The State of Astronomy Education in the U.S.

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Introduction

I would like to set the scene for the discussion that will follow in this book and bring up a few disturbing points which I believe any discussion about astronomy education will ultimately have to address.

Let me begin by posing the following question: where does astronomy education take place in the United States? Those readers who teach will probably say that it takes place in classrooms like theirs (anywhere from first grade through the university.) But I want to argue that astronomy education happens in many other places besides the formal classroom.

It happens in hundreds of planetaria and museums around the country; it happens at meetings of amateur astronomy groups; it happens when someone reads a newspaper or in front of television and radio sets; it happens while someone is engrossed in a popular book on astronomy, or leafs through a magazine like *Sky & Telescope*; it happens in youth groups taking an overnight hike and learning about the stars; and it happens when someone surfs the astronomy resources on the internet. When we consider astronomy education, its triumphs and its tribulations, we must be sure that we don't focus too narrowly on academia and omit the many places that it can and does happen outside the classroom.

Some Disturbing Statistics

Certainly, the classroom is a vital and important part of the picture. After all, formal education is a big business in our country. At all levels, from kindergarten to college, the country enrolls some 60 million students and has 4.6 million teachers and other staff. The total cost of educating our young is $466 billion, about 8% of our gross domestic product (National Center for Education Statistics 1994). Are we getting our money's worth?

In 1988, the Public Opinion Laboratory at Northern Illinois University conducted a survey of a representative sample of 2,041 American adults to get a sense of their scientific literacy. Among the 75 basic science questions was a question about the motion of the Earth. Respondents were asked, "Does the Earth go around the Sun or the Sun around the Earth?" 21% got it wrong and 7% said they did not know. The 72% who got it right were then asked what period of time the trip took. Only 45% got it right, 17% said 1 day, 2% said one month, and 8% said they did not know.

This means that 94 million people in our country could not correctly say that the Earth went around the Sun AND that it took a year to do so! And astronomy is not alone in being a field about which Americans know little. The Carnegie Commission on Science, Technology and Government reported in 1991 that 47% of US 17-year olds could not convert 9 parts of ten to a percentage and that (in a

multiple choice survey) 63% of adult Americans thought that lasers work by focusing sound waves (Beardsley 1992).

In September 1993, the Department of Education issued the report of a survey on adult literacy in the U.S. Those in the survey were given a calculator, told the cost of a carpet per square yard, and were given the size of a room. The question was, how much should carpet cost to cover the entire room. Even with a calculator, 96% of the representative sample of American adults could NOT do it correctly (Barber 1993).

And that's only one part of our problem. In June 1990 the Gallup organization conducted a national survey of beliefs among adult Americans. About one in four said they believed in the basic premise of astrology, and 74% read their horoscopes at least occasionally. 47% think that UFO's are real, and 27% think that aliens have actually touched down and visited the Earth.

You may laugh at the notion of taking this kind of belief seriously. But when funding for the SETI program was being debated in Congress, at least one of the people's representatives said on the record that there was no need for a radio astronomy search because UFO records revealed that aliens were already here and could thus be contacted at no expense to the government. More seriously, if a large number of our citizens (and even our leaders) believes that our lives are governed by and decisions can be made by magic and superstition, will they feel the same urgency we do about the need for greater understanding of science and technology to solve the difficult problems of our age?

And if you don't believe that such fiction sciences have an influence on public policy, I should perhaps just remind you of the revelation that came out of the Reagan administration – that a San Francisco astrologer named Joan Quigley was given almost total control of the President's schedule during much of his time in the White House. The White House chief of staff, Donald Regan, wrote later:

> "Virtually every major move and decision the Reagans made during my time as White House chief of staff was cleared in advance with a woman in San Francisco who drew up horoscopes to make certain that the planets were in favorable alignment for the enterprise...Although I had never met this seer,...she had become such a factor in my work, and in the highest affairs of the nation, that at one point I kept a color coded calendar on my desk as an aid to remembering when it was propitious to move the president of the United States from one place to another, to schedule him to speak in public, or commence negotiations with a foreign power" (Regan 1988).

What makes the widespread belief in pseudoscience and widespread ignorance about science possible in our country? Greedy and ignorant media, cynical publishers, and many scientists sticking their heads in the sand all bear some of the responsibility, but our system of education is certainly a main culprit. Many teachers, especially at the elementary level, just don't receive adequate training in science and the scientific method. Thus it is a lot easier and less frightening for them to teach as little science as possible or to teach science out of the textbook. And many high schools in this country have relaxed their requirements and offerings in science to the point where we might say they are not just relaxed, they're ASLEEP.

In 1986, the National Science Teachers' Association surveyed the high school teaching scene. To take one example, of the 24,000 high school in the US, about

1/3 offered no physics course at all. Many of the courses that *are* offered in physics are taught by teachers whose training is in some other field. And of the physics teachers, 82% teach only two or one physics classes in a school year!

That same survey showed that in the year of the survey, only 57% of US high school students were enrolled in any science class! 43% were taking no science at all that year! Of the 1990 graduating class, fewer than 50% took a chemistry class, and about 20% took physics. Contrast that with other countries where students take three science classes every year of high school.

