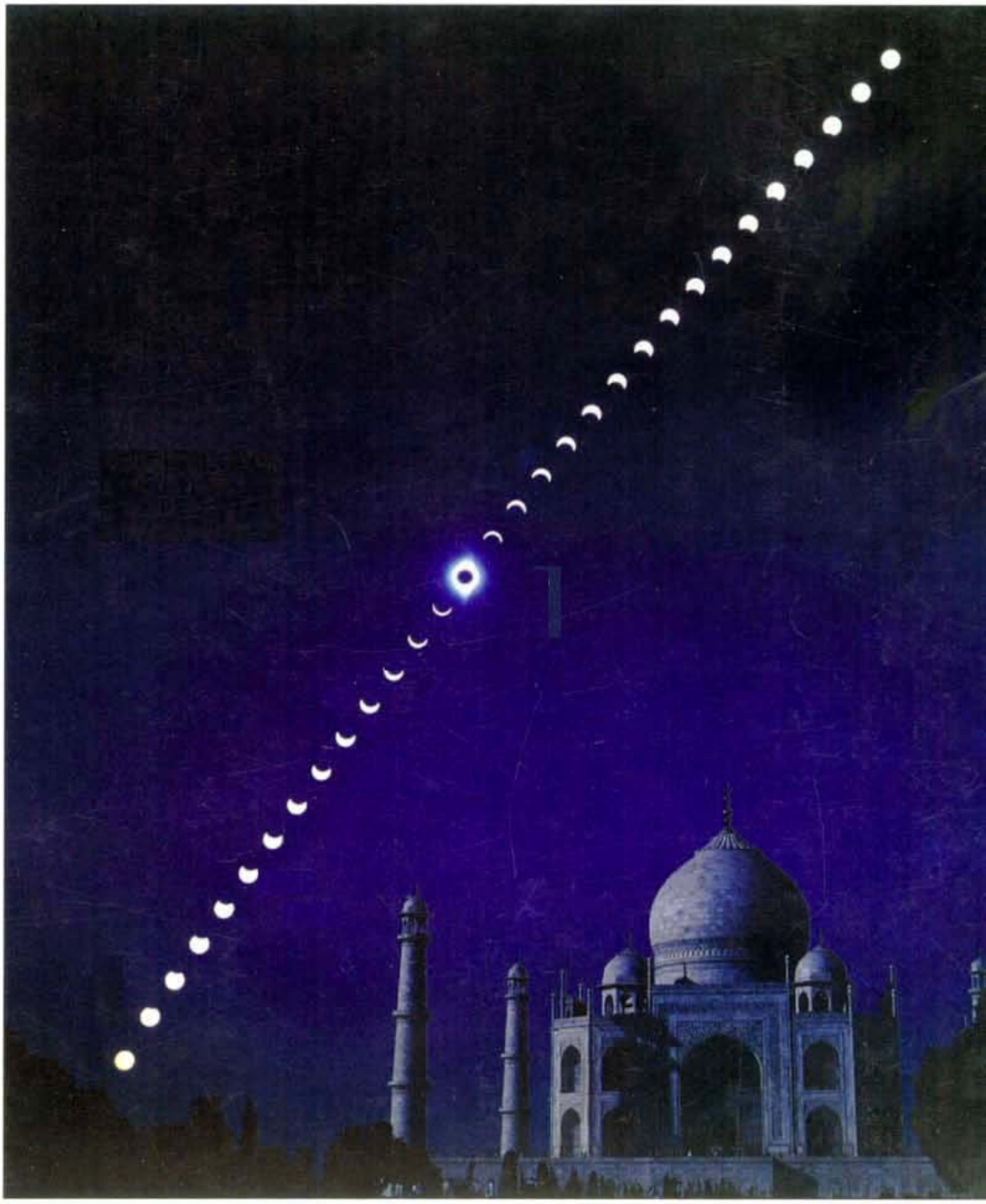
IPS '96 Osaka

International Planetarium Society
1996 Conference, Osaka, Japan

Proceedings

New Potential for the Planetarium



Title: Solar Eclipse at India on October 24, 1995
Photo: Isao Akita

表紙の写真は、IPS'96 記念天体写真コンクールで最優秀賞を受賞した作品です。

「インド日食　日食の連続撮影」
1995年10月24日$7^h25^m00^s$～$9^h55^m00^s$ 5分間隔
ブロニカEC f＝105 mm　ケンコー4D　フィルター1/500～1/125s
フジPROVIA50　皆既中 F4 t＝1/8s ノーフィルター
風景：タージ・マハールF16 1/500s　多重撮影
インド・ルプバスにて　撮影者：秋田勲

The cover photograph shows the work that won the Grand Prix at the IPS '96 Commemorative Astronomical Photograph Competition.

Solar Eclipse over India on Oct. 24, 1995
October 24, 1995 $7^h25^m00^s$-$9^h55^m00^s$ Interval: 5 minutes
Bronica EC f=105 mm Kenko 4D Filter: 1/500-1/125s
Fuji PROVIA50 During total eclipse: F4, t=1/8s, no filter
Landscape: Taj Mahal F16, 1/500s composite near Agra, India
Photographer: Isao Akita (Joyo, Kyoto, Japan)

序言／PREFACE

国際プラネタリウム協会１９９６年大阪大会を成功のうちに終了することが出来ましたのは、大会の実施のために早くから準備作業に取り掛かって下さった方々、大会の裏方として活躍をして下さった方々、そして大会に出席して会を盛り上げて下さったプラネタリアンの皆様のおかげであります。ここにあらためて大会を成功に導いて下さった方々に深く感謝の意を表します。

今回のＩＰＳ’９６大阪大会のテーマは「プラネタリウムの新たな可能性を求めて」と設定されましたが、テーマの趣旨は十分に生かされたと考えています。以下に編集致しました諸報告をＩＰＳ’９６の記念としてご覧いただき今後の皆様のご活躍の参考にしていただきたいと思います。

今回のＩＰＳ’９６の最大の特徴はアジアで初めて開かれたということです。しかも物価高で名高い日本で開かれたということです。そのため、準備を進めてきた我々としましては海外からいったい何名の方にご参加いただけるか、特にアジアからどれだけ来ていただけるかということを心配しておりました。幸いなことに海外からは百名を越す方々のご参加を得ました。お陰様で、アジアで初めて開く大会を記念して設けたアジア・フォーラムも充実した内容となりました。次なる心配はＩＰＳの会員が少ない日本のプラネタリアンのご参加をいかにして獲得するかということでありましたが、各プラネタリウム研究団体、天文教育研究団体ならびに関係企業の皆様のご協力で国内からの参加者は約二百名となりました。

少なくとも私の耳に入る限りでは、今回の大会について大変ご好評を得まして喜んでおります。では次に行われるＩＰＳ’９８ロンドン大会のご成功を祈ります。

国際プラネタリウム協会１９９６年大阪大会
準備委員会委員長
大阪市立科学館館長
中野　董夫

The International Planetarium Society 1996 Conference, Osaka was a great success, thanks to all participants who gathered from around the world, as well as those who prepared for and supported this event behind the scenes. I would like to take this opportunity to express my sincere gratitude to all those concerned.

I believe that the objective of IPS '96 Osaka, to search for the "New Potential for the Planetarium," was well understood and fully discussed throughout the Conference program. Here, in these proceedings, you will see reports on the Conference which I trust will be helpful for your future activities.

IPS '96 will be remembered as the first IPS Conference in Asia. At first, we organizers were concerned about whether many planetarians would come to Japan, known for its high commodity prices. We were however delighted to welcome over one hundred participants from abroad. In particular, the presence of many Asian planetarians promoted the significance of the Asia Forum, a program concurrently held with IPS '96 to celebrate the first IPS Conference in Asia. We were also concerned about whether the conference would attract many Japanese planetarians, since we had only a few IPS members in Japan. However, some 200 planetarians gathered from around the country, due mainly to the cooperation given by various planetarium research organizations, astronomical educational bodies, and related enterprises.

As far as I know, we have received a most favorable reputation for the Conference. I sincerely hope that the next Conference, IPS '98 in London will be equally successful.

Tadao Nakano

Tadao Nakano
Chairman of the Conference
Director, Science Museum of Osaka

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"Past/Now/Future"

名古屋市科学館プラネタリウム34年のあゆみ

北原政子　毛利勝廣　Masako KITAHARA　Katsuhiro MOURI

名古屋市科学館　天文係　Nagoya City Science Museum　Astronomy section

名古屋市科学館が1962年、名古屋市制施行70周年記念事業として設立されて34年が経過しようとしている。その間日本は高度経済成長を遂げ、様々なスタイルのプラネタリウムが生まれて現在に至った。当館プラネタリウムは、時代の変化と共に新しい映像・音響機器を補充してきたが、そのスタイルは一貫して、解説者が直接見学者に語りかける生解説方式をとり続けている。統計資料と昨年度行ったアンケートを基に当館のあゆみを振り返ってみる。

1．名古屋市科学館プラネタリウム

名古屋市科学館は1962年に天文館からスタートした。1964年には理工館、1988年に生命館が開設され、天文、理工、生命科学の総合科学館として今日に至っている。年間入場者は約70万人。開館からの総合計は約1700万人でそのうち、プラネタリウム見学者は約70％の1200万人を占めている。名古屋市の人口は約220万人で、非常におおざっぱな計算ではあるが、全市民が34年間に5.5回プラネタリウムを見た計算になる。

プラネタリウムドームは直径20mのフラット型。同心円配列の座席は450席。ツアイスⅣ型は開館以来34年間健在である。館内スタッフによるメンテナンスに加えて、10年に一度ドイツから技師を招いてオーバーホールを行っている。

補助投影機類は各種特殊投影機に加え、スカイラインやオールスカイマルチプロジェクター、ＸＹズームプロジェクター、４台（うち２台はＸＹ雲台つき）のビデオプロジェクターや映像編集システムなどがある。

投影する番組の制作から入れ替え、解説まで6名の専門職員で行う。一般投影のテーマは月替わり。さらに学習投影や今回のポストコンファレンスでご覧いただく特別番組などで、年間合わせて20番組以上を自作している。

また、昨年からインターネットの科学館ホームページを開設。天文情報の発信を行っている。

観望会は月１回のペースの市民観望会（抽選300名）と月２回のペースの昼間の星をみる会、年に一度の市民星まつり（約3000名参加）等がある。

開館直後から天文クラブを運営しており、最近では小学生、中学生、一般クラスを合わせて3000名ほどの会員がいる。またその中から育った天文指導のボランティア組織、天文指導者クラブ（ＡＬＣ）は名古屋市の公式のボランティア組織として、現在約300名が活動中である。

2. 見学者数の変化

図１は開館から現在までの見学者数を表したものである。開館の年は11月からのスタートのため少ないが、その後は順調に見学者数を増やして6年後の1968年には30万人の大台を越えた。最近は事故や工事などで休演の月があり、フル開館に換算すると33-34万人といったところである。

図２はチケットの発売方法が現在と同じになった1976年からの個人入館者の大人と子供（小中）の割合の変化である。プラネタリウムはかつて子供の方が多かったが、現在では大人の方が明らかに多くなってきている。かつて子供の時代にプラネタリウムを体験した世代が大人になり、自分でやってくるようになったのだろう。プラネタリウムやその解説内容は、本来大人の観賞にたえるクオリティを持っている。大人がじっくりと星を楽しみにやってくるプラネタリウムでありたいと考えている。

図１　プラネタリウム見学者数の推移

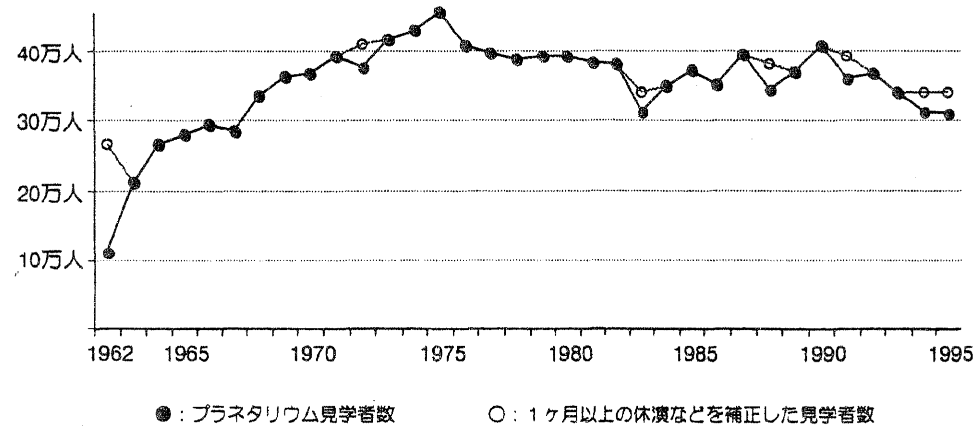
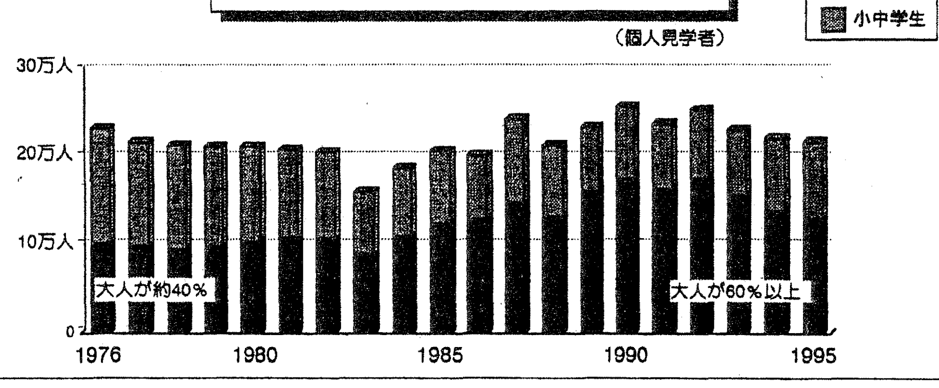


図２　プラネタリウム見学者の大人子供の割合推移



3．アンケートによる見学者層

図３～５は1995年に実施したアンケート結果をまとめたものである。平日と日祝日の初回から最終回まで月に４日くらいずつ分散してアンケートを行った。全対象者は2863名である。その問いかけと結果を見てみる。

(1) 今までに当館のプラネタリウムにおこしになった回数は？（図３）
平日も日祝日もほぼ73％の人がいわゆるリピーターである。もう一度足を運ぼうと思って、実際に見に来る人がこれだけいることは、スタッフにとっての大きな喜びである。

以下は、全てリピーターの回答

(2) プラネタリウムにおこしになる頻度は？（図４）
リピーターの中には、毎月１回以上見るという完全？リピーターが6.2％。年に一度以上プラネタリウムを見るという人が62％いる。

(3) 専門職員の生解説だということをご存じでしたか？（図５）
80％の人が専門職員の生解説だということ意識して見に来ている。

(4) テーマが毎月変わるということをご存じでしたか？（図６）
75％の人がテーマが月変わりだということを意識して見に来ている。

このようにリピーターが多いこと、そのリピーターは生解説であることやテーマが毎月変わることを知った上で、見に来ているということが分かった。これは当館の特徴であり、見学者が期待するところでもあろう。

4．さいごに

名古屋市科学館プラネタリウムの特徴は、毎月テーマが変わること。そしてそのテーマ設定は、天文学の広い分野をとらえていること。さらに専門職員による生解説を行っていること。自主制作による独自の演出をしていることなどがあげられる。そして大部分を占めるリピーター見学者にそのことは十分に浸透していることが分かった。34年間続いたこれらの特徴を生かし、さらに時代の変化に合わせて、見学者のニーズをとらえていくべく、今後も努力を続けていきたいと考えている。

図3　今までに当館のプラネタリウムにおこしになった回数は？

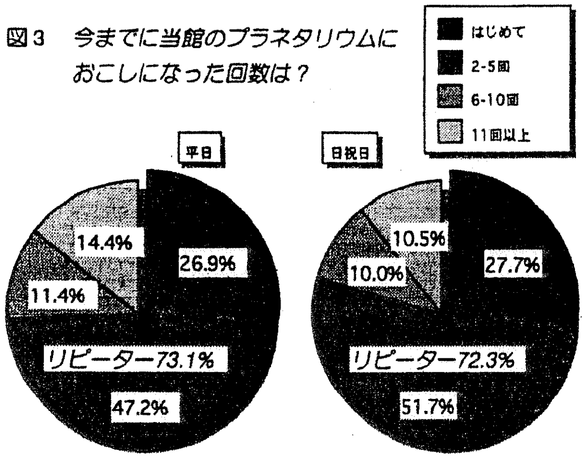


図4　2回以上の方におたずねします。おこしになる頻度は？

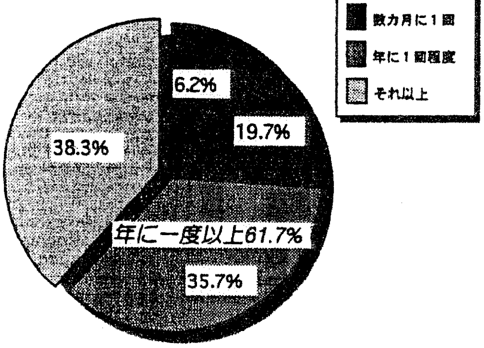


図5　2回以上の方におたずねします。専門職員の生解説だということをご存じでしたか？

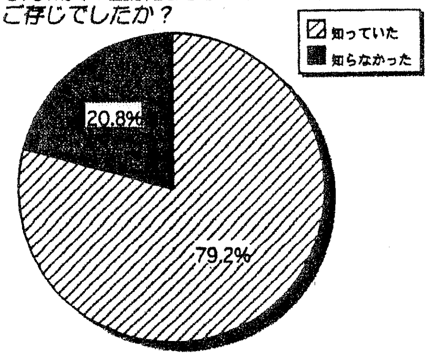
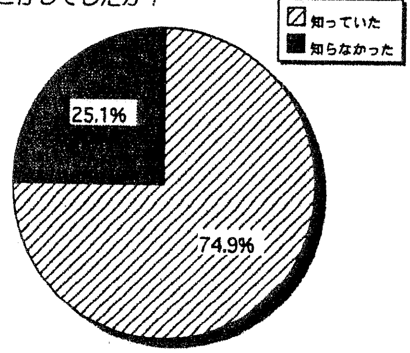


図6　2回以上の方におたずねします。テーマが毎月変わるということをご存じでしたか？



ZEISS OUT, DIGISTAR IN

Undine Concannon

London Planetarium

Our President asked me to give this paper because he thought that some of you, who might be contemplating a renovation like ours, would be interested in the reasons why we chose a Digistar projector, and not a new Zeiss.

Firstly, I should say a little about what kind of a planetarium we have. The London Planetarium is not part of a scientific or academic institution. If we were our decision might well have been different. What we are, is part of Madame Tussaud's wax exhibition, one of the ten most visited tourist attractions in London. This gives us between 600 and 700 thousand visitors every year.

That means two things. Firstly, the type of show: two thirds of these visitors come primarily for entertainment, and are not in a particularly scientific frame of mind. The Zeiss projector produces a beautiful starfield, and this is fine for a traditional night sky show. But our market research shows us that most of our visitors want more than this. Digistar introduces a truly spatial element - whether it is flying around and through the Solar System, watching the proper motion of the stars, or plunging right into a galaxy. Its tunnel effects, or flights through city streets, are certainly high on our visitors' ratings

Secondly, the demand for shows is such that, during peak periods, we put on between 12 and 13 shows every day. We cannot afford breakdowns.

We also needed a projector which did not require us to close down every year for a week or more of maintenance; and also one which would not wear out, but could be periodically upgraded to take advantage of improvements to soft- and hard-ware.

Another practical aspect was weight. Our project involved inserting a new auditorium floor within our existing outer dome. Even with additional foundations, this had to be a lightweight structure, and it is probably not able to bear the weight of a Zeiss projector, although we did not know this at the start of the project.

Cost was, of course, a major factor. The budget for our renovation was £4.5 million (nearly US $7 million, or Yen 720 million). This was to include a 3-storey entrance tower, two new staircases, projection dome, replacement of all projection equipment including the star projector, the best possible audio system, plus all the usual services. A new Zeiss was would have used up well over half of this. However, even with a reduction in its cost, our decision would have remained the same.

While the capital cost of Digistar II fitted much more comfortably into the overall project cost, we do recognise that in a thirtyfive year period (that's how long we had our Zeiss) the likely cost of upgrades etc. is likely to be about the same, or even a little more. Balanced against that, however, is the much reduced cost of maintenance.

The final reason was that we hire out our planetarium in the evenings for a variety of corporate events. These may be product launches, incentive trips for executives, or celebrations of various kinds. Although this part of our business is secondary to the daytime public star shows, they are extremely profitable,and we had them very much in mind when we redesigned the seating layout. The flexibility of Digistar is ideally suited to these non-astronomical events; as are lasers, of course, but Digistar is much less hassle! Our clients especially like to see their logo treated in imaginative ways by Digistar

All these factors pointed us in the direction of Digistar, But it was not until the development of Digistar II, with its brighter and sharper stars, that we felt really able to take the plunge! We felt that, for our particular type of visitor, what it lost in star brightess it gained in exciting graphic effects, and this has proved to be true, even with groups coming to our more educational programmes, such as for schools, or Astro-Navigation, I am convinced that we made the right decision.

Russian Planetariums: Present State and Development Tendencies

Michael V. Grouzdev
Planetarium Director, Yaroslavl Planetarium
Vice-Chairman, Russian Planetarium Association
Russia

By 1996 there were only about 30 planetariums left in Russia. And each year we learn about the closure of 2-3 others. Why is that ? with rare exceptions planetariums are state institutions. At the times of economic instability of the society planetariums appear to be quite vulnerable. An important role in the preservation of planetariums belongs to the recently founded Russian Planetarium Association.

More than half of planetariums make use of old buildings (in most cases they are the former churches, many of which are being returned to parishes now). About 20 planetariums need technical reconstruction badly now. The Yaroslavl Planetarium had its last reconstruction in the mid-'60s. All the equipment has become out-of date and obsolete. It is becoming more and more difficult to carry on with the main function of the planetarium - cultural and educational, creating visial and audio images. Planetarium is a synthesis of theatre, cinema and school classroom.

Most Russian planetariums give extra education, so mostly school students come to them. They can watch special effects and rare sky phenomena, as well as separate and series of programmes on physics, astronomy, geography.

The long-existing information vacuum aroung Russian planetariums can be overcome with a special periodical "Russian Planetariums" publised in Russian and English - the thing we need badly, but all the attempts to create it are facing financial problems. We still hope though, that planetariums in Russia will live on for the sake of children.

THE PARIS-LA VILLETTE PLANETARIUM IN PROJECT

MARC MOUTIN

CITE DES SCIENCES ET DE L'INDUSTRIE

The Planetarium of La Villette is located in the Centre for Science and Industry, one of the greatest science museum in Europe, north to the centre of Paris.

The Centre offers more than 30 000 square meters of science and technology exhibits open to the public.

In a very modern building, permanent and temporary exhibitions, some specially devoted to children propose very interactive and up to date exhibits : experiments, computer games, video films...

Besides the Planetarium, one of the major attractions, the Centre offers also an Omnimax theatre, a Dynamic cinema, a 3D cinema and a real submarine which can be visited.

At present, the Planetarium hosts the star projector Space Voyager from SPITZ Inc. The equipment is based on a Starball with 10164 optics, projecting as many stars and producing a very beautiful and realistic starfield. Around the Starball are located 10 spot projectors for the planets, 2 disk projectors for the sun and 2 special Image projectors working with slide projectors : one for the moon and giving a very realistic image of our satellite and another one to move any celestial object on the dome.

The Image system is based on a 32 screens all-sky with 120 SIMDA 3262 slide projectors driven by DATATON software, and 3 classical SONY projectors for the video images.

The sound system consists in 24 loudspeakers spatialized all over the dome, a 32 channels desk and a 24 channels OTARI tape recorder.

Opened in October 1986, after ten years of intensive running, with 6 to 9 shows per day, 6 days a week and about 400 000 visitors per year, a renewal of the Planetarium facility is planned for 1997.

The main purpose of this upgrade is to improve the reliability of the Star projection system, and to update the video and sound systems with digital equipment.

Concerning the star projection system, an international call has been launched for studying technical solutions in 2 possible ways : by renewing the servo control system, and so keeping the Starball which provides a very realistic starfield, or by a complete replacement of the projector.

The result of the studies will be given next fall and the final decision should be taken at the end of 1996.

The upgrade of the video projection system will authorise to get bigger images on the dome and better quality with digital equipment.

Concerning the sound system, the upgrade should consist in getting a digital workstation to enforce the sound quality and to facilitate the post production work.

This general upgrade of the theatre will be the occasion of a new range of products for the public. Shows about astronomical news and events will be proposed.

New school shows will be developed too.

FIRST EUROPEAN MEETING FOR ITINERANT AND SMALL PLANETARIA

Loris Ramponi

Centro Studi e ricerche Serafino Zani, Lumezzane, ITALY

Susan Reynolds

OCM BOCES Planetarium Syracuse, New York, USA

Forty astronomers and planetarians met in Lumezzane (North Italy) on 13-15 October 1995 for the **first** European meeting of Itinerant and Small Planetaria. This meeting was organized by the Italian Planetaria's Friends Association and the IPS Portable Planetarium Committee. Participants stated that these were three days of intensive interaction with colleagues. They were very long days and extremely worthwhile. The friendships and contacts formed will extend a vital network that began in Richmond, Virginia (USA) at the 1988 IPS Biennial Conference. The purpose of this network remains to join locations of mobile and small planetaria in an effort to assist one another in developing and thriving effectively and efficiently.

There was representation at this first meeting from eight countries: France, Italy, Norway, Slovakia, Sweden, Ukraine, United Kingdom and United States (California, New York, Massachusetts, Nevada). A wealth of information was collected about existing itinerant planetaria in Europe and diverse experiences and techniques of mobile planetaria.

Meeting activities included:

Lessons in American:

"Messages From a Time Traveler" using Starlab (presented by Susan Reynolds, IPS Portable Planetarium Committee).

The lessons were presented to Italian Secondary Students of English and meeting participants.

An annual Teacher Exchange Program was established as a result of the success of this experience and interest of teachers.

Demonstrations of Various Models of Small and Itinerant Planetaria and Domes:

Cosmodyssee II, Gambato, Goto EX-3, Starlab and Ray Worthy's homemade dome were examined.

Demonstrations of Practical Lessons Through Workshops:

"First National Starlab Workshop" devoted to revealing the versatility of Starlab and its fifteen different cylinders (conducted by Susan Reynolds, IPS Portable Planetarium Committee).

"Pedagogic Aids Workshop" about the use of paper, glue and scissors to make sundials, astrolabes and other teaching instruments useful outside the dome to extend the planetarium experience (conducted by Michel Dumas, Le Val d'Oule, FRANCE).

"Celestial Navigation Under the Starlab Dome" (conducted by Philip Sadler, Harvard University/Learning Technologies, Inc., Cambridge, Massachusetts, USA).

Communications by Invitation:

"Astronomical Itineraries for Schools and Public" included information about a census of sites of interest for the teaching of astronomy such as planetaria, observatories, sundials, astronomical monuments, archaeoastronomy sites, meteorite craters, mini solar system models made in natural trails or parks and so on (presented by Dieter Vornholz, Olbers Planetarium, Hochschule Bremen, GERMANY).

"Italian Galileo Model III Planetarium" included a brief description of this currently out of production model (presented by Angela Turricchia, Aula didattica Planetario, Bologna, ITALY). A more detailed paper (by Renzo Berlincioni, Planetarium Maker, Florence, ITALY) will be published in the proceedings. Ms. Turricchia also spoke about activities of didactical experiences with children from Bologna Primary School using a half dome Galileo planetarium, pictures, fables and a few mathematical accounts.

"The History of Planetariums" prompted some discussion about the role of itinerant and small planetaria and the direction which they seem to be taking with regards to education/entertainment (presented by George Reed,Spitz Inc., West Chester University, Reno, Nevada, USA).

"Astronomy for the General Public at Astrorama." Participants were treated to an exciting videoclip as Jean-Louis Heudier (PARSEC, Nice, FRANCE) spoke about the eight years of planetarium and astronomy programming provided for the general public at Astrorama, an education center in the south of France.

"Astronomy Activities in Slovakia." Patricia Lipovska (Presov Observatory and Planetarium, Hurbanovo) and Marian Vidovenec (Slovak Central Observatory, Hurbanovo) presented information about the current situation and activities at their locations.

Mythology of the Heavens Puppet Show:
This delightful show was presented by the Astronomical Association of Rovigo in collaboration with the Teatro Amico.

Remembrance:
A time was set aside during the meeting to remember Guido Casadei, an Italian planetarian and President of the Brescia Astronomical Association, who died in September 1995. A portion of his collection of over 300 astronomical stamps was shown.

Annual National Conference of Italian Planetaria:
This conference ran concurrently with the European meeting on 14 October 1995.

"Shadows of Time" IV Annual Contest and Awards Ceremony:
During this conference there was an open exhibition of sundials built by contestants in the fourth annual international contest "Shadows of Time." Everyone attending both meetings (European and National) participated in a ceremony where awards were presented to the winners of this contest.

Evening at the Specola Cidnea Astronomical Observatory:
Meeting participants joined the general public in a visit to this unique observatory situated in a castle on top of a hill in the center of the city of Brescia. Skies cleared enough to view several beautiful deep sky objects.

Trip to Serafino Zani Astronomical Observatory:
Clear skies greeted participants as they approached this magnificent, wonderfully equipped observatory. This facility is the promoter, in Lumezzane, of a variety of astronomical and scientific activities. Both students and the general public are served by utilizing the observatory, four different planetaria, as well as a large store of interactive exhibits and teaching instruments.

Guided Visit to a XVI Astronomical Clock:
The meeting ended with a guided visit to the Piazza Loggia in Brescia where Giovanni

Paltrinieri, celebrated gnomonist, gave a detailed explanation of the complex XVI astronomical clock built to be viewed from both sides of the tallest building.

Post Conference Tour:

Luca Talamoni, Marghera Planetarium Director, organized a tour to Venice which included visits to the Marghera Planetarium and Museum and the Venice Planetarium. Demonstrations in these planetaria allowed participants to see Mr. Gambato's very impressive projector and technology in action. (Mr. Gambato builds precision planetarium projectors and observatories.) The enlightening and humorous stories of Mr. Talamoni and Mr. Gambato were also enjoyed by all as we were guided to view historic Venice.

Conference Conclusions:

During a final discussion period it was proposed that European small and portable planetarians continue the experience of the meeting with a bi-annual appointment. The next meeting could be organized in 1997 and then alternate with the International Planetarium Society Conference. Two publications, "Guidelines for the Next European Meeting of Itinerant and Small Planetaria" and "Proceedings" of the 1995 meeting, were compiled to aid the next meeting organizers. The "Proceedings" include: a list and descriptions of itinerant planetarium makers world-wide; sources for instruments and publications about teaching astronomy; a list of addresses for regional/national/international planetarium associations (and, if existing, the addresses of the portable planetarium representative of each organization); a directory of all known European itinerant planetaria users; copies of papers delivered at the meeting; and a copy of the report from the American teacher (including the lesson text and student comments). These publications may be obtained by writing to: Loris Ramponi, AAP-Archivio Nazionale Planetari, Centro Studi e ricerche Serafino Zani, via Bosca 24, CP 104, 25066 Lumezzane (BS), ITALY; or Susan Reynolds, OCM BOCES Planetarium, PO Box 4774, Syracuse, NY (USA).

THE NEW KUWAIT SCIENCE CLUB PLANETARIUM

Fuad AL-JOMAA & Zaid AL-QUAIE'I

KUWAIT SCIENCE CLUB

The planetarium of Kuwait National Museum was destroyed during the Gulf war. Its burned out remains have since been converted to a public monument in remembrance of the invasion.

It took one year and a half to install the equipment and to construct the special inner screen and the astronomical exhibition. The total costs amounted to 3 million dollars.

The astronomical exhibition near the entrance comprises some instruments, and new and old astronomical charts. Moreover, there are colorful paintings on the interior walls which were taken from the ancient constellations that were described in full details by the famous Moslem astronomer, Abdul Rahman Al-Sofi.

