NEWSLETTER

IAU COMMISSION 46: THE TEACHING OF ASTRONOMY

President and Newsletter Editor: John R. Percy
Erindale Campus, University of Toronto, Mississauga, Ontario, Canada L5L 1C6
Electronic mail: percy@astro.utoronto.ca

Vice-President: Julieta Fierro
Instituto de Astronomia UNAM, AP70-264, CP 04510 DF, Mexico
Electronic mail: julieta@astroscu.unam.mx

Organizing Committee: A. Batten, A. Arellano Ferro, M. Gerbaldi, L. Gouguenheim, S. Isobe, D. McNally, J. Narlikar, D. Wentzel

ISSUE #41; JUNE 1995

MESSAGE FROM THE PRESIDENT

During the first half of 1995, thanks to an administrative leave from my university, I have been able to travel widely, lecturing and learning about international astronomy education, and publicizing the work of Commission 46.

In February, I spent three weeks in South Africa, primarily to participate in an IAU colloquium on stellar pulsation. I visited UNISA (University of South Africa), a "distance university" with 150,000 students, and a well-developed astronomy program. I also visited an excellent little science centre at the University of Pretoria, and met with members of many of the centres of the Astronomical Society of Southern Africa. Most significantly: Patricia Whitelock and I organized a very successful one-day workshop for 100 school teachers on the weekend before the IAU colloquium. To my knowledge, this is the first such workshop to be held in connection with an IAU symposium or colloquium. There is much that Commission 46 could do to support the development of astronomy education in the "new" South Africa.

In March, I attended the 5th International Conference on Teaching Astronomy, in Vilanova i la Geltru, Spain, very ably organized by Rosa M. Ros, Spain's representative to Commission 46. I met educators from many different countries, and got my first close look at the very active astronomy education scene in Spain.

May brought three exciting weeks in China, on a combination of research and education business. As well as visiting my research colleagues at Beijing Astronomical Observatory, I visited the three universities most active in training astronomers (Beijing, Beijing Normal, and Nanjing), the largest planetarium (Beijing), a major science museum (Beijing), a "children's palace" of science and culture (Nanjing) and two of China's best high schools. I gave a total of 13 lectures, including several on astronomy education to various audiences, and made many contacts for the future.

In June, I will be giving the opening address at a major conference on astronomy education, to be held in Baltimore, June 24-25; Don Wentzel chairs the LOC. In July I will make my first visit to an ISYA: International School for Young Astronomers, in Brazil. Since ISYA is the most prominent program of Commission 46, this visit will be a highlight of my term as president.

The work of Commission 46 is progressing well. In addition to the ISYA in Brazil, the first plans for TAD (Teaching for Astronomical Development) are in the works. The positive results of the Visiting Lecturer Programs in Paraguay and Peru are evident. The photometer of the Travelling Telescope is busy in Paraguay. The proceedings of our meetings in The Hague in 1994 will soon appear in the publications of the IAU. The first issue of our new electronic newsletter should be travelling through the Internet as you read this message. We are busily planning for our second international conference on astronomy education (proposed as an IAU colloquium), to be held in London UK July 8-12, 1996. Derek McNally chairs the LOC, and Lucienne Gougenheim chairs the SOC. And I am very much aware that, in every corner of the Earth, astronomy education is being done with imagination and enthusiasm — thanks to the efforts of people like you. My special thanks go to all the members of the Organizing Committee of Commission 46, and to all those other people who are making our programs and projects possible.

PLEASE CIRCULATE THIS NEWSLETTER!

INTERNATIONAL COLLOQUIUM ON ASTRONOMY EDUCATION

An astronomy education colloquium is planned for 1996 July 8-12 at University College London, and The Open University, UK. IAU sponsorship and support is being sought. The program includes: university education, school education, public education, distance learning, as well as student learning patterns and problems.

Further information can be obtained from the chair of the LOC: Dr. D. McNally, University of London Observatory, Mill Hill Park, London NW7 2QS, UK; phone 44-(0)-181-959-0421; fax 44-(0)-181-906-4161.

THIS NEWSLETTER GOES ELECTRONIC

This newsletter is gradually being transformed to an electronic format, except for those readers who have no access to e-mail, or for whom e-mail is prohibitively expensive. To receive the electronic newsletter, send your e-mail address to: Armando Arellano Ferro (armando@astroscu.unam.mx).