A 1985 survey by the Stanford School of Education revealed an interesting fact about the roots of the problem. A typical elementary school student in the US spends about 25 hours per week in instructional activities (that by itself is sobering). But of those 25 hours, how much time does a student spend on science? What would you guess...a fifth, an eighth? The answer turned out to be 44 minutes or about 3% – and much of that on learning vocabulary rather than discovering ideas.

But I want to end my depressing statistics with a positive thought: survey after survey reveals that when students are asked what topic in science is most interesting to them, the top two winners are consistently dinosaurs and outer space. The fascination of astronomy is a powerful tool for engaging the intellect and imagination of our youngsters, and this is what encourages us to make it part of the positive school experience of every child.

Nor do I want to imply that the public at large is necessarily uniformly hostile toward astronomy (or even science). There is by all indications a tremendous hunger among many people in this country to share in the excitement of scientific discovery and to know more about the fruits of scientific exploration. And astronomy seems to be near the top of the list of topics the public is eager to learn more about. The problem is more that this hunger is so often left unsatisfied, that the meager meal of science gruel set before the public by our educational system and the media, leaves them, like Oliver Twist, dreaming of a richer repast.

So let us turn from this very quick taste of the problem to the places where solutions might be expected. I've divided the places where astronomy education takes place in the United States into six broad (and somewhat arbitrary) areas:

1. Graduate Education

According to the American Institute of Physics, there were 125 PhD's in astronomy awarded in the U.S. in 1994, plus about 71 physics degrees in astrophysics, for a total of 196. This was up significantly from the combined figure of 125-150 per year that the AIP has been reporting for some time. (There were also 34 terminal masters degrees awarded.) What kind of job are we doing in training these graduates of our programs?

The answer to that question depends on what you expect these graduates to be doing. If all they will be asked to do is astronomical research, then by all measures we are doing an excellent job. All over the world, students in the sciences long to come to the U.S. and Canada to get a top research education. Certainly, the culture of most of our astronomy departments is based on this expectation: research skill is what is sought out, research skill is what is rewarded. It is true that many of these researchers will wind up in academia and will also be asked to teach, but many (not all, but many) graduate programs manage to convey to research students that having to teach is a minor irritant that any smart person can learn to put up with.

On the other hand, if we expect teaching to be a significant part of the students' future responsibilities, then our picture of graduate training is a bit more somber. A few astronomy departments do make a serious effort to help their students become better teachers, but most follow the old prescription for how you teach a kid to swim: throw a graduate student into a pool of lukewarm students and let him fend for himself – he'll soon pick it up!

Now in many large introductory undergraduate courses around the country, the first person non-science students have close contact with in astronomy is a graduate student teaching assistant. Given the emphasis on research skills, this teaching assistant often turns out to be someone pretty unprepared for making much of this "first contact." The resulting experience is thus often an unsatisfying one for each side.

If we are going to change the culture of the astronomy departments, we must first foster a sense that education has value in the training and work of astronomers commensurate with the value they place on research. In some astronomy departments (as they are currently structured), this may be harder than finding a snowball on Venus. But in others, the slow winds of change are starting to blow.

A number of universities are now starting or considering a masters program that will combine astronomy and education, and specifically prepare students for teaching, planetarium education, or science communication. As an example, both Sonoma State University near San Francisco and the University of Arizona in Tucson have had experimental programs in this direction. And at the Center for Extreme Ultraviolet Astrophysics, a research institution in Berkeley, it is now official policy that any staff member may spend up to 10% of his or her time on pursuing science education projects in or out of the office.

I think much more can be done in this area, and it can be done without endangering the research excellence for which the astronomical community in the United States has justly been renowned. Indeed, one needs only listen to some of the talks at astronomical meetings to know that stronger teaching and communications skills could even benefit those astronomers who never see the inside of a classroom.

2. Undergraduate Education

Here I refer to teaching non-science majors about astronomy, as part of some general education program, not to the much smaller area of teaching specialized courses for undergraduate astronomy majors. To appreciate the growth of this part of the astronomy education enterprise, we must bear in mind that there has been a tremendous increase in the number of people getting college degrees in the U.S. in recent decades.

Before World War II, only 8% of Americans went to college; today more than half will get a bit of college education, and about a third will actually graduate from college. Even in 1950, only about 500,000 college degrees were awarded in the country: 432,000 bachelors, 58,000 masters, 6,000 PhD's. By 1995, projections are for 1.7 million degrees, among them almost 1.2 million bachelors, 75,000 medical, legal and other professional degrees, 377,000 masters, and 41,000 PhD's (National Center for Education Statistics 1994).

All this has meant a large increase in the number of college professors and instructors in many fields, not just astronomy. (This increase has been very

dependent on federal and state government funds, and there may be significant changes in the college and university systems as the pressure of decreasing government funding begins to hit home in the next decade.)

In 1993, there were 2,157 4-year colleges and universities in the US plus about 1,500 2-year colleges (but some of these are technical training schools, so the number of 2-year colleges as we would think of them may be closer to 1200.) In 1995, the U.S. Dept of Education projects that about 15 million students will be enrolled in some institution of higher education, from community college to research university. And in the United States, we keep learning beyond our younger years: In 1990-91, out of a total US adult population of 182 million, the U.S. National Center for Educational Statistics reported that 57 million (about 32%) had taken some sort of adult education or training course in the last 12 months. How many of these students are taking an introductory astronomy course?