At the upper floor, there is the auditorium which seats 126 visitors in a semi-circular arrangement; its diameter is 15 meters.

The main projector, the Spacemaster, can show about 9000 individual stars as can be seen with the naked eyes on both sides of the globe, plus the milky way galaxy, the nebulas, the sun, the moon, and other planets. Additional projectors have been installed to show the different constellations. All the projectors and the audiovisual equipment are operated automatically by special computers which control their movements.

That was the remains of Kuwait National planetarium which was established in 1986 during the celebration of Kuwait's 25th National Day.

After liberation, a new planetarium in Kuwait was challenged by the Emir of Kuwait goal of rebuilding Kuwait as a "better place than before the invasion". The science club responded by building a facility that would allow it to expand its interest in astronomy education. The new science club planetarium features a Spitz system 512 with ATM-3 automation and elevator under a 10 meter dome.

The construction of the planetarium was completed in three main phases:

- The first phase consisted in the construction of the planetarium building itself with the 13 meter diameter outer dome, made of fiberglass. It also included the extension of the old Astronomy Association building. After the outer dome was put and the interior decoration completed, the office furniture were then put in.

- The second phase consisted in the installation of the equipment which included the main projector (SPITZ 512 projector), a screen, other display materials, the main control unit. This phase also included the preparation of the staff who will be called to manage the project; this was accomplished through training the staff on how to operate the equipment, present the astronomical shows and programs, as well as on the modern techniques used in managing a planetarium. In addition a training session on equipment maintenance took place; this included detection of faults and how to fix them, the requirements for further extension and the acquaintance with the necessary technical operations.

An exhibit hall is annexed to the planetarium which displays daily astronomical applications. The whole building is located next to the building of the astronomy and meteorology amateurs association, thus making them as one scientific system and a center that provides scientific, cultural and recreational services to the general public, school students, teachers, amateurs and professionals, as well as to institutions interested in planetarium activities.

- The third phase marked the contact with the public who visited the planetarium. It's this phase which defined the needs of the planetarium in programs and shows that will be presented to different categories of the public. The preliminary operating phase is considered as an important stage for the staff to get to know the capacities of the equipment in presenting shows and programs that would suit the needs of every educational and professional institution.

"ALOHA KILOLANI" - BISHOP MUSEUM PLANETARIUM 1961-1996

PETER D. MICHAUD

BISHOP MUSEUM PLANETARIUM

HONOLULU, HAWAI'I, U.S.A.

As Bishop Museum's Kilolani Planetarium prepares to replace our existing 30 foot dome with a new 23 meter facility, we faced the issue of developing our final program. Given this rather unique opportunity, we decided to use it as a chance to develop a unique program. In the process, we believe that we have developed some innovative concepts that can be used by others - even if you'll be keeping your existing dome!

Before reviewing how we made this show one of our most effective interactive programs ever, please excuse me as I succumb to nostalgia, and look back at the past 35 years at the Bishop Museum Planetarium.

Like many US planetaria, the Bishop Museum Planetarium was born in 1961 as a result of our nation's race with Russia to land a man on the Moon. That race to the moon would start a tradition at the Bishop Museum Planetarium to share the human spirit of exploration with visitors from around the world.

Exploration of our own world became an important part of the Bishop Museum Planetarium's mission in the early 70's with the construction of the experimental Polynesian Voyaging Canoe called Hokule'a. Even today, modern navigators continue to come from across the Pacific to visit the planetarium and learn how the early Polynesians might have used the stars to find the Hawaiian islands.

Although research and programs on ancient Polynesian navigation continue at the Bishop Museum Planetarium, another type of exploration has become even more important over the past few decades. This is of course the exploration of our universe from Hawaii's highest summit, Mauna Kea.

Starting in the late 60's Mauna Kea has probably been the fastest growing and most significant astronomical observatory in the world. Today, the summit boasts the world's largest pair of astronomical telescopes with the twin W.M. Keck 10 meter observatories, as well as almost a dozen scopes that dot the 14,000' summit. Currently under construction is Japan's 8 meter Subaru telescope, the 8 meter Gemini telescope, and the Smithsonian's Submillimeter Array.

Acclaimed by many as the world's premier astronomical observing site, Mauna Kea will continue to be pivotal in programming at the Bishop Museum Planetarium, especially as we prepare for the construction of our new facility.

Scheduled to open in 1999, the new Bishop Museum Planetarium will be a state-of-the-art 23 meter facility with full multi-media capabilities, a large format film system, and seating for 225. When this new facility opens its doors, it will be our objective to utilize dynamic, interactive programming that not only involves our audiences, but makes them feel like a part of our production process. This will be done by using traditional front-end, formative and summative evaluation techniques as well as other concepts like those used in our final retrospective program called "Aloha Kilolani: 35 Years of Hawaiian Skies."

Currently being presented daily at the Bishop Museum Planetarium, "Aloha Kilolani" will be our feature program until demolition begins within the next 6 months. Highlighting many of the topics that have been presented at the Bishop Museum Planetarium over the past 35 years, this program includes such topics as Polynesian voyaging, Mauna Kea observatories, tropical skies, Polynesian sky legends, and even Hawaii's total solar eclipse of 1991.

Upon entering our planetarium for this program, audiences are given a sky map that has special tear-off ballots printed on the bottom of each map. At the end of the program audiences are asked to vote for their favorite topic so that we can determine what topics our visitors find most interesting. Visitors are also assured that the most popular topics will be used in the production of our first program at the new Bishop Museum Planetarium.

With 4 months of "Aloha Kilolani" behind us, we have found this program to be one of our most popular. We have also been pleasantly surprised by the high percentage of audience members that actually vote. Although we have not analyzed the estimated 10,000 responses submitted to date, it appears that about 75% of the audience members actually do vote, and preliminary sampling has revealed some interesting trends. For example, it appears that a high percentage of our visitors really appreciate having a live star show at the end of each show, as well as re-affirming our belief that Mauna Kea and Polynesian voyaging are popular topics in Hawai'i.

Although we have not done a full analysis of our audience responses, our 'gut' feelings are that this form of audience participation has been very effective. We also feel that our experience with this experiment is not unique to our environment and that this type of survey could be done by almost any school or public planetarium in the world.

In the future Bishop Museum plans to use this technique to assess audiences interest in many other general astronomy with topics such as Black Holes, cosmic strings etc. We also plan to use this method to help determine what students and teachers are most interested in so that our school programming will continue to better meet the needs and interests of our students.

Bishop Museum hopes that others in the planetarium field will experiment with this technique and share results with our colleagues. It is important to remember that we need to know what our audiences expect and <u>want</u> or they may not <u>want</u> to see our programs!

IS IT TIME TO EXPAND? - HOW WE DECIDED

Ken Miller

Bishop Museum Planetarium, Honolulu, Hawaii, USA

As my colleague Mr. Michaud discussed in the previous paper, Honolulu's only planetarium opened at Bishop Museum in 1961. We have recently gone through a process of studying our planetarium to see if we should renovate the current facility or start over again with a new one. Our conclusion to build a much larger, more sophisticated facility was reached by studying three factors; hardware, audience, and economics.

Hardware History

Our current planetarium is one of hundreds of 9 meter facilities built during the post-Sputnik era throughout America. When built, our planetarium, like many other Spitz A3-P installations, had concentric seating for 100 visitors, a single slide projector, a few simple special effects projectors, and a monaural record player for background music. Over time, as audiences exposed to television became more demanding, more hardware was added to our dome.

In 1987, Bishop Museum spent $100,000 to upgrade its planetarium. A Sky Skan automation system was connected to 23 slide projectors and dozens of special effects. Video projection was added, as was a modern audio system. Since presentations would be focused primarily in one direction, 77 unidirectional seats were installed.

While this renovation allowed much more flexible programming, it was still limited by the aging star projector and the size of the dome. Our Spitz A3-P is the second ever produced. It has suffered many breakdowns and we have lost the use of many of its functions. continued servicing of this ancient piece of equipment was not a reasonable alternative. So, it was decided that we should replace this projector with a different one. But should it be in the current 9 meter dome or a larger one?

Our Audience

Honolulu is a remote Pacific community with a population of approximately 800,000. Each year, it receives 6 million visitors from around the world. Our audiences come to the planetarium for three reasons. Since we are America's only planetarium located south of 23 degrees, visitors come to us to learn more about tropical skies. Since Hawaii is host to the world's greatest telescopes atop Mauna Kea, our planetarium has become the layman's window on current astronomical research. And finally, our planetarium has become known as a research lab for modern Polynesian navigators. Many have studied in our dome to develop and practice the non-instrument navigation techniques used so successfully on the famous Hawaiian canoe, Hokule'a.

Each year, our planetarium serves over 100,000 visitors, making us one of the busiest 9 meter domes in the world! To accommodate large crowds on weekends and during vacation periods, we have had to move to a 22 minute show format given twice each hour. On peak days, the waiting period to get into a program may be 2 hours. The demand for planetarium programming from our audience certainly argued for a larger dome to replace the current one. The question was, "how big?" We guessed that we needed at least 200 seats to accommodate our peak visitor days.

Economic Issues

As we saw the need to expand our planetarium's seating capacity, we also realized that the costs to operate a larger dome had to be considered in our deliberations. We will have to sell tickets! An early desire to build both an enlarged planetarium **and** a flat-screen large format film theater was tempered with economic reality. It was agreed that the spectacular natural history films shown in OMNIMAX™ and similar theaters around the world would increase our museum's educational and entertainment value. However, our site is not huge and peak periods only represent a small percentage of the full year's business. These factors, along with the cost difference to build it, indicated that only one theater could be built. So we recommended that both the planetarium projector **and** a 15 perforation, 70 mm film projector **share** a single dome.

While this "combo dome", with both stars and film is fairly common in Japan, it goes against conventional wisdom in America. In the few US planetariums which have tried the "combo dome," audience demand for the 15/70 film program has driven out many of the planetarium's hours of operation. However, Bishop Museum's history has shown that our audiences seem to have an unusually strong interest in tropical astronomy. Therefore we projected that alternating film and star shows, throughout the day, would bring in sufficiently different audiences to make the theater a financial success. To check our internal expense and revenue projections, we hired museum consultants White Oak Associates of Massachusetts, and attractions consultants Economic Consulting Services of California.

Both firms told us to think of the dome as only one part of a smoothly integrated museum experience. They said the average American museum visitor will gladly pay $3.50-$4.00 for each hour of educational entertainment. As we add 1,000 square meters of natural history exhibits and 3,000 square meters of science garden, and expand our gift shop and restaurant, we add to the time a visitor will stay on our campus. Having both types of theater experiences to offer will also lengthen the visitor's stay. As a result, we will be able to increase the visitor ticket price without giving the perception that our museum is overpriced.

Both of these firms independently arrived at the same two conclusions. First, the theater should be a 225 seat, 23 meter dome. Second, it will generate sufficient ticket revenues to more than support its own operations.

What's Next?

Finally, the decision was made to replace our 9 meter dome with a 23 meter dome, and to put both planetarium and 15/70 film projectors in it. Media Five Ltd., a Honolulu architecture firm, is designing our new Science Learning Center. They are working with consulting architects HGA of Minnesota, experienced designers of many domed theaters around the world.

Now the planetarium staff's task is to choose which exciting new technologies we will add to our new planetarium. We will use fiber optic and T-1 Internet links to bring real-time and stored video images into the dome from Mauna Kea and other observatories around the world. We will use laser graphics to add excitement. Electronic voting stations at each seat will try to bring back the audience interactions we will lose by going to a larger dome. And we will bring 15/70 film clips into our star shows as spectacular special effects to enhance a beautiful, optically projected night sky.

Currently, ground breaking is scheduled for early 1997, with opening in the spring of 1999. We invite everyone to stop in Honolulu for your vacation and to watch our progress. Perhaps we can even help you make a productive side trip to Mauna Kea! If we can be of assistance to anyone considering expanding their planetarium, please feel free to contact us. We will undoubtedly uncover many mistakes in our plans, and would like to help you avoid them. Thank you to everyone who has given us good advise so far, and good luck to all of you in **your** expansion plans!

STATUS OF THE NEW CHABOT OBSERVATORY AND SCIENCE CENTER: PREPARING FOR THE THIRD CENTURY

Michael Reynolds, Ph.D. and Larry Toy, Ph.D.

Chabot Observatory and Science Center

Begun in the 19th Century, and now over 110 years old, and 80 years in its present location, the Chabot Observatory and Science Center (COSC) will begin the 21st century in a new location in the hills of Oakland, California as a state of the art public observatory, planetarium and science center. The observatory lies directly on a branch of the Hayward fault, an active earthquake fault. Its move to a safer and better location was assured when a grant for $17.5M was received from the United States Government.

The centerpieces of the current observatory are two large refractors, an eight inch Alvan Clark donated by Mr. Anthony Chabot as part of his founding gift in 1883, and a twenty inch Brashear, built in 1915. They will form the center of the observatory complex at the new site on a 13 acre parcel donated by the City of Oakland. At an elevation of 1500 feet, it is the highest point in the City of Oakland, in Joaquin Miller Park. In addition, a 36 inch Cassegrain, a smaller remotely controlled telescope, and a large number of smaller, portable instruments will complement the two refractors, along with a meridian transit telescope from the former site, which was at one time used to calibrate time in the western United States.

In addition, COSC will have a state of the art planetarium, with an 18-21m tilted dome, an optical starball projector, an 8-70 hemispheric motion picture projector, and a laser and/or CRT graphics projector. Interactive and multilingual capability is also included. The current 9m dome Spitz A3P is planned to be moved to create a teaching planetarium and conference room, and additional portable planetarium projectors are planned to supplement the current Starlab projector, used for outreach and integrating science curriculum in the classroom with activities at the science center.

Exhibits and laboratories focused on astronomy, related physical science, and environmental science will use the natural park setting for both indoor and outdoor exploration of nature. Special facilities will include the famous Chabot Telescope Maker's Workshop, and a Challenger Center. A library and teacher resource center will house Chabot's historical astronomy collection and teaching materials.

COSC intends to be a science center for the new century. To accomplish this it will be completely wired with fiber optics and computer connections to the area schools, the internet, and to other local, regional, and worldwide networks. This will allow COSC to be a "virtual" science center, where students, teachers, and the general public can visit COSC 24 hours a day, 365 1/4 days a year, from anywhere in the world. Students will be able to remotely operate a telescope and observe animals and plants in our park surroundings from their classrooms. We intend to link ourselves with other similar facilities around the world to allow our students to interact with students from different lands, working on joint projects with our remote facilities. We also have embarked on a major teaching training and education program, providing support for teachers in science education both in summer institutes at the site and during the course of the school year through interactive two way audio and video workshops transmitted to the school site.

The new Chabot Observatory and Science Center looks forward to opening its doors in early 1999, and intends to apply to host the first IPS conference of the 21st century, in 2002.

NEW TECHNOLOGIES FOR PLANETARIUMS: MAJOR PLANETARIUM PROJECTORS - STATE OF THE ART 1996

Larry Toy, Ph.D. and Michael Reynolds, Ph.D.

Chabot Observatory and Science Center

This paper is the result of visits to all of the major planetarium manufacturers in the last three years and subjective evaluations of their planetarium projectors designed for large domes (over 15m).
Instrument starfields observed included :
Goto Helios GSS (several around Tokyo, February, 1995)
Goto Uranus prototype (Goto Factory Test Dome, Tokyo, February 1995)
Minolta Infinium Alpha (Minolta Factory Test Dome, Toyakawa, February, 1995)
Minolta Infinium Beta (near Tokyo, February, 1995)
Minolta Infinium Gamma (Otsu and Tokyo, 1993)
Spitz Space Voyager (Charlotte Discovery Place, July 1995)
Zeiss Universarium Mark VIII (Jena, June, 1996)
Zeiss Starmaster partial prototype (at Santa Rosa Junior College, CA, March 1995)
Evans and Sutherland Digistar II (London, 1996)

General Comments:

The "holy grail" of planetariums is clearly to create an illusion that the observer is looking at the real sky under ideal conditions. The major manufacturers listed above have all been much more successful in approaching this than would have been imagined one generation of instruments before (perhaps epitomized by the Zeiss Mark VI). There are significant differences among the projected skies, many having to do with assumptions about what is to be observed, where, and how. Others have to do with the limitations of the technology and size of the dome.

There are two different definitions of viewing location. One is that as viewed from earth, while the other is as viewed from a point above the earth's atmosphere. For all manufacturers, this has led to using more than the traditional 6000 stars to reach 6th magnitude. Two have chosen about 50% more stars (8000-10,000) to mag 6.5, while two have chosen to have options up to about 4 times as many (25,000! stars), to about one magnitude fainter, above the earth's atmosphere.

In addition, different approaches have been taken with respect to deep sky objects, with some manufacturers reproducing the illusion of a naked eye observation, while others have included binocular views (that is one can see further detail in the dome using binoculars.)

Another important factor is the apparent depth of the star field. Ideally the projected image makes the dome disappear. Related to this is the geometric distortion coming from the observer not being located at the center of the dome. That also causes the observer to at least subconsciously be aware of the presence of the dome.

In addition there is the overall brightness of the starfield. The illusion of reality within the time limits of a normal planetarium show (30-50 minutes) requires stars which are significantly brighter than the real sky, since the normal dark adaptation period of 30 minutes or more for the real sky would be impossible for the planetarium. Accurate color temperature is not possible if the projected star brightness differs from the real sky, since the eye's response curve changes with the intensity of image, particularly at low light levels. The reflectivity of the dome adds a further compromise for brightness, since many of the largest domes also share a hemispheric film system. There the reflectivity is around 40% or less to minimize cross bounce for the film. For a single purpose planetarium dome reflectivity can be closer to 50%-60%.

The ultimate and most difficult test is that of the brightest stars. Here most often is seen the compromise between total flux achieved usually by increasing the disc size, and intensity, which gives the more accurate illusion of brightness. Thus the total integrated relative magnitude of the brightest stars may be correct, but because it is coming from an extended source (i.e. a disk), the illusion is of a fainter, disk shaped star.

Other factors include mechanics, control systems, reliability, service.

Comments on Specific Instruments:

Goto Helios GSS (Sumida, Adachi, and Tamarokuto near Tokyo, February, 1995)
18, 23 and 27m. Colors are fairly good, cooler than real, no blues. Sirius and 0 mag fairly large. Deep sky objects are grid patterns through binoculars. About 25,000 stars. Great rotation pan system. Has third axis for real precession.

Goto Uranus prototype (Goto Factory Test Dome, Tokyo, February 1995)
18m. good Milky Way, excellent constellation figures. 0 and 1st magnitude stars are definite disks. Color temperatures for stars appear cooler than real. Less differentiation of 3rd through 6th mag.

Minolta Infinium Alpha (Minolta Factory Test Dome, Toyakawa, March, 1995)
Seen in 23m (40%) dome. Excellent sky, revised since Cocoa (IPS '94) installation. Good depth, much better than Cocoa. Excellent differentiation of brightness of fainter stars. For 1st magnitude stars from star plates images were fairly large. Decent size for 1st mag from projectors. Very good colors of projector stars (10 stars) . Sirius and Canopus were fairly large. 0 mag stars were a little large. Simultaneous scintillation. Superb deep sky objects. Viewable through binoculars. About 24,000 stars.

Minolta Infinium Beta (Katsushita City near Tokyo, March, 1995)
18m dome. (1991) Re alistic colors, 2nd mag not easily resolvable, 1st mag resolvable but not too large in size. Not as much depth as bigger domes. A revision has been announced for brighter and smaller bright stars.

Minolta Infinium Gamma (Otsu and Tokyo, February, 1993)
Seen in 15-17m domes. Very good sky, esp. first magnitude stars, not as much depth of fainter stars. Colors good, except blue stars looked too white. Around 9000 stars.

Spitz Space Voyager (Charlotte Discovery Place, July 1993 and 1995)
Most recent Space Voyager. 27 m dome. Extremely dark adapted when viewing sky (1/2 hour or more) excellent illusion of depth. Good small size of bright star images. Planet motions were not smooth, controls a bit awkward in manual control. On return visit, stars viewed without as much dark adaptation. Depth still good, but not as good as first visit. around 10,000 stars. seem to be enough.

Zeiss Universarium Mark VIII (Zeiss Test Dome Jena, November, 1994, June 1996)
24m dome. 9100 stars to 6.55 mag. Random scintillation. Almost all star images beyond resolving limit. Colors excellent. Deep sky objects have detail through binoculars. Excellent depth. Stars look like the real sky. By far the brightest star fields. Planets on zooms, can have both real sky and binocular appearances. Very quiet operation.

Zeiss Starmaster partial prototype (at Santa Rosa Junior College, CA, March, 1995)
13m dome. Saw star field of Orion region. Appears impressive, with small star images, apparently beyond resolution limit, except for 0 mag and brighter which are close, but not as small as Mark VIII. Very bright images. Claimed usable for 60 (18m) foot or smaller dome..

Evans and Sutherland Digistar II (London Planetarium, June, 1996)
18m dome. Not directly comparable with optical projectors. However, stars of second magnitude and fainter appeared much smaller and star like than earlier Digistar I. Brighter stars have definite discs and appear to lack significant differentiation in brightness. Also monochromatic images very evident for brightest stars. Reflectivity of dome above 50%.

CONTINUOUS AUDIENCE RESPONSE MEASUREMENT: A TOOL FOR PROGRAM DEVELOPMENT

Michael Lynch

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Communication is a dynamic process. If we seek to learn how an audience reacts to a program, be it a television, film or planetarium program, we can choose to ask a series of questions about the program in a questionnaire that we administer at the end, or we can use a more sophisticated technique called Continuous Audience Response Measurement (CARM), also known as Continuous Response Measurement (CRM).

We can use CARM to measure any reasonable one- or two-axis question that involves introspection on the part of the respondent. Such questions usually involve asking about changes in the mental state of the respondent, manifested as changing opinions, feelings, or evaluations. The choice of question is limited only by the imagination and cleverness of the researcher, but the nature of the question should be one where the respondent is able to make responses in "real-time". Thus, questions that require large amounts of thinking will not generally be appropriate for CARM.

The earliest sorts of questions involving this technique have been of the sort, "To what degree do you like or dislike the program?" As the respondent views the program, he or she operates a knob or slider on a hand-held instrument connected to a central data collecting computer. At the extreme ends of the knob or slider are the labels "strongly dislike" and "strongly like". We are essentially asking that the respondent express his or her affective (feeling) responses along a single dimension (like/dislike) about a particular object (the program being viewed).

Continuous Response Measurement is actually an old research technique. CRM was first proposed by Paul Lazarsfeld in 1932 while a junior researcher at the Psychological Institute of the University of Vienna, and later refined by Lazarsfeld at the Bureau of Applied Social Research in the U.S. In 1945, Lazarsfeld and Frank Stanton, then a media researcher at the Columbia Broadcasting System (CBS), were awarded a patent for their "program analyzer", a system in which audience members signalled liking and disliking using a simple two-pushbutton device.

CRM has been used in media research since its inception. CBS was the first to make extensive use of the system to test new television programs on audiences before committing to full-time production. Its use was quickly adopted by the other broadcast networks, however, and by the 1950s, both Hollywood and advertising had adopted the technique as well. The high cost of these early systems made their adoption possible only by well-financed organizations. Today, with computer hardware so readily available, this technique is now available to organizations for whom earlier systems would have been cost prohibitive.

THEORETICAL JUSTIFICATION

Early users of CRM operated their systems in a decidedly "non-theoretic" manner. That is, while they felt that they were obtaining valuable and accurate data about audiences, they did so without the benefit of a coherent psychological framework which could account for their early successes. This was largely due to the predominance of the behaviorist (or Skinnerian) school of psychology, which generally rejected psychological theories that attempted to explain behavior in terms of inner mental processes that could not be directly examined in a laboratory. As cognitive psychology began to supplant behaviorism, theories which attempted to model internal mental processes became more acceptable to a new generation of research psychologists.

In 1957, a major work by Osgood, Suci, and Tannebaum (1957) provided some of the earliest theoretical underpinnings for a number of subsequent cognitive theories that bear on our topic. They introduced the notion of the *semantic space* and the *semantic differential.* Semantic space refers to the entire body of beliefs and attitudes which might be held in the mind about some topic or object (often called the *attitude object*). In this theoretical formulation, people are posited to develop complex, multi-dimensional, cognitive structures (semantic spaces) toward attitude objects.

A semantic differential refers to a single dimension within a semantic space. It is generally represented by a pair of opposing words or phrases, which serve to anchor the extreme points of a continuum along some dimension. The pairing *happy-sad* is a semantic differential.. Thus, the complex attitudes and beliefs in a semantic space about some object can be decomposed into a set of simpler, semantic differential pairings. An example will help to make this clearer.

We can look at an artist's painting, and in so doing, experience a complex set of reactions. We could, if we wished, classify the painting as *happy* or *sad*; *bright* or *dark, well-executed* or *amateurish, light* or *heavy, traditional* or *modern, bold* or *mild.* As we think about it, we see that there may be any number of dimensions along which we could regard the painting. In fact, social scientists have produced extensive lists of such semantic differential pairs, which have been used in a large body of research into attitude formation.

Thus, in a static measure (e.g., a questionnaire administered at the end of a planetarium show), we might expose a respondent to a planetarium program under development, then present the respondent with a list of semantic differential pairs. The respondent would then mark off each one, perhaps on a scale of 1 to 7, and so produce a complex profile of the attitudes the respondent held toward the program. This technique is quite powerful, and is frequently used in such settings as television program concept testing, new product development, evaluation of trial advertisements, development of political campaigns, and the like.

However, this ability to elicit a complex attitudinal profile is usually limited to a single, static evaluation made at the end of the exposure. CRM is a dynamical measure, but the tradeoff for its use is that we are greatly limited in the number of dimensions that we can investigate at one time.

With CRM, we restrict our attention to, at most, one or two semantic dimensions (using a slide potentiometer or joystick, respectively). We do so largely because we know that it is very difficult for people to operate more than one control simultaneously under CRM conditions and still produce accurate responses. Our system at the University of Connecticut uses a single slide potentiometer in the hand-held instrument.

This restriction is an unavoidable tradeoff: we are seeking dynamic data along one or two dimensions instead of obtaining complex, but static, semantic differential data for a large number of dimensions. There do exist special techniques for gathering dynamic data along more than one or two dimensions, by using multiple exposures and/or multiple samples, but space prevents their inclusion here. An excellent review article by Biocca, David, and West (1994) discusses several of these techniques, as well as many of the other aspects of CRM discussed in this paper.

There is by now an extensive body of literature which has demonstrated the usefulness of the technique. There is clear evidence that the changing position of the potentiometer correlates well with the changing underlying cognitive states of audience members. CRM systems of various kinds have found wide use and acceptability in marketing, media, and social science research situations.

THE CRM SYSTEM AT THE UNIVERSITY OF CONNECTICUT

Dr. James Watt has designed and constructed a low-cost CRM system at the University of Connecticut which has already been used successfully by faculty members and graduate students in several research projects.

The hand-held device is equipped with a slide potentiometer and five pushbuttons (Figure 1). The CRM system at the University of Connecticut can support up to 16 audience members if both the slider and the push buttons are used, or 32 audience members if only the sliders or pushbuttons are used, but not both.

Data from each instrument can be sampled at any desired rate up to 30 times per second. Data recording is timestamped with SMPTE time code, and the entire system is SMPTE interlocked with the source material. At UConn, this is most often Super VHS tape or other video format, but the system can be readily synchronized with other SMPTE source such as automated planetarium systems. Data are collected into a simple "flat file" which can then be subjected to a number of post processing applications. Note that data files can become quite long.

A system to generate live, on-screen summary data is under development, as are several post-processing analysis tools. Currently, we use software tools that we have developed as well as the statistics package, SPSS, to perform our analyses.

ANALYZING THE RESEARCH DATA

CRM readily generates large amounts of time-series data. Selecting an appropriate sample rate is thus very important. Too fine a sampling rate will certainly result in more data, but not necessarily more useful information. Five samples/second is reasonable for even rapidly changing program material, and useful information can be obtained with sample rates of 0.5 to 1.0 samples per second.

Good insight into the audience responses can often be obtained simply by examining the resulting graphs (Figure 3). Usually, we are more interested in the mean value of all respondents at each point in time than in any individual response. To avoid clutter, the individual responses are not shown. For this discussion, Figures 3, 4, and 5 present a contrived example designed to illustrate the analysis techniques.

Many more elaborate techniques are available to use, including sophisticated techniques as ARIMA (*A*uto*R*egressive *I*ntegrated *M*oving *A*verage) (Box and Jenkins, 1976) and Fourier Analysis (Watt and Meadowcroft, 1990). There is space to discuss two others.

Figure 4 shows both a mean (thick line) and standard deviation (dotted thick line) plot of the audience responses. What does a plot of standard deviation tell us? Since it is a measure of variance, higher SD areas indicate those points in the program where audience response is more polarized. This has been often observed to be the case with more controversial program material about which the audience have strong differences of opinion; for example, in a program about creationism and evolution presented to some U.S. audiences. In the example, SD seems to be lowest about one-third of the way through the program, and would have been lower still if not for those few respondents who liked the program during that period. The combined graph is telling us that during this period of the program, the audience are in nearly complete agreement that they dislike the program.

We can also perform an analyses of group differences. Assume that, in our example, the audience was divided into two groups based on age. Figure 5 shows two mean values obtained for the two groups of eight respondents each. If the solid line represents young people and the dotted line represents older people, we would be justified in concluding that older people generally enjoyed the program less than young people, and that during the beginning and middle portions, especially, the older people were far less likely to enjoy the program than young people. We do not yet know the reasons for the difference: perhaps the middle portion of the program was too loud or flashy. If we suspect that some factor in the program is causing this result, we may want to run another sample, this time directly asking the "degree to which the program is too loud and flashy." It is often a good idea to ask the audience exactly what they liked or disliked about the program afterwards in addition to using the CRM, whenever it is important to probe exact reasons for particular responses.

USING CARM IN THE PLANETARIUM

Why might we want to use CARM during planetarium program development? First, let me hasten to reassure program developers that CARM is not a substitute for creative thinking or creative development of the program. Some of the reasons for use are:

- When it is clear that audiences are not enjoying the program overall.
- When the cost of the production is high.
- When there is a need to "calibrate" content for particular age groups or educational levels.
- When the program content is controversial

We may begin our research with like/dislike, but we could also ask questions such as "Is the material too simple or too complex?" or "Is the material boring or interesting?" We are limited only by our imagination.

To preserve the validity of the results, it is vital that the research be conducted under conditions as close as possible to the final program environment.

Finally, I will close with several observations about the use and abuse of CARM. First, as mentioned earlier, it is important to recognize that CARM is not a substitute for creative thinking, writing, or program development. CARM is a tool that can be used diagnostically, but it does not replace the creative process.

Second, CARM results should not be allowed to undermine other production goals. For example, students may well score educational content as "too difficult", but it would be inappropriate to use their responses as a justification for "dumbing down" the resulting program.

Nevertheless, when used prudently, Continuous Audience Response Measurement has the potential to be an invaluable aid in the creation of planetarium material.