DEVELOPMENT OF AN ASTRONOMY COURSE

In the December 1994 issue of this Newsletter, we reported on the establishment of the European Association for Astronomy Education. The Declaration unanimously adopted by the participants of the founding workshop (Garching, Germany, November 25-30, 1994) included the following very interesting proposal regarding a "universal" astronomy course. —*Editor*

The main purpose of astronomy teaching is to make the students aware of humankind's place in the universe, its bearing on the real world the students live in. Thus, the students will be able to appreciate the singular nature of the Earth in the universe and the importance of its preservation. Presently, however, this purpose cannot be fully achieved because the relevant topics are scattered over several subjects, such as geography, mathematics, physics, chemistry, biology and philosophical education. Also, the present curricula in Europe do not fully exploit the natural curiosity of young children for astronomy-related topics, and thus limit what can be achieved at a later age.

To remedy the present situation, we propose the following:

To take advantage of the natural curiosity of young children, astronomy teaching should start at the junior level. In that phase, the teaching should concentrate on the place of the Earth in the solar system as most of the astronomy-related questions that preoccupy children derive from daily experiences caused by the movement of the Earth, the moon and the sun. In order to achieve a good understanding, the following are essential:

1. Models should be used extensively to aid the students in obtaining a three-dimensional understanding of the world around us.
2. Simple observations are necessary to relate the teaching to the real world.

By the age of 14, students should have acquired

- knowledge and understanding of the sun, the moon, the Earth and their principal relations (the seasons and their effects, the movements in sky and space, the nature of these bodies, etc.); and

- a first view of the solar system.

In addition, they should have

- acquired a basic understanding of what the stars are; and
- performed simple observations of the day- and night-sky.

It is felt that this is the minimum all people should know about astronomy.

Beyond the age of 14, we also propose astronomy for all students continuing with their education. Astronomy teaching at this phase may be based on the concept of "the powers of ten" (study the universe and its components in a series of steps, each representing an increase in scale of a factor of ten) in order to achieve the desired global picture of the place of humankind in the universe. In this way, some of the most important elements of astronomy can be covered, such as

- physics of the sun, the solar system and the stars
- stellar evolution
- measurement of distances
- astrophysical tools (instruments, methods)
- the use of artificial satellites and space probes
- evolution of the universe.

It is the long-term goal of the EAAE to study the possibility of assembling a universal astronomy course based on the above topics.

A "quick-look" course of this type could be given at the beginning of this phase to provide a first survey of the subject and to ensure that those who leave education early have had contact with these important concepts.

With the acquisition of more knowledge about all the natural sciences, the same type of course, but more complete and comprehensive, could be given towards the end of school.

The course would *illuminate astronomy as a human endeavour, with associated doubts and lack of answers, the interplay between experiment, observation and theory, the philosophy of science, the scientific method and the interaction between science, technology and society.*

USING COMPUTERS TO PERSONALIZE A LARGE CLASS

R. Robert Robbins; Department of Astronomy, University of Texas, Austin, TX 79712 USA

Common Problems with Large Classes. At the University of Texas at Austin, we have between 5000 and 6000 liberal arts students each year taking basic astronomy classes to satisfy the science requirements of their various majors. These numbers make it clear that almost all of our classes are BIG. And in the end-of-semester student evaluations of our classes we find a number of complaints commonly heard at all schools where classes are forced to be large. In order of frequency, we hear that: (1) testing is too infrequent, (2) it takes too long to get the tests back (feedback is slow), and (3) there is too little contact with the professor.

The Keller Method. I have implemented a course design at Texas that tries to deal with these problems, based on a modification of a format originally proposed by Fred Keller that was designed to increase the amount of positive reinforcement received by the students. The Keller Method design has no lectures; it is a reading class and requires that good content materials be available. At Texas, we use the textbook Discovering Astronomy, 3rd. edition, by Robbins, Jefferys and Shawl. The selected content material is divided into manageable Units which the students study one at a time, each at their own rate. When students feel prepared on one unit of material, they present themselves for testing. Thus, the students are responsible for studying at the proper rate and self-pacing themselves to achieve the grade they desire.

A Keller-method course emphasizes mastery of the material and it enforces this by requiring a high score on the Unit tests. A student who does not achieve the required level on the quiz must repeat the quiz until he does; we allow our students to attempt a Unit test 4 times. In the end, the grade for the class depends entirely upon the number of Units passed; there is no "curve." For example, at Texas a student who passes 20 Unit tests receives an A, a student passing 16 receives a B, etc. Since a Keller method class typically emphasizes understanding the material more thoroughly, it typically "covers" less content than a conventional lecture.