I wish we had a more precise answer to this question. No one seems to know how many introductory astronomy students there are per year in the U.S. In preparing this summary, I surveyed textbook authors and publishers who keep track of these sorts of statistics. The best estimate I can come up with is that about 200,000 students take astronomy in the US per year. The last survey I am aware of was done by Darrel Hoff in 1980 (Hoff 1982), in which he sampled about 20% of the colleges that had even one astronomy faculty member. He estimated that the general education astronomy enrollment in 1980 was about 300,000; this fits in with the general sense everyone has that the numbers have declined in the last decade or so.

When we think of who teaches such astronomy courses, those of us from four-year university backgrounds tend to picture a person trained in astronomy, who may teach one or two classes per semester. But in real life, many of the courses are taught at smaller and two-year colleges, by people with training in other sciences and perhaps a less than complete familiarity with the results of modern astronomy. In some of these institutions, a teaching load might be 15 units per semester: five 3-unit classes each term (sometimes even the same class offered in 5 different sections.)

At such colleges, the instructors serving large numbers of students generally work in isolation from the research community and rarely have the opportunity to upgrade their skills by coming to conferences such as this one. They rely on the textbook and the ancillary materials that publishers provide for much of their information, and rarely have a chance to interact with other teachers of astronomy. Many teach the way they were taught, and even the best teachers find themselves unable to maintain the enthusiasm of their early years. The astronomical community (and the AAS and ASP in particular) really do need to come up with creative ways to include these instructors in our programs and activities and help them to revitalize their teaching from time to time.

3. K-12 Education

Currently, the U.S. enrolls about 46 million K-12 students per year and tries with varying degrees of success to prepare them for life in the 21st century. In many ways, the school system in America reminds an observer of Saturn's ring system: from far away, it looks ordered and beautiful, a testament to the organizational powers at work in the system. But the minute you get closer, what you see is the chaos of countless individual pieces, some colliding, some moving together, some all knotted up. And what are all the pieces doing ultimately? Going in circles of course!

I've already mentioned some of the serious problems in science education in US schools – those problems are, of course, only a tiny subset, of the much larger problems confronting the entire educational system. For example, one legacy of our frontier past is that the US education scene consists of many fiercely independent "empires". All fifty states have different rules and requirements; and there are 16,000 school districts in the country, in many of which local school boards maintain their own priorities and regulations with a grim determination.

Our society expects our schools to do much more than merely teach our students basic liberal knowledge. Today, we expect our schools to fulfil many of the functions that were the province of the extended family, of religious institutions, and of the community at large just a few decades ago. As Peter Schrag wrote recently in *The New Republic* magazine, "No country has ever done, or even tried, what this country is now trying: To take such a diverse population of children – 20% of them from below the poverty level, many of them speaking little English, many from one parent or no-parent families – and educate each child at least through the 12th grade..." (Schrag 1991).

In 1990, Bruce Alberts, now the head of the National Academy, wrote poignantly about high school science teachers in California: Such a teacher might typically teach 5 classes a day, with three different preparations and a total of more than 160 students. A dedicated teacher, with labs, setup, preparation, grading, student conferences, and all the paperwork schools require, will work something like 70 hours a week, and have an average starting salary of $22,000 per year. Who would want this job? Or who, once having this job, would not be tempted to cut corners, give lots of rote assignments, skimp on hands-on lab experience, and just try to survive? (Albers 1990)

If we really felt that education is important in the US, would we pay teachers so much less compared to lawyers, accountants, business leaders? Why, in a culture that glorifies money, are we surprised when students (especially students from low-income families) get the message early on – teaching and learning must not be so important to adults, or film stars and basketball players would not earn outrageously more than a mentor teacher.

But, despite our expectations of them, schools in our country cannot by themselves solve all the problems that threaten the education of young people. If we really want to make changes in the ways our children are educated, we must be prepared to examine the other influences on their lives as well. For some children, these include poverty, violence, drugs, neglect, ill health, and lack of proper housing. But even for children growing up in economically and emotionally stable environments, there is a pernicious influence that was much discussed as a problem when I was growing up, but today seems to be treated mainly with resignation – television.

A typical student in the US spends about 900 hours a year in school and between 1200 and 1800 hours in front of a television set (Barber 1993). In 1993, the average US household had a television set on for about 8 hours per day (Wright 1995). And what does a youngster learn from commercial television – often the exact opposite of what we try to teach them in school:

- That the only thing that matters is the instant gratification of every urge ("just do it," as the popular slogan says);
- That what counts in America is money, celebrity, and fun;

- That anything can be true and can happen (and that anecdotal evidence is enough to prove any assertion.)

Think of how teachers are shown on most television programs on the commercial services: mostly as objects of derision. And how are scientists usually portrayed (when they are shown at all)? Mostly as evil villains, or naive agents of serious catastrophe that result from their experiments getting out of control. These "lessons" of television viewing are rarely lost on our students!