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Figure 1: Arrangement of Hand Held Device

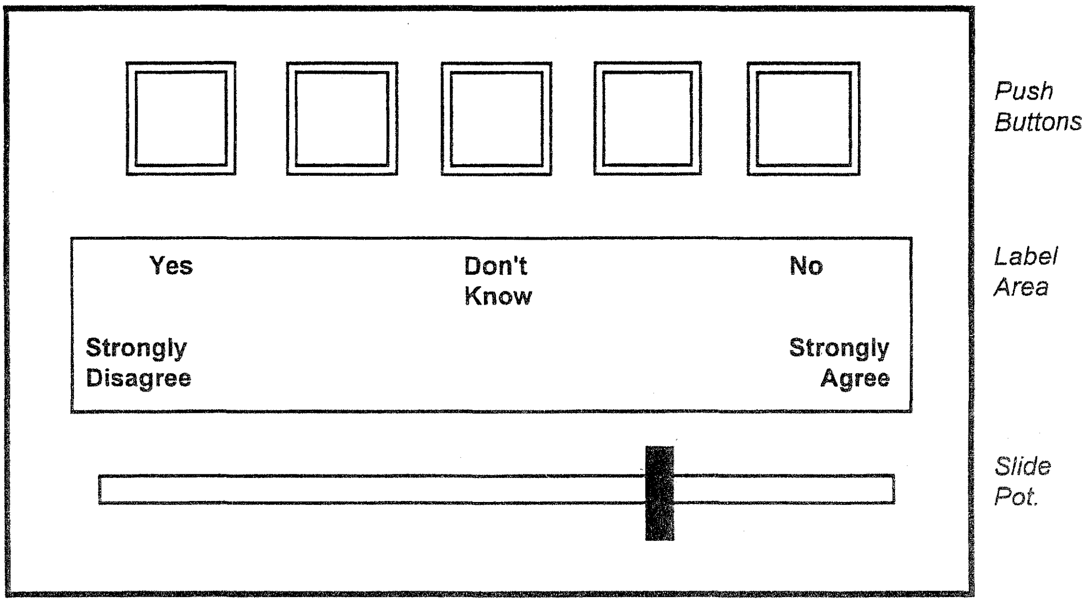
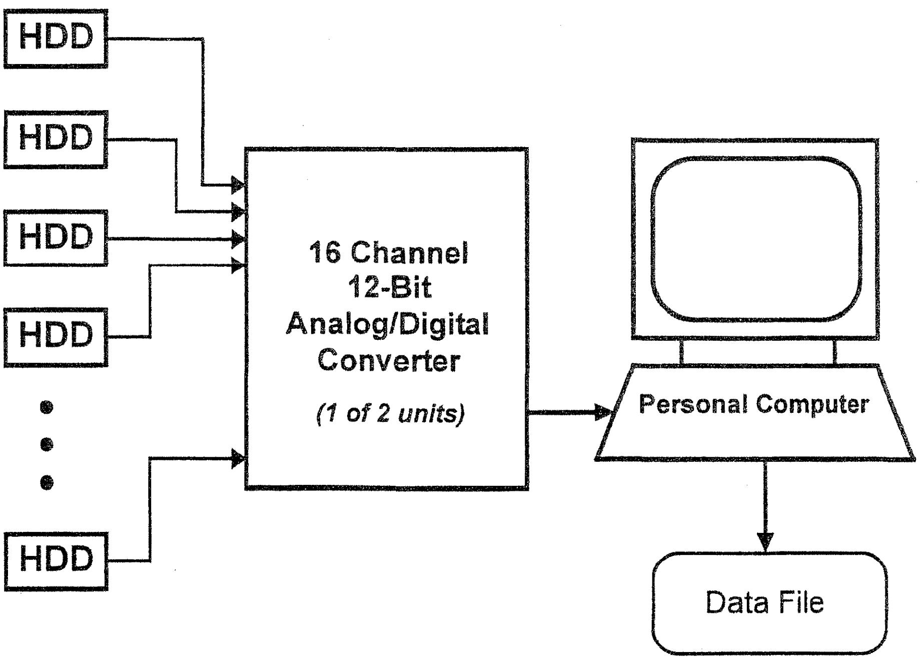


Figure 2: System Configuration



System supports 16 HDDs if both pushbuttons and sliders are used; 32 HDD's if only sliders OR pushbuttons are used.

Figure 3: Mean of Sixteen Respondents

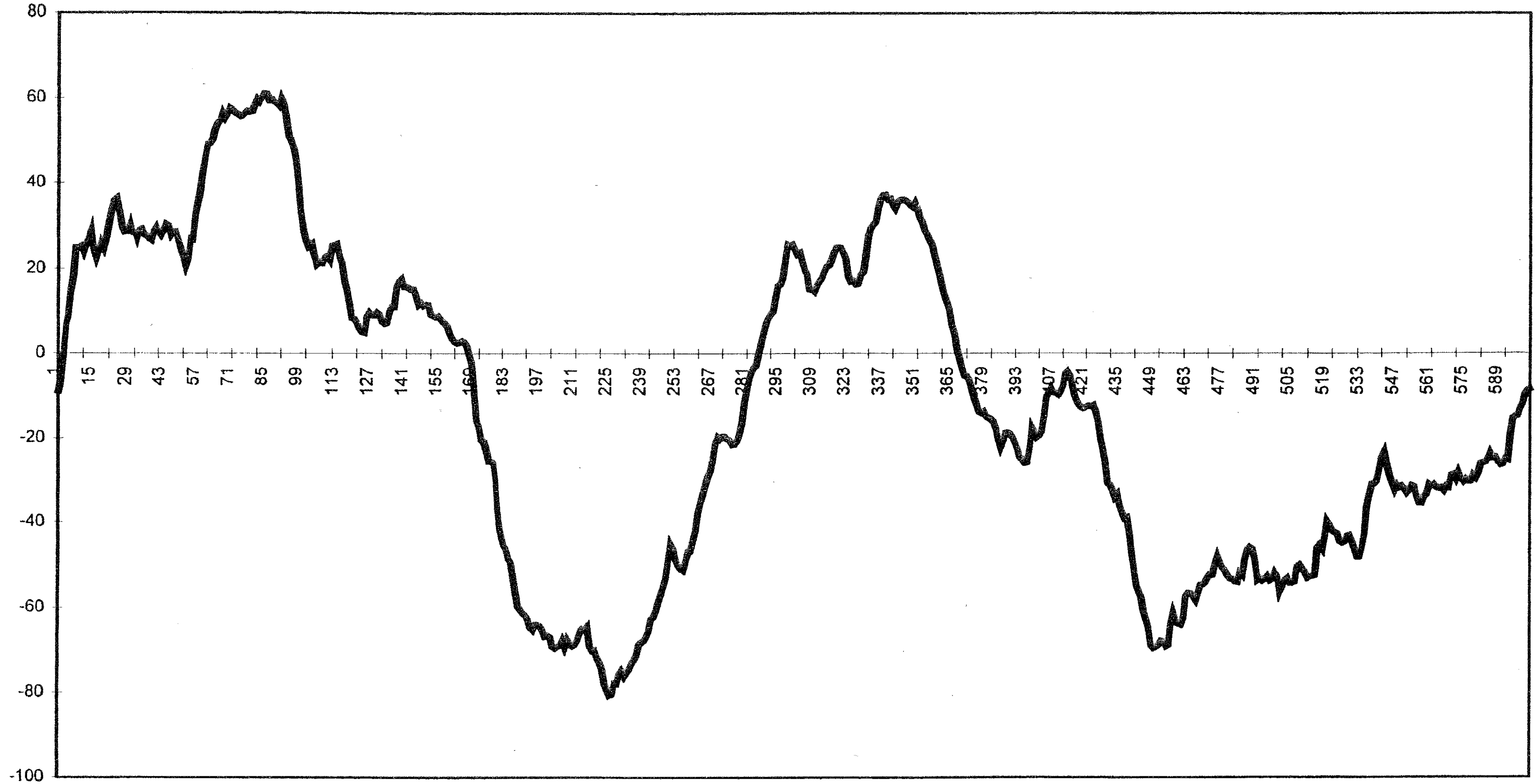


Figure 4: Mean of Sixteen Respondents, with Standard Deviation

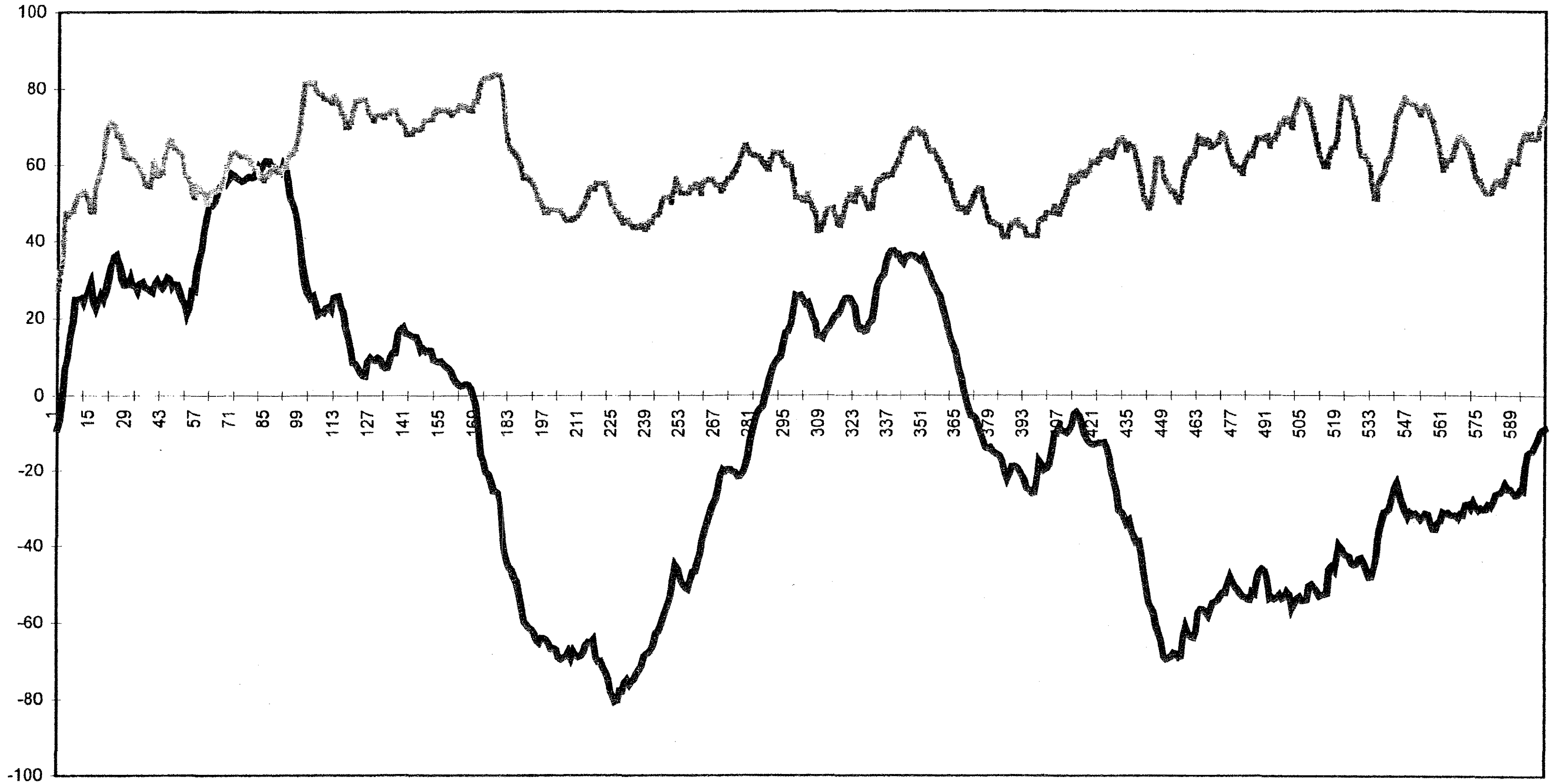
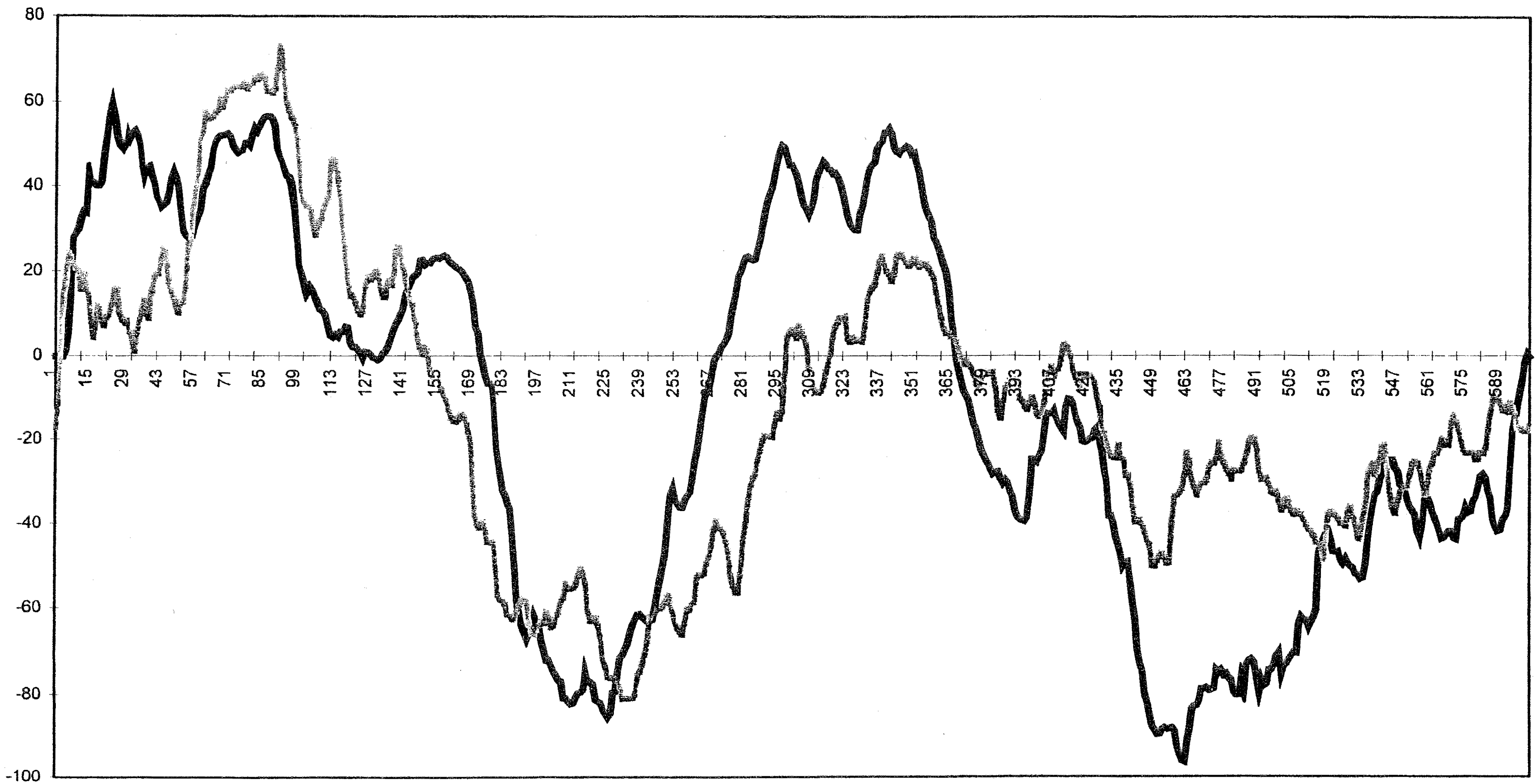


Figure 5: Means of Two Groups of Eight Respondents Each



SESSION

"Show"

プラ番組——映像と音響、融合へのかつての試み

本間保太郎

日本プラネタリウム協会　個人会員

□はじめに

ここに紹介するプラネタリウムの自動投影番組（以下‘番組’とする）とその制作手法は、13年も前のものである。にもかかわらず、あえてこの場でそれを発表することにした理由は、今日においても、同じような制作手法による番組をあまり見ることがないためである。かなり古いものなので、私自身、こまかな部分の記憶は薄れているが、制作手法の一例として、また絵と音の関係を考えるキッカケとして、今後のプラネタリウム番組の発展に役立てば幸いである。

□番組の構成要素

番組について考えよう。星像も絵の一部と考えれば、番組は「絵」「音」の2つの要素から構成される。すなわち、私たちは「絵と音」によって観客に訴えかけて行かねばならない。

□番組における絵と音の関係

ふだんの私たちの体験は、目から入る絵と、耳から入る音が密接に関係しあっている。それゆえ、「絵と音」で訴えかけて行く番組においても、これらは密接な関係になくてはならない。すなわち、絵と音をいかにうまくかみ合わせるか、である。

さらに、番組は構成やテーマなど、作者の意図を持った「創作物」であるから、絵と音がただ合っているというだけではなく、両者が相乗効果を生むような使われ方をしなくてはならない。すなわち、いかに芸術的な雰囲気を作り出すか、である。これから述べるのは、主に後者を試みた作品の例である。

□私の考えたこと

絵と音を芸術性豊かに融合させるには？…　私が思いついたのは、“もともとある音楽に絵とナレーションを合わせればよいではないか！”である。音楽は芸術である。芸術に番組をおんぶさせちゃえ！という考えである。

なんとも単純な思いつきではあるが、実行しようと思うとかなりむずかしい。しかし、映像やストーリィを思い起こさせる音楽に、誰でも何度かは接したことがあるだろう。その感覚を利用するのである。

□選曲について

ここで重要なのは、映像やストーリィをイメージするのは、音楽の「部分」ではなく

「全体」でなくてはならない、ということである。

例を紹介しよう。スポーツの演技種目のひとつにアイススケートがある。フリーの演技やアイスダンスでは、音楽にあわせてスケートが行われる。だがその使い方はひどいものであった。動きの激しいシーンでは激しい音楽を、優雅なシーンでは優雅な音楽を…といった具合に、その場その場で全く違った音楽を「ツギハギ」していたのである。結果、部分としてはともかく、全体としてまとまりを欠いたものとなっていたのである。

芸術性を壊さないためには、一貫した音楽を使用するのがよい。1984年、カナダで開かれたワールド・チャンピオン・シップ、アイススケート・フリーで、J.Torvill & C.Dean組は、M.Ravel作曲「Bolero」全曲1) を演技に取り入れ、見事1位となっている。この演技のartistic impressionは私のみならず、観衆にとっても相当に大きなものであったように記憶している。

1) 一部アレンジを施しているかもしれない。

□手法に対する反論

しかし、このような手法は、いわゆる名曲と呼ばれるものを冒涜するものだ、とする見方もあるかも知れない。だが、Walt Disneyのアニメ映画「Fantasia」2) は、絵と音が見事に融合し、素晴しい芸術的相乗効果を生んだ作品の例と言ってよい。センスがともなえば、必ずしも失敗になるとはいえない。

また、曲にあわせて構成やストーリィを考えるのはナンセンスで、番組にあった音楽を作るのが当然、という意見もあるだろう。しかしわが国の現状をかんがみれば、音楽の使用料等を払っても、オリジナル曲を作るより安上がりで早い。しかも一流の作曲家・演奏家のCD等を使えば、芸術性もバツグンである。ただ、これらの名曲・名演奏を生かすのにもセンスは必要である。

2) J.S.Bach "Toccata & Fugue" やP.I.Tchaikovsky "Nutcracker" などの名曲に、アニメーションによる映像をつけた作品(1940)。指揮は当時の名指揮者L.Stokowsky。

□構成・テーマ

具体的な制作の話に移る。番組の長さは45分前後。前半は当時の日本の番組の慣習に従い、季節の星座とそれにまつわる神話を入れる。後半20分はテーマ部分に移り、終了というパターンである。テーマは、「宇宙の広さ(広い!)、その中にある地球(小さい!——けど大切)」とした。話としては、遠く宇宙空間を旅してきた‘光’が途中地球に立ち寄り、宇宙の歴史と広さ、そして地球の大切さを語り再び宇宙へ去って行くという、たわいもないものである。

□使用曲

J.Brahmus「Symphony No.1」である。テーマ部分にはこの曲の第4楽章をまるまる使用した。先にも述べたが、曲「全体」から受けるイメージが大切である。私の場合、それが先のテーマそのものだったのである。インスピレーションが大切である。

□とりかかり

曲を何回も聞いているうちに、その構成（図1）がつかめてくる。同時にドラマの流れも何となく浮かんでくる。音楽もストーリィの場合と似たような流れ——起承転結——が多いので、何度も曲を聞きながらイメージし、ゆるやかに固めておく。

それとほぼ同時に、部分から受けるイメージも固めておく。たとえば序の部分では、地上からおびただしい数の星が輝く宇宙空間への飛躍が連想され、続く旋律（図2）はそこに浮かぶ地球を彷彿とさせる。プラネタリウムの星が活躍することになろう。

主要部にある第一主題（図3）は、宗教的な、あるいは懐古的な響きが感じられ、宇宙創生を語るにふさわしい主人公のテーマと考える（また、そうすべきである。なぜならこのテーマを軸として音楽が、話が展開して行くからである）。

同じ旋律でも奏でる楽器により受けるイメージが違うこともある。主要部、第2主題のあとにオーボエで表れる旋律（図4）は、はかなげではあるが、少しずつ確実に形を形成する原子を思わせ、同じ旋律だが、再示部でバイオリンが奏でる（図5）と、しなやかでたくましい生命力を思わせるのである。

以上の作業は、曲を聞きながら、ほとんど頭の中で行われた。音楽は時間的芸術である。したがって、それにともなって進行するドラマもまた、途切れのない滑らかなものであるべきであろう。スコアとニラメッコしながらではむずかしい。

□目に見えるようにする

頭の中での作業がほぼ終わると、目に見えるようにする作業となる。台本作りである。台本は、まずスコアを参考にイメージした絵を並べて行き、大まかな流れをつける。その後でセリフを絵に添えて行く。各セリフの出だしには小節数でタイミングを書き込む。ちょうどよい小節内でセリフが収まるよう、曲を聞き返しながら長さを決めて行く。

ここで注意すべきことは、シーンの中心が、絵なのか、星なのか、音楽なのか、セリフなのかを見極めることである。セリフ作りに気をとられていると、説明しようというあまり、ついつい書きすぎてしまうのである。絵で大まかな流れはできているので、セリフは「つなぎ」程度でよい。（というものの、後で聞き返すとなかなかそうはなっていない、というのが正直な感想である）

□仕上げ

細かい部分を修正し台本が完成すれば（台本作りは全制作時間の半分以上を占めた）、あとは一般的な作業——スライド制作、録音・編集、装填で番組は完成である。ただし録音は曲を流しながらスコアを追いかけ、演技者にキューを出して同時録音した。またスライドはフィルム2枚重ねでフレームレス処理を施した。なお、これらの制作にあたっては、サークル・オプティカル35[3]の皆さんの協力をいただいた。

3）プラネタリウム番組の自主制作を目的に結成されたアマチュアの団体。現在は解散している。

□おわりに

今回紹介した番組は、いわば「スペースオペラ」を目指した実験的作品である。番組

に「絵」と「音」（特に音楽）、さらに「科学性」までをも盛り込み、それらの相乗効果を狙った大変欲張りなものである。結果は、制作者の自己満足もあろうが、投影はおおむね好評であったように思う。ここで実際の作品をお見せできないのが残念である。興味のある方はご連絡いただきたい。

さらには、同じ様な制作手法による番組の出現も望んでいる。インスピレーションの得られる曲との出会い、作家のセンス、台本作りにかなりの時間が必要、などのことから（もちろん十分なギャラも！）、「作家性の強い制作手法」ということもできよう。「作家性」は今後の番組作りにおいて重要なファクターになると考えている。

図1.第4楽章の構成とドラマの流れ

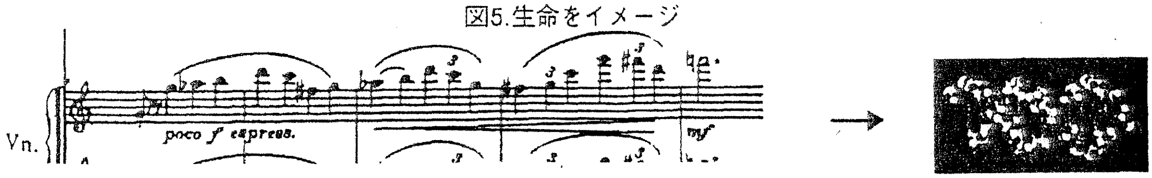
序		主要部	再示部 兼展開部	結尾
1部	2部			
地球から宇宙へ →		宇宙の始まりと歴史 →	宇宙の広がり →	地球へ

図2.地球をイメージ

図 3 .主人公をイメージ

図4.原子をイメージ

図5.生命をイメージ



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THE NEW CHILDREN'S SHOW AT THE AMSTERDAM PLANETARIUM

by Peter Smolders
Head Artis Planetarium, Amsterdam, The Netherlands

This year the Artis Planetarium in Amsterdam (The Netherlands) introduced a new exiting show for children, entitled "Suske en Wiske en de Verdwenen Sterren." (Suske and Wiske and the Vanished Stars). The show was introduced after four years of "Sesame Street and Milky Way", which was also very succesful.

The new show is based on Belgian strip characters Suske and Wiske (a boy and a girl), well known throughout Europe and the world (even published in Japan) under different names.
The soundtrack was made, using the voices of Belgian actors (in the north of Belgium the language is Dutch), who starred earlier in a succesful musical "Suske and Wiske". Songs from this musical were used, with a new text, especially written for the show. New strip drawings were made in Belgium in black and white and coloured by computer at the Artis Planetarium. They were printed and subsequently slides were made by Planetarium photographer André Bontenbal. Sometimes drawings even completely cover the Planetarium dome, using the Digidome software, developed by the Artis Planetarium. Additional video is used.
The main theme of the show is light pollution. Suske and Wiske and the other heroes of the show receive a letter from the planet Lumen, attached to a falling meteorite. The emperor of Lumen asks for help: in old books they have discovered that the planet in the distant past had an impressive starry sky, but now no stars can be seen anymore. Our heroes travel to the distant planet, somewhere in the Milky Way and discover why the stars have disappeared: the whole planet shines with artificial lights during the night. So they pull the main plug of the planet and the stars appear again.
Returning to the Earth they already see from a distance that a lot of big cities are extremely lit on the night side of the planet. The message is clear: we sould do everything to prevent our stars to disappear also. Light pollution is a serious problem for anyone interested in looking at the heavens.
At the very end of the show one of our heroes jokingly throws the main switch of the planetarium and everything becomes dark.
The new planetarium show for children is a huge succes. On sundays and holidays extra shows have to be organised to accomodate the public -mainly parents and small children.
So the message is clear: chosing well known children's heroes can be very effective and profitable for planetariums around the world.

番組制作におけるキャラクター設定について

高橋　博子

仙台市天文台

1．はじめに

現在日本には、一般公開されているプラネタリウム館が２５０館程あります。投映は、館の性格や機種等の違いによっていろいろなやり方で行われています。

仙台市天文台の場合、一般投映ならびに幼児投映は「生解説＋オート番組」の形式が基本です。番組は、自作です。企画、シナリオ、録音、スライド加工、プログラム、組み替え等を職員で行っています。私たち自身が、絵を描いたりナレーションの吹き込みもしますが、作品によっては友人知人の協力を得る場合もあります。数人の職員が交代で番組の担当になりますので、担当者によって作風は様々です。ナレーションだけの番組もあれば、キャラクターを登場させるものもあります。キャラクターも、声だけの時もあれば絵を出す時もあります。

同じ館の中でさえ決まった形式というものはありませんから、ましてや２００以上もプラネタリウム館があれば、投映方法は千差万別でしょう。その館独自のものや地域性を出せるからこそ面白いとも言えます。

プラネタリウムの仕事に携わり、投映や番組で頭を悩ませながら、「こんなに沢山プラネタリウム館があるけれども、みんなどうやって投映を考えたり、番組を作ったりしているのだろうか。」ということに、以前から大変興味を持っていました。そこで今回、ＩＰＳにおいて「番組制作におけるキャラクター設定」という題目で発表させていただくのを機会に、参考資料としてのアンケートをお願いしました。多数の回答をいただいたことを、この場をおかりしてお礼申し上げます。

2．アンケートの結果から

アンケートの集計から、日本におけるプラネタリウム館の投映形態と番組の制作方法、ならびにキャラクター設定に関して、グラフで表してみました。１８２館中１３８館から回答をいただきました。円グラフは、１３８館を１００％としました。

①プラネタリウムの投映形態（図１）

＊生　　：すべて生解説で投映を行っている

＊オート：すべてオート番組で投映を行っている

＊生+ｵｰﾄ：生解説の後オート番組を投映する、あるいはオート番組のみの投映も行うが生解説の投映もあるなど、オートと生を色々な形で組み合

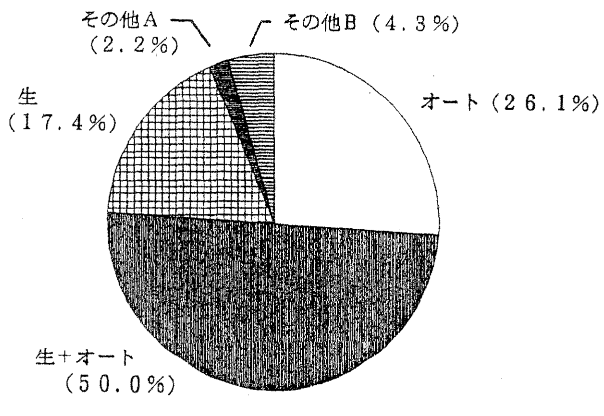


図１　プラネタリウムの投映形態

わせて投映を行っているところは、すべてここに入れた
＊その他：投映はコンピューター制御ではなく手動であるが、既成の番組あるいは自作の録音番組などを組み合わせた投映などを行っている
キャラクターに関する調査が今回の目的の一つなので、
その他Ａ：キャラクターを用いていない
その他Ｂ：キャラクターを用いている　　とした

②プラネタリウム番組の制作形態（図２）
＊自主制作　：生、オート番組とも館の自作で行っている
＊一部制作　：企画、シナリオ、絵など、一部分でも館が制作に携わっている
＊委託　　　：メーカー、制作会社に委託している
＊その他　　：上記以外の制作形態の館を、自主制作と委託とに分けた

何らかの形で制作に関わっている館がとても多いことが分かりました。

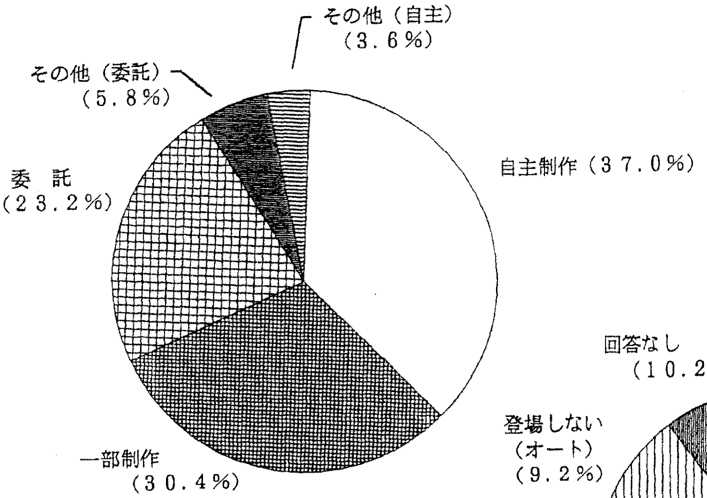


図２　番組の制作形態

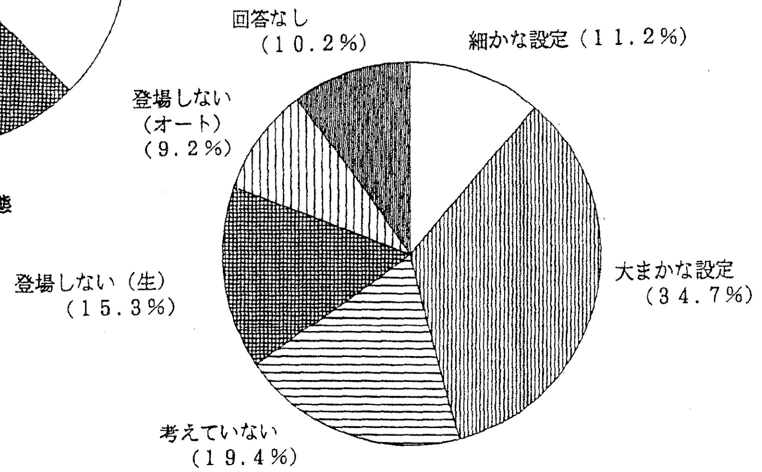


図３　キャラクター設定

③キャラクター設定（図３）
＊大まかな設定　：大まかに考えている
＊細かく設定　　：番組での位置づけなど細かな設定をしている
＊考えていない　：キャラクターの位置づけ、性格づけなどあまり考えていない
＊登場しない　　：キャラクターは出さない