The "Texas Variation". The course format implemented at Texas is a variation on Keller's original design that has been successfully operating for a number of years now, serving some 400 students per semester. Perhaps the most unusual feature of the class is that it is open and staffed all day long, 9 to 5 every weekday. A room is dedicated to the class (the room is used as a lab at night) and students may come in at any time they feel ready to request a test and demonstrate their mastery of the material in the Unit. Thus, each student paces himself and all of the students in the class are never present at one time; they come in when it is convenient for them. The students may also come in to receive tutoring or other study assistance, since a knowledgeable person is present at all times to answer study questions. This study assistance can be supplied by the professor, teaching assistants, or even selected and responsible astronomy and physics majors.

A vital aspect of the course design is our use of personal computers plus software we have developed that performs virtually all of the *routine* aspects of testing and administration. Specifically, when a student appears for testing, the software checks the student's record and determines which Unit the student is to be tested on, and then it automatically assembles a unique quiz for each student by randomly choosing multiple-choice questions from a large bank of test questions. We now have some 2000 questions written; during the semester, the 400 students will attempt something like 10,000 quizzes, so the need for the computer is obvious.

The quiz is then transmitted to one of 8 terminals installed on a local area (Appletalk) network and the student takes the test on the terminal by clicking alternatives on the screen with the mouse. When the student is finished being tested, the tests are graded on-the-spot by the computer, the student is given a chance to review the questions he missed, and the student records are automatically updated. Thus, the computer handles the testing, grading and record keeping for a class of 400 with virtually no manual intervention necessary. Testing is frequent and feedback is instantaneous.

Perhaps the greatest benefit is that — freed from the routine chores of the class — the instructors are thereby able to spend most of their class time interacting personally with students and tutoring them one-on-one as they study. Another advantage of the self-paced format is that in spite of the large class size, it is easy to incorporate observational activities into the study sequence; in our case, three of the units direct the students through laboratory exercises (*Making Angular Measurements with a Cross-Staff and Quadrant*, *Using a Celestial Globe* and *Observing Spectra*) instead of readings. The textbook mentioned above comes with a kit of materials that students use to assemble their own observing instruments.

The bottom line is that a student contacts an instructor much more frequently than in a conventional large lecture. We also feel that our format has enabled us to achieve one of Keller's principal goals — a course structure that maximizes the positive reinforcement given to students — and to realize in practice the spirit of Keller's original name for this mode of teaching — the Personalized System of Instruction.

The computer equipment required to achieve these goals is not sophisticated. The main computer used as the system server is an Apple Macintosh IIci, with 5 MB of RAM and an 80 MB hard drive, and the 8 terminals are Macintosh Classics that do not even have hard disks. The programing of the testing and record keeping software was carried out in HyperCard, a unique and versatile programing medium that organizes text, data, and pictures into "stacks" like index cards. One moves between stacks and carries out operations on them by clicking on-screen buttons. The software was written entirely by Parvinder Parmar, who is now an Assistant Professor at Moorhead State University.

<u>Customizing the System for Other Users</u>. Note that the course design we have described here is certainly not restricted to astronomy classes or even physical science classes. It could be applied to any large self-paced class that is tested with multiple-choice questions — in physics, psychology, etc. Of course, adequate instructional materials must be available — either a good text must be located or the instructor must write or construct appropriate reading materials and study aids. Often it is necessary for the instructor to author a supplemental study guide to the textbook (as I have done at Texas). Of course, the instructor's greatest single chore is to create and "debug" a large number of objective questions for each study unit. Most of this work must be done before the class commences.

Our software system may be modified for any self-paced class by someone with an intermediate-level familiarity of HyperTalk, the special programing language of HyperCard. Such a person would be able to implement changes such as the number of terminals, units, questions per quiz, passing level, allowed attempts per unit, and grade thresholds. We have written a manual for users to assist them in this process.

A fuller discussion of this course and its associated software can be found in our article in the September 1994 edition of the <u>Journal of College Science Teaching</u>.