Before leaving the disquieting arena of K-12 education, let me turn just briefly to the places where so many of our teachers are trained – our schools of education. In the 20th century, the US has evolved a whole slew of specialized schools and departments for preparing our teachers. In many of these programs, you do not need to take any science (and certainly any physical science) to become an elementary level teacher. It is one of the few majors that do not have such a requirement, which means it actually selects out those people who are afraid of science. This is one reason why so many elementary teachers transmit a fear, a hostility, a shudder at the very mention of science to their young students, at just the time when kids' minds are seeking not just information but values.

Estimates are that more than 2/3 of math and science teachers in the US today do not meet the recommended proficiency standards of their own professional associations (Beardsley 1992). But, especially in the higher grades, the problem is not that teachers do not know enough science. The problem is more often that the schools of education, despite their many courses on teaching technique, rarely prepare teachers to present science the way it should be taught – in ways the students, at their own stages of reasoning, are ready to understand. So science teachers often model their teaching of science on how they learned science, in big college lecture courses, from textbooks full of facts. No wonder 11-year olds get turned off.

Now some schools of education in this country do make a valuable effort to train teachers in the value of science and its most effective presentation. But as long as schools of education remain separate "fiefdoms" from the departments of science at our universities, and as long as these programs continue to allow teachers to graduate without proper grounding in the method and teaching of science, our children will continue to have role models whose own attitudes toward science would be charitably described as luke-warm.

In 1983 the National Commission on Excellence in Education published *A Nation at Risk,* a report that decried the state of education in the US It called the "rising tide of mediocrity" a "peril to our very future as a nation and a people." It compared what was happening in our schools to an act of war, except it was an act we had declared on ourselves. The report (and others like it) made many recommendations, but so far there have been few effective follow-ups and few additional resources for waging this hidden war.

You can read about a few really good initiatives to reform science teaching later in this volume. But no amount of teacher training in science will address the fundamental problems of low pay, low morale, overcrowded classrooms, boring and often outdated textbooks, and masses of students overwhelmed by life that confronts teachers in so many schools today. The entire country must begin to deal with these issues, and must face them with adequate resources to do the job. Thus far, I am very pessimistic about the will or the ability of our elected leaders to do so.

4. Informal Education Institutions

Much of the learning of astronomy in this country is done outside the classroom, in institutions and through organizations that sometimes interact with the schools (through class visits, for example) and sometimes act independently. These include planetaria, science museums, observatory visitor centers, NASA facilities, youth groups, and many similar organizations. Let us examine each category briefly, with the understanding that you can find more about each of them in other parts of this volume.

A. Planetaria

There are approximately 1,100 planetaria in North America, visited by millions of people each year (see the paper by Manning later in this volume.) About 30% of these serve school groups only, while about 60% do both school and public shows. For many youngsters, a planetarium visit is their first (and in some cases only) introduction to astronomy. The quality of this introduction can vary widely, depending on the skill and background of the presenter and how the planetarium environment is used. Nevertheless, most children have a fond recollection of their planetarium experience, and for many children in cities, it may be the only time they really experience a *dark* night sky.

Planetarium educators are organized into a number of regional organizations, and into the International Planetarium Society (although not everyone belongs to these groups.) My main observation of the field is that planetarium educators tend to be somewhat isolated from the astronomy research and even college education community; this can occasionally lead to some problems in keeping up with current science, but I don't think these are a major cause for concern. More important is a sense that planetarium educators get of being peripheral to astronomy, despite the large numbers of people for whom they serve as primary contact with the world of astronomy. I think it would be very useful for the main astronomical societies to make more of an effort to involve and get involved with the planetarium enterprise; the AAS has recently taken some first steps in this direction.

B. Museums

Many science museums have astronomy exhibits, where visitors can read or participate in activities relating to astronomy or at least space exploration. Many museums also sponsor youth and education programs after school or on weekends. As in planetaria, there are many museum visitors who are first exposed to modern astronomy through such programs. Science museum educators also have an organization, called the Association of Science and Technology Centers (ASTC), with offices in Washington. The same comments I made above for planetaria would apply to astronomy staff at many science museums as well.

C. Observatory Visitor Centers

A number of the major observatories are expanding or putting in visitors centers which have an educational component. Some of these centers accommodate a large number of visitors; for example, Kitt Peak has 150,000 visitors per year. An especially good center has been built at the Lowell Observatory, where you can experience a computer simulation of a night at the observatory. Of course, there are budget problems that prevent much expansion in this area, but my feeling is that more cooperation among observatories and more communication among those of us

working in astronomy education would have a salutary effect on these efforts.

Another aspect of the work of observatories is responding to requests for information from the public. Some observatories have developed excellent materials of their own, others use the materials developed by such groups as the Astronomical Society of the Pacific. Again, it would be helpful to have a list of available resources for those whose responsibility is responding to public inquiries.

D. NASA Education Efforts

NASA has extensive efforts to help in science education, but it is difficult for a mere mortal (including personnel at NASA) to know and understand all the programs they have and all the decisions they make. Astronomers and astronomical organizations have had a lot of trouble finding ways to work with the NASA Education Division, despite much recent effort on both sides. The organizers of this conference, for example, were unable to get a representative of the NASA education side to participate. In addition NASA has also had a reputation of being much stronger in the area of education about human space flight, than about astronomy.