②で、番組制作に一部分でも関わっていると回答された９８館に、キャラクター設定についてたずねました。意識的に細かい設定を行っている館は１１館でした。又、生解説の

みの館で、キャラクターは出さないというのはもっともだと思いますが、オート番組を組み込んでいる館でも、「うちはキャラクターは使っていません」という館が9館ありました。その中には「安易にキャラクターを登場させるのはキライです」というご意見もありました。このことは、今回のテーマに通じるところがあり、大変参考になりました。

3．キャラクター

さて、「プラネタリウム番組のキャラクター」について考えてみます。これはもちろん、プラネタリウムの番組にはキャラクターが必要ということを前提にしたものではありません。これから番組を制作する時、テーマを生かすための方法をいろいろ考えます。ナレーションでもっていくか、キャラクターを作るかということも重要な項目の一つです。

では、キャラクターがあった方が説明しやすいとした時、その位置づけや役割などをどのように考えていったらよいでしょうか。難しいテーマは、子どものキャラクターにしゃべらせさえすればいいというような安易な発想は、持っていないでしょうか？信じられないほど物知りだったり、現実的な場面において余りに現実離れしすぎている設定は観客にとっても違和感があるかもしれません。

いかにして観客を楽しませ満足させるかということは、投映作り、番組作りの基本です。観客が満足するということは、番組に自分が入り込むことが出来る、ひいてはキャラクターと一体感を持つことが出来る、ということにつながるのではないかと考えます。キャラクターがただのお人形ならば、観客は第三者的にしか見ることは出来ません。しかし、キャラクターが血の通う人間や動物に見えた時、キャラクターの心が感じられた時、観客はそのキャラクターを身近な存在ととらえることが出来るのではないかと思います。この子だったらこうするだろう、こうしてくれるかもしれないと観客が感情移入することによって、キャラクターが生きてくるのです。そうなった時、番組が自分の中で動き始めるのではないでしょうか。

4．キャラクター設定

－ほんの少しキャラクターの性格を頭に置くことで、番組（物語）
中のキャラクターは、実に生き生きと人間的なものになる－

もし、プラネタリウムの番組にキャラクターを入れることにした場合、企画あるいはシナリオ担当者は、ほんの少しだけこんなことを意識してみませんか？

キャラクターは、絵を描く人、声を出す人で表現されます。これに個性をつけてあげるのが私たちです。個性を引き出すにはどのようなことをすればいいでしょうか。例えば、キャラクターを人間とした場合。

①年齢、性別　　②個人の性格　　③家庭環境、育った環境

こういったものが、その人の個性を作るのでしょう。

☆例１：キャラクター設定－ようすけ　（ＣＤ－ＲＯＭ　わくわく銀河体験から）

小さな地方都市に住む好奇心旺盛な小学４年生。星にも興味を持っていて夜空を眺めるのが好き。物事に柔軟に対応できる力があり、”マリン”（宇宙の科学者）に出会ったときも初めは驚いたが、すぐに打ち解けて仲良しになる。

＊性格　　：好奇心旺盛で活動的。人なつこい性格で誰とでもすぐ仲良くなれる。ややあわてんぼうな一面もある。
＊性別　　：男
＊年齢　　：１０歳。７月７日生まれ。

＊血液型　　：Ｂ型
＊特技・趣味：特技はサッカー。町のジュニアサッカーチームに所属している。塾に入っていないが、成績は中の上。得意科目は理科と体育。国語が苦手。趣味は珍しい石ころを集めること。
＊その他　　：お父さんは天文ファン。天体望遠鏡も家にある。お父さんから聞いているので星に関しては普通の小学４年生より少し知識がある。が、最近、お父さんも仕事が忙しく、自分もサッカーの練習に明け暮れているので、あまり星の話はしていない。

一見、番組の内容とはまるで無関係にも思える設定ですが、これはとても大事なことです。シナリオのみでは表現できない部分を、絵をかく人や声優さんに伝え、イメージをふくらませてもらうのに役立つからです。

☆例２：驚く場面（子どもが宇宙人に遭遇する）
①好奇心旺盛な子ども　　　：わっ、君本当に宇宙人なの？　と嬉しがる
②憶病で怖がりの子ども　　：ぎゃー！！う、う、うちゅうじんだー！
③もっと怖がりの子ども　　：何も言えず固まってしまう
④冷めた子ども　　　　　　：どうせ中に人が入ってるんだろ・・
⑤冷静な子ども　　　　　　：こんにちは。君は誰？どこから来たの？
⑥知ったか振りの子ども　　：知ってるよ、知ってるよ。
　　　　　　　　　　　　　　ワームホールを通って来たんだろ！おまえ。

このように、性格によってリアクションは全く違ったものになるでしょう。また、「わっ、君本当に宇宙人なの？」という言葉ひとつとってみても、性格によって異なったしゃべり方になるでしょう。
この違いが個性であり、個性が明確に表れることによって、そのキャラクターに深みが出るのだと思います。そして、キャラクターに深みが出て血が通うことによって、作品自体もさらに生きてくるのだと思います。

５．さいごに

私はこれまで、キャラクター設定に関しては、「星の好きな小学生の男の子」程度の大ざっぱなことしか考えていませんでした。しかし、昨年、ＣＤ－ＲＯＭ制作に携わる機会があり、漫画家、ナレーター、制作会社の方たちと共同で作業をしていくなかで、キャラクターの持つ影響力の大切さを知りました。プラネタリウムは、星がメインであり、キャラクターがメインになってはいけないと思います。でも、生き生きとしたキャラクターが番組をさらに盛り上げる役割を担ってくれるのであれば、もっと楽しいと思います。
今回アンケートの回答を読ませていただきながら、キャラクターについて色々考えました。番組によっては、目立たせたくない、表に出したくないキャラクターもあるはずで、そのことが一つのキャラクター設定だろうと思います。また、今も数多く行われ、最もプラネタリウムらしい、お客さんにとっても根強い人気のある生解説。これは、解説者自身がキャラクターだろうと思うのです。少々訛っていても、とちっても、解説者の個性が表れた投映というのは、観客にとって、きっと安心出来て、親しみが持てて、満足の出来る投映なのかもしれないと思いました。
仙台市天文台でも、昨年より少しずつキャラクターの設定を意識するようになりました。そのことが、いい番組作りにつながることを願っています。今後とも、みなさんと一緒に考えていきたいと思います。

IMIMANGALISO YESIBHAKABHAKA
A PLANETARIUM SHOW IN XHOSA

THEO FERREIRA

SOUTH AFRICAN MUSEUM

Background

The Planetarium is a division of the South African Museum situated in Cape Town. The facility opened in October 1987 and consists of a Minolta MS15 star projector operating under a 15 meter dome. The star projector is complemented by an Electrosonic automation system controlling slide projectors, video tape players, laser disc players and a limited number of special effect projectors. The facility seats an audience of 124, presenting both school and public shows. Our average attendance is approximately 90 000 representing an equal number of public and school visitors.

Introduction

"Imimangaliso Yesibhakabhaka" or "Wonders of the Sky" is a unique Xhosa language Planetarium presentation. Why the need for a Xhosa Planetarium show? South Africa is a multilingual country where the different language groups are, to a large extent, geographically divided (with the exception of the larger industrial centres). Prior to South Africa's Government of National Unity, elected in 1994, there were only 2 official languages, namely English and Afrikaans (a Dutch derivative). South Africa now boasts 11 official languages amongst which we find, Xhosa, Zulu, North Sotho or Pedi, South Sotho and Venda, to mention a few. Although running to capacity audiences it soon became apparent that we were not serving a large part of the greater Western Cape population, the Xhosa speakers. In practice, the South African Museum has always had an open door policy, however very few Xhosa speaking South Africans were visiting our facility. Indeed very few were even aware of the existence of the Planetarium, which was perhaps perceived by many as an elitist institution.

Motivation

In 1992 the planning process was initiated to produce a Planetarium show in Xhosa aimed principally at the primary school population . This process was started before the South African Government initiated their R D P program (Reconstruction and Development Program). At this time there were also 17 different education departments throughout the country many operating on very limited budgets. (Now there are only 9, one for each province with a central controlling body). By producing a show which would introduce basic astronomy to young people from disadvantage communities and by extension, basic science, we would to some extent be able to address the inadequacies of the school education system. Furthermore, no astronomy is included in the curricula of South African schools, besides very basic concepts in the geography syllabi.

The importance of introducing pupils to basic science and mathematics can best be illustrated by the statistics below:-

Final Year High School Examination Results - Science 1993

Total # Candidates	# Writing Science	# Passing Science
470 948	95 174 (20%)	66 524 (14%)

Final Year High School Examination Results - Maths 1993

Total # Candidates	# Writing Maths	# Passing Maths
470 948	157 701 (34%)	80 050 (17%)

Content

The big question was which information to include in the show, bearing in mind that in the sixth school year (age 11 to 12 years) the medium of instruction changes from Xhosa to English? In the end, we included nearly all the basic concepts from the solar system to galaxies; in retrospect, far too much information. The show was scripted in English by one of our school teachers, who used references from everyday life to make it easier for the audiences to identify with new and sometimes difficult concepts. The earth, for example, was compared to a soccer ball, making it easy to visualise it being round. Some African folklore was included to make it more entertaining.

Production

The script was translated into Xhosa by a student, Terry Ngantweni, from the Astronomy Department at the University of Cape Town. This might have appeared to be relatively simple task, but to find words for some of the astronomical terms was not always easy or in some cases not possible. Once completed, the script was checked by a Xhosa speaking member of our education staff. The voice-over was done by Terry from the University, who, for a first timer, excelled. We soon discovered that African languages are more descriptive and the pace of delivery is a much more relaxed and slower, requiring us to add more visual material! Originally we had wanted to use traditional music, but African music has lots of rhythm and beat and eventually we ended up using mostly "space" themes. Artwork was produced in house, photographed by our resident photographer and the show was ready to be packed and pulsed.

To enable pulsing the show, an English voice-over was synchronised to the Xhosa voice-over on a spare channel on the tape deck (8 track Fostex). In addition this solved the problem for non-Xhosa speaking operators. The operator has a set of headphones and can listen to the English soundtrack, thereby synchronising the projector movements, etc. to the original Xhosa soundtrack. A cue sheet with the relevant instructions giving clock times (from the tape and read from the computer monitor) further assists the operator.

With a total operating budget of only R65 000 ($16 000) per year, public presentations taking precedence and school shows not being subject to any major deadlines, the production time was rather slow and the show was completed in 1995.

Marketing

To facilitate the marketing of the presentation an outreach officer, Esmé Matshikiza was employed to make contact with the relevant schools, community organisations and other interested parties. Part of Esmé's duties include processing the bookings, liaison with the schools and meeting the groups on arrival. This prevents any misunderstandings caused by language barriers. Although there is a small entrance fee for school children, no groups are excluded from attending our facility, due to financial constraints.

The show officially opened in September 1995 to an invited audience, amongst whom were, two school groups, representatives of various educational bodies and our Minister of Arts, Culture, Science and Technology Dr Ben Ngubane. Local newspapers provided press coverage, the event was publicised on national radio and favourable comments were made by the Minister to Parliament.

CONCLUSION

"Immimangaliso Yesibhakabhaka" has been well received by audiences and other interested parties. After nine months the show has been seen by 2800 pupils and teachers from local teachers training colleges. This might not be perceived as a huge audience, but considered as a growth from virtually zero we are extremely proud of our achievements. This is the only Xhosa language planetarium show but, whether this is the first African language planetarium presentation, I am not sure. We are, after all communicators, and I trust we are succeeding in our goal. I am confident, however that our efforts have definitely contributed to multicultural communication in the "new" South Africa.

COMET RENDEZVOUS AT THE HAYDEN PLANETARIUM

AMIE C. GALLAGHER

American Museum - Hayden Planetarium
New York, NY USA

The Hayden Planetarium wanted to enhance people's knowledge of comets with the arrival of Comet Hyakutake in March of 1996 and Comet Hale-Bopp due in the spring of 1997. The staff thought an exhibit on comets would be appropriate.

Brian Sullivan, the Hayden's Production Designer, and I wrote a 9-minute slide show for one of our theaters. The show introduces the audience to comets, what they are and where they come from, and recalls incidents involving comets hitting planets, like Tunguska in 1908, and Comet Shoemaker-Levy 9 at Jupiter in 1994.

Dennis Davidson, our Astronomical Artist, painted a mural of a comet, and had large transparencies made of Comet Hale-Bopp, Comet Halley, and the Giotto spacecraft's image of Comet Halley's nucleus.

Matthew Dougherty, Planetarium Intern, and I become "Celestial Chefs" every afternoon and concoct a comet nucleus out of household materials: good old New York City water, dirt from outside the Planetarium, ammonia, dark corn syrup, and dry ice. Dry ice is the only supply I couldn't find at the grocery store. It can be found at any ice house, just look one up in the yellow pages. The first two days we did the demonstration, I went downtown to pick up the dry ice. That got tiring. Luckily, the ice store I work with has a delivery service. I have a standing order to have ten pounds of dry ice delivered every other morning. We keep it in a small cooler and it lasts exactly two days.

Matthew Dougherty also put together a display, based on preliminary research done by Francine Jackson, one of our Planetarium Lecturers, showing comets in history that were represented in a variety of artwork pieces. Comet Halley, for instance, was represented in the Bayeux Tapestry commemorating the Battle of Hastings in 1066, and Giotto di Bondone painted Comet Halley as the Star of Bethlehem in his 1303 fresco *Adoration of the Magi*.

And the centerpiece of the exhibit area is a 6-foot long comet nucleus model constructed by Brian Sullivan. The nucleus is constructed of a wood frame surrounded by wire mesh. This is coated with flannel sheets dipped in white glue. A thick paper mache is then added on top to form a rough surface. We toyed with the idea of putting dry ice inside the model each day to accurately represent the gasses sublimating off, but we figured that would result in too much touching and fussing with the nucleus. Instead, a fog machine was purchased and installed underneath the model. A metal pipe runs from the machine into the model. The smoke puffs out of the machine into the belly of the nucleus model, then escapes through hundreds of tiny holes poked into the surface, thus representing outgassing.

Information alongside the model tells the visitor that if a real comet nucleus were scaled down to the size of our model, the coma would be about 12 miles across, the size of Manhattan. The tail would stretch from New York, past Los Angeles, past Hawaii, all the way to the west coast of Australia.

Dr. Neil DeGrasse Tyson, Director of the Hayden Planetarium, and Dennis Davidson plotted Comet Hyakutake's path across the sky. Maps were prepared and made available to the public and media.

So far, response to the exhibit is very positive. The maps made answering the thousands of questions we got during March much easier. Instead of saying, "look north on the 24th," we'd just say, "we have a map of the path that we can mail or fax to you." Visitors enjoy the live comet demonstrations we do each day, especially when we invite a child up to stir the concoction. And informational signs around the exhibit area answers commonly asked questions like "what is a comet?" and "where do they come from?"

We have filled a void in our exhibit space -- an empty area is now an active area, and a topic not discussed anywhere in our halls is now explained thoroughly.

LET THE AUDIENCE DO THE SHOW

Alan Gould

Holt Planetarium, Lawrence Hall of Science
University of California at Berkeley, USA

At Lawrence Hall of Science at the University of California at Berkeley, we develop planetarium shows that are not hi-tech, but are state-of-the-art in audience participation.

Fig. 1 Lawrence Hall of Science [slide]

Eight of our planetarium shows are published in a series known as *Planetarium Activities for Student Success (PASS)* which may be available soon in Japanese translation.

To see how planetarium audience participation works, here are activities from our most recent show, *Mysteries of Missing Matter*—not part of the PASS series.

Fig. 2 Mysteries of Missing Matter [Slide]

The show is about the search for dark matter, but we start with some classic mysteries involving unseen things in the sky that affect visible things.

[I hold a white stick and white board vertically about a meter apart.]

For example, there is a "magical" invisible force that can make these two objects fly towards each other and stick together. Do you want to see it work?

[I do the "gravity magic trick"—turn the board and stick so that the stick will drop onto the board.]

Gravity does seem sort of magical. To show how gravity affects planet movement, we take advantage of our circular seating arrangement and have volunteers from the audience model planet movements around the "Sun" in the center of the planetarium.

The volunteer playing "Venus" takes large steps, the one playing "Jupiter," medium steps, and the one playing Uranus, "baby" steps.

William Herschel's discovery of Uranus in 1781 revealed previously invisible matter in the solar system. [Slide: Uranus]

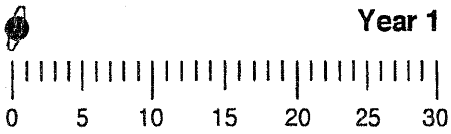


Fig. 3 Diagram of Uranus and measurement scale, superimposed on starfield. [Slide]

Pretend you are looking at Uranus through a large telescope. Let's watch its slow movement in the sky. The scale will allow us to measure how far Uranus moves each year.

At this point, we hand out data sheets for visitors to mark Uranus' position, but in the interest of time, you may use whatever paper you have, or just follow along without paper.

Notice that Uranus is next to the "0" mark on the scale.

Let's observe Uranus for a few years. [At each position I ask, "How far did Uranus move this year?" and have visitors record that number.]

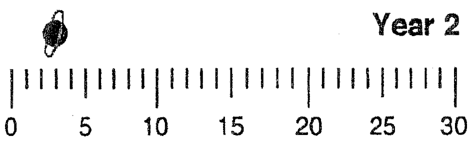


Fig. 4 Year 2 [Slide]

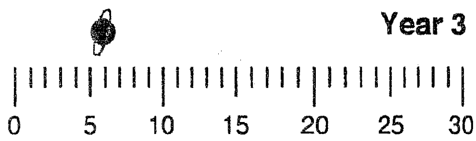


Fig. 5 Year 3 [Slide]

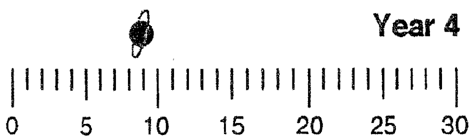


Fig. 6 Year 4 [Slide]

Can you predict how much it will move in the next year?
[Audience answer: it moves 3 degrees each year. Very regular.]

Let's see if you were right.

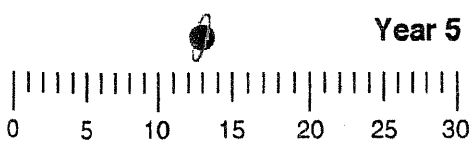


Fig. 7 Year 5 [Slide]

"How far did Uranus move this year?" [Audience: 4 degrees!]

Let's check that by observing another year.

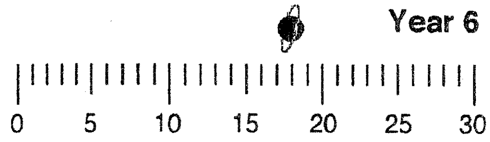


Fig. 8 Year 6

What is happening to Uranus' speed? [Audience answer: It is increasing!]

Let's observe for a few more years. [At each position I ask, "How far did Uranus move this year?"

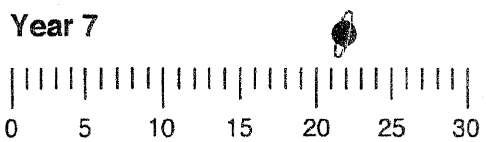


Fig. 9 Year 7

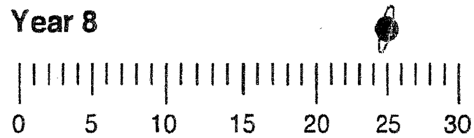


Fig. 10 Year 8

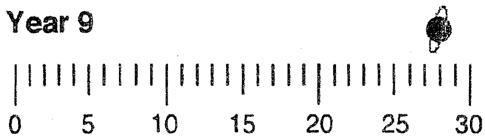


Fig. 11 Year 9

What's happening to its motion? [I will wait for audience answer: It slowed down and then returned to a constant speed.]

Observers in the early 1840's noticed that Uranus was very slightly off (1.5 minutes of arc away) from where it should be, according to Newton's law of gravity.

What do you think might have caused Uranus's motion to deviate from what we expected? [I will wait for audience answer: there could be beyond Uranus yet another planet, whose gravity affects Uranus.]

Astronomers computed where they thought a new planet should be in order for its gravity to explain Uranus's unexpected motion. This quickly led to the discovery of Neptune.

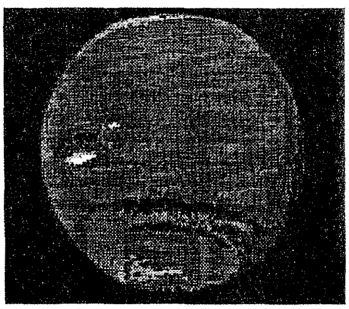


Fig. 12 Neptune [Slide]

In yet another example of how unseen matter can affect visible objects, we demonstrate a binary star system in which one of the stars is "dark," and causes the visible star to follow a wobbly path.

Fig. 13 Galaxy—M104 [Slide]

Finally, we address the current mysteries of the motions of galaxies. We again take advantage of our circular seating arrangement , to have the audience model the way stars in the galaxy revolve around the center of the galaxy.

At first we have the "stars" behave like the planets of a giant solar system. Rows of people closer to the center of the planetarium walk around taking large steps, while rows farther out, representing the outermost stars in the galaxy, take baby steps.

But this model is wrong!! In real galaxies, the outer stars move faster than expected.

To illustrate, we repeat the model with the inner stars take baby steps while the outer stars take large steps.

Even this model is flawed, because in real galaxies all the stars are moving at about the same SPEED, but we use the model to convey the real mystery: From Newton's Universal Law of Gravity, we expect the stars closer to the center of the galaxy to be moving faster, but in real galaxies, they do not!

A solution to the mystery is that the galaxies behave perfectly in accord with Newton's Law of Gravity—IF there were 10 times more material than we can see.

Development of this show was funded by the Center for Particle Astrophysics, at the University of California in Berkeley, where people are trying to solve the mystery of what the dark matter is.

[Slide: CPA people looking for dark matter.]

Here some researchers at the Center for Particle Astrophysics looking for dark matter on the ground outside their lab.

I hope that this talk gives you a sense of how we do audience participation shows in our planetarium at Lawrence Hall of Science of the University of California at Berkeley.

Thank you for your kind attention.

NEW SHOW PRODUCTIONS FROM BUHL PLANETARIUM

Martin Ratcliffe(1) and Terence Murtagh (2)

1. Henry Buhl, Jr. Planetarium, Carnegie Science Center, Pittsburgh, PA, U.S.A.
2. York Films, Oasis TV. 6-7 Great Pulteney St. London. W1R 3DF

Following the success of our show titles "Cosmic Perceptions" and "Through the Eyes of Hubble" that have sold around the world, the Buhl Planetarium have produced a new brochure outlining its full range of high quality show productions that are available, with new ones made in conjunction with York Films of England.

We present some new computer graphics comprising scenes from planetarium shows now in production which will be released through the Henry Buhl, Jr. Planetarium as finished productions. In addition, some animations will be available through Sky-Skan Inc of Nashua, New Hampshire, U.S.A.

The graphics have been produced on various computer platforms but represent the state of the art in rendering material for planetariums. Although expensive to produce with such high production values, they can be afforded by even small planetaria.

Excerpts shown during this paper include scenes from the forthcoming starshow"Comets-From Ice to Fire" and features computer modelling of Comet Hyakutake, Halley's Comet nucleus, various spacecraft and scenes of planetary formation in the early solar system.

For a new show projected for completion in 1997, new computer graphic renderings of the giant planet Jupiter and its moons are shown in preparation for a Giant Planets show detailing the dramatic results now coming from the NASA Galileo mission to Jupiter, and the forthcoming Cassini mission to Saturn and Titan.

In addition some newer renders of views from future productions featuring scenes of Saturn's rings from its cloud tops and Neptune from within its rings are presented.

The future trends in the use of computer modelling will be featured as will be the various media most suited to planetarium star show production.

Terence Murtagh, Producer York Films, Oasis TV. 6-7 Great Pulteney St. London. W1R 3DF Phone ++44 171 434 4133 fax 171 294 2843 Direct++ 44 171 734 7435, E-mail tmurtagh@dircon.co.uk

Martin Ratcliffe, Head, Henry Buhl, Jr. Planetarium & Observatory, Carnegie Science Center, 1 Allegheny Ave, Pittsburgh, PA, U.S.A., Tel +1 412 237 3399; FAX +1 412 237 3395; E-mail ratcliffem@clpgh.org

日本国内におけるプラネタリウムソフト・メーカー調査

小野　夏子　板橋区立教育科学館

Survey on Japan's Software Companies Producing Planetarium Programs

Natsuko Ono (Itabashi Science and Education Center) JAPAN

(e-mail:MHG03265@niftyserve.or.jp)

I will introduce the results of the survey on Japan's software companies producing planetarium programs in Japan, with reference to their names, addresses, programs, and materials.

現在、日本国内には３００館を越えるプラネタリウムを持つ施設があります。館の設置目的や利用状況、スタッフ人数や待遇、予算措置などは千差万別ですが、「おもしろい、たのしい番組を投影したい」という願いは同じだと思います。また、プラネタリウムを訪れる側も「おもしろい、たのしい番組を投影して欲しい」と願っています。

「プラネタリウムの番組制作はプラネタリアンの仕事。それをメーカーに任せるなど言語道断」と仰る方もあるかもしれませんが、予算や職員状況、設備などその館の事情によっては、メーカーに番組制作をお手伝い願うことがより良い番組を投影していく上で最善の策で有る場合もあります。

ところで、現在、日本国内にプラネタリウムの番組を制作供給を行うメーカーはどのくらいあるのでしょうか。今回の「ソフト・メーカー調査」は、ＪＰＳ団体賛助会員名簿とプラネタリアンの皆様からの情報をもとに14団体をまとめました。（今回、私の調査が及ばなかったメーカーがあるかもしれません。）

項目として調べたのは「プラネタリウム番組と素材の供給」についてです。調査結果は、別表にまとめました。（郵便番号でソートをかましたので地域順になっています。）

「番組」の欄には、アルファベットで「A」「O」「R」「X」の４種類の分類記号とコメントが記してあります。分類記号の意味は、以下の通りです。

A(All) …………すべてのソフトに対応。（既成のソフト、オーダー番組とも。）

O(Order) ………オーダー番組のみ注文を受ける。（既成のソフトの供給はない。）

R(Ready) ………既成のソフトの供給のみ行う。（オーダー番組制作は行わない。）

X(the Other) …「既成のソフト」「オーダー番組」に分類できない変則的なもの。

また「番組」欄では、以下のように用語を使用しています。

「既成のソフト」…既にメーカーが持っているソフト。「オーダー番組」に比べて割安であるが、納入館の要望による変更などの融通がきかない場合がある。

「オーダー番組」…各館からの注文で制作するソフト。「既成のソフト」に比べて割高であるが、館の意向や設備（投影機の種類や数）に合わせた番組が可能。

「素材」欄では、「○」「×」記号とコメントが記してあります。ここでいう「素材」とは「スライドやビデオなど番組の一部となるもの」をさします。、メーカーによっては「シナリオのみ」といった「注文」にも応じてくれるようです。

現在、日本国内には、「一覧」に掲げるようなソフト・メーカーが存在し、貴館の番組作りに様々な形で応援・協力してくれます。この「一覧」をよりよい番組作りにご活用いただければ幸いです。（今回は「番組」という形式で供給のあるメーカーをご紹介しました。他にも天体写真スライドなど「素材のみ」供給といったメーカーもあると思います。）

thanks

今回の「ソフト・メーカー調査」を行うにあたり多くのプラネタリアンの皆様からの情報を頂きました。伊丹市立こども文化科学館・丸川章さん、葛飾区郷土と天文の博物館・新井達之さん、富山市科学文化センター・吉村博儀さん、平塚市博物館・後藤真理子さん、米子市児童文化センター塚田慎介さん（館名50音順）他の皆さんに情報提供・ご協力頂きました。この場を借りて御礼申し上げます。

PLANETARIUM ソフト・メーカー一覧 JAPAN

社名	日本シネセル株式会社	担当	渡辺氏	☎03-3582-2691/FAX03-3589-3209
所	〒107　東京都　港区　赤坂　１－９－１５			
番組	O：オーダー番組のみ制作供給。	素材	○全天周映画素材を中心に素材供給。	
ｺﾒﾝﾄ	実写映像のライブラリーが充実。全天周映画のショート販売も可。			
社名	株式会社　トマソン	担当	上松氏	☎03-3280-6700/FAX03-3280-6737
所	〒108 東京都　港区　高輪4-22-10　小川ビル１Ｆ・３Ｆ			
番組	A：既成ソフト有り。オーダー番組も制作	素材	○ＣＧビデオ素材有り。	
ｺﾒﾝﾄ	既製ソフトは「クリスマス」番組。			
社名	株式会社ﾋﾞｼﾞｭｱﾙﾌﾟﾛﾓｰｼｮﾝ	担当		☎03-3464-4881/FAX03-3464-4924
所	〒150 東京都　渋谷区　宇田川町 36-22　ノア渋谷ﾊﾟｰﾄ2-801			
番組	O：オーダー番組のみ制作供給。	素材	○素材は希望に応じて提供。	
ｺﾒﾝﾄ	各館の独自のソフト作りをお手伝いします。			
社名	株式会社エンコム	担当	浅野氏	☎03-3478-6976/FAX03-3478-5957
所	〒150　東京都　渋谷区　神宮前 4-23-13　神宮前ハウス１Ｆ			
番組	A：既成ソフト有り。オーダー番組も制作	素材	○ＣＧ画像動画・静止画とも充実。	
ｺﾒﾝﾄ	企画から組込みまであらゆる作業に対応できます。			
社名	株式会社サイエンスアート社	担当	野口氏	☎03-3406-4970/FAX03-3406-4979
所	〒150　東京都　渋谷区　渋谷 3-3-10 秀和青山レジデンス 303号			
番組	O：オーダー番組のみ制作供給。	素材	○スライド素材は希望に応じて提供。	
ｺﾒﾝﾄ	作画制作・ＣＧ制作・パネル展示制作など。			
社名	株式会社　五藤光学研究所	担当	奥木氏	☎0423-62-5311/FAX0423-61-9571
所	〒183 東京都　府中市　矢崎町 4-16			
番組	A：既成ソフト有り。オーダー番組も制作	素材	○素材は希望に応じて提供。	
ｺﾒﾝﾄ	既製ソフト充実。星座解説・神話・テーマ解説の組み合わせ自由。			
社名	ベネッセ・スタードーム	担当	衛藤氏	☎0423-56-0814/FAX0423-56-0815
所	〒206　東京都　多摩市　落合 1-34　株式会社ベネッセ・コーポレーション			
番組	R：既成ソフト（幼児番組）のみ供給。	素材	×素材提供は今のところなし。	
ｺﾒﾝﾄ	進研ゼミのキャラクターが、登場する「幼児番組」を提供します。			
社名	株式会社リブラ	担当	田部氏、鷲巣氏	☎0462-72-6384/FAX0462-78-1161
所	〒242　神奈川県　大和市　下鶴間 665-8			
番組	A：既成ソフト有り。オーダー番組も制作	素材	○素材は希望に応じて提供。	
ｺﾒﾝﾄ	おもしろい仕事なら何でもやります。（デジスター番組も制作）			
社名	株式会社ｻｲｴﾝﾃｨﾌｨｯｸつくば	担当	宗政氏	☎0298-51-0103/FAX0298-52-6670
所	〒305　茨城県　つくば市　吾妻 2-9　つくばエキスポセンター内			
番組	A：既成ソフト有り。オーダー番組も制作	素材	×今のところ素材提供はしていない。	
ｺﾒﾝﾄ	既製番組の内容変更・追加等、納入館の希望に応じて対応。			
社名	ﾐﾉﾙﾀﾌﾟﾗﾈﾀﾘｳﾑ株式会社	担当	山田氏、川合氏	☎05338-9-8721/FAX05338-9-3578
所	〒442　愛知県　豊川市　金屋西町 1-8　東海事業所センター内			
番組	A：既成ソフト有り。オーダー番組も制作	素材	○一般ビデオ、ＣＧなども。	
ｺﾒﾝﾄ	ミノルタのハード・ユーザーへソフトサービスを行う。			
社名	あさだ考房	担当	浅田氏	☎052-782-0663/FAX052-782-0663
所	〒468　愛知県　名古屋市　天白区　植田山 3-1910 パークサイド植田山306			
番組	O：オーダー番組のみ制作供給。	素材	○シナリオなど、ご相談に応じます。	
ｺﾒﾝﾄ	天文書籍の出版、イベント企画なども行います。			
社名	テクニカルファクトリー	担当	小島氏	☎06-355-5911 /FAX06-355-5918
所	〒534　大阪市　都島区　東野田町 1-7-4　脇田・住友生命京橋第２ビル６Ｆ			
番組	O：オーダー番組のみ制作供給。	素材	×素材は希望に応じて提供。	
ｺﾒﾝﾄ	ＣＤ－ＲＯＭ等映像メーカー。社内に録音スタジオ有り。完全社内制作。			
社名	有限会社ｽﾀｼﾞｵイーハトーヴ	担当	西谷氏	☎06-536-5012 /FAX06-578-0109
所	〒550 大阪市　西区　立売堀 1-7-8　井本ビル３Ｆ			
番組	A：既成ソフト有り。オーダー番組も制作	素材	○天体写真など多数。	
ｺﾒﾝﾄ	ユニークなソフト制作。組込み・装填作業のみも可。各ﾒｰｶｰの機種に対応。			
社名	株式会社ＢＳＳ企画	担当	大谷氏	☎0859-33-0661/FAX0859-22-0590
所	〒683　鳥取県　米子市　明治町 63　名島ビル			
番組	X：共同制作番組のみを年２回制作供給。	素材	×素材提供はしない。	
ｺﾒﾝﾄ	年２回共同配給。継続配給が条件。実写を多様。１作品スライド枚数 150～ 200枚。			