LEARNING CENTERS

W. Scott Kardel; Assistant Director, Education, Lake Afton Public Observatory, Wichita, KS USA

A Learning Center is a portable version of one of the exhibits found at Lake Afton Public Observatory. Local teachers may reserve these Learning Centers for two weeks. Learning Centers provide the Observatory with a powerful tool in educating young people. They give students materials not readily available, while bringing astronomers into their rooms to generate excitement and provide much-needed answers to questions. A Learning Center includes activities, materials necessary to explore a topic in depth, and a visit from a member of the Observatory staff to make a classroom introduction of the materials. Four Learning Centers are currently available to teachers: Make Your Own Telescope, Solar System Treasure Hunt, Fun With Light, and Meterorites.

Make Your Own Telescope

The Make Your Own Telescope Learning Center allows students to build a simple telescope from lenses and plastic pipe. A member of the Observatory staff presents the kit to students in such a way that they discover some properties of lenses and which lenses should be used in constructing their telescope. Students construct their own telescopes for use in their own room. The Learning Center includes a variety of lenses, telescope mounts and parts, enough for an entire class. An activity book provides activities on using a telescope, magnification, and light gathering power, as well as background information on lenses and telescopes.

Solar System Treasure Hunt

The Solar System Treasure Hunt Learning Center puts current information and photos of the planets into students' hands and then guides them to classify the planets based on their properties. Seventy-six planet cards, each with a photograph or drawing and explanatory text, are used to lay out the general characteristics of the nine planets of the solar system. Students use the planet cards to hunt for specific kinds of planetary features (larger than Earth, more than 5 moons, close to sun, etc.) where these features are found students end up with a good understanding of the properties and differences between the rocky planets, gas giant planets, and Pluto.

Meteorites

The Observatory's Meteorites Learning Center provides students with a rare classroom experience — the opportunity to touch and study a rock from space. A presentation by a member of the Observatory staff introduces students to meteorites, what they are, where they come from, the types of meteorites, and their importance. This presentation includes a variety of meteorite samples that students get to examine. An activity packet, additional materials, and two meteorites (iron and stony) are left with the students in the classroom for two weeks.

Fun With Light

The Fun With Light Learning Center gives students an understanding of the properties of light through the use of a wide range of lenses, mirrors, colored filters, and a good light source. The kit is designed to foster experimentation. Students are guided through several experiments as a member of the Observatory staff makes a classroom presentation demonstrating the use of lenses, mirrors, and colored filters. Students discover convex and concave lenses, the law of reflection, and how colors of light can combine. This Learning Center comes with a class set of materials and an activity guide.

Lake Afton Public Observatory

The Lake Afton Public Observatory provides the people of south central Kansas an opportunity to learn more about the universe and what takes place in it. Observatory programs center around its 16-inch telescope. Objects viewed in programs are all connected by a common theme. For example, during the program Life Story of a Star, people see objects in the sky that represent stars at different stages of their lives — a star-forming nebula, a cluster of young stars, a contrast double star and a dying star. Other programs focus on objects in the Milky Way galaxy, the solar system, the history of astronomy, the sun, and so on.

The Observatory serves the general public with programs on Friday and Saturday evenings (also Sundays during the summer), school groups in the daytime on Thursdays and in the evening on Wednesdays and Thursdays. University astronomy lab students use the Observatory Monday and Tuesday evenings.

Educational Activities and Games

The Observatory has produced additional educational materials that are available for national distribution.

BINGO Games: Solar System BINGO introduces students to features found on the planets; Stellar BINGO explores the properties of different types of stars; Moon BINGO helps students learn the relationship of the moon's phase, position in its orbit, and location in Earth's sky.

Card Games: By playing a memory game, students become familiar with astronomical terms using the Astronomy Cards or the phases of the moon using the Moon Phase Cards.

Activity Books: The Observatory has produced two 130-page books of classroom activities that teachers can use to teach astronomy. These activities include classroom demonstrations, group projects, and individual worksheets on the moon, solar system, sun, and stars. Within each subject, there are activities for a variety of age groups. There is one book for grades K - 6 and another for grades 7 - 12.

The Lake Afton Public Observatory, located in Wichita, Kansas is a cooperative effort between Sedgwick County, Wichita State University, the City of Wichita, and the Wichita Public School system. The Observatory's educational efforts are supported in part by NSF grant OSR-9255223.