As a result of the frustration some NASA scientists have had in getting the word out about NASA results in astronomy, a few years ago NASA's Astrophysics Division decided to hire its own education staff to produce educational materials and activities. The first two leaders of this effort were Jeff Bennett (now at the University of Colorado) and Cherilynn Morrow. The current person in this position is someone with a great deal of senior policy experience at NASA, Jeff Rosendhal (see his article later in this volume.) As a result of recent changes at NASA Headquarters, much of the Astrophysics Division education effort will now actually be carried out through the Space Telescope Science Institute.

One of the things we hope to do through Project ASTRO at the Astronomical Society of the Pacific is to compile a list of the activities at all the NASA Offices and Centers that relate to astronomy education. Some of these can already be found in the Appendix to this volume which lists national astronomy education projects.

E. Others:

Other astronomy education programs that take place outside the formal school systems include the Challenger Centers with their space flight simulators for kids, the Young Astronauts clubs around the country, which occasionally do astronomy activities, scout and other youth groups, which have inspired many youngsters through astronomy merit badges and similar programs, and astronomy camps, some of which you will read about in this volume. In response to some of the crises in K-12 education that I discussed above, a number of interesting grass-roots efforts are springing up to supplement science in the schools with after-school and summer activities, sometimes in connection with a local science center, youth group, or amateur club. At the present time, there is unfortunately no central clearing house that would keep track of and disseminate the results of such efforts.

5. Amateur Astronomers

The U.S. has a large population of amateur astronomers, people whose hobby is astronomical observing or following astronomical developments in a serious sort of way. I like to divide the amateur community into three categories: *Research-level amateurs* are those who have sophisticated telescopes and detectors, or who carry out serious observing programs. These amateurs are usually members of such

specialized organizations as the American Association of Variable Star Observers, Association of Lunar and Planetary Observers, or the International Amateur-Professional Photoelectric Photometry Group, or they are working in conjunction with a professional astronomer in their community. There are probably not more than a few hundred of this group in our country.

Observing amateurs are those who have a telescope and regularly take it out for observing the sky, either for their own amusement or with a community or school group. These amateurs are frequently members of some of the more than 200 amateur clubs in the U.S., many of which are, in turn, members of the umbrella organization called the Astronomical League. The League currently has a combined membership of almost 13,000 people (Beaman 1995).

Armchair amateurs are those who mainly prefer to read about astronomy and may do some casual observing from time to time. Some of these amateurs are members of local clubs, but many are not, and pursue their interest in astronomy through magazines or books they read, programs they watch on television, and lecture series they may attend. Some are members of such national organizations as the Astronomical Society of the Pacific or the Planetary Society. New converts to this group these days can come from those browsing the many interesting astronomy rest-stops on the information superhighway.

Many members of the three groups are tied together by the two main magazines for amateurs, *Sky & Telescope* and *Astronomy*. This latter has a circulation of about 170,000, while *Sky & Telescope's* is over 120,000. Estimates of the total number of amateurs in the U.S. range from 200,000 to 500,000, often depending on how exactly you define the term. This figure, 40 to 100 times the number of professional astronomers, represents a tremendous population with potential in astronomy education.

Many amateurs are already involved in education, by going for occasional visits to local schools or putting on neighborhood star parties, where youngsters get their first look through a telescope. The amateur community organizes a National Astronomy Day each spring, where they make a special effort to bring telescopes to where people are and show them the night sky. The Astronomical League has a number of educational programs and publications, although they are limited by being purely volunteer efforts with no budget to support them.

But much more could be done. Many amateurs have time, knowledge, energy, and enthusiasm, which could much more actively be harnessed in the service of education. Some professional astronomers and educators worry that amateurs will tell students erroneous things; but at the level of a 5th grade class, the physics of quasar energy mechanisms isn't really a relevant topic. The phases of the Moon, why telescopes are needed to observe celestial objects, or the joys of hunting comets are much more relevant to the reasoning level of the youngsters.

This was the thought behind Project ASTRO, a two year program we have been piloting at the Astronomical Society of the Pacific with support from the National Science Foundation: to set up ongoing partnerships between amateur (and professional) astronomers and 4th to 9th grade teachers in 45 sites around the state of California. Astronomers visit "their" classroom not once, but at least four times, and work with the teacher to put together age-appropriate hands-on classroom and after-school activities.

We found that, with proper training, and when they are provided with a suite

of good activities and teaching resources, amateurs (and professionals) can do an excellent job in helping students get excited about astronomy and science in general. We now hope to extend the project to five other states around the country and to develop training workshops for interested partners at both AAS and ASP meetings (see the paper later in this volume.)

Project ASTRO has also produced *The Universe at Your Fingertips,* an 815-page loose-leaf notebook of exemplary activities, resource lists, and teaching suggestions that incorporate the best ideas from our project and many others around the country. It is available through the A.S.P. Catalog.

6. The Astronomy Interpretation Community

In some ways, the interpreters to the public are the most far-reaching part of the astronomy education community, because they include the media. It is sobering to remember that one episode of "Unsolved Mysteries" on television is seen by more people than all the students all of us in the symposium will ever teach during our entire careers.