（1996.7. 調査）

プラネタリアン初心者用テキストの制作について

小森　龍二

岐阜市科学館

プラネタリウムの担当者は、天文の知識や機械操作等というかなり専門性が必要とされる業務でありながら、残念ながら現状では専門職として認められているとはいえません。担当者として採用される場合、その適正等の配慮が特別される場合は少なく、また、公務員の場合、事務職員が異動によって急遽担当者になることもあります。さらに、プラネタリアンとしての技術や知識を習得する場もありません。このような現状ですから、新規採用や異動の場合の新人教育について、頭を悩ましておられる方も多いことでしょう。

そこで、パソコン通信を通じて交流のあるプラネタリウム担当者から、新人プラネタリアンの研修のための手引書を制作しようという提案がなされました。それに同調する各地のメンバー１３名が、プラネタリウムのメーカーや機種を越えて、１９９４年5月以来、お互いに草稿を提示し、意見を述べ、校正をしてきました。そして、この程ようやく完成稿として仕上げる事ができましたので、ここに紹介いたします。

1　テキストの内容

このテキストの形態と構成は次の様になっています。

Ａ４判・１０１ページ

第１章　プラネタリウムにたずさわる
第２章　プラネタリウムの仕事とは
第３章　プラネタリウムで使われる用語解説
第４章　投映にあたって
第５章　投映以外の業務
第６章　法律・規則などについて
第７章　参考資料

内容は、第１章、第２章では、プロとしての心構えやプラネタリウムの仕事について述べており、また第４章では、ここがいわゆる本文ですが、実際の投映における技術解説を述べております。更に第７章では、天文関係の書籍やパソコンソフト、プラネタリウムに向くＢＧＭ等を紹介をしています。全般的に初心者を対象にしているため、ベテランにとってはややもの足りない部分もあるでしょうが、全くの初心者だけでなくある程度の経験者にもきっと参考にしていただけると思います。

2　パソコン通信を使ったテキスト制作

このテキスト制作にはニフティ・サーブというパソコン通信ネットワークを利用しました。

ニフティ・サーブには各種のフォーラムが開設され、その中のスペースフォーラム（ＦＳＰＡＣＥ）に「プラネタリウムの部屋」という会議室があります。ここでは、業界関係者だけでなく、一般の方々が自由に参加してコミュニケーションをしています。プラネタリウムに関する情報や番組の感想、プラネタリウムへの期待などが毎日熱心に書き込まれていて、プラネタリウム関係者にも非常に参考になります。

この会議室を訪れるプラネタリアンから、初心者研修のための手引書を作っては、との提案があり、それをきっかけにこのテキストが制作されることになりました。複数の人間が分担して文章を制作しようとするときに、パソコン通信のメール機能が非常に役に立ちます。ワープロで作った文章を、一瞬の間に遠く離れたメンバー全員に送ることができ、全員で検討したり校正したりすることが簡単にできます。全員が一同に集まる機会を持つのはなかなか大変ですが、パソコン通信を利用すれば、自分の好きな時間を利用して、メンバーとのコミュニケーションがとれるのです。

なお、スペースフォーラムには、この他にも、天文ソフトや天体写真のデータが登録されている「データライブラリ」や、最新の天文情報を取り扱う「オンライン天文台」もあって、私たちプラネタリウム関係者にとってまさに情報の宝庫といえます。また、同じニフティ・サーブのホーム・パーティー（ＨＰ）という一種のグループ間通信の機能を利用して、プラネタリウム関係者だけが業界の話題を意見し合う場も作っております。

皆さんも、パソコン通信を利用して、御自分の仕事の幅を広げてみてはいかがでしょうか。

SESSION
"Education"

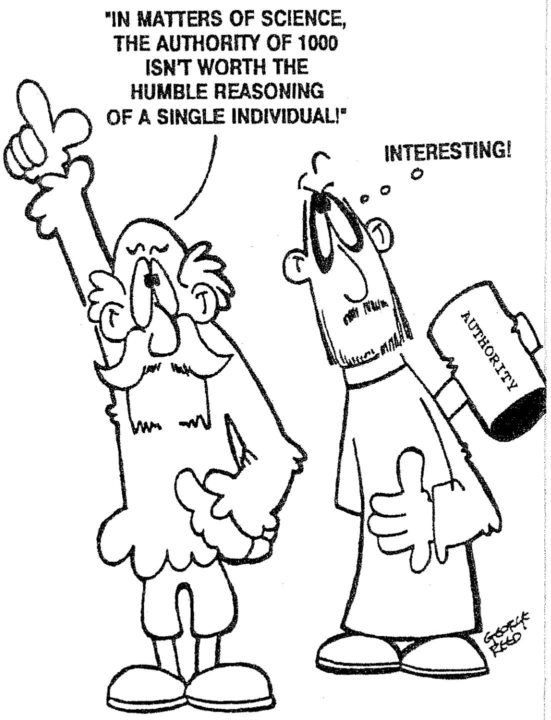
BLIND FAITH IN ASTRONOMY AND THE PLANETARIUM

Dr. George Reed

Spitz,Inc.
West Chester University, United States

We must be careful that the myths we present in our planetariums only extend to the stars and not to the history of astronomy, otherwise we will give a false impression of how science operates. As an example, the famous Galileo episode is often cited as an illustration of religious faith in conflict with the methods of science. In truth, the Galileo episode was a basic struggle over authority. Galileo's problems with the church had to do with the resolution of on whose authority or word the decision on the construction of the universe was to be made. It had little to do with religion and science per se except as to which system of inquiry was to decide the "official" accepted version of the universe.

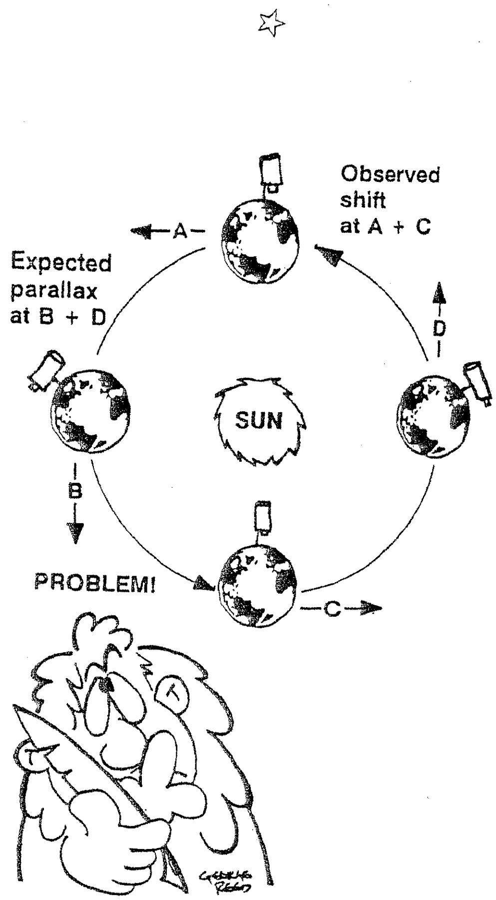
Both sides in this historic 1633 conflict between the Catholic Church and Galileo held positions based on "blind faith." Neither side had conclusive proof that the construction of the universe they championed was superior to the other. "Eppur si muove" - "And yet it moves," was spoken by posterity, not by Galileo. This apocryphal statement of defiance attributed to Galileo has meaning today only because history proved that Galileo had the unmitigated gall to be proven correct.



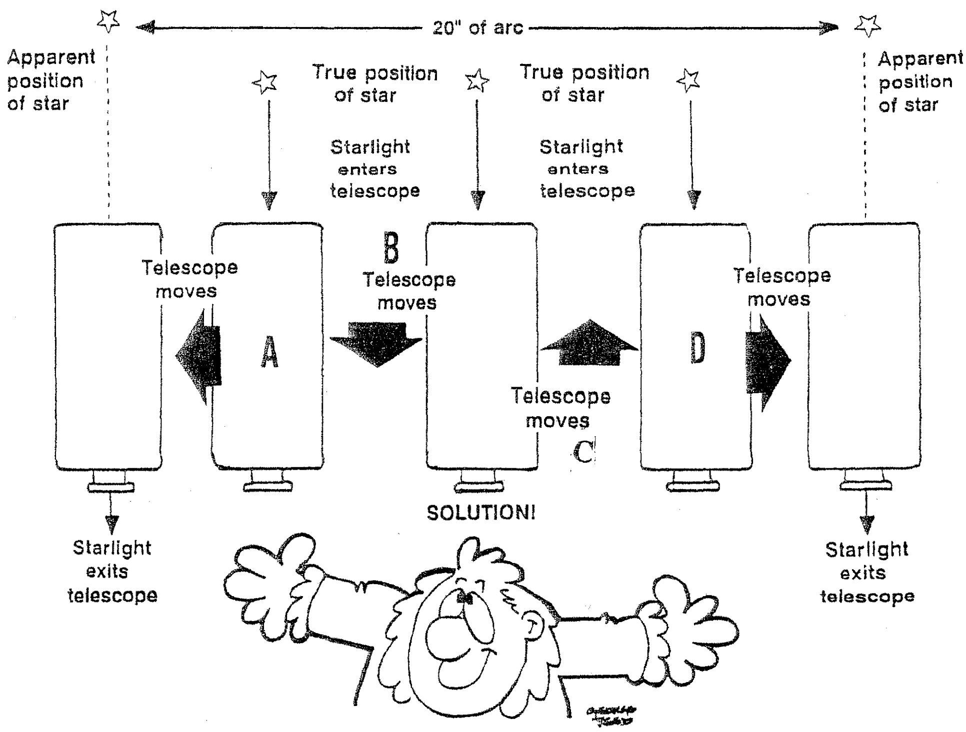
In 1633, Galileo had absolutely no proof that the earth rotated and revolved. And this was the source of his difficulties with the church. Galileo believed the earth rotated and revolved on "blind faith", and the astronomers who followed Galileo continued to follow his blind faith belief in the earth's rotation and revolution. It was long after the Galileo episode before the motions of the earth were demonstrated to be true.

James Bradley in 1725 began a search for the evasive stellar parallax to be found in the stars if the earth--truly-- revolved around the sun. Using a chimney telescope to observe the zenith passage of the star Gamma Draconis, Bradley did indeed discover an apparent motion of the star. But it wasn't the motion expected. The motion appeared 3 months earlier and later than expected due to parallax.

Bradley had accidentally discovered the aberration of light, the apparent displacement of a star's position due to the effects of the finite velocity of light combined with the orbital velocity of the earth. Bradley had discovered the first proof that the earth was in orbit around the sun, but it had taken just under a century after Galileo's trial.



THE ABERRATION OF STARLIGHT



The first measured parallax of a star was accomplished by Thomas Henderson observing Alpha Centauri at the Cape of Good Hope in 1833, but not announced until 1839. This was two centuries after Galileo and two millennia after Aristarchus' heliocentric proposal predicted a parallax if the earth revolved around the sun.

Jean Foucault in 1851 suspended a 200-foot pendulum with a one-foot diameter bronze sphere weighing 56 pounds from the domed ceiling of the Pantheon in Paris. The pendulum was set in motion so that a stylus attached to the sphere cut a notch in a 12-foot circular ring of sand on a table beneath the swinging pendulum. After a few swings of the pendulum, and with only the downward force of gravity acting on the pendulum, it became evident that the plane of the oscillation of the pendulum was slowly moving clockwise. Foucault offered the demonstration as a physical proof of the earth's rotation. The earth was rotating under the pendulum. The pendulum made the earth's rotation visible.

Blind faith still plays a role in astronomy today. We still accept theoretical constructs as "blind faith" models of reality before conclusive proof has appeared. Black holes and the Big Bang creation of the universe come to mind. Like Galileo, sometimes blind faith is rewarded, but this is a part of science that isn't always presented. It's important to recognize "blind faith" situations because it's a lesson that can extend into other areas. Even the business of planetariums. How much of what we do in the planetarium is due to "blind faith?" How well do we satisfy our audience's expectations? What are their expectations? Do we have proven answers or do we have blind faith answers?

TILT !!

David Linton, Professor of Astronomy

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MY MOTIVATION

At the Symposium on the Teaching of Astronomy at the University of Maryland in June of 1995, discussions I was involved in regarding teaching the seasons caused me to mull over a teaching method I have utilized off-and-on during my teaching career. The following is a summary of that method and the demonstration which has been developed with the very generous help of the Evans and Sutherland Corporation. Most noteworthy is the work done by Neal Mayer, Lead Engineer of Digistar for E&S. Field-testing was done at Taylor Planetarium in Bozeman, Montana.

It is important to point out that this demonstration cannot be done on a traditional planetarium, since it involves the total relocation of the ecliptic. The demonstration may be seen (on a flat screen monitor) at the Evans and Sutherland booth in the vendors' area during this conference.

INTRODUCTION

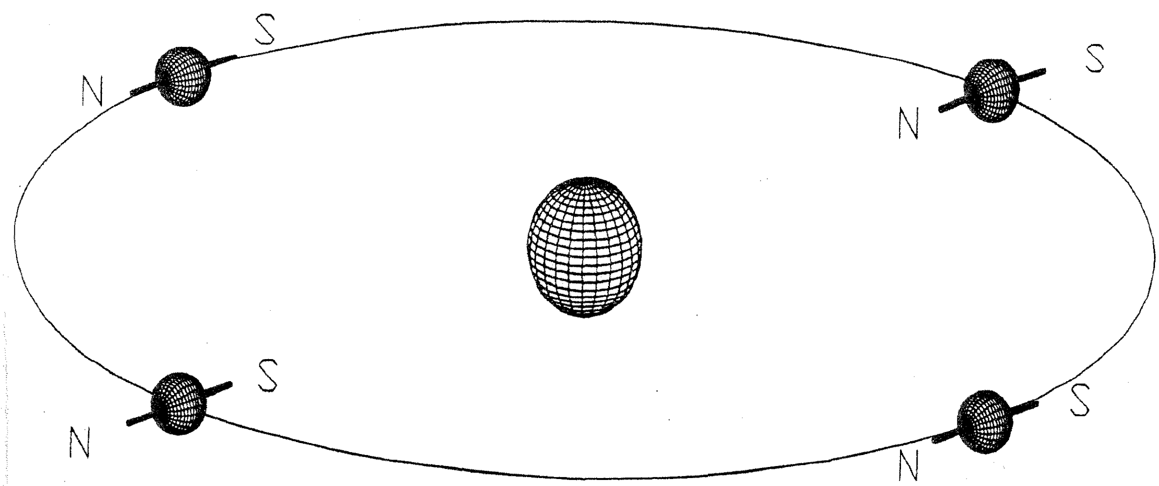
My education, before and during the time I migrated to Astronomy, was heavily influenced by the instruction I received in Physics and Math. In these disciplines, in order to most fully aid students in developing a deep understanding of basic principles, students are asked to apply their understanding to many different physical situations. The act of applying one's knowledge, I believe, plays a very important role in the educational process.

As I began to teach a quarter-century ago, I sought ways for my Astronomy students to apply the new knowledge they were gaining. As I did so, I came up with one application that has worked very well in improving my students' understanding of earth's seasons. One caveat: this application must be preceded by a thorough teaching of earth's seasons and a careful introduction of the exercise itself. It is also helpful for the students to prepare for this exercise by using a globe and a light bulb to describe the seasons of the earth.

THE APPLICATION

Ask a group of students to use the same light bulb and globe as before, this time to describe the seasons of the earth **if the earth's axis were tilted by 90° rather than 23.5°.** Tell them that this means that the earth's axis will lie in the plane of the earth's orbit as earth revolves around the sun. Do not show them the earth's movement, but rather ask them to translate your words into a modeling of the earth's movement. Be willing to provide occasional guidance, as there are several ways for the students to go wrong.

Figure 1: The Earth with a 90° Axial Tilt



The most common mistake is for the students to change the orientation of the axis as the earth goes around the sun, oftentimes keeping the earth's axis pointed directly at the sun. My preference is to allow the students in the group a chance to self-correct their errors, but I am ready with the appropriate question at the right moment: "Is this," I ask, "a correct extrapolation from the real world?" I have them reexamine the real earth, its tilt, and its orbit. They begin to see that a new north star will be needed, and that the earth will have one polar cap forming while the other one melts.

Some students develop the concept of East and West poles. We discuss the meaning of an axis of rotation, and of a the poles as being the ends of that axis, and they discard the concept of E/W poles.

In short, the students directly (with occasional help from their teacher) confront their misunderstandings, which I am able to easily diagnose by watching, by listening, and by occasionally asking questions. By applying their understanding, they have improved that understanding.

A LAB EXTENSION

It is possible to carry the exercise further. Once the students have a clear view of how the earth and its axis are oriented relative to the sun, I ask them to determine what the seasons on this altered earth would be like as seen from the north pole, the south pole, the equator, and Champaign. I give them a table to fill out, with the following information to be determined for each location: sun's altitude at noon, number of daylight hours, and their prediction of what the average temperature will be—each of these evaluated on the first day of each season.

(Figure 2) Tilt Table: Seasons on an Altered Earth

Fill in the blanks as indicated for the earth-with-a-90° tilt. Orbital position numbered "1" has the sun overhead the North Pole. Other positions are reached in numerical order after position 1.

Orbital Position	Location on Earth	First Day of Which Season?	Maximum Altitude of the Sun	*Number of Daylight Hours (If sun is always below the horizon, use "ABH".)	Average Temp (Examples: Very hot, hot, moderate, cold, very cold.)
1	North Pole		90° (given)		
1	40° N latitude				
1	Equator	XXXXX			
1	South Pole				
2	North Pole				
2	40° N latitude				
2	Equator	XXXXX			
2	South Pole				
....................**Note: Table repeats through orbital positions 3 & 4.**					

CHANGING THE SEASONS IN THE PLANETARIUM

I would love to reward a group which has successfully solved the 90° tilt puzzle with a visit to a planetarium , showing what these [altered] seasons would actually look like. This view from earth's surface would supplement the view of these seasons from space that was provided in the earth globe & light bulb model. This two-view approach is often what we employ in teaching the real seasons.

Recognizing that a change in axial tilt would be manifested in the planetarium by a change in the location of either the celestial equator (and poles) or the ecliptic, I quickly reached two conclusions:

1. The only planetarium which could allow the inclination of the ecliptic to be changed: Digistar.
2. A collision involving the early earth could conceivably have altered the direction of the earth's axis, but not the orientation of earth's orbital plane. It is less confusing, however, to change the location of the ecliptic than to change the locations of the celestial equator and poles.

After conferring with me over the phone, Digistar Lead Engineer Neal Mayer volunteered to tackle the "interesting" problem of creating a new location for the ecliptic. I scripted the show, and we conferred by e-mail on his successes and difficulties. We thus revised and expanded the show until we arrived at the sky demonstration that you may see in the Evans and Sutherland booth.

TILT !! THE DIGISTAR DEMO

In order to finish in a timely manner, this demo has what may seem to be an overly rapid diurnal motion. You may wish to view it more than once to fully understand it.

We shall begin on the earth you are familiar with, at 40° North latitude, the latitude of Champaign, Illinois (also northern Honshu and southern Italy). We shall commence at sunrise on the first day of Spring.

Date	[Date on Alt Earth]	Comments
Mar 21	[Mar 21]	First Day of Spring in the Northern Hemisphere The sun rises due E, sets due W, reaches 50° at its highest.
Jun 21	[Apr 14]	The furthest north the sun gets for the real earth, 23.5° north of the celestial equator; 15 hrs of daylight
	[May 1]	Sun reaches zenith; 18 hrs of daylight Altitude Range: -10° to +90°
	[May 11]	Sun becomes circumpolar; 24 hrs of daylight Altitude Range: 0° to 80°
	[June 1]	Sun has halved its distance from the NCP. Altitude Range: 20° to 60°; 24 hrs of daylight
	[June 20]	Sun becomes motionless at the NCP Constant Altitude: 40°; 24 hrs of daylight
	[July 31]	Sun touches the horizon for the first time in 80 days. 24 hrs of daylight
	[Aug 10]	Sun again reaches zenith, after an absence of more than 100 days from the southern half of our sky. Altitude Range: -10° to +90°; 18 hrs of daylight
Jun 21	[Aug 27]	Sun returns to its normal path at the summer solstice. 4 1/2 mo. have passed with the sun north of its range in the skies of the real earth; 15 hrs. of daylight
Sep 20	[Sep 20]	The autumnal equinox. The sun rises due E, sets due W, reaches 50° at its highest; 12 hours of daylight
Dec 22	[Oct 14]	The normal winter solstice declination is reached only 24 days after the first day of Fall; 9 hours of daylight.
	[Oct 31]	Sun reaches only 10° altitude at noon; 6 hrs of daylight. Altitude range: -90° to +10°
	[Nov 9]	Sun touches the horizon at noon; Zero hrs of daylight. Altitude range: -80° to 0°

From this point on, the sun will not be seen until the end of January, although there will be some twilight observed around midday for about the next two weeks. Star watchers will get little sleep for the next two months.

To survive this dark and cold time, non-astronomers on such a world might remain indoors, or perhaps they would migrate. Let's imagine they were to migrate to the equator.

{Move south, until latitude = 0°}

Two other diurnal paths for the sun appear as we travel south, one for [Dec 1], with the sun 20° from the SCP, and one for [Dec 21], with the sun at the SCP all day long.

Here at the equator, the sun is seen year-round, with each day having 12 hrs of daylight.

SUMMARY

When comparing this situation to the real earth, it should be remembered that the altered earth would receive exactly as much energy as does the real earth. The difference lies in how that energy would be distributed over the surface of the planet. A much greater percentage of the energy would be delivered to higher latitudes, and consequently the equator would on the average be much cooler. Away from the equator, the seasons would offer extremes best characterized as brutal.

One difference in the nighttime sky is that there would be no seasonal march of the constellations—the sun has no eastward movement, only north or south. For six months, the set of constellations appearing on the celestial meridian at midnight would be exactly the same. Then, after the sun reaches the (northern) summer solstice (the NCP), the set of constellations on the celestial meridian at midnight would be those halfway around the celestial sphere.

As the sun's declination varies during the year, the rising and setting times of the sun would change as well—except at the equator. At the equator, there would be a six-month constancy of constellations not only at midnight, but at every hour of the night.

This altered earth of course reminds us of the planet Uranus, but the difference is considerable in one important way. The distance from the sun to Uranus is almost 20 a.u. At this distance, the intensity is always very low (1/400 as intense at 20 a.u.), and even having the sun at the zenith all day long would not provide a very hot day (by earthly standards).

QUESTIONS REGARDING AN ALTERED EARTH (FOR DISCUSSION OR FUTURE INVESTIGATION)

1. Would windstorms be any more severe? Some areas of the earth's surface would be heated very intensely at times, and cooler air would be drawn in from other locations. Since this would likely involve air movement toward the north or south, the coriolis force would need to be considered. It might be expected that hurricanes and tornadoes would be more frequent on the altered earth.
2. What would the phases of the Moon be like if:
   a. the Moon orbited in the plane of the earth's equator?
   b. the Moon orbited in the plane of the ecliptic?
3. What would tides be like on such an altered earth? (See Comins article for discussion)
4. What strategies could life follow to survive the seasonal extremes?
5. Would life have been any less likely to progress from the sea to the land?
6. Just how hot/cold would it get at any particular location? (A modified climate model would be required). What would the hottest/coldest time of the year be?
7. For each latitude, which day provides the greatest insolation (heating from the sun)? This is not the same question as #6, as the earth's thermal inertia does not enter into this question. This is an interesting problem in integral calculus, especially for the middle latitudes. [Does Champaign get more heat in 24 hrs with the sun at a constant 40° altitude, on a 24 hour-day with the sun circling from the horizon to altitude 80°, or on an 18-hour day with the sun arcing from the horizon to the zenith?]

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WHEN HUMANS NAVIGATE MARS

Linda Irby

The Science Place Planetarium

With thanks to The U.S. Naval observatory, Dave Williams, NSSDC, NASA, Chuck Acton and David Siedel, JPL, Wilgus Burtin, The Science Place Planetarium, Joe Vines, Lacy Ward, Ray Benge, Richland College, and Frank Irby.

Do you want to walk the surface of Mars? Do you dream of exploring Valles Marineris and climbing Olympus Mons? Do you want to inspire others to dream these dreams? Mars exploration is an opportunity for you, as planetarians, to encourage students, and the public, to study our history and dream of our future. This paper was developed as a basis for educational, hands on, planetarium programs, seminars, or workshops.

Some current programs question how humans will live and work on Mars. But exploring the Mars frontier will carry hazards that earth explorers never dreamed of. Yet this exploration will be similar in many ways. As you drive away from your Mars base and disappear over the horizon how will you find your way back? What navigation tools will you have? Can you use or depend on a magnetic compass? Will you have an expensive global positioning satellite system in orbit? Or will you have a grid of navigation radio stations around the globe?

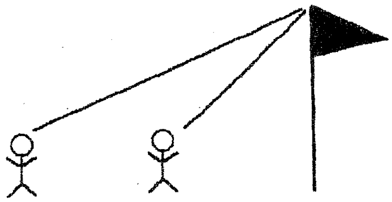
The celestial navigation system developed and used on Earth the last 300-400 years might be the least expensive solution. Although the marine sextant used in celestial navigation requires an ocean to provide a horizon reference it can be modified to provide an artificial ocean horizon for Mars. Celestial navigation with the simple quadrant or a modified marine sextant can work on Mars because of the following Earth/Mars similarities:

- ✰ The coordinate system:
  - ✰ The equatorial plane is perpendicular to the axis which passes through the planet's center.
  - ✰ A 360-degree circle is described by the diurnal rotation of the planet.
- ✰Parallels of latitude lie north and south of the equator (zero latitude).
  - ✰ Meridians of longitude lie perpendicular to the equator.
- ✰The planets coordinate system projected on the Celestial Sphere forms the celestial coordinate system.
- ✰ Each Celestial Sphere object has a sub-stellar or sub-solar point known as the ground, or geographical, position (GP) on the planet below.
- ✰ The GP has a longitude and latitude.

Using these geometrical relationships you can determine your position relative to that of the GP of a stellar object by measuring the altitude angle of the object by sextant or quadrant. If the angle is 90 degrees you are under the object, and your latitude and longitude is the same as the GP of that object.

As you move away from the GP of the object, the angle will become smaller. See Figure 1.

Figure 1. The angle changes with distance.

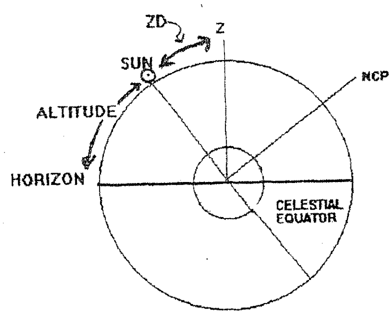


The approximate latitude can be obtained by measuring the altitude of the sun or star by quadrant or sextant and using the geometrical relationship between the declination of a star and the zenith distance. The Zenith distance of the celestial equator equals the navigator's latitude, Figure 2:

$$\text{Latitude} = \text{Dec} \pm \text{ZD}$$

where: the ZD = (90 degrees - the Altitude angle)

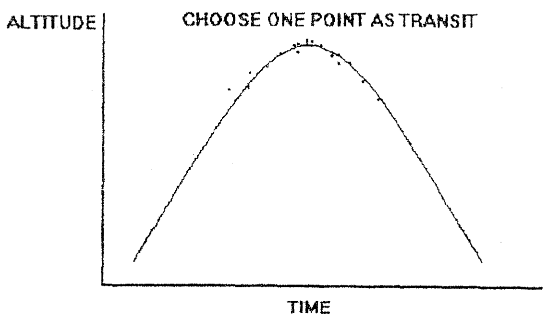
Figure 2. Zenith distance relationship.



A fairly accurate Longitude is obtained by observing the Sun's meridian transit, recording the time, plotting the graph, Figure 3, and using the geometrical relationship:

Longitude = Greenwich(or Mars) Mean Time of transit - the Equation of Time - 12 hours.

Figure 3. Sun transit.



The approximate Latitude and Longitude are also obtained by using the reduced sightings of three stars and plotting the resulting triangle on the map. These results will be approximate, but more precise results can be obtained by using navigation tables which record the position of the sun, selected stars, and planets for each day. These tables can be adjusted for any planet in the solar system.

Mars shares our starry sky at night and our sun in the day therefore the constellations and the stars will be familiar. However because of differences in the planets size, rotation, and revolution some basic navigation constants will need adjustment. A comparison between Earth and Mars, Table 1, will help point out some of the changes needed.

Table 1 Mars/Earth Comparison

	Mars	Earth	Influences:
Magnetic field	Weak	Good	The magnetic Compass
Eccentricity	.093	.017	The Equation of Time
Equatorial Diameter	4,217 Miles	7,926 Miles	The Nautical Mile
Rotational Period	24.62 Hours	23.4 Hours	Tabulated Hour Angle
Axis tilt	23.98 Degrees	23.4 degrees	Tabulated declinations
Pole star	$\prod^{'}$Cygni ??	Polaris	Latitude by direct sighting

The Celestial navigation system uses several defined units which are found in the current navigation tables. These units can be adjusted for Mars:

- ☆ Earth's Nautical Mile is defined as one minute of arc on a great circle or 60 nautical miles per degree. Since the definition of a nautical mile is based on Earth's circumference, the Mars nautical mile will be different. See Table 1.
- ☆ The equation of time, or the analemma, which is a result of the eccentricity of the orbit, will be recomputed for Mars. See Table 1.
- ☆ Declinations will need to be adjusted because of the slight difference in tilt.
- ☆ A Martian time system must be established or Earth time can be used if the navigation tables are adjusted.

A "north star" will be assigned in order to find latitude by directly sighting the star and applying a trigonometric correction to the angle obtained. The North Celestial Pole for Mars lies at approximately 317.65 degrees right ascension and 52.87 Degrees declination. There are several 6th magnitude stars within a couple of degrees of the NCP. Brighter candidates are within 6 degrees, see Table 1.

Classes or workshop groups can make these adjustments using arithmetic and simple algebra. And, although some background study is necessary to understand the principles of celestial navigation, the possibilities for activities on all levels are almost unlimited. Altitude measurements can be made in the planetarium using paper quadrants or sextants. The Mars analemma can be graphed. Perhaps a sample Mars base can be constructed which might lie on the Greenwich Mons or Fuji Mons meridian. Student astronomers could model the meridian passage of the sun and discuss how the time signal could be relayed around the planet. Other subjects might include the history of the quadrant and sextant, the development of the time and coordinate systems, orbital mechanics, and, of course, the constellations.