BLOSSOMS OF SCIENCE — CENTER FOR SCIENCE EDUCATION

David Pundak; Jordan Valley Regional College, Jordan Valley, 15132, Israel

Blossoms of Science was founded in 1992 for the purpose of bringing the sciences to the North of Israel. The staff of *Blossoms of Science* at the Jordan Valley Regional College includes researchers, teachers, youth guides, and teams working on courseware for science education. Among the services offered by *Blossoms of Science* are an astronomical observatory, an information center, and some 15 different extracurricular astronomy classes.

In the 21st Century those societies will prosper that know how best to organize and utilize data. *Blossoms of Science* is working to better prepare educators and their pupils for the technological future, by teaching science in a more interesting manner. To this end various educational projects in astronomy have been developed for kindergarten, elementary, and high school students. In addition, a project now under development will help make satellite photos available to high school students working on matriculation projects.

Blossoms of Science continues to bloom as a result of a number of factors — successful government policy on science teaching, efficient integration of scientists into the staff, and the initiative of the staff. The success of *Blossoms of Science* in scientific and educational work has induced educators elsewhere in Israel to open other *Blossoms of Science* branches. Currently *Blossoms of Science* is opening sub-branches in Be'er Sheva and in Um-El-Fahm.

Extracurricular Astronomy Classes. Extracurricular classes of all kinds can be found in most Israeli schools. To the established tradition of offering elementary and high school pupils the opportunity to learn subjects not generally taught in school *Blossoms of Science* has added a unique approach, astronomy classes based on the American Project STAR program.

Project STAR — Science Teaching through its Astronomical Roots — aims at providing students with the basic principles of natural science through hands-on experience. The emphasis is on student participation in the learning process. The teacher's role is to help the students formulate relevant questions, design and carry out experiments to find the answers, and analyze the results.

Blossoms of Science astronomy classes are held at various schools in the North of Israel. *Blossoms of Science* provides instructors and Project STAR materials. Classes usually take place for two hours each week, either during regular school hours, or after school. In addition a variety of out of school activities offer the students the chance to deepen their knowledge and broaden their horizons. These activities include Star Parties, visits to the *Blossoms of Science* Observatory, and popular lectures and discussions at the Astronomy Study Center.

Teacher's Seminars. *Blossoms of Science* offers a variety of seminars for elementary and high school teachers. One of the goals is teaching educators how to incorporate space science and astronomy into their normal curriculum. These subjects provide a very effective means of attracting pupils to the natural sciences, and can help to make science lessons more interesting. Another goal of the seminars is to show how the scientific method can be taught to school pupils using the Project STAR approach. These seminars have had great success in the past and continue to be very popular with school teachers. Another type of seminar has been developed for kindergarten teachers. Here the seminar is built entirely around the Project STAR approach. The goal is to show kindergarten teachers how to use celestial phenomena to hone their pupil's observational skills.

Astronomy Information Center. Space science and astronomy fire the imagination of children and adults alike. Questions such as What makes the stars shine? How did the Universe begin? Is there life on other worlds? continue to fascinate us. Now, for the first time, a facility exists in Israel whose purpose is to answer such questions. The *Blossoms of Science* Space Science Information Center, on the shores of Lake Kinneret specializes in providing the interested layman, teachers, and students with information on astronomy, astrophysics, and space exploration.

The Space Science Information Center includes:

- An updated collection of books, periodicals, and fact sheets on space exploration and astronomical topics, as well as updates from NASA, ESA, and other space agencies worldwide.
- A library of computer programs dealing with space science.
- A wide selection of astronomy and space science teaching materials — slides, viewgraph sheets, and videos — designed to bring the fascination of "The Final Frontier" into the classroom.

Mobile Astronomy Laboratory. The purpose of the Mobile Astronomy Laboratory is to allow school children to do astronomy experiments and observations at school and in their own neighborhoods. The Mobile Lab will provide pupils and teachers with the means to become familiar with what we now know about the world beyond Earth and how we know it. One component of the Mobile Astronomy Lab will be a portable Starlab Planetarium. Built to be set up quickly in any large classroom or gymnasium, the Starlab has many of the basic features of larger planetaria — it shows the night sky for any time of the year and any location on Earth, including stars down to 4th magnitude, planets, and the Sun and Moon. Special projection cylinders allow one to display the celestial coordinates, constellation outlines, or even the inside of a living cell. In addition, the Mobile Astronomy Lab will include a computerized 11-inch telescope outfitted with a CCD camera, a computer for storing and analyzing photos, and an assortment of optical equipment for enjoying the night sky.