The astronomy interpretation community includes editors and reporters at daily newspapers and magazines, producers and writers on radio and television, the authors of introductory books on astronomical topics, the writers of children's books, and the authors of astronomy software. Let's look at this world briefly:

A. Magazines

If you examine a list of the top 100 magazines by circulation, you do find some rays of hope amidst the gathering darkness of gossip and entertainment magazines. In 1994, there was one in the top 5 US magazines that regularly features very high quality astronomy articles: can you guess which magazine that is? .... *National Geographic* (with a circulation of about 9.5 million).

In the top 20, we have *Time* and *Newsweek*, both of which have had excellent physical science reporting. The top 30 includes *Smithsonian* and the top 40, *Popular Science.* And one of the largest circulation periodicals in the country, the Sunday newspaper supplement called *Parade* (which is mostly pap), regularly features wonderful essays by Carl Sagan which extol the scientific perspective and debunk popular pseudo-sciences.

In the category of smaller circulation special interest magazines, we have a number that do an excellent job of reporting astronomy to their readers: In addition to *Sky & Telescope* and *Astronomy* (which we have already mentioned), there are *Discover, Scientific American, American Scientist,* and *Air and Space.* Excellent and regular coverage also appears in the news pages of such magazines as *Science, Nature,* or *Science News.* Plus many of the astronomical and space interest societies issue their own magazines, such as *The Planetary Report* from the Planetary Society, *Mercury* from the Astronomical Society of the Pacific, or *Ad Astra* from the National Space Society. Here, although specialists occasionally complain about a subtle point being missed, the reporting is very, very good indeed, and astronomy stands out among sciences as receiving and offering the best coverage for readers with a serious interest in the field. Of course such readers are relatively small in number compared to the population of the country.

B. Daily Newspapers (and Radio and TV News)

If you follow astronomy reporting in U.S. newspapers, you are probably used to reading the syndicated copy of some of the very best science reporters (from such newspapers as *The New York Times, The Boston Globe,* or *The Los Angeles Times*. But these reporters, many of whom have some training in science, and who generally belong to a trade organization called the National Association of Science Writers, are really the cream of the profession. Under that cream comes a much larger group of reporters, editors, and radio and TV people whose training and judgment have become a cause for national concern.

In the old days, many journalists were trained in some academic subject (or self-trained) and went out to report the news. Today, there are over 400 schools or departments of journalism in the US (although many are slowly changing their names to include words like communication and media – in part because many of their graduates hope to earn large salaries reading the news from cue cards on television.) These graduates, armed with courses as unspecific and muddled as anything our schools of education can come up with, are beginning to fill the ranks of the radio, television, and print media in the country. Many have minimal or no training in science and a good fraction share the larger public's distrust of and sense of intimidation by scientists.

Even many of the elite journalists in the first group don't do as much digging and reporting these days as you might imagine. They have a kind of symbiotic relationship with the public information officers at universities, research labs, and scientific societies, whose job it is to get out the news from their institution and have it be as widely disseminated as possible. (The two groups are actually so interwoven that journalists frequently move from one to the other and back again with ease.) Because no reporter can keep up with all that is happening in every science, many have come to rely on public information officers to identify noteworthy stories for them. And those are usually the stories that are then developed. There are exceptions – often stories with a local angle or a whiff of scandal – but many journalists are happy to pluck the fruit from the low hanging branches of the information tree; it is rare to see them do much climbing on their own.

In San Francisco for example, a city that has three of the very best science journalists on the staff of its two newspapers, it has nevertheless been true that the majority of astronomy stories the public got to read or hear about in the past two years have been determined by only two processes: 1. what stories Steve Maran, the Public Information Officer of the American Astronomical Society, decides to feature at the society meeting press conferences (which are attended by many top science reporters whose stories are frequently syndicated around the country); and 2. what stories NASA and Space Telescope Science Institute public information officers decide to hold news conferences or issue illustrated news releases about.

When the non-elite group of journalists cover some science story (especially on radio and TV), they often do so reluctantly and frequently make a muddle of it. Or they wind up simply rewriting a press release or wire service copy, or focusing on a local scientist who can comment in 20 seconds on the story. And, often it turns out that most of what these journalists call science news is actually news about medicine or applied technology.

It is these second-tier journalists who often get confused (to make the most charitable interpretation) between science and pseudoscience. They were the ones who reacted to the Nancy Reagan astrology revelations by interviewing local

astrologers (who made it all sound like the most natural thing in the world that the president's schedule should be determined by astrological forecasting) and by doing puff pieces on all the movie stars that also guided their lives by astrology.

But there is another part of modern journalism, which more rarely gets discussed: the *gatekeepers of the media.* Decisions about what gets on the evening news are usually not made by the people you watch on your screen. Decisions about what gets significant coverage in the newspapers are not made by the people whose bylines you know. Decisions about what topics are discussed on the radio are often not made by the people whose voices you hear.