When we explore space, we will take our knowledge of the stars with us. There is no doubt the stars will be part of our future. As we travel into the solar system perhaps the almost forgotten sextant will be a standard tool among the high technology navigation equipment on board the ship. Surely the stars will continue to guide us in space as they have for so long on Earth.

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KEPLER'S THIRD LAW IN THE PLANETARIUM

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INTRODUCTION

Kepler's Third law describes planetary orbits with the well-known relationship that the square of the period in years equals the cube of the semi-major axis in Astronomical Units. It is easy to demonstrate this law from an external viewpoint that looks down on the orbits from above. But it can also be demonstrated and derived from an Earth-based viewpoint using the star projector. At Bowling Green, we have developed a laboratory-style exercise that demonstrates Kepler's Third Law for both the inner and outer planets using our Minolta star projector.

MEASURING PERIODS AND RADII

In the exercise, students measure the period and orbit radius for all five naked-eye planets. The measurements are made by observing the motions of the Sun and planets along the ecliptic, and recording the dates of conjunctions and the angles of elongation between the Sun and planets. The ecliptic serves both as a calendar for the dates of conjunction and as a protractor for the angles of elongation. Since our ecliptic is calibrated in one day intervals, it is easy to use it as a calendar by recording the position of the Sun. The ecliptic can also be used as a protractor to measure the apparent angle between the Sun and a planet by using the approximation that one day's space along the ecliptic equals an angle of one degree.

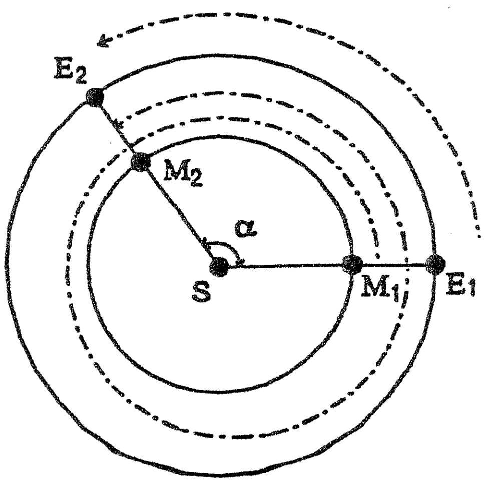

Figure 1. Successive inferior conjunctions of Mercury. M_1 and E_1 are the positions of Earth and Mercury at the time of the first conjunction. M_2 and E_2 are the positions at the time of the second conjunction. The Earth moves through orbital angle α between the two conjunctions, equal to the angle along the ecliptic between the locations of the two conjunctions as seen from Earth. Mercury moves $360°+\alpha$. By measuring the angle α and the number of days between successive conjunctions, the sidereal period in years can be calculated. (In the case of Venus, both Earth and Venus move 360° more than in the case of Mercury.)

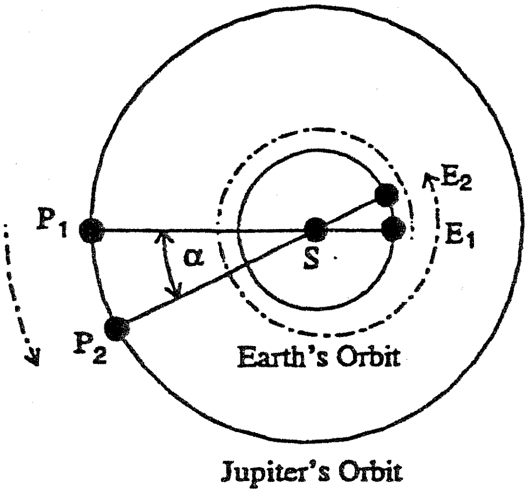

Figure 2. Successive conjunctions of Jupiter (or Saturn). E_1 and P_1 are the positions of Earth and Jupiter at the time of the first conjunction. E_2 and P_2 are the positions at the time of the second conjunction. Jupiter moves through orbital angle α between the two conjunctions, equal to the angle along the ecliptic between the two conjunctions as seen from Earth. The Earth moves $360°+\alpha$. By measuring the angle α and the number of days between successive conjunctions, the sidereal period in years can be calculated. (In the case of Mars, both the Earth and Mars move 360° more than in the case of Jupiter and Saturn.)

The orbital period must be measured indirectly, since we are constrained to an Earth-based view. Figure 1 for the inner planets and Figure 2 for the outer planets show the orbital geometry involved. For each planet, we use the star projector to locate two successive conjunctions of the planet with the Sun. We record the two dates. Since the two conjunctions occur at different places on the ecliptic, we also record the angle between these two places. From these measurements, the sidereal period can be calculated. An annotated set of steps guides the student through these calculations.

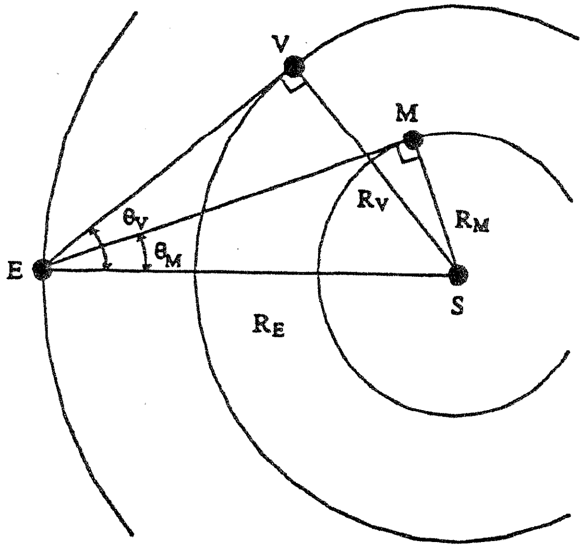

Figure 3. Maximum elongations of the inner planets. The angles θ_M and θ_V are the angles of maximum elongation. They are measured in the planetarium for both eastern and western elongations to help average over orbital eccentricity. The orbital radius in A.U. is then given by sin θ.

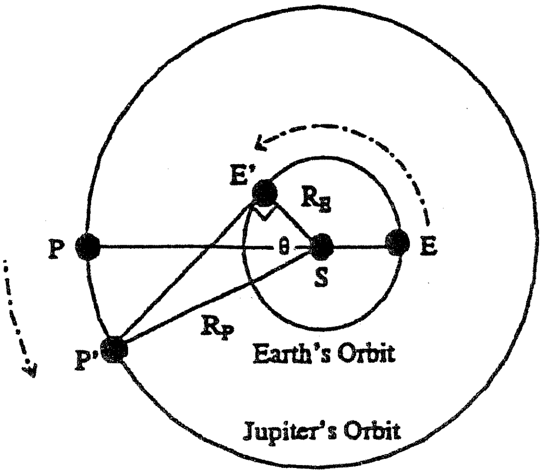

Figure 4. Conjunction and quadrature of an outer planet (for example, Jupiter). S marks the Sun. E and P are the positions of Earth and Jupiter at the time of conjunction. E' and P' are the positions at the time of quadrature after conjunction. The Earth moves through angle ESE' between conjunction and quadrature. Jupiter moves through angle PSP'. These angles are determined in the planetarium by measuring the dates of conjunction and quadrature and using the sidereal period determined earlier. From these angles and the right triangle SE'P', the angle θ is easily calculated. Then the orbital radius in A.U. is given by $1/(\cos\theta)$.

The orbital radius must also be measured indirectly and in terms of the radius of the Earth's orbit. Figure 3 for the inner planets and Figure 4 for the outer planets show the orbital geometry involved. For Mercury and Venus, the angle of maximum elongation must be measured. These are the angles SEM and SEV in Figure 3, and the sines of these angles give the orbit radius in A.U. For Mars, Jupiter, and Saturn, the *dates* of quadrature must be measured. (Quadrature occurs when the planet and Sun are 90° [91 days] apart.) These dates are used to calculate the angle θ in Figure 4, and 1 over the cosine of this angle gives the orbit radius in A.U. An annotated series of steps guides the student through these calculations. Elongations and quadratures both east and west of the Sun must be measured for accuracy, and data are taken at 5 day intervals around the relevant dates. Accurate quadrature measurements for Jupiter and especially Saturn are essential.

RESULTS AND CONCLUSION

When all the periods and radii have been measured, then P, R, P^2, and R^3 can be tabulated and graphed to illustrate Kepler's Third Law. Table 1 lists some typical results and shows that reasonably accurate periods and radii can be obtained with careful measurement.

Table 1. Sidereal periods and orbit radii

	---measured values---				---"real" values---	
planet	P(yr)	R(AU)	P^2	R^3	p(yr)	r(AU)
Mercury	0.25	0.45	0.06	0.09	0.24	0.39
Venus	0.61	0.71	0.37	0.36	0.62	0.72
Earth	1.00	1.00	1.00	1.00	1.00	1.00
Mars	1.87	1.56	3.50	3.80	1.88	1.52
Jupiter	13.0	5.7	169	185	11.9	5.2
Saturn	32.3	10.3	1043	1092	29.5	9.5

The measurements can be completed in about two class sessions, one for the inner planets and one for the outer planets. To complete each session in about 45 minutes, the class must already be familiar with the planetarium sky and the instructor must be well-prepared and move the star projector efficiently through the various conjunctions, elongations, and quadratures.

At a previous class meeting, the students are given an exercise packet providing historical background and a complete explanation of the geometry and procedures involved, so they can arrive well-prepared. After taking the data in class, the students complete the remaining work at home individually or in groups. We have tested several generations of this exercise in both small and relatively large college classes, have fine-tuned the write-up for clarity of explanation and procedure, and found that most students catch on quickly to the data-taking procedure and complete the analysis successfully.

This exercise provides the student with an experience in a quantitative and advanced use of the planetarium, gives some practice in taking and analyzing data, and shows for one case how the god's-eye-view results we often show are derived from Earth-view measurements. Copies of the complete lab packet are available by contacting the author.

THE SOLAR SYSTEM TONIGHT
A Daily Look At The State Of The Solar System ©

Dedicated To The Late Dr. David Bohm

Presented By Ervin Bartha

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Over the past six millennia, humanity's observation and study of the cosmos has become increasingly intense and precise. Yet the primary discipline of astronomy, and offshoots such as astrophysics and astronautics have continued to remain a vague, remote and somewhat esoteric realm for the vast majority of the human population. Even though there has been an extensive effort to make the findings of space science available to a wider audience, generally human beings are still more concerned about personal security and insecurity than they are about investigating and developing a conscious way of relating to the enormous and essentially unknown universe of which we are all a part. Perhaps the lack of universal relationship has contributed to the fragmentation and disintegration that are rampant in almost all societies. And yet there also seems to be another even more powerful impulse simultaneously being felt by the members of our species. It is a yearning for integration and unity amidst the chaos, a necessity to connect to a greater reality.

As we rapidly approach the twenty-first century, a great many of us feel we are at the same time approaching a point of critical mass in which the direction of human evolution or devolution is in the balance. One direct and positive way in which the global community can be reconnected to a greater ***cosmic*** balance is through daily exposure to its more local but unquestionably larger scale components. Instead of having a nightly weather cast related to our disjointed microscopic personal realities, why not put the pattern of a day's activity on planet earth in context with the patterns of the entire solar system? What happened today on the Sun? What happened today on Mercury; on Venus; on Mars? What's going on this evening on Jupiter and Saturn, and on their multiple satellites? What's the latest from Uranus, Neptune, Pluto and the Oort cloud? How does all this relate to what's happening on my planet, in my locality, in my home? In ***our*** homes, in ***our*** localities, in ***our*** solar system? In ***our*** galaxy? In ***our*** universe?

The means is possible for doing a daily or weekly "State of the Solar System" broadcast on radio, television, internet or whatever other means exists or is to be invented. A preliminary network of planetaria already exists to initiate the idea. These presentations could be anywhere from thirty to forty-five minutes. With a universally accessible database, each planetarium could simultaneously report the daily or weekly state of each of the solar system's members in relationship with our own planet. A totally different view of ourselves in a greater reality could be injected into common consensus consciousness. And with such a view we might all be able to address our human level crises in a more impartial manner.

Truly we wouldn't feel so down if we would only look up more often. If we create and generate that which is ***immediately*** universal for one another, that which is universal in each of us ***will*** respond. The twenty-first century beckons us all. The more consciously balanced we go into it, the more consciously balanced we'll all come out of it.

Thank you

SCALING THE SOLAR SYSTEM

Dr. York H. Clamann

St. John's Episcopal School, Abilene, Texas USA

It is said that Alfonso the Wise, King of Castile (1221-1284) once said, "If I had been present at the creation, I would have given some useful hints for the better arrangement of the universe." For many years astrologers, astronomers, and teachers have attempted to demonstrate the vastness of the solar system. As measurement entered the science arena as an indispensable entity, models of the solar system became distinctly vague.

Although we readily agree that our eyes are the organs of sight, the brain is an integral component of the sense of vision. I am sure that you have heard of the man seated in an airplane who remarked to his seat-companion that the automobiles below looked as small as ants. "They are ants, my friend", remarked the companion, "we have not yet left the ground!" Imagine standing on a street behind a large truck. It certainly looks large! Now the truck begins to drive away from you. Although our eyes tell us that the truck is getting smaller, our brain knows that the size of the truck is not actually changing. The message from our eyes is incorporated with previous knowledge, and results in the understanding that the truck is moving away. The rate at which the object seems to become smaller determines the mental estimation of the speed at which the object is departing.

This is acceptable for sizes and distances which we commonly see here on Earth. However, it poses a problem for teachers and researchers in the field of astronomy. Imagine civil engineers being given only the centimeter to use in their measurements as they plan cities and highways!

The solar system sizes and distances are fairly well established measurements. One of the best data sheets for these measurements is the Hansen Planetarium Solar System Fact Sheet, which can be obtained from the Hansen Planetarium Education Department, 15 South State Street, Salt Lake City, Utah, 84111 USA. This sheet gives various values for the same concepts, so that the reader may have several aspects of a concept from which to choose. For example, if you wish to discuss interplanetary distances, you might choose kilometers, miles, astronomical units or light travel time.

Even outstanding computer programs such as Carina Software's Voyager II (my personal favorite for planetarium work), which produces accurate figures, cannot accurately and correctly depict the relationship between planet sizes and planet distance from the sun. The individual pixel can only be made so small, and the computer screen so large.

I assume that we all recognize a Ping-Pong ball. If I use this ball as a model of the Earth, the sun will be over four meters in diameter, and will be nearly 500 meters away. The problem of producing an accurate model of the solar system depends upon the definition of the primary unit of measure.

Early history records the Earth as the center of the universe and conceptualization. It is easily recognized, measured, located and manipulated. Thus, even today, most solar system models are based on Earth measurement. Since this makes the demonstration of interplanetary distances awkward, a different scale is used for these measures. This is usually not explained to school children (or the general public, for that matter) so an unmentioned factor becomes an erroneous "fact".

In 1994, I became an agent for the Harvard University-Smithsonian Institute's Project SPICA, where such problems were addressed. We used the entire floor of a basketball gymnasium to depict a model of the sun based on the size of a schoolroom globe of the Earth. Naturally, there was insufficient space to depict the interplanetary distances.

The core of the problem, as I have said earlier, rests with the selection of a basic unit of measure which is recognizable, reproducible and measurable. To this end, I have chosen the Sun as my standard. It seems to be a bit large for planetary diameters, and a bit small for interplanetary distances, but, on the average, works quite well for both. As an example, I have chosen a model of the Sun with a ten centimeter diameter. This allows me to produce a model solar system on the property of the school where I work, St. John's Episcopal School in Abilene, Texas. The measurements below are not guaranteed, and are presented only to give a pattern to be followed. The smallest measurement is 0.17 mm (the diameter of the planet Pluto), and the largest is 424 meters (the distance between the Sun and the planet Pluto).

Sun = 10 cm diameter

PLANET	Planet Diameter (in millimeters)	Sun to Planet (distance in meters)
Mercury	0.35	0.416
Venus	0.87	7.77
Earth	0.92	10.75
Mars	0.49	16.37
Jupiter	10.30	55.91
Saturn	8.66	102.51
Uranus	3.67	206.18
Neptune	3.56	323.56
Pluto	0.17	423.85

There are many models which depict the solar system on the market today. As planetarians, we use the best which we can afford, and hope to make our point. I agree that a beautiful model such as the one in Lars Broman's planetarium in Borlange (Sweden) would require much work and cooperation. I hope that these thoughts which I present here will germinate thought in the discussion of the proper scale of our solar system. Thank you for your kind attention.

HOW DO WE LEARN ABOUT THE WORLD?

Marie Rådbo

Chalmers University of Technology
Sweden

" Is Egypt further away than the stars?"

The question may sound odd, but if you are a five-year-old boy and your mother is an astronomer going to Egypt, then the question is very logical, because it is part of his endeavour understanding the world and his place within it.

It seems like there always has been a desire to understand what the world looks like, and from a historical point of view it is obvious that people always has tried to make models of the world, starting from what they observe with their own eyes. It is also obvious that there has been a wish to be situated in the centre of the world in all the different models, but at last people had to accept that we don't live in the centre of the universe. But even today it is as important for people to understand their own position in the world, and each child starts very early to investigate his/her surroundings, starting with the bed and the room. Gradually the children understand more and more about the structure of the world, but it seems that there is an end in their learning when they are quite young. Is there a way to help them? Yes, science can offer an explanation of the world: *In the end, what science does is change the way we think about the world and our place within it* (Krauss 1994). The question is however, does science succeed to explain the world? *The question is important, because science provides the best way of understanding the world* (Wolpert 1993).

When teaching science, it is of main importance to consider the learners own experience (Harlen1995), and one of the points I want to stress here is that in order to make the picture understandable and meaningful, it is necessary to draw attention to the position of the learner in relation to the objects illustrated. We all know the importance of pictures, and therefor I take it for granted that illustrations most of the time are more important than words in explaining the world to children. Let me take a chair as an example to explain what I mean. A chair looks different depending on the position of the viewer; if I see it from above, or from one side, or if I am sitting in it, but in every case I can understand that it is the same chair, because I am familiar with the shape of the object, as well as the size. On the other hand, if an unknown object is illustrated from different positions, there might be problems.

POSITIONS

When we illustrate the universe it is impossible to relate to everyday experience, and therefor we must pay even more attention to the position of the viewer. When discussing different positions below, I have classified them in two categories; egocentred and allocentred, where egocentred is used for illustrations which everybody can observe with the naked eye. Allocentred, where allo means another in Greek, is used for all the other illustrations, close up pictures of the planets for example and illustrations from different positions than the egocentred (Rådbo 1996).

The solar system is a splendid example of an allocentred position. To illustrate it in a meaningful way, I assert that it is necessary to point out that we see it from outside, a position which you never can observe with your own eyes. If not, smaller children may too easily interpret the illustration as if there are two earths, one in the solar system and one where we live (Vosniadou 1994). I suppose that this also is the reason why children very often ask me to point out the earth on the starry sky in the planetarium.

However, the main problem is perhaps that most children don't even have the possibility to imagine what it would be like in another position than their own until they are at least 8-10 years old. In what ways do we take this fact into consideration when planning our planetarium shows, which for example deal with the planets and the solar system? We all know that this is a favourite topic for children shows, but unfortunately I think there is a tendency in too many shows not to mind the positions, i.e. relating them to the viewer. Although adults have this skill I am sure that they too mostly think of the world from their own position. For me coming from Sweden, I am used to see the map centred around Europe, but for people in Japan the world looks totally different, centred around their country. Consequently I think it is as important in ordinary shows as in school-shows to point out the different positions. And if we do, then I think that switching between ego- and allocentred positions, will improve the understanding of the universe and hopefully contribute to people finding astronomy both understandable and exciting, which in my opinion ought to be one of the main goals for every planetarium.

THE PRESENTATION OF THE WORLD

To find out a little more about the treatment of positions, I have studied illustrations in some textbooks and popular books on astronomy for children, taking different positions into consideration. It turns out that there is not a single book pointing out the positions of the reader and consequently there can't be any discussions about the effect of changing positions either. In many illustrations the two different positions are mixed in one picture, which results in a confusing model of the world. In many books there is also a tendency to concentrate on details, like the phases of the moon, but I wonder of the value of these topics, if one doesn't have a feeling for the wholeness or knows where, when and how the phenomena is visible from the earth. It is also a well-known fact that children have difficulties interpretating two dimensions into three dimensions and a lot of phenomena, for example the phases of the moon, requires that skill. I am afraid that the effect of reading these books might be that the child will find astronomy difficult and boring, since he/she probably gets confused not understanding anything. Since I am convinced about the importance of relating the presentation to the reader for a better feeling and sense of the world, of course I find the result of this study very depressing.

In a Digistar planetarium we have got a new possibility to show the world in three dimensions, and hopefully this modern tool is used to improve the understanding of the universe, not just for nice effects. In my opinion a planetarium is not just a fancy amusement park, but we also have an educational responsibility, but I also think that we have a unique possibility to combine these two goals, by showing that learning is funny. I am also convinced that most people visiting a planetarium really wants to learn something new, and that they are satisfied afterwards if they have got a new feeling for their surroundings and for the world. I am sure this goes for all shows, not just the school-shows.

THE UNDERSTANDING OF THE WORLD

Children try hard to understand the world and their own place within it, but according to what have been said here, there seems to be problems. Now let's think about what happens if you fail to grasp the world when you are young. Will you learn it automatically when getting older?

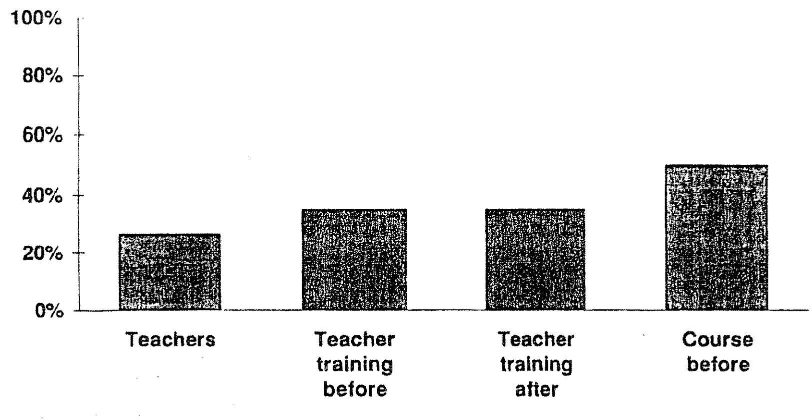
To find out, I have tested different groups of adults, most of them teachers, to see if they know about the structure of the world. But there is also another reason for testing teachers. Since we have seen that different media obviously fail to present the world, hopefully the teachers might be the rescue. For comparision I have tested four different groups; teachers, teacher student before and after taking the astronomy course and a control group. To test their perception of the world they got the following task, with the right answers within parenthesis:

> Number the following objects from 1 to 7 so that the answer shows a pattern from what is closest to the earth to what is furthest from us:

- Satellites in orbit	(2)
- The Polar star	(6)
- The Rainbow	(1)
- Andromeda galaxy	(7)
- The Sun	(4)
- Pluto	(5)
- The Moon	(3)

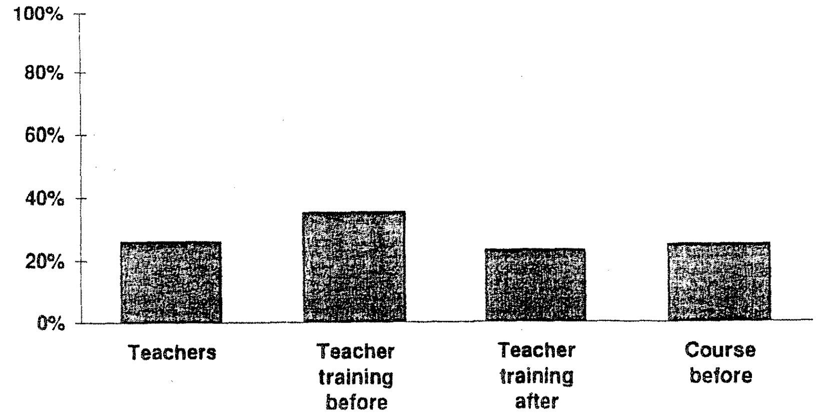
Altogether there were 503 people doing the test, and 164 of them answered it totally right, figure 1. It is worth noting that almost everybody seems to know that the Andromeda galaxy is a foreign galaxy, and those not answering correct obviously have problems with our neighbourhood, i.e. the solar system (Rådbo 1995).

Table 1. Percentages of the respondents answering totally right.



In analysing the result, I have looked at different relationships concerning their markings of each object. If they for example have numbered the Polar star as number 5 and Pluto as number 6, it is equivalent with them thinking that Pluto is further away than the Polar star, figure 2, which shows that one of four teachers think that this is what the world looks like. Comparing the distances between the sun and Pluto, the result is even worse, since one of three teachers think that the sun is further away than Pluto. I wonder if they have thought about the consequences of their models? And what is the value of presenting a model of the solar system if people don't understand it, nor can relate it to the rest of the universe?

Figure 2. Percentages of respondents thinking that Pluto is further away the stars.



So it looks like even the teachers fail to explain the world to the children, since they don't know the structure themselves. The study might also indicate that you don't automatically learn to grasp the world when getting older.

SUMMARY

Now my son has become a teenager and he knows about the relations between the distances to Egypt and the stars, but he and his friends don't know for sure about different relationships in the universe, for example between Pluto and the stars. I am not surprised, since I have found illustrations in the books which easily can be interpreted as if the stars are closer than Pluto. Obviously the books, the science lessons and the teachers, they have all failed to teach them, so what other possibilities are there for them to learn about the world? I am convinced that the planetarium is the right place. But what do we do with this responsibility? Do we really present the world in an understandable way or are we nowadays more and more tempted to use all special effects available? Do we realise what hidden messages about the structure of the world we present in all our shows, no matter the topic?

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Use of Multi Media in Planetarium Programmes in Indian Context

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India

Resource is a constraint for management of planetaria in India. Most of the planetaria have usual projection systems of Goto, Carl Zeiss or Spitz. Only at a few places advanced systems like astrovision, space simulators are either in operation or in the process of installation. Presentation of programmes are usually carried through the slides, film strips etc. Used in the projection system consisting of a main projector and a combination of the special effect projectors.

Coupling of video projection with conventional system and supplementing with laser sources are feasible and affordable. But these have not been exploited so far. In view of the state of art technologies being availabel, use of multi media in conjunction with the existing projection system can be a reality. This can enhance the versatality of presentation and make the programmes more lively. Frequent updation/modification is also possible.

ASTRONOMY, 2ND CONTACT, a CD-ROM ELECTRONIC TEXTBOOK

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West Valley College, 14000 Fruitvale Ave., Saratoga, CA 95070, USA

Background:

Welcome to a demonstration of my *Interactive Multimedia Electronic Astronomy Textbook - **Astronomy: 2nd Contact***. This is the first of its kind, providing not only complete coverage of astronomical topics found in a college course in astronomy for non-science majors, but a valuable supplement to traditional methods of classroom instruction: lecture, chalkboard, slides, movies, overhead transparencies, written tests, etc. In the hands of the student, the *Textbook* allows the learner to determine the content, direction, and speed of learning. In the hands of the instructor or Planetarium Director, the *Textbook* provides immediate access to charts, illustrations, photographs, and animations that demonstrate astronomical data and/or concepts.

Open (Distance) Learning is gradually being integrated into college and university curricula as a teaching/learning method. For better or worse, more and more students are obtaining some of their education electronically. There is every reason to believe that the growth in distance learning will be an exponential one. The subject of Astronomy lends itself to take advantage of this type of learning, with its content being highly visual, and the concepts requiring sequential layering of information to arrive at precise understanding. There is, I believe, a need to provide students with a new type of textbook, based not only on the **written word**, but on **interactive animations** that take the place of the gradually–developed concepts of the traditional chalk and blackboard, on short **video clips** that take the place of long, drawn–out movies and videotapes, on color and black and white **photos**, and on **charts/tables of data**. The interaction with all of these media on the CD–ROM will be enhanced with **sound**, providing the learner with a multi–sensory experience. If the *Textbook* is used in conjunction with a graded class at a college or university, a test bank of questions will be available on the CD–ROM both for practice and for final grading of the learner. In addition, in order to easily access the vast number of valuable sites on the World Wide Web that provide support for the learning of astronomy, the CD–ROM will provide the means by which to navigate directly to a given Web site from within the Program in order to enhance the learning even further. This assumes, of course, that the computer being used is connected by modem to the Internet.

The basic content of this *Electronic Textbook* is taken from the 4th Edition of the astronomy textbook of the same name written by me and published by Kendall-Hunt Publishing Company in 1996. For an examination copy of the book (ISBN 0-8403-9001-7), call the publisher (319-589-1000). I have used the textbook successfully in my Planetarium at West Valley College since 1986. I have been teaching astronomy at the College since 1969.

I have discovered, over the years, that students are quite aware that their most effective learning derives from what they DO. That was the model (and indeed MOTTO) used at my college of primary learning: the United States Military Academy at West Point. WE LEARN WHAT WE DO. Although the most effective learning of astronomy results from doing astronomy, for the non-science major with little background in the philosophy, language and methods of science, a reasonable alternative is to encounter the subject by building upon what is already known about space. Hence one reason for the title of my textbook: ***2nd Contact***.

Everyone has had some contact with the subject of astronomy, whether it be awareness of the phases of Moon, images of early Moon-landings, observance of an eclipse, meteor, or comet, or even casual glances at tabloids that sensationalize claims of alien abductions! My objective in writing the textbook (and publishing the electronic textbook) is to provide an avenue for the interested non-science reader to build upon his/her previous knowledge of Earth and sky toward a greater appreciation of and understanding of the discoveries and theories about the universe around us.

Purpose:

Location: The electronic Astronomy textbook in CD-ROM format is designed for use in school, business, and home environments.

Audience: The CD-ROM is intended to be used by or in conjunction with High School/College students who have little or no science background, and by members of the public who are interested in modern discoveries and theories of the universe. It may also be used by anyone who requires reference material relating to concepts and/or data about features of the universe.

Technical Requirements:

The Demo is made to play with the following specs:
Processor: Standard Macintosh 040 or Power PC processor
RAM: A minimum of 8 MB total
Resolution: 640x480 at 8-bit color
System: System 7.1 or later with Quicktime 2.0
Software: Demo is self-running, but requires uncompressing with *DiskDoubler*
Copy Demo to hard disk, uncompress with *DiskDoubler*, then click icon to run

The CD-ROM will be made to play with the following specs:
Cross-platform: PC or Macintosh
Double-speed CD-ROM player

Content:

Introduction:
A dramatic, visually-exciting introduction will attract the user's interest in exploring the contents of the electronic textbook.

Review of Navigational Methods:
The user is presented with the option of going directly to the main menu, or taking a short excursion to learn how to navigate through the Textbook using buttons, hot spots, movie controls, etc.

Content Menu:
The user, depending upon his/her interests, goals, requirements, and/or whims, is presented with the main navigational menu that provides access to the contents of the Book in any of four pathways, all of which are interconnected to one another:

Chapter Text with Interactivity:
This navigational route is basically the text of ***Astronomy: 2nd Contact*** presented on pages of a book, but with attached tabs that provide immediate access to photographs, diagrams, animations, and Quicktime movies that highlight and/or illustrate and/or clarify concepts that are presented in text on that particular page of the Book. After interacting with the selected photograph, diagram, animation or movie, the user is returned to the page from which he/she parted.

Thematic Menu:

This navigational route is for the user who is more interested in exploring a particular **theme** in astronomy, without necessarily reading a lot of textual material. Choosing from a list of themes takes the user to a succession of photographs, diagrams, animations and/or Quicktime movies that illustrate the chosen theme. They will be those very photographs, diagrams, animations and/or Quicktime movies that are accessible during the Chapter Text navigational route, but in an ordered sequence so that the theme is developed in a progressive manner. The user may select to navigate to the Chapter Text route during this route if he/she desires more thorough information on the chosen subject.

Index:

The index provides the user with direct access to a particular astronomical concept or definition. By selecting a word or phrase, he/she may navigate directly to a first-time-used word, photograph, animation or Quicktime movie.