Astronomical Research. The Astronomical Observatory of *Blossoms of Science* is equipped with a computerized 14-inch telescope, CCD cameras and filters, and computational equipment and software for image analysis. The observatory's unique location — it is the lowest altitude astronomical observatory in the world, located 200 meters below sea level — allows some unusual opportunities for research. In particular, several projects are now underway in atmospheric studies, aimed at providing answers on how the atmosphere effects starlight of various wavelengths and whether this effect can reveal the existence of pollutants in the atmosphere. The research staff of *Blossoms of Science* consists of two full-time professional astronomers. In addition, *Blossoms of Science* encourages student participation in research projects at the observatory.

Remote Sensing Computer Net. *Blossoms of Science* is currently developing an educational program using satellite photos available through Internet. Numerous photos from different satellites using a variety of analysis techniques are currently downloadable. Proper use of such photos can help students get a feel for the inter-relatedness of Earth's ecological and climatic systems. As a first stage, *Blossoms of Science* will train teachers and pupils in the use of data bases and computer networks. Participants in the program will learn how to access data, how remote sensing images are obtained and analyzed, and how to organize research projects based on satellite images. At a later stage, a computer network will be established among five schools around the country. In these schools it will be possible to realize the fullest potential of the program, with the students doing all the work themselves — downloading, analyzing, and researching. Because remote sensing has applications in many fields, from archeology to irrigation systems, and from bio-diversity to geology, it presents a unique means for students to broaden their knowledge. In addition, the remote sensing project will help to hone the skills necessary to keep pace with our information-based civilization.

Matriculation Projects. The matriculation research project provides an outstanding opportunity for the student to experience every stage of scientific research. The student learns how to formulate questions, choose methods for finding answers, and analyze results. And of course, the whole project must then be written up in a clear and convincing format. *Blossoms of Science* provides students interested in doing their matriculation project in astronomy and astrophysics with the tools and counselling necessary to carry out actual astronomical research. The student can carry out his or her project under the direction of professional astronomers at the *Blossoms of Science* observatory. In the past a number of highly successful matriculation projects have come out of the *Blossoms of Science* program — research into pulsating stars, other variable stars, history of astronomy, archeo-astronomy, star formation, and atmospheric studies, to name just a few.

In addition, *Blossoms of Science* is currently working with the staff of the Poria Hospital to help students who wish to do research in medicine. In the future *Blossoms of Science* will host special classes for high school students aimed at honing their research skills in preparation for their matriculation projects.

NEW APPROACHES TO EDUCATING THE PUBLIC — PLANETARIA[1]

Nirupama Raghavan; Nehru Planetarium, New Delhi, India

Introduction

Planetaria came to India exactly forty years ago, beginning with a school planetarium in Pune. It is only in the last ten years, however, that there has been a spurt in the number of planetaria in the country. Today there are 11 planetaria that offer regular shows, about 7 that offer shows once in a while, and 8 almost ready to open to the public.

The Nehru Planetarium in New Delhi was started in 1984. This was the first public planetarium to state explicitly that its purpose was education. In the last ten years this planetarium has steadily worked to build up activities aimed at strengthening astronomy education for the general public as well as school students. Today we serve approximately 250,000 people per year at the planetarium alone. Several times that number are reached whenever we collaborate with the print and electronic media, as we did during the Shoemaker-Levy-9 collision with Jupiter.

Public Shows

The planetarium public shows are attended by people who come from widely different economic and social backgrounds. So the program design must necessarily use methods that will appeal to the maximum number of people. The fact that among all the sciences, astronomy is closely associated with cultural practices, helped us in finding common threads that would interest most of our audiences.

Festivals: The Indian civilisation has been a long and continuous one spanning 5000 years. Many cultural practices, even today, are really rooted in time-keeping based on the position of the sun, the moon, the planets and the stars that can be traced back to great antiquity. Almost always, the astronomical significance is forgotten; ritual and the attendant commercialisation, even frenzy have taken its place! In our programs, we systematically explain the festivals as a way of astronomical time-keeping in which the whole community took part. The most interesting example is the way that the lunar and solar year were brought in phase by a "Dussera" celebration lasting ten days. This festival is celebrated in practically every part of India, albeit with a different story, but with a remarkably similar underlying theme — of time standing still for 11 days, before ringing in the new year, thereby bringing the lunar year in phase with the solar year!