Making these decision is the role of the gate-keepers, editors and producers who filter the news, select the stories to be covered, and direct the tone of the material that will be read on the air. These gate-keepers are often young, superficially educated, and lack any serious knowledge of science. Yet they are the ones who assign the stories to reporters, determine the length of articles or broadcast pieces, and decide where these pieces will appear. They have been, many of them, raised on a steady diet of the kind of journalism we now have, and so accept the current system without question.

Furthermore, it is this group, more than the reporters, that is actually charged with minding the corporate bottom line at their institutions, and is thus most likely to pander to the worst instincts of the public instead of educating them. (Just count the number of news stories about ghosts around Halloween or the predictions of psychics around the new year.) Their sense of the public trust of journalism is founded much more on an entertainment than an educational model, and the trends in what gets reported and how it gets reported clearly bear out their influence. Small wonder that serious science and skeptical inquiry, which is the best thing the scientific method has to teach us, get such short shrift.

C. Radio and Television Programming

Now we get further into the media wasteland, where oases are harder to find. You will hear about some of the oases today, such as the *Stardate* and *Earth & Sky* radio programs, the *Nova* television series on PBS, the new telecourse on astronomy from Coast Community College, an occasional special somewhere on a cable channel, etc. The most successful astronomy TV program was *Cosmos,* which I believe is still the most watched program in PBS history. It is estimated to have been seen by 500 million people in more than 60 countries since 1980. But it is a sad exception to the general rule of what is seen on television on an average night.

Overall, the television picture is very dim indeed, with vast quantities of pseudo-science being served up by most of the commercial networks. (This is being exacerbated by the tremendous growth of what is called "tabloid TV" – shows that generally imitate the contents and approach of the tabloid newspapers.) Science on many stations is often limited to ten-second newsbites on the evening news which make little sense to the uninitiated (and are generally what I call Guinness Book of World Records stories – the farthest galaxy, the biggest black hole, the most distant comet.)

By the way, if you are one of the people in this country who watches little or no television, and therefore thinks the problem of so little worthwhile contents on the air is not a major concern, you should know that in 1993, the average American household had a television set on for 7 hours and 51 minutes each day (Barber 1993)!

That's only the average! It boggles the mind to think of it (and rots the mind to do it.)

As a country, we need to recognize the enormous power that the media have, and pay more attention to how decisions are made in the media. By this I don't mean censorship, but rather undertaking a long-term educational program to make sure that those who have the responsibility for deciding what goes on the air (or what is printed) have the education and the informed background to make sensible judgments. One step would be to introduce and require excellent science overview courses developed specifically for students going into journalism. Another would be for everyone who is dissatisfied with science coverage on the media to make his or her voice heard locally or nationally. (In San Francisco, the work we have done at the ASP has increased the amount of astronomy on local radio and television significantly and, although it took a while, it was not a very painful exercise.)

The argument the media always make in response to such concerns is that they are merely giving the public what it wants. But this argument is specious. Someone like me, who began life in Communist Eastern Europe, never got to taste a mango or an avocado as a child. Thus I would never have known to ask for a mango or an avocado or that I wanted one. But after we came to America, I was introduced to a much wider range of foods: my palate was educated...and now I ask for mango and avocado regularly. Similarly, I would suggest that when the media tell us that people are much more interested in the Bermuda triangle that the Great Attractor, they are merely confessing our joint failure at educating both the gatekeepers of the media and the public.

In focusing so strongly on the entertainment aspect of their mission over the educational aspect, the media lose sight of the fact that there is an alternative to pandering to the lowest taste. It is the far more difficult and long term job (and the almost forgotten pleasure) of elevating the tastes and desires of their audience to new levels of perception and understanding.

I should mention that there is a national organization which is making a creditable effort to help the media sort out science from fiction science. The group is called the Committee for the Scientific Investigation of Claims of the Paranormal (CSICOP), a mouthful of a name, but a group with their hearts in the right place. It consists of scientists, educators, magicians, philosophers, lawyers, and other skeptics whose interest is to get the rational, skeptical perspective about fiction science out to the media and the public. Among astronomers, Carl Sagan, David Morrison, Ed Krupp, Don Goldsmith, Steve Shore and I have all been very active in CSICOP projects relating to astronomical pseudoscience.

Through their superb magazine, *The Skeptical Inquirer,* their meetings and workshops, and their information releases to the media, CSICOP has managed to alert and educate a significant number of reporters to stop and consider what they are doing when they file a story involving pseudoscience. They also work to bring together such reporters with skeptical spokespeople before a story is written. (They can be contacted at: P.O. Box 703, Amherst, NY 14226; I urge everyone in astronomy education to get to know their work and support what they are doing.)

D. Nontechnical Books for Adults

In 1993, roughly 45,000 new books were published in the U.S. [*Publishers Weekly,* Mar. 7, 1994, data from R.R. Bowker Co.] Of these, about 2,000 were classified as science, although I suspect that the librarians who do this classifying

may well include some pseudoscience in this category. Such books, written by both scientists and science journalists, can be an important way that educated laypeople learn about new developments and ideas in science.

When a really excellent book comes along, such as *Lonely Hearts of the Cosmos* or *First Light,* it can give laypeople marvelous insight into how astronomy is really done today. A best seller, such as *Cosmos* or *A Brief History of Time* (which by the end of 1993 had sold over 5.5 million copies worldwide), can turn more people on to astronomy than thousands of astronomy courses.