Evaluation:

In its final form, ***Astronomy: 2nd Contact*** will include evaluation modules that the student can access and take at any time. The results of the evaluations can either be for the exclusive use of the student (self-evaluation), or entered into a database for exclusive use of the instructor responsible for grading the student in a course of instruction.

Low budget multimedia projecting program

Presenters Masami Osawa Sayama Central Children's Nursery Department
Masanori Iriko Volunteer

The initial introduction of this system was made by Mr. Iriko, a volunteer at the Sayama Central Children's Nursery Department. After careful examination by Mr. Tateno, Mr. Sekiya and myself, the Department has finally decided to introduce the system with what is believed to be an extraordinary budget, approximately 3 million yen. At the time of tightly sealed budget , 3 million yen expenditure is quite an irregular spending. In fact, most of us felt that it would be impossible to persuade our department's chief Mr. Kataoka and Mr. Ishikawa. But, both gentlemen show very generous understanding toward this program. For our department 3 million yen is quite a lot of money.

While initial introduction was very smooth , we believe that our challenge lies ahead.

An advantage of this system is that with low budget it can achieve maximum capability of special effects. Since the original Goto system was a manual operation, we must rely entire operation with self made programs with live narrations by our department's personnel. The current system has replaced the latter part of the original program which was consisted of slides pictures.

This system is capable of creating animated pictures by using scanners. It can also enlarge or diminish sizes of pictures already introduced into the computers. Colorations can be changed according to the preferences of viewers. When sound effects are required , sound truck music can be heaved simultaneously. All pictures can be projected by using special projectors. It may be connected the internet system in the future.

It took approximately one month to produce this system of very hard working of us all. I would like to express my deepest appreciation for those who showed remarkable understanding for what we are doing. Now, we would like you to enjoy our first program " Tanabata Tales".

Personal computers

Applecomputer's 7500
displays
Keywords
Scanners
Film Scanners
Printers

Software

Authoring Tools
Irast Creating Systems
Picture processing tools
Sound processing tools

STAFF

Supervision Tetsuo Tateno
Volunteer Masanori
Director Masami Osawa
Iriko
Original Script

Manuscript Kazue Kume
Pictures Katutoshi Yokoyama
Sound Kazue Kume

新しいプラネタリウムシステムの紹介

本部　勲夫

京都市青少年科学センター

京都市青少年科学センターでは，1995年末からプラネタリウムの大規模な改修工事を行っており，1996年７月20日にリニューアルオープンすることになった。今回の新しいプラネタリウムシステムについて紹介する。

1．プラネタリウム機器制御システム

当センターでは，従来からマニュアル操作による生解説でプラネタリウム投映を行ってきた。この方式のメリットは，観客とのコミュニケーションが図りやすく，状況に応じて投映内容を変えることができる点にある。しかしながら，更新前のプラネタリウムシステムは昨今のマルチメディアに対応しておらず，プラネタリウム本体といくつかのスライド投映機を操作する程度だった。

そこで，今回の更新にあたり，マニュアル操作，生解説の特徴を発展させながら，マルチメディアに対応するプラネタリウムシステムの導入を考えた。

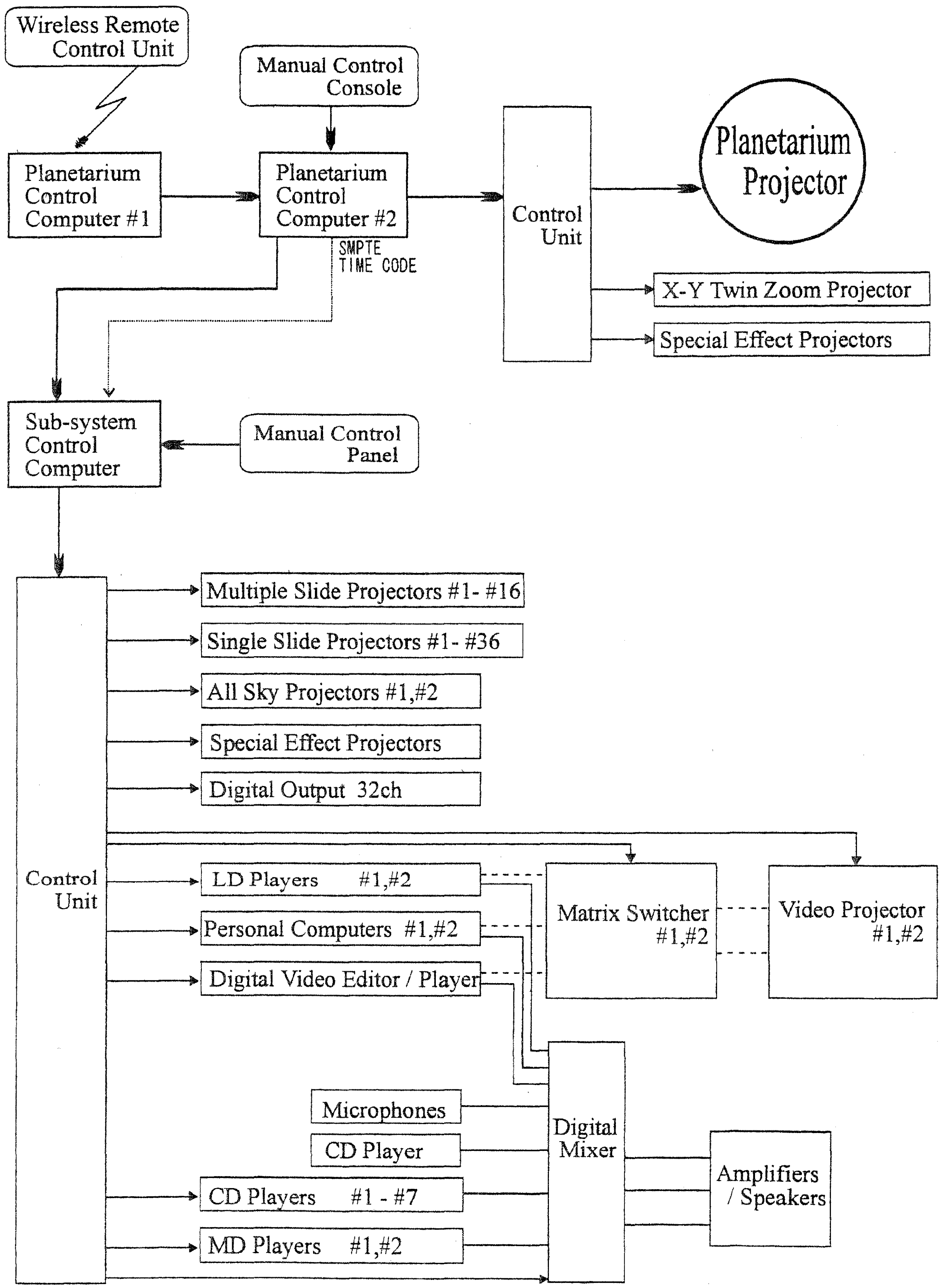
このシステムの主な特徴は，以下のとおりである。

(1) コマ送りできるスライド投映機（オールスカイ投映機，パノラマ投映機，Ｘ－Ｙズーム投映機も含む）は，すべてランダムアクセスが可能である。
(2) ビデオプロジェクターでＬＤやデジタルビデオ及びパソコンの画像を投映できる。
(3) 複数のＣＤプレーヤーやMDプレーヤーを同時にリモートコントロールできる。
(4) デジタルミキサーに記憶させた音響効果(設定)を呼び出すことができる。
(5) プラネタリウムはコンピューター制御の宇宙型である。
(6) (1)～(5)のすべての機器はオートとマニュアルで制御できる。
(7) ショートプログラムや命令を制御卓のコンピューターの画面上にアイコンとして登録し，それをランダムに実行できる。その画面上のアイコンを操作することによって(1)～(5)のすべての機器を制御できる。
(8) (7)のアイコンを操作する代わりに専用のワイヤレスリモコンを操作しても同様のことができる。

このシステムによって，あらかじめ設定しておいたショートプログラムや命令を自由に選択しながら投映することが可能になった。例えば，同じ星空解説でも子どもが多い場合には，スライドなどを使った星座神話を紹介し，大人が多い場合は最新の天文情報の解説を折り込む。…というふうに同じ一般投映番組でも客層に合わせて，雰囲気に合わせて内容を変更することができるのである。さらに，ワイヤレスリモコンを活用すれば，観客とのコミュニケーションあふれるプラネタリウム投映が実現する。

このシステムの構成は，次ページの図１に示すとおりである。また，使用した主な機器のリストを表１に示す。

図１：PLANETARIUM CONTROL SYSTEM



《表１：プラネタリウムシステムの主な機器リスト》

機器の種類	機器名
Planetarium Projector	MINOLTA：INFINIUM γ Ⅱ （特別仕様）
X-Y Twin Zoom Projector	MINOLTA：VARIABLE ZOOM ST
Special Effect Projector	MINOLTA：UNI-SHOOTING, MALTI-SHOOTING, … SKY SKAN：SNOW, SINGLE LIGHTING STROKE
Multiple Slide Projector	KODAK：EKTAPRO 9010
Single Slide Projector	MINOLTA：C-650
All Sky Projector	SKY SKAN：ALL SKY SYSTEM
LD Player	PIONEER：LD-V540
Personal Computer	SONY：QL-30B1BM3
Digital Video Editor / Player	AVID JAPAN：MEDIA COMPOSER MC900
Matrix Switcher	IMAGENICS：SW-55(FOR NTSC), HDS-5(FOR RGB)
Video Projector	BARCO：DATA701s
CD Player	DENON：DN-951FA
MD player	DENON：DN-995R
Digital Mixer	YAMAHA：02R

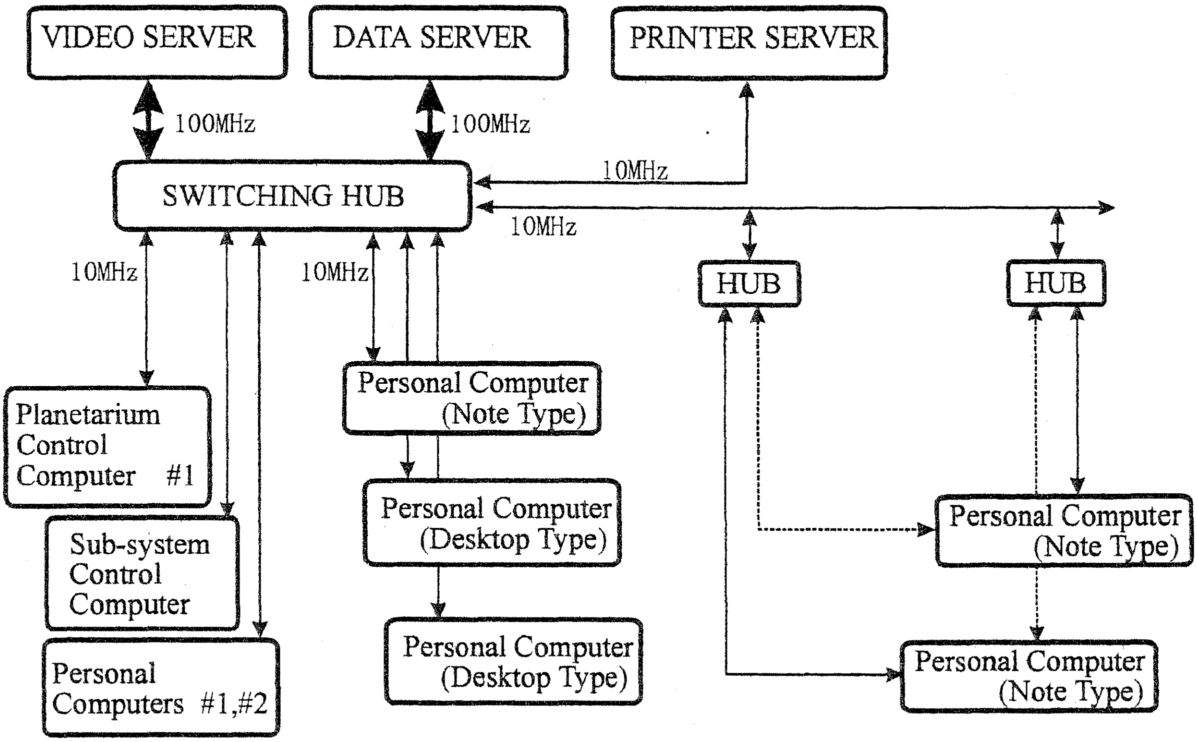
２．プラネタリウムのＬＡＮシステム

当センターでは，毎月番組を自主制作しており，いかに効率よく制作できるかが更新の際の重要なポイントであった。そのために静止画や動画あるいは音楽を作成するためのデスクトップ型パーソナルコンピューターと主にプラネタリウムの番組プログラム等をオフラインで作成するためのノート型パーソナルコンピューターを導入した。また，これらのコンピューターとプラネタリウムの演出に使用するためのコンピューターを結び，サーバーを核としたローカル・エリア・ネットワーク（LAN）を構築した。

このネットワークは次ページの図２に示すようにサーバーとクライアントの形式を採用している。サーバーには画像関係のファイルを貯えるビデオサーバーとプログラムファイルその他のデータを貯えるデータサーバーがあり，プラネタリウム番組で使用するファイルはこれらのサーバーに貯えるようにする。プラネタリウムとは別の３つの部屋に接続コネクター（HUB）を設置し，そこにサーバー以外のコンピューター（ｸﾗｲｱﾝﾄ）を接続できるようになっている。また，サーバーの出入り口にはスイッチングハブ（SWITCHING HUB）を設け，複数のクライアントから同時にアクセスしても通信速度が遅くならないようにしている。

このネットワークにより，画像ファイルのようなサイズの大きなものでも簡単に転送できたり，プラネタリウム投映中でもプログラムやソフトの制作及びその修正を効率的に行うことができるようになる。ただ，複数の人間が使用するネットワークの管理が難しいため，安全にかつ有効に使用していくための方策を考えることが課題である。

図２：PLANETARIUM LAN SYSTEM



リモコンを活用したプラネタリウム学習について

中　山　　浩

京都市青少年科学センター

1．はじめに

京都市青少年科学センターは開設(１９６９年)以来２７年間，毎年市内の全小学校５年生と中学１年生(計，約２万人)にプラネタリウム学習を実施している。本年７月２０日のプラネタリウム・リニューアル時(２度目)には，コンピュータをフルに活用した本体・補助機器の制御システムを構築した。(詳細は当センター本部所員が発表する)

そこで導入されるリモコンシステムは，世界初の本格的なものとして学習投映での活用を期待している。以下，リモコンの具体的な姿を中心に紹介したい。

2．リモコン装置の外観

リモコンは主として，１～６までの数字キー，あらかじめ機能が設定されているキー(Ｒｅｄ，Ｌｉｎｋ，Ｅｎｔｅｒ，Ｎｅｘｔ)，およびジョグ・シャトルで構成されている。リモコン装置の外観を図１に示す。

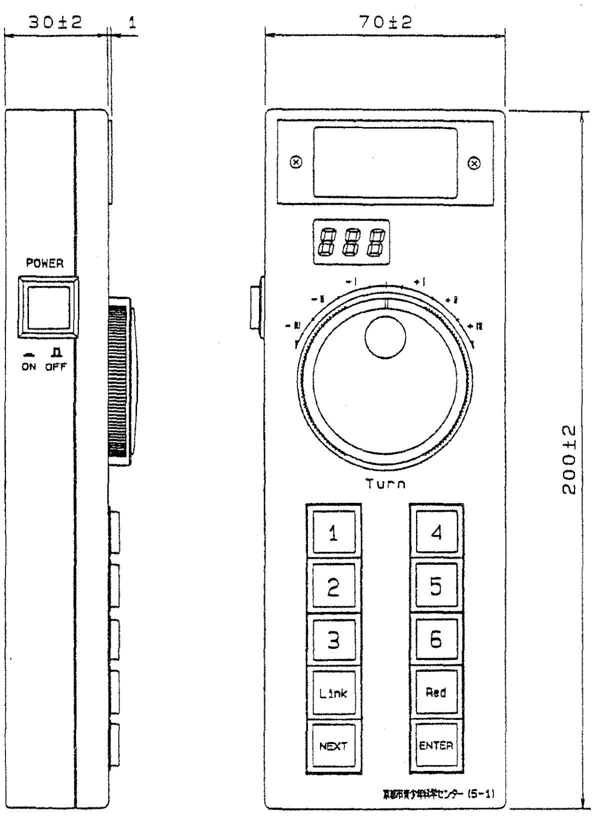


図１　リモコンの外観

１～６：ショート・プログラム or
　　　　コマンドを選択するキー

Ｒｅｄ：学習用(ノート筆記用)
　　　　赤色灯の点灯キー

Ｌｉｎｋ：朝夕焼け自動調光
　　　　のＯｎ／Ｏｆｆキー

Ｅｎｔｅｒ：選択されたプログラムや
　　　　コマンドを実行にうつすキー

Ｎｅｘｔ：プログラムのステップ
　　　　を１つ進めるキー

ジョグ・シャトルは回転系(日周・年周・緯度・才差など)の操作が，微動も含め，３段階のモードで実行できるものである。

３．リモコン装置の機能

リモコン装置の主な機能としては，あらかじめエディターで記述されたショート・プログラムの実行ができること，ジョグ，シャトルによる回転系(日周・年周・緯度・才差など)の操作ができることなどであるが，具体的にプログラムや機能を選択する方法は以下の通り。

（１）１～６の数字のキー：

連続して２つのボタンを押すことにより，あらかじめ記憶させたショート・プログラム，または，単独のコマンドが選択できるようになっている。この機能のために，(１・１)，(１・２）～（４・６)までの２４パターンのメモリーが用意されている。但し，一定の機能については頻繁に利用することが予想されるので，あらかじめ以下の様にコマンドが割り当てられている。

・ショート・プログラムおよびコマンド	……９パターン
・スライド１，２の点灯とその消灯	……３パターン
・星座絵１～５の点灯	……５パターン
・プラネタリウム時計のドームへの表示	……１パターン
・回転系(ジョグ・シャトルの機能の変換)	……５パターン
・未　設　定	……１パターン

（２)Ｒｅｄ，Ｌｉｎｋ，Ｎｅｘｔ，Ｅｎｔｅｒのキー

これらのキーは単独で，２．で記述した機能を選択する。

（１)，（２)どちらのキー入力の場合も，押したキーが表示部に略号で表示された後，あらためてＥｎｔｅｒキーを入力することで実行される。これは暗やみ中での誤操作を極力防ぐためのものである。また全部のキーは電源の投入時に背面照明される。

４．リモコンを利用した学習

このリモコンを用いると，投映者が児童・生徒の中に入り，子供たちの視点で星座の解説ができる。また，理解の状態を細かく把握しながら学習をていねいに進めることができる。

分岐・選択型の学習においてはショート・プログラムを１つのモジュールとして，学習をフレキシブルに組み立てることができる。児童・生徒の小さな発言をくみ取りつつ，学習が展開できるものと考えている。

当然投映者はコンソールに縛られないため，ダイナミックな演示・演出ができる。インパクトのある効果的な演示実験を学習に取り入れていきたい。

５．まとめ

今回のリニューアルで，子供たちの発言に基づく指導の展開を１つ１つのモジュールとして，プラネタリウムの番組に直接反映できるという学習にとっては理想的なシステムを構築できた。今後のプラネタリウム学習で十分活用していきたいと考える。

INTERNATIONAL PARTNERSHIPS IN PLANETARIUM EDUCATION: AN INTERIM REPORT

Kevin Lane-Cummings & Robert Leung

Pacific Science Center, Seattle & Hong Kong Space Museum, Hong Kong

Through an award from the International Partnerships Among Museums (IPAM) program, the Hong Kong Space Museum (HKSpM) and the planetarium at Pacific Science Center (PSC) in Seattle are developing and exchanging a set of educational astronomy programs for students.

This 12-month project involves three elements, each of which will be discussed in this paper:

- Each planetarium develops a school show and post-visit worksheet.
- The shows are exchanged and adapted to suit the recipient planetarium.
- Students and teachers are surveyed, and the shows are modified to maximize learning.

At the time of this writing (June 1996), the project is about half completed. A final report will be produced in approximately 6 months, and may then be published in the *Planetarian*, the Journal of the International Planetarium Society.

SHOWS AND WORKSHEETS

For this exchange program, HKSpM has developed *Sun, Moon, and Stars*, and PSC has developed *The Planet Show*.

Hong Kong Space Museum

Sun, Moon, and Stars is a lively, interactive show for students age 7 & 8, and will debut on July 3, 1996. Two cartoon "hosts" (*Ada*, from Hong Kong, and *Bob*, from the United States, **Figures 1 and 2**) are joined by several guests (Uncle Sun, Mr. Star, Miss Moon) to teach kids about basic astronomy concepts. Included are topics such as finding directions with the sun and stars, discussing the concept of constellations, and watching the different phases of the moon.

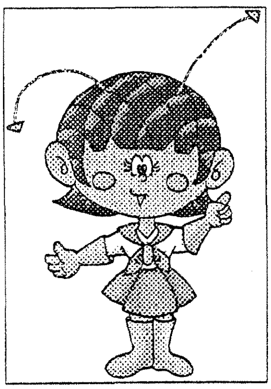


Figure 1: Ada

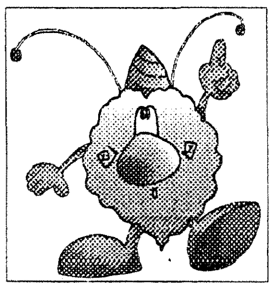


Figure 2: Bob

All planetarium shows in HKSpM are pre-recorded and centrally controlled by an automatic system. There are 316 seats in the theater. An interactive system has recently been installed, comprising 3 buttons that each student can press to make choices during the show. By connecting the interactive system to the computer that controls the planetarium, the students affect the content of the show. Furthermore, individual responses from students can be analyzed in a later stage to see how much the students have learned in the show. For example, here is an excerpt from the script:

Ada: Uncle Sun is coming up.
Uncle Sun: [rising up on the left] Good morning, kids.
Ada: Kids, tell me which direction is the East? On the left, in front of you or on the right? Make your decision and press the button right now! Let's see the outcome!
[If a majority of the kids pick 'left']
Uncle Sun: You're right. The direction in which I rise is the East.
[If a majority of the kids pick 'front' or 'right']
Uncle Sun: As a matter of fact, I rise in the East.

Pacific Science Center

The Planet Show is a 40-minute live planetarium demonstration developed by PSC staff for students ages 8-18, and will begin its run at PSC in early October 1996. The show introduces the planets through 3 levels of observation: (1) naked-eye; (2) telescopic; and (3) spacecraft "up-close-and-personal".

The planetarium at PSC, in contrast to HKSpM, presents only live astronomy shows, even for the general public. Its 40 concentric seats encourage discussion and questions from the visitors, and allow the Planetarium Demonstrator to adapt the show to the level of the group. This allows us to create shows for a broad range of ages: for instance, we spend more time with 8-year-old students presenting the differences between terrestrial planets and gas giants, while 18-year-old students will discuss details of *why* those differences exist. The visual effects remain the same; instead, the Demonstrator adapts the "script" during the show.

As an example of how we can make a live Planetarium show much more interactive, here is how we present the first segment of *The Planet Show*:

1) The Demonstrator informs the students that the night sky they are looking at contains several planets, and it is their job to determine which points of light are planets and which are stars.
2) The students are asked to suggest what factors will help them decide. They come up with color, brightness, position, and movement.
3) Three or four students are allowed to point out possible planets using an arrow pointer.
4) Everyone closes their eyes, house lights are brought up full (to wash out the motion of the planets), and the Demonstrator advances the date 2 weeks.
5) When the house lights are dimmed, the students are asked to call out whether each possible planet has or has not moved against the background stars.
6) This is repeated for several more "weeks" until consensus is reached among the students about which points of light are really planets.

Worksheets

Both planetaria are developing worksheets and teacher guides that will be distributed to students and teachers as they leave the theaters. They will contain activities for the students to do in their classrooms or at home, as well as questions to allow the teacher to assess the students' learning. Some of the activities included in the worksheets are a sundial, moon finder, and instructions for shrinking the solar system down to the size of a room.

EXCHANGE AND ADAPTATION

One of the challenges for this project will be presentinh a show developed for a computer-controlled planetarium (HKSpM) in a live planetarium (PSC), and vice-versa. Because of the interactive system installed at HKSpM, we feel the two planetaria are much more similar than they might otherwise be. However, we do have to make some adaptations.

Sun, Moon, and Stars will be adapted during the summer and fall of 1996 in preparation for its live debut in Seattle in October 1996. *The Planet Show* will be adapted during the fall of 1996 in preparation for its debut at HKSpM in early 1997. Some of the concerns during this adaptation are:

- At PSC, will the Demonstrator take on one of the roles in the original show (such as Bob), or will s/he become a narrator while the characters do the rest?
- How will the 3-choices presented by the HKSpM interactive system be adapted to a live show?
- Many of the visuals in the HKSpM show are on many separate projection systems; how will PSC accomodate them in the more limited technical space?
- At HKSpM, interactivity is more limited; which questions will the students answer with the interactive system, and which will just be stated by the narrator?
- What visual elements will be added by HKSpM for the more sophisticated space?

To facilitate these adaptations, and to increase the personal and cultural exchange of this program, a staff member from each planetarium will spend 4 weeks at the other planetarium. Mr. Lane-Cummings visited Hong Kong during June and early July 1996. A HKSpM staff member will visit Seattle during October 1996. Some of the objectives during these exchanges are as follows:

- Observe the installation and testing of the host planetarium's school show.
- Discuss the procedures and concerns with adapting the show for use in the visitor's planetarium.
- Create and adapt a post-visit worksheet for the show.
- Establish personal and professional connections to facilitate future exchanges.

The worksheets will also be exchanged. At this time, we plan only to translate the worksheets from Cantonese to English and vice versa, so that each planetarium can use the worksheets for both shows. Following the evaluation surveys (see below) we may each modify the worksheets to be more appropriate for the local audience.

SURVEYS AND MODIFICATION

After the shows are installed by the planetaria, we will begin surveying some of the students and teachers to see whether the shows are meeting the teaching objectives, and how the show can be modified to make it more interesting. For example, here are some of the proposed questions for students after the *Sun, Moon, and Stars* show:

- In what direction does the sun rise?
- Which constellation will help you find the Pole (North) Star?
- Does the moon ever look a little bit like a banana? Like a carrot?
- Did you enjoy the show?
- How did you feel afterward?

- What was your favorite part?
- Was there anything you didn't like about the show?

We also want to know the opinions of teachers, so we will ask questions such as:

- Did the content of the show fit in with your class curriculum?
- Did the students learn things that they couldn't have learned in your classroom?
- Was the astronomy content too simple, too difficult, or just right for your students?
- What would you modify to make the show better?
- Would you bring your students to see this show next year?!

Information obtained from these surveys will be used not only to modify the shows, but also to analyze differences between Hong Kong students and Seattle students. We are curious to compare:

- Which students learn more of the astronomical content
- Which students are more accepting of a silly or sophisticated style to the shows
- Which students prefer (or are better at) learning through interaction

INTERIM CONCLUSIONS

We have been pleasantly surprised at the amount of similarities in the programs of the two planetaria, even though our theaters are of very different size and complexity. Because our missions are essentially the same, and the objectives of the shows compatible, working together on both the shows and the worksheets has been very enjoyable.

We also strongly encourage other planetaria to consider such international partnerships, both formally through awards such as the IPAM program, and informally through staff contacts. By learning what challenges and solutions other organizations have worked on, we can learn not only how to present shows to our international visitors, but also to develop new ways to teach and entertain our local audiences.

CREDITS

Funding for this IPAM exchange is provided by the Bureau of Educational and Cultural Affairs of the United States Information Agency. IPAM is administered by the American Association of Museums. We would also like to thank our respective organizations for allowing us to spend a month in residence with our partner institution.

学習投影プログラムの紹介

Introduction of Educationally Planetarium Program for Students

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要旨
「学習投影は授業である。そして、プラネタリウムは、学校の教室ではできない星空の疑似体験をするいわば天文の実験室のようなものである。」このような考え方から、我々のプラネタリウムでは講義のような一方向的な解説を中心に組み立てるのではなく、教室で行われているような子どもができるだけ主体となるような参加型の内容にしている。

Abstract
Planetarium Program is a kind of school lessons, and Planetarium is an astronomical laboratory provides students with pseudo experience of the starry sky they don't have in the classroom.We are assembling our planetarium program in the classroom activity style, other than the ordinary lectures.

Ⅰ. Introduction

Suginami Science Education Center was established in 1969. The main purpose of the Center is to promote and complete of science education for Suginami City schools. Therefore, students come to participate in many courses of science experimentation, mostly planned from first grade of primary school to third grade of junior high school. The use frequency is once a year for each grade.

The dome diameter is 15 meters and the number of seats is 162. Attending children are divided into from 1 to 4 classes (40 persons - 160 persons) studying all together in the planetarium. As there are so many students,lecture style may be easier. But we try to make classroom activity. The reason for it is to make the planetarium a "Laboratory".

On the other hand, we use wish to make it an "Audiovisual room" too. Students can access to a great deal of visual materials that they don't have in their school; e.g. fresh astronomical images, videos which feeling of being on the spot, computer graphics etc. It may indeed form a kind of astronomical "Library".

We represent herein the characteristics and an example of our program.

Ⅱ. Characteristics

1. Class

As shown in the Table 1.

Table 1　contents of guidance and time for each grade
(mobile classroom science study guideline *)

grade	time	contents
2nd-3rd grade in J.H.S.	80min.	Extent of the Universe
1st grade in J.H.S.	80min.	Rotation and Revolution of Earth
6th grade in E.S.	80min.	Apparent Movements of Stars
5th grade in E.S.	80min.	Apparent Movements of Sun and Moon
4th grade in E.S.	80min.	Constellation and various Object
3rd grade in E.S.	50min.	Night sky walk
2nd grade in E.S.	45min.	Night sky walk
1st grade in E.S.	40min.	Night sky walk

* mobile classroom science study guidelines prepared by Suginami ward experts : By reading these guidelines, we know how to deal with the lesson units given in the Center. Each grade class will have a different guideline.

2. Policies

In order to obtain best results, it is important to;

(1) Decide the role of the school teachers

a. Contents of course units

Because time is limited, we can't teach everything concerning with astronomy. We should discuss with school teachers about what can be best done with Planetarium to keep our program in good concordance with the school lessons.

b. Team Teaching

"Team Teaching" is a style of teaching that involves more than one teacher.

Basically, school teachers would give general lessons, and our staff would operate the planetarium and explain specific astronomical topics. However, at the present time almost class are still being done only by our staff.

(2) Make children to participate in study

Different from the lecture style which students are given information in one direction, we persuade the participation style which students take part more actively in lessons by talking with their teachers.

For example, we let them search stars and constellations by themselves, put observation on record, and so on. In the planetarium, they are helped with the red light illuminations. They are also free to tell their opinions and represent their study results by using OHP and we are trying to adopt their ideas as much as possible.