Mythology: There is an abundance of astronomy-based mythology in India. They usually relate to observed phenomena of naked eye objects in the sky: the sun, the moon, the planets and the stars. By carefully juxtaposing the myth with the modern scientific explanation, we connect with our audience and are able to transfer the modern concept more successfully. The emphasis here is on the phrase "carefully juxtaposing!"

Concept transfer: The conventional wisdom has been that public audiences do not want to hear concept explanations in a planetarium program. The programs at Delhi have at least one concept explanation in one program. Often these are simple, like the position of the sun, the moon and the earth at full moon or the retrograde motion of the planets. Our audiences have expressed their

---

[1]This paper was presented at the Joint Discussion on "Current Developments in Astronomy Education" at the 1994 IAU General Assembly. Due to an unfortunate breakdown in communications, it was not included in the proceedings. — JRP

satisfaction in truly grasping these concepts.

Analogies: In addition to using the available hardware to bring alive a concept to the audience, analogies are used in a structured fashion to convey concepts. Once again, care is taken in the choice of analogy and the sequence of explanation. Such a technique is very effective.

Story-based Shows: Children are among our most regular visitors. So simple programs of direction-finding from the constellations, journeying to an asteroid or the recipe for making a star narrated as a story with characters have proved very popular. In these programs we have used both actual children and cartoon characters. Testing at the end of programs shows that the instructional success is high.

Music: India is a very musical country, rich in folk, classical and film music. We use mood creating music to explain phenomena, using the same music to underline similar ideas. In this way the music serves as an excellent memory device.

Curriculum Based Shows

Live Programs: The Indian school curriculum has a few lessons in astronomy, normally adjunct to environmental science, geography or physics. Since school teachers are not normally exposed to training in astronomy these lessons were rarely if at all taught. It became clear that the planetarium had to step in to fill the gap. As a result, over the years we have designed and presented curriculum-based live programs that have been extremely successful. Specially created teaching aids employed in large theatres, for different age groups are very useful. Special mention must be made of the excellent contribution that human models make in presenting concepts clearly.

Newsletter: A Newsletter was published but had to be discontinued for financial reasons. However we provide astronomical photographs, star maps, scripts of the programs, up to date data to the school and university communities.

Student Projects

The facilities and expertise of the planetarium are available to school students to perform projects. Over the years we have developed projects in four categories: Naked Eye, Telescope, Photographs and Handbooks, and Planetarium Projector. Significantly, the majority of students who opt for projects in astronomy are girls!

Exhibits

Complementary to the shows in the planetarium theatre are the models that a visitor encounters in the foyer. Simple models encourage the visitor to operate them any number of times and learn. Again the models that are most effective are those that involve the visitor to take active part. A much enjoyed model is a sun dial where the visitor is the gnomon. This model can also be used to find the height of a person; if several persons of different height use it together, the latitude of the place can be measured. For a model so versatile it takes only a can of paint to construct!

Contests

One of the universally popular ways of getting young people interested in anything is through organising contests. Every year a Space Quiz contest is held for high school students. Winners in these contests have gone on to become good amateurs or have even studied astronomy in college. Also in recognition of the visual appeal of astronomy and its deep cultural links we run an annual

Space Art contest. The paintings are very good but lack variety, as visual material available to school students is very limited. This is an area which needs strengthening.

Astronomy Camps and Workshops

The school curriculum in astronomy in India is very sketchy but the interest in the subject very high. So for the past year we have been running a more structured course in the form of a camp. This includes participatory instruction in the theatre, constructing things participants can use in the real sky etc. The scale of the solar system is presented through a scale model walk! Props like face masks are used to make the instruction interesting.

The planetarium has also been conducting Telescope Making Workshops for the past three years. A team of five students grind and polish a 6-7" mirror; they then construct a wood and aluminum Dobsonian mount for the same. This year eighteen school groups made 7" telescopes in preparation for the world wide Jupiter Watch for the Shoemaker-Levy-9 collision with Jupiter.

Public Sky Watch

During the months of October through February the planetarium organises public sky watches by arranging several telescopes. In this, the planetarium is actively assisted by the Amateur Astronomers Association. Watches with lectures and demonstrations are also arranged whenever there is a celestial event taking place.

Amateur Astronomers Association

The planetarium brought together many individuals who were interested in astronomy and encouraged them to form an association. This association organises regular observation sessions, lectures from well known individuals, has facilities for mirror grinding, photography, etc. The planetarium provides space, equipment and library facilities. We would like to start other services like a video library, CCD cameras, an electronic bulletin board, etc. but we are very short of funds. Recently the association played a very important role during the week of the Shoemaker-Levy-9 impact with Jupiter, in communicating with the public.

Summary

A planetarium is a place that is readily accessible to all groups of the population. In a situation where the public has no other authentic source of information, the planetarium has the responsibility to act as a focal point of all related educational activities. All the programs developed in the Nehru Planetarium have tried to fulfil that responsibility. In this we have been most successful whenever we have:

(a) Shown that modern astronomical knowledge is a result of continuous improvement in the means we have to observe the universe in a logical extension of the ancient observations that underlie every culture.

(b) Adopted people-centered design of activities rather than equipment-centered ones.

TRIENNIAL NATIONAL REPORT

CROATIA

Zeljko Andreic; Rudjer Boskovic Institute, Dept. of Physics, Bijenicka c. 54, 41000 Zagreb, Croatia

General Information. The school system in Croatia consists of obligatory elementary school (8 years), secondary schools and gymnasiums (usually 4 years) and universities (undergraduate studies usually last 4 years). A new educational curriculum is being implemented since 1991, after Croatia became an independent state. The new curriculum is still being tested and modified with the main objective of becoming similar to the curriculum in the states of the European Community. Croatian astronomers and teachers involved in teaching astronomy are mainly members of the Croatian Astronomical Society (CAS).

Elementary School. Basic astronomical facts are included in the courses of geography, physics and mathematics. Astronomy can be offered as a non-obligatory course in the last four years of elementary school. A curriculum for such courses has been prepared by CAS and is supported by the Croatian Ministry of Education and Sport.

Secondary School. Again, basic astronomical facts are included in courses of geography and physics. Astronomy can be offered as a non-obligatory course and the curriculum for it is available, also being produced by CAS. This curriculum is of modular design, starting with basic astronomy and covering celestial mechanics, solar system, galactic astronomy and astrophysics (total of 8 modules). Each module takes a third of the school year to complete. The modules are more-or-less independent and can be freely chosen by the teacher so that the teacher can adjust the content and the level of his or her lectures to the students.

Teacher Training. Teacher training is constantly offered through several day-long courses co-organized by the ministry of education and CAS. There are 3-4 such courses yearly.

Gifted Children. Gifted children are being cared for by special programs in biology, geography, physics, chemistry, mathematics, informatics and astronomy. The programs are supported and supervised by the ministry of education and are carried on by professional societies in the particular field. In astronomy, CAS organizes astronomy contests for pupils from elementary and secondary schools. The contests have 3 levels (municipal, regional and state). Children are required to show their knowledge of astronomy and a presentation of their own work is required in the state contest. This work is stimulated to be practical rather than descriptive.

Most successful pupils at the state contest are awarded participation in the summer school of astronomy where they are exposed to a lot of observational activities. This school celebrated its 30th birthday last year.

The public observatory of Visnjan organizes the Visnjan School of Astronomy which is open to more advanced students. This school is international in character and is open to participants and lecturers from Croatia and abroad, mainly from neighboring states of Slovenia and Italy. The school is also partially supported by the Croatian Ministry of Education and Sport.

University Education. Astronomy is present as an optional course in the study of physics at the four universities in the country: Osijek, Rijeka, Split and Zagreb. The astronomy course is obligatory for future teachers of physics. Astronomy is also an obligatory course at the Geodetic Faculty of the University of Zagreb. Astrophysics can be studied in the 4th year of the undergraduate study of physics at the University of Zagreb. There are seven astronomy-related courses and six seminars in the curriculum. No postgraduate study is available at the moment in Croatia. The university has no observatory of its own. Students can carry on their observational programs at the public observatory of Visnjan where they are offered equipment and professional support free of charge. Limited possibility for M.Sc. and Ph.D. study exist at the Hvar Observatory.

Public Education. Croatia has one planetarium (Zagreb) and two public observatories (Visnjan and Zagreb). In addition there are about a dozen amateur astronomical societies scattered all over the country. These societies are partially supported by the state and they also offer observations and other astronomy-related activities to the general public from time to time. Croatia also has a long tradition of Astronomy Day, with many activities organized for the general public by CAS and amateur societies countrywide.

Contributions to this Newsletter are welcome. Please send them to John Percy (address at the beginning of this Newsletter).