On this front, there is good news and bad news: the good news is that fine books in popular astronomy are still finding a publisher; the bad news is that these publishers rarely promote or advertise such books with any energy or enthusiasm. Instead, they reserve their advertising budgets for the books they consider "guaranteed big sellers", a phrase which then becomes a self-fulfilling prophecy. As a result, some of the best astronomy books of the last decade have sunk without a trace in the vast murky ocean of modern publishing.

E. Children's books

One area of astronomy education that has received very little attention are children's books, despite the fact that these can have a strong influence on youngsters. Several astronomers and science writers have produced whole series of astronomy books for kids, among them the late biochemist Isaac Asimov, the former director of the Hayden Planetarium Franklyn Branley, British astrophysicist David Darling, the current director of the Griffith Observatory Ed Krupp, the associate director of the Pacific Science Center Dennis Schatz, journalist Seymour Simon, and NASA aerospace specialist Gregory Vogt. Alas, mixed in with these excellent and reliable books -- often on specific single topics in astronomy – are a host of muddle-headed, error-filled books written by people with little science background and published by organizations and publishers who should – in many cases – know better.

At the ASP, we have collected and reviewed hundreds of children's books on astronomy and will be publishing recommendations for the best of them in *The Universe at Your Fingertips* Resource Notebook that will come out of Project ASTRO.

Conclusion

In this quick overview of astronomy education, I have purposely focused on the problems and challenges, because many of the other papers in this volume will focus on the various solutions being proposed. Throughout the country, scientists, engineers, and educators are becoming concerned about these problems and looking for ways we can change the cultures we live in to improve the nation's understanding and appreciation of science.

In astronomy this effort is just beginning (on all but the most local of scales), and those of us involved in educational reform, whichever of the communities that I've discussed we belong to, still feel a bit isolated and untethered. There is a great need for a more organized and coordinated effort in astronomy education, and I very much hope this conference can be the beginning of such coordination and organization.

The American Astronomical Society has formed an Astronomy Education

Policy Board, which is looking at how to bring about institutional changes in the worlds of astronomical research and university education that will encourage and reward work in astronomy education. More about the plans of this Board can be found in the paper by Suzan Edwards later in this volume.

In the appendix to this volume is a catalog we have compiled at the Astronomical Society of the Pacific of some of the national projects in astronomy education. (Many of these are also described in contributed papers throughout this volume.) We intend to continue to update and expand this catalog, and would welcome sugggestions and additions from readers.

Let me conclude with the following more general thoughts: Everyone who attended this conference is already dedicated to astronomy education, or else you would not be sacrificing a pleasant summer weekend attending a symposium on the subject. But we make up only a tiny fraction of the total astronomical community. I hope as part of your dedication you will share your enthusiasm for education with colleagues, students, amateurs, and all the other categories I've discussed.

I'd like to make the simple suggestion that everyone in astronomy ought to devote a minimum of 1 percent of their time to improving astronomy education for nonscientists: if we take a 40 hour work-week and 52 weeks in a year, 1 percent works out to 21 hours a year. That's enough for seven three-hour sessions with a local teacher and 6th grade class; for preparing or giving a workshop for local astronomy graduate students and postdocs about recent developments in education and things they can do to help; for organizing a meeting of a local amateur astronomy club on what they can do to get involved in the problems I've outlined; or for spending several afternoons with the staff of the local planetarium.

I urge everyone who works in or loves astronomy to do this not only out of a sense of duty or compassion. The ominous news from recent developments in our nation's capitol is that (as Jeff Rosendhal has been pointing out) the unwritten compact through which the federal government has supported science and universities for the sake of their value to national security shows signs of breaking down. New generations of our leaders (like new generations of our students) do not feel immense loyalty or warmth toward science. And their apathy may well allow very serious cuts in the budgets that support so much of our scientific enterprise.

Our crisis in the public understanding of science is like a disease that has slowly attacked our country over the years. If it is allowed to fester untreated for much longer, the body politic will surely send its own antibodies to the source of irritation, and the resulting "cure" may be worse than anything scientists can now imagine. Thus the work we do today in science education may well turn out to be the single most important thing that can be done to assure the continued good health of the science of astronomy in the United States.

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Discussion

Bisard.

I strongly believe the ASP must conduct a national survey of "Learning Astronomy" rather than "Teaching Astronomy" at all levels of K-16. This could be a small grant supported project but one which answers who? what? where? when? with regard to the learning of astronomy.

Crawford.

Building awareness and interest are critical, and the younger the better. IDA's Star Watching Program has had some excellent student feed back, for example:
"I never saw a star before, now they're my friends."
"I never looked up at night before." etc.

Mechler.

Tabloids comment and call for more on science itself as a process in astronomy textbooks.

Hoff.

I made a comment on the fact that H.S. students spend only about 1.5 hours out-of-doors per week. This is both a fact to be concerned with and a challenge for those who develop astronomy activities.

Fraknoi.

I agree with the concern. With the overwhelming role that television and video/computer games now play in the evening lives of our students, some rarely get to observe the night sky and thus become aware of its beauties and patterns.