Ⅲ. Example of lesson "Apparent Movements of Stars" for the 6 grade class

Student's study activity	Points of guidance	Tool and setting
1.Memo tools 2 worksheets	Distribute 2 worksheets	Daylight
2.Learn when they want to find celestial objects, they should know the zenith and the azimuth	Attention when observing in planetarium	Local scenery Overhead light, Azimuth light
3.Check on appearance of stars, and announce any findings	Brightness and colors of star appearance of milky way,etc.	Culmination →night sky
4.Compare the starry sky with the urban sky, think about environmental problem	Make students understand why we can't see more stars in the urban sky and make them think what to do to see.	Night sky of full marks Reproduction of the urban sky
5.Using "star chart", find stars and constellations by themselves	Explain how to use "star chart" Make them find by themselves Found star and constellation are announced (answer introduction)	Red light Star chart Memo tools Laser pointer
6.Learn about constellations and stars	introduce main stars, constellations and myths	Constellation picture projection machine

7.Observe star movements Expect star movements, and see for themselves	Make them observe star movements and record on work sheet	Grid Work sheet Red light OHP Laser pointer
8.Learn about various heavenly body	Explain about astronomical news or topics	Laser disc Slides Videos Computer images Programs

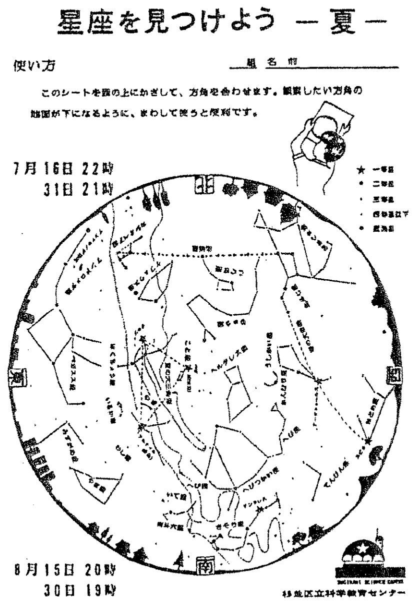

Fig.1 Worksheet for students①.Star chart for each seasons (8 kinds)(size:B4)

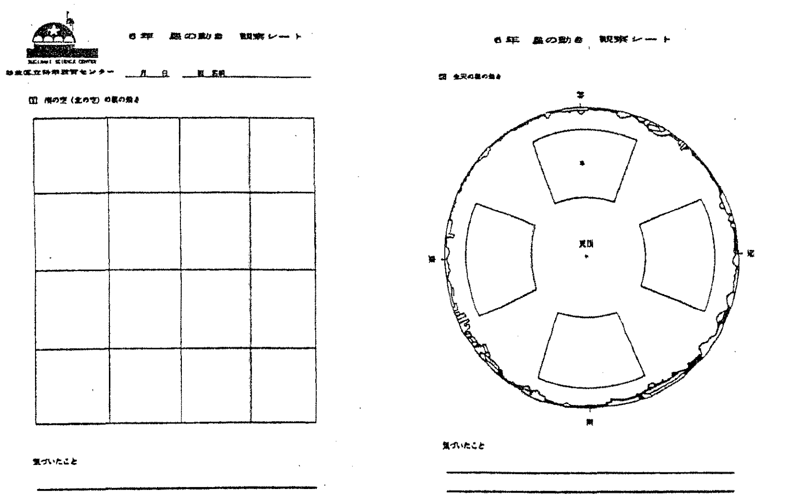

Fig.2 Worksheet for students②.Observation sheet (size:B5) front: for one direction
back: all sky

Ⅳ. Conclusion

1. Advantages
   - The class matched to children's understanding degrees can be done.
   - Because lessons go on around finding and the activity by student, content can fix on them.
   - Motivation for real observation : Students would want to see the real sky.
2. Problems
   - By keeping balance with other science experimentations, students may come to our planetarium not always in right times. Therefore, attending courses in the planetarium may less its original meaning.
   - Average number of students is 80. There are not enough chances for all of them to represent their study results.
   - Because findings and activities of the child are many targets, we can't increase the lesson speeds.
   - Rarely, there are teachers who rely too much on the planetarium program for all their astronomy classes. Clarification of the roles between our program and the ordinary school curriculum is needed.

OBSERVATORIES AND PLANETARIA: THE BEST CONNECTION TO DIFFUSE ASTRONOMY

Loris Ramponi

Associazione Amici dei Planetari - Centro Studi e Ricerche Serafino Zani

Abstract

The most powerful center for the diffusion of astronomy, to the public and to schools, combines the presence of the Planetarium and of the Public Observatory. The dome of the simulated sky and the giant dome of the real sky invite the public to discover the main everyday celestial phenomena.

The comfort of the artificial sky must not let us forget the importance of the observation of the celestial sphere. In modern life where video and virtual images take more of our time, it is important for planetarians not to forget to involve the students and the general public in the direct observation of the celestial objects.

The announced Hale-Bopp comet will be an important occasion to fulfill the purposes above mentionned.

With this communication, ispired by our ten year experience, we would like to describe the reasons of the best connection between Planetaria and Public Observatories and some practical proposals. Our attention is devoted in particular to the educational aspects, mainly to the activities that don't require expensive facilities and for this reason are accessible to both small or mobile and big Planetaria.

Why a best connection?

In this last part of the century the success of the interactive exhibits in the science museums and science centers has been continually growing. The Popular astronomical observatories can be considered among the first science centers where interactive techniques have been applied. Inside the popular observatories telescopes are used directly by the public who can often choose what to observe and, when public attendance isn't excessive, people can try to localize a brilliant celestial object through the telescope pointer, with the assistance of the Observatory operators.

The announced Hale-Bopp comet, that promises to become the comet of the century, will be an important occasion to invite the public in the direct observation of the night sky, while under the simulated sky of the planetaria it will be possible to inform the public, with the support of many images, about the nature of these amazing celestial objects.

The presence in the same building or in the same city of a Planetarium and an Observatory gives the best possibilities in the public diffusion of astronomy.

To combine together theoretical and practical activities between the artificial and the real sky allows the astronomy beginners the first steps among the planets and the stars.

The main celestial objects observed under the planetarium dome, after looking in the real sky and watching through telescopes with the help of a guide, then could easily be identified in their backyards or outside their home windows on their own.

Probably most of the people that follow a Planetarium show are surprised to discover the high number of stars projected under the dome, because all the people that live in populated areas see only the most brilliant celestial objects for the presence of light pollution. For this reason the bad sky visible in the city observatories, is showed in all its fascination in a Planetarium. In the city observatories it is often very difficult to describe the constellations, while this operation is most effective under the simulated sky. Therefore a Planetarium shows the constellations visible also in other periods of the year and the southern (or northern) constellations, difficult to see because low above the horizon or always invisible in our latitude.

The presence of both facilities allows also the overcoming of a big problem in the organisation of public observational evenings: clouds! In an Observatory with Planetarium the program is always garanteed. When the meteorological situation doesn't permit observations the public is invited under the Planetarium dome. Our experience proves that many people think that also with clouds it is possible to see throug telescopes some celestial object or that it is it enough to see one star (that appears between the clouds) to justify an interesting first time telescope observation. The people that visit an Observatory for the first time don't change their program not even in the case of clouded nights. In all these occasions (we organize four evenings each week and this situation is frequent) the presence of a Planetarium is very important if we don't want to demotivate a potential new regular visitor or put out the small flame of Urania (the goddess of astronomy) which might start burning in the newcomer's heart. The purpose that pushes people for the first time in their life to consider the possibility to visit an observatory is the curiosity to observe the sky through telescopes. For this reason it is important to substitute the clouded sky with the simulated sky. In our case the program of the evening is also garanteed with a public lecture, each evening different, before the observations and with a guided visit to the instruments for the people that visit the observatory for the first time.

During the dayly visits of schools in a Planetarium the presence of an Observatory or an open air space with telescopes introduces many practical activities under the real sky. After seeing the planets under the planetarium it is possible to observe some of these through the telescope in the dayly hours.

In the appendix of this communication have been described some practical proposals through a list of key words: Hale-Bopp comet, activities about the constellation recognition, Astronomical days, Astronomical itineraries, Astronomical drawings, Music under the domes, Astronomy and natural sciences activities, Sundials, the planetarium under the Observatory dome and Astronomical journeys.

APPENDIX

COMETS
Hale-Bopp under the inflatable domes

After Hyakutake another comet of the century? Hale-Bopp will be another important celestial phenomenon to approach the general public to the knowledge of astronomy. These spectacular events are the best advertising occasions for Public Observatories and Planetaria. Since the start of the new school year we will be diffusing the planetarium program "Hale-Bopp" comet making a special transparent Starlab cylinder used under the fixed dome of the Observatory and the inflatable mobile ones. The cylinder shows the comparisons between drawings of the comets observed in the past, from the Chinese until today, the different types of comet orbits (using a "window" at the top of the cylinder), the evolution of the comet (using the cylinder in motion and tilted 90 degrees) and the comet tail always opposite the Sun. With the Deep sky cylinder we will speak about the Messier catalogue prepared to help comets hunters, while with the Starfield cylinder the path of the comet among the constellations will be shown. During the period of visibility of the comet an inflatable dome and a mobile telescope will travel through our area.

CONSTELLATIONS
Practical exercises under the real and the simulated sky

Learning the constellations in the city sky is very difficult. Each year we organize a course for the people interested in recognizing the constellation patterns. There is a great interest in the initiatives among people of all ages and professions. For the exercises we use a planetarium. The first lesson is devoted to the star maps and atlases, using also celestial globes and astrolabs. The following lessons propose practical activities under the planetarium dome. In each lesson the operator describes the constellation of one season. Then each participant is involved in the exercises using the pointer to show the constellation asked by the operator. From the third to the sixth lesson, after the planetarium exercise, the participants are involved in the naked-eye observation of the sky in the surroundings of the observatory where the initiative has been held. Another practical activity proposed during the course is the observation of particular star fields compairing celestial maps with the real sky observed through binoculars. The lessons take place each month. In this way the participants have the possibility to make experience in the backyard of their house and to follow the change of the night sky. The monthly maps published by the Observatory divide the sky in four parts (the sky of the evening, of the first and the second part of the night and the sky of the morning). In each map some constellation are indicated, while the public is invited to recognize the others.

The use of the planetarium to teach constellations patterns is also proposed during the annual course for the beginners of telescope observations. Before the practical lessons in the Observatory about the use of telescopes, the astrophotography, CCD and other facilities, the participants of the course follow also lessons about the constellations under the planetarium dome. We use also the "Deep sky" Starlab cylinder to invite the people to learn the positions of the most interesting telescope celestial objects. In the following lessons cluster, nebulae and galaxies are observed under the Observatory dome through a 40 cm telescope.

DAYS
Planetaria and Observatories together to promote astronomy

In many countries there is an astronomical day that involves all the astronomical organizations in public activities. In some European countries an yearly Day about planetaria is held in the Sunday before or after the spring equinox.

In some countries, like Slovakia, many Public Observatories partecipate in the "Day", while in Italy the program contains also the telescope observations on the planetarium sunroofs or in the near by Observatory.

In Italy Planetaria and Observatories are involved together in the yearly Day against light pollution (one saturday in October near New Moon). The Planetaria simulate the consequences of artificial light in the night vision of the sky or show the real sky that in the city it is now impossible to see, while the Observatories invite the public to discover the sky through telescopes and the difficulties for the observation, for example, of "deep sky" objects in the area contaminated by light pollution.

ITINERARIES
The biggest astronomical exhibition of the city

Planetaria and Observatories are the main reference points of a trail beetwen the sites of astronomical interest. The census of these sites has been published in Italy and in other countries and increases the astronomical interest in a certain area that becomes like a big open air permanent exhibition about astronomy. As examples we signal the guide-book of the city of Prague and the astronomical itineraries for the city of Rome and Brescia. These guide-books could also be a good starting point for the coordination of the scientific sites of public interest in the city.

An itinerary through the city sites of astronomical interest can start from the planetarium/Oservatory and continue through the astronomical sections of the local science museum (for example collections of old instruments or exhibition of meteorites), and touch the main sundials, monuments of astronomical interest and perhaps a mini solar system created in a park to complete this city itinerary. The park around a Museum or a Planetarium/Observatory, a recreational area, a mountain or nature trail, a city park could become the site of a mini model of solar system.

LOGOLAND
Astronomical drawings

A proposal to begin the advertising of a Planetarium or an Observatory when the building isn't ready could be the organization of a contest for the logo of the facility.

We use specific logos for each different initiative published in our journal or in the monthly program to keep the attention of the public alive and to facilitate the communication of our activities.

A new logo contest has been organized. It is devoted to the logo of the "Day of Planetaria". The deadline for participants is October 15. The people interested could ask for the contest rules writing to our organisation or to Presov Planetarium (Slovakia).

MUSIC
Notes in the night under and outside the dome

Music concerts under the planetarium domes are a well-known experience. We have tried also to organise a similar experience in the garden of the Observatory and in the conference room of the Observatory. In the first case we proposed original music composed with electronic instruments played with a slides projection of the best astronomical images and without comments. For this experiment we chose the beginning of the summer, calling the initiative "Festival of the solstice". In the second case a live concert has been played in the conference room of the observatory during the "National day against light pollution". The problem of light pollution isn't well known by the general public. In this Day each year we try to invite to the Observatory the people that aren't interested in astronomy to speak about the amazing word of the celestial sky and the original aspect of the night sky changed by the artificial lights. We think that music could attract the interest of these people and their presence gives us the possibility to diffuse the knowledge of the light pollution problem and the technical solutions proposed by the international astronomy community.

NATURE
Not only stars in the planetarium/Observatory

We have developped some ideas for a twinship between astronomy and natural sciences. The Observatory site is used during the day for natural science activities, in particular with schools: guided trails with orienteering exercises, birdwatching though the same binoculars used also for sky observations, microscope observations of the insects collected during the trail or preparation of the herbarium, projection under the planetarium and at the end the telescope dayly observations of the Sun, the main stars and the planets. The microscopes are used also for a journey from the world of the very small to the infinite of the sky seen through telescopes. Under the Planetarium dome we develop many programs of non astronomical interest using also selfmade hemispheric Starlab projections (prehistory, evolution of the living beings, the human body, volcanos). We invite also the committee of natural parks to develop astronomical activities in their areas through the initiative named "Star parks".

SUNDIALS
Learning the sun mouvements inside and outside the domes

Knowing how to read a sundial means to know the main topics of positional astronomy and therefore the classical subjects of a planetarium lesson. The presence of a sundial outside (or inside, see internal meridian with gnomonic hole) a Planetarium or an Observatory is very important to test these topics with a practical activity. The presence of a sundial is also the occasion to decorate with an artistic work the wall of a building of public interest. The sundial is also an astronomical open air interactive exhibit and the analematic model is probably the best solution to involve directy the public in the use of this sun clock. The presence of an analematic sundial near the entrance of the Exploratorium (San Francisco, USA) and the Deutches Museum (Munchen, Germany), the pioneers of the interactice science museums, is the best example of the use of this sundial that involves the public. In Italy and other European countries (in particular France) there is a long tradition in the making of sundials and also today there are people whose work is builting vertical or other kinds of sun clocks. In these countries census of the existing sundials are in planning and also the restoration of old sundials is promoted.

In Italy since 1988 an international contest for sundial makers has been organised. In these last eight years we have collected in a photographic exhibition more than four hundred examples of sundials of different kinds. Since the last contest these images have been collected in a videocatalogue. The next contest will be held in 1997.

TELESCOPES
A planetarium under the Observatory dome

Some Observatories situated near or inside populated area have been stopped their observational activities for light pollution problems. Their domes can be used for pedagogical activities, for public sky observations and also to create a planetarium under the observatory dome.

Some topics of positional astronomy developped during the planetarium projection could be proposed through practical activities, that involve the students in particular, also during the Observatory visit. With the telescope installed under a dome we can reproduce the three main arcs described by the Sun in the equinoxes and in the solstices (while under the planetarium these three differents sun paths are shown by the sun projector). It is enough to select the correspondent declinations of the Sun and to move the telescope from East to West, imagining you extend it to the dome, and identifying the different seasonal points of sunrise and sunset at the bottom of the dome.

We usually indicate the compass points on the bottom of the Observatory dome with four letters. Under the dome we can show our main circumpolar constellations with adhesive paper or phosphoreshent materials and a laser pointer as they appear at the Poles. Infact we can use the automatic rotation of the dome to show what happens at the high northern (or southern) latitudes for the effect of dayly motion. In this way we can propose also in the Observatory, but involving directly the students in these practical experiences, the same topics developped at the Planetarium.

TOURISM
Astronomical journeys

The people travel more and more. The Planetarium simulate also a journey at different latitudes, while the Observatory shows the celestial sky of our location. With the collaboration of the travel agencies we have invited the travellers to visit the Planetarium/Observatory and to learn about the celestial phenomena visibile in the latitude of their next journey. This special planetarium program, that could be offered by the travel agencies to the customers that buy tickets for far destinations, include the following topics: constellations visibiles at latitudes different from our location, therefore the orientation through stars (Polaris or Southern Cross), the easy orientation using stars near the equatorial latitudes (the celestial navigation of Polinesian peoples); the north or south noon culminations of the Sun depending on the hemisphere; the zenith culmination of the Sun between the two tropics; the northern or southern celestial sky, depending on the travellers country, and the legends of the constellations from other lands (examples of sites of archeoastronomy interest: Megalitic monuments, Egypt and Center America piramids and so on); the circumpolar constellations visibile in the locations of high latitutes and the circumpolar constellations visibile at the antipodes of our location or in the hemisphere opposite to ours; the mid-night sun and the "white nights" of high latitudes; the short twilights and the highly tilted Moon like "a small boat" visible at the equatorial and tropical latitudes; the clear and dark sky and the Milky Way visibile in the sites, like the big natural park, far from the populated areas; the zones of visibility of the next sun eclipses and the geographic areas where it is more frequent to see auroras.

Collaboration with Public Observatories

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1. Introduction

Recently, many public observatories were founded by local governing bodies in Japan(Fig. 1). The number of ones is about 200 and will be increasing in future (Suzuki, 1996). The maximum aperture of telescopes becomes large every year. There are four 1-m telescopes at present. Expensive detectors (e.g., a cooled CCD camera) and high performance computers become the standard equipments of a public observatory.

Because an astronomical observatory is generally located in underpopulated area avert artifical light, its traffic access is not convenient. On the other hand, a planetarium is usually located in a populated area. But there is no dark night sky. If a planetarium is connected with an observatory using the Internet, many people will be able to observe astronomical objects detected by a large telescope. The collaboration with public observatories will be of help to popularization of astronomy at planetariums powerfully. I present here examples performed at Misato Observatory.

2. Experiments and Results

We examined three experiments using the Internet. Misato Observatory have a 105-cm reflector, a largest telescope in Japan and a facility of the Internet.

The first experiment was a live relay broadcast for a disappearance of the Saturn's rings on November 19, 1995 (Watanabe et al., 1996). We used a video conference system CU-SeeMe* which is able to excute on PC and Mac. Usually, video conference systems are used for a one-to-one communication. A reflector of CU-SeeMe is able to use for a multi-cast communication. Because there were many and unspecified participants on this brordcast,one-way traffics were obliged. Dual - way traffics which is an advantage of the Internet were

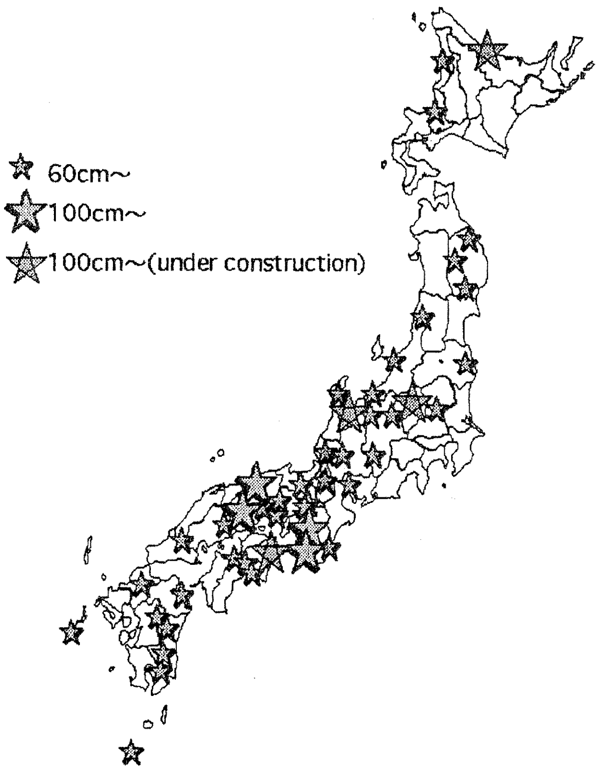

Fig. 1: Distribution of public observatories in Japan.

*Cu-SeeMe: http://cu-seeme.cornell.edu/

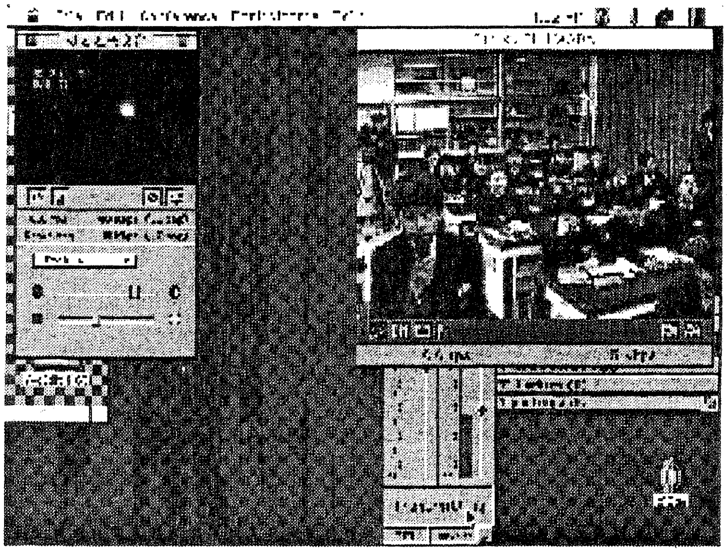

Fig.2: A snapshot of a remote lesson from Misato Observatory (Tanaka et al, 1996a)

spoiled.

The second experiment was a remote lesson for the Attached Junior High school of Wakayama University on February 20 and 22, 1996 (Tanaka et al., 1996a). We taught students a variation of the Venus shape using CU-SeeMe(Fig. 2). A live video of the Venus detcted by 105-cm reflector was transmitted. Many students said after this lesson, "I want to go to the observatory and to see a real image".

The third experiment was a live relay broadcast of Comet Hyakutake between March 23 and 27, 1996 (Tanaka et al., 1996b). We opend a latest comet image on a Home Page of the WWW server. A visitor's list were prepared on this page to able to tell us their impressions.

We demonstrated that live video images through the Internet give the audience a motivation learning on astronomy.If a same expriment are performed at a planetarium, highly educational effect will be expected.

3. Discussion

We are performing an another project using the Internet for the purpose of popularization of astronomy. It is "Public Astronomical Observatory Network (PAONET)" since 1994 (Okyudo, 1994). On this network, the latest exciting images detcted at research facilities of astronomy are automatically transmit to a hundred public facilities. But these images are not enough to satisfy curiosity of a citizen, because they are not live.

Video coference systems are effective tools to transmit live video images of astronomical objects. But their qualities are not enough at present, because astronomical objects are usually faint. We need a high speed digital line (optical fiber) in order to keep their qualities. We propose a plan of Remote Public Telescopes Network. Many remote telescopes connect with each other using a high speed (about 155Mbps) degital line in this plan. If it comes ture, one will observe a real live video anytime and anywhere.

If we connect to a foreign telescope over the ocean, we will observe stars in the daytime. We als propose to establish an International Public Observatory Society such as IPS. If planetariums and publi observatories in the world collaborate with each other, popularization on astronomy will become mor interesting.

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The Scene of the Solar Eclipse at Calcutta

Ramanatha Subramanian
Director, M.P. Birla Planetarium
India

25th October 1995 was approaching. in great contrast to the scene at the previous total solar eclipse which cut through India (on 18th Feb 1980) crowds were milling at the planetarium a full week in advance for buying the special solar goggles for the safe viewing of the eclipse. The vantage point for a few hundred thousands was the diamond harbour, a seaside resort about 40 kilometers from Calcutta, which was in the path of totality. apprehending traffic jams, people reached the place the previous night and occupied whatever accommodation was available. Dr. W. Livingstone of Kitt Peak National Observatory, U.S.A. who had participated in ten total solar eclipses till then was very much there.

The author led the team consisting of astronomers, some professors from universities of south India, staff members of the M.P. Birla Planetarium and the students of the astronomy courses conducted by the planetarium. Two big buses were specially arranged for this. The author set up the necessary equipments for photographing the corona and diamond rings through (i). still cameras attached to telescopes, (ii) through cameras fitted with telephoto lenses, (iv) through video cameras and (v) through movie cameras. Image projections were also arranged for the benefit of the students. Neutral density filters ranging from nos four to eight and welders' class were also used. The students and others were watching the progress of the eclipse through double coated mylar film goggles . The weather was excellent and clear, contrary to the predictions of the meteorological office. The studies of the eclipse through still and video photography are presented.

SESSION

"Hardwares"

A NEW GENERATION OF PLANETARIUMS

PHILIPPE HUYARD

R.S. AUTOMATION INDUSTRIE 42290 SORBIERS FRANCE

What does R.S. Automation make ?

They make industrial automatic controls for a wide range of uses. In the past few years, planetariums have become a new type of activity.

Several types have now been built. There is a complete range, varying in size and purpose, and these fall into two categories. The first consists of medium-sized and large planetariums, with domes of 12 meters or more in diameter, and the second type consisting of portable planetariums. Each of these has its own advantages. We will consider them briefly :

- A large permanent planetarium has a high quality projector, giving the audience a very good image of the sky. The large number of audiovisual elements currently used, make up the system which is well known, and which is still being developed.
- On the other hand, smaller systems exist, which are portable. Their advantages are well known, one of the most important ones being the cost. But there are other advantages such as that of educational value, and I myself have had the pleasure of using this type for several years. But hundreds of shows have revealed their limits.

A PLANETARIUM WHICH COMBINES THE ADVANTAGES OF BOTH THE PORTABLE AND THE LARGE TYPES

This idea has led to the design of a new system, which has been patented. Here are its main features :

It is known as the Roving Star, and is mounted on a trailer which can be towed by an average-powered vehicle. The dome and the cylindrical part unfold. In the base of the cylindrical section, there are seats, which the audience will appreciate. It can be rapidly installed by one person.
With the dome in place, here is what we find in the interior :

We start with the sky projector. It is in the form of a star sphere, and therefore very compact and low in the field of view. It projects 1500 stars for the whole sky, using lenses for the brightest stars. Around it are five mobile components which display the sun, the moon, and the planets. Their movements are computer driven. This allows function changes for an element representing a planet. This element can, through the program, become another planet, or a shooting star, or also an artificial satellite.

In the same area, in the centre, there are two slide projectors, the sound system and the control system. They operate with a fade-in and fade-out mode.

All these components can be operated manually or automatically. The manual mode, and the principle of computer control of the components, allow positions to be changed very rapidly, to demonstrate astronomic phenomena.

Because there are two slide projectors, it is possible to program both simple shows and short sequences on a specific topic.

The advantages over conventional portable planetariums are obvious. The spectators have comfortable seats, which is a particularly important asset for an adult audience. The possibilities are superior to those of entirely manual systems. The short program can make up the essential part of the show, but the presenter's talent can be used to a maximum. The best use will probably be short sequences, which can be programmed by the presenter, according to his desired timing. This allows him, if he wishes, to give a commentary adapted to the group, to concentrate on his presentation, and to watch the audience's reactions.

Suggested use of this planetarium :

In regions of low population density, isolated groups can be offered a performance in conditions which are technically better. As an additional feature for major exhibitions, or during astronomical events, the planetarium can be erected out of doors.

THE NEW ZEISS STARMASTER PLANETARIUM

Volkmar Schorcht

Carl Zeiss Jena GmbH, Germany

In August this year, the first Zeiss Starmaster Planetarium will be installed in Wolfsburg, the German city, in which the headquarters of the famous Volkswagen company are situated.

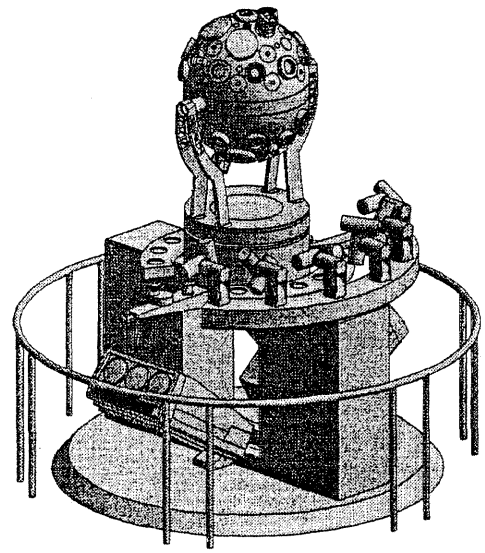


Fig. 1 The new Zeiss Starmaster *incorporates plenty of new technologies for modern planetarium presentations.*

The Starmaster represents a new generation of Zeiss medium size planetariums for both flat and tilted domes of 12 m to 18 m in diameter. It incorporates plenty of new technologies for modern planetarium presentations, technologies that are unique in planetarium history.

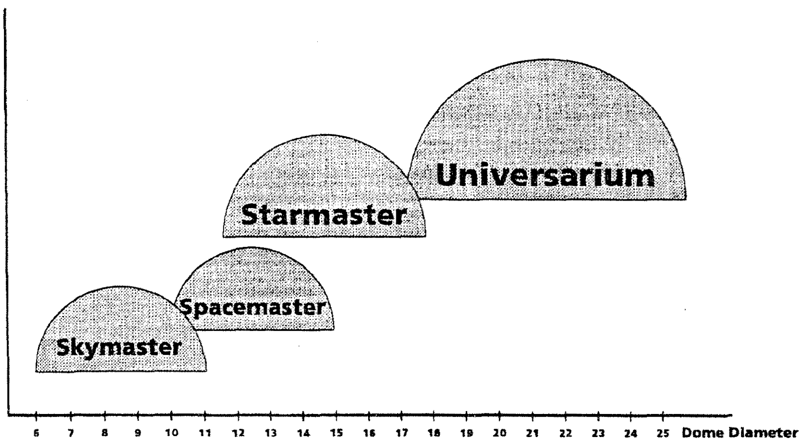


Fig. 2 The Starmaster *fits readily into domes of 12 m to 18 m dia.*

Which are the main new features of the Starmaster?

In the past nearly all optical planetarium projectors used the division of the celestial sphere into 32 fields introduced by W. Bauersfeld in 1923. The Starmaster design is based on 12 projectors with wide-angle lenses.

This new sky division has some important advantages: We save space on the star ball to add other projection systems, and the diameter of the star ball has been reduced to less than three quarters of a meter. That figure corresponds to only 5 % of the dome diameter.

For the first time the meanwhile legendary Zeiss fiber optics projection of the starry sky is available to medium sized domes. Each star projector consist of up to 900 fibers for the projection of stars of unsurpassed brilliance.

Please come to see our demonstration of the fiber optic projectors during the visit to the Osaka Science Museum. Seeing is believing. Our cordial thanks to the IPS officials and to our Osaka Planetarium friends who invited us to present the fiber optics sky.

The gain in brightness of the projected stars allows us to reduce their diameters. Even the bright stars can now be generated with an angular diameter below the resolution power of our eyes. And the method of indirect seeing – well known to sky watchers – is applicable to detect the faintest stars of the fiber optics projection.

Time to adapt the visitor's eyes is something you never have to consider again. What happens to your stars when you project a panorama? They just vanish. With the fiber optics sky this problem belongs to the past.

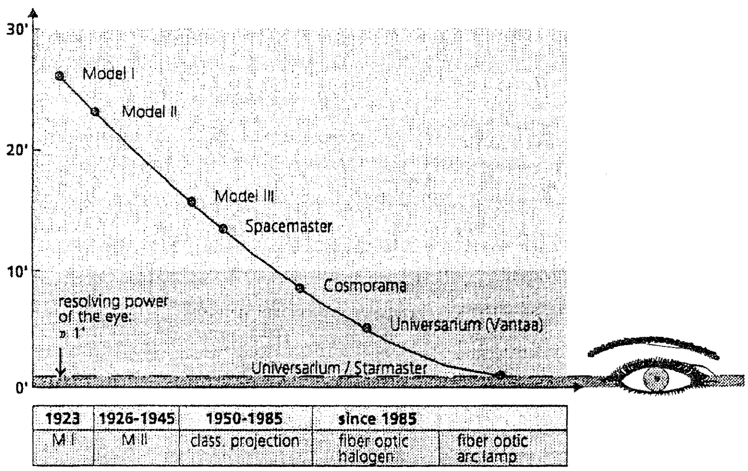


Fig. 3 Reduction in diameter of 0 magnitude stars with Zeiss planetariums since 1923

The fiber optic projectors come with a new method to simulate scintