. Later, I found out that an existing NEO survey program active at the time actually lost funding in the months after the Jupiter impacts.

I only received a few dozen replies from my 300 inquiries to the top grossing companies in the United States. Those companies that responded thought that the idea to search for NEOs was a good, even noble concept... however, 'at this time our company does not fund research in this area. We wish you luck in finding funding for this worthwhile endeavor', was the typical response.

So ended, what I thought was nature's greatest public relations stunt for the possible funding of scientific research, and it failed to generate even one funder from corporate America. Nature did the best she could offer for NEO research funding. No one was interested.

Additional in-person conversations with Gareth Williams and Brian Marsden in the summer of 1995, both members with the Minor Planet Center (MPC) at the Harvard-Smithsonian Center for Astrophysics,

outlined the viability of and the necessary steps needed to initialize a program to detect and track NEOs. Marsden and Williams agreed that using 'off-the-shelf' amateur astronomy components, i.e. computerized telescope, CCD camera, computer, and software, in an amateur search for NEOs was realistic. I spent several hours with Gareth Williams going over the equipment needed and the procedures used in searching for and detecting NEOs. All of this equipment in 1995 was less than \$20,000. This amount was beyond my personal budget at that time, but the reality was getting closer.

The latest well-publicized threat to the Earth for NEOs occurred on Thursday, March 12, 1998. The news media announced that Asteroid 1997 XF11, an asteroid 1.6 km in diameter, was thought to be on a collision course with the Earth. Calculations (flawed and hurried) indicated that the collision was to occur on October 26, 2028. Better orbital elements were used the next day to determine that this 'hit' will be a miss. Asteroid 1997 XF11 was only first discovered in December 1997. Even the one day panic of an Earth killer asteroid predicted to wipe out civilization in 30 years, was mostly forgotten in less than a week.

Interestingly, in the summer of 1998 there were two movies released that had as story lines the impact of the Earth by asteroids and comets, *Armageddon* and *Deep Impact*, respectively. The science was abominable, the story lines and characters too Hollywood, and the real threat was lost in the music and hype. I had not given up looking for funding and being taken seriously, but things were a bit depressing.

### **Enter NASA West Virginia Space Grant Consortium**

I am employed by West Liberty State College (WLSC), as the director of its educational outreach program, the SMART-Center. The SMART-Center is a hands-on science center for area students and teacher in-service programs. In 1997 WLSC joined the West Virginia Space Grant Consortium. There are 52 Space Grant Consortia - one in each of the 50 states, Washington, D.C., and Puerto Rico. These Space Grant Consortia are funded by NASA, who is in turn funded by congress. The goals of the Space Grant Consortia are to fund basic research at the college and university level and encourage school teachers to develop new and innovative ideas and curricula for their students.

In the spring of 1998, I submitted a Research Enhancement Grant to the West Virginia Space Grant Consortium. The title of this Research Enhancement Grant was "Initiation of a Near Earth Object Detection Program". The only trouble with these NASA Space

Grants is that they do not pay for equipment, only personnel, consumables, software, and domestic travel. I could, however pay myself and members of the local astronomy club ASTROLABE to meet once a week for several hours at a time starting in November of 1998. During each weekly meeting we planned and discussed the various aspects necessary for the development of a NEO Observatory. We bought through the Space Grant necessary software, the SMART-Center bought the CCD camera, and with my portion of the salary (as principal investigator) I could then afford to buy the initial computerized telescope for the observatory. At last things looked like they were coming together.

### **Selection of Equipment**

The first task of our NEO observatory group was to decide on what kind of telescope to purchase. Price was, unfortunately, a big deciding factor. We wanted large aperture for NEO searches, ease of use for searches, computer compatibility to not only drive the telescope, but to eventually allow the telescope to be partially autonomous and eventually remotely controlled, clock drive, and tracking, with all of the 'bells and whistles'.

There was a half-joking discussion of using photographic film for our NEO searches. This was more to discuss the merits of CCD than anything else. The art of photographic techniques and searches have their place. We wanted to utilize the high tech end of late 1990s off-the-shelf astronomy equipment and techniques as Marsden and Williams had suggested in 1995.

After less debate than any of us was expecting, we settled on purchasing all the equipment, i.e. telescope and CCD camera, and most of the ancillary software from Meade Instruments Corporation. Our reason for this can be summed up in one word 'compatibility'. We wanted minimal future problems with equipment and software interfacing. We liked the Meade prices and products, and in recent comparison tests<sup>3</sup> with similar products from other astronomy equipment and software manufactures we found Meade superior.

### **Site Selection**

While the merits of various computerized telescopes, CCD cameras, and ancillary materials and software were being discussed, a parallel concern was mounting. We were getting together the 'stuff' needed for the NEO observatory, but, where will the NEO observatory be located? For the utilitarian reason of ease, it was decided that the NEO observatory needed to be less than a 30 minute drive from the Wheeling area,

be located on a remote farm site, and situated as high as possible. We envisioned a remote grassy knoll in a pastoral setting without electricity, water, or phone line access. Contingencies for the lack of utilities to run the NEO observatory were considered and planned for. Luckily we all had access to *Sky & Telescope* magazine articles showing how other intrepid amateur astronomers had made the best of remoteness for their observatories. This, then, was not a deterrent.

The NEO group set up a site search campaign. We asked everyone we knew to ask everyone they knew about local farm sites. Several leads looked good, but none panned out. After four months of looking without success, I was privately growing a little more than concerned. The equipment and software was arriving - with no prospect of a home.

The site, as luck would have it, was found on a long business car trip from Wheeling to Washington D.C.. Dr. Andy Cook, the Dean of sciences at West Liberty State College, whom I am honored to work with on the SMART-Center as the WLSC liaison, asked during a lull of 'college talk', 'How is this asteroid search and observatory going?' I said the NEO group was going full tilt, we have equipment and software and we are coming up to speed on them at our weekly meetings. The only ingredient missing is a site location. I related how all of us have beat the bushes and asked everyone we could think of, with so far no luck. A smile rolled across his face, 'You have not asked me', he said. It was true. Somehow I had not asked my good friend and mentor. Andy had lived in the area all of his life, and he just might know someone who knows someone. He continued to drive and smile and patently waited. At last he asked 'Ask me'. Confused, I asked playing his game, 'OK, do you know anyone that has a farm within 30 minutes of Wheeling, with a high grassy knoll, that would possibly let us use the land to build our NEO observatory'. He said, 'Yes I do'. I was pretty excited. 'Who?' I asked. He really drew out the suspense and acted as though he was concentrating on the road. At last he said 'Me. My family has a farm with a high grassy knoll. In fact it is the highest point in Marshall County. Let me talk to my brothers and let you know'.

Presently the NEO group is in negotiations with the Cook brothers for the use of the Cook family farm. We have already offered, to the Cook brothers agreement, to name our Meade LX200 10 inch telescope the *Jesse E. Cook Telescope* after their father.

The Cook brothers had one condition in the the use of their family farm for the NEO observatory. They wanted the local elementary school to be involved. This falls in step with the future plans to utilize the Sir Arthur

C. Clarke Near Earth Object Observatory for both classroom instruction and informal science education. Pre-school through college age students and the public at large will be able to access the observatory for a variety of educational endeavors.

### Naming Our NEO observatory

Naming anything seems to have many political connotations and ramifications. None of us really felt comfortable in these sorts of waters. Do we name our observatory, simply The Wheeling NEO Observatory? Or do we get fancy? This was one of the myriad of parallel tasks we discussed.

As serendipity would have it, knowing of my intense interest in asteroids and all things astronomical, my colleague Dr. Ted Spickler brought to me an article from *Science*. The title was *Presidents, Experts, and Asteroids*, by Sir Arthur C. Clarke<sup>4</sup>. I thanked Ted for the article and filed it away to read. The next day, to my delight, at the bottom of page 1530 was the author's mailing address. During the weekly NEO group meetings, I had joked that the absolutely best name for our NEO observatory would be the *Sir Arthur C. Clarke Near Earth Object Observatory*. All agreed that this would be ideal, but how do you get in touch with Clarke in Sri Lanka? And, would he want his name on our fledgling NEO observatory?

With Clarke's address now, I thought, why not, its just a little time and some stamps. I mailed Clarke on December 22, 1998, the last thing I did before leaving for Christmas break. On January 5, 1999 to my delight I received an e-mail from Clarke stating 'I appreciate your offer to name your observatory after me, and will be honoured - though I am losing track of all the things that have been named after me...'. If it were anyone else, they would have been boasting. Things were greatly looking up. We had a team - the NEO group, a telescope, CCD camera, software, a site location, and now a name. All that is left is the real work of building the observatory and searching for sky rocks.

### References

- 1 Arthur C Clarke, *Rendezvous With Rama*, Harcourt Brace Jovanovich, Inc., New York (1973)
- 2 David Morrison, *Spaceguard Survey*, NASA publication, (1992)
- 3 Alan Dyer, The Meade LX200 Schmidt-Cassegrain, *Sky and Telescope*, (April 1998)
- 4 Sir Arthur C. Clarke, Presidents, Experts, and Asteroids, *Science*, vol. 280, 5 June 1998, pages 1530-1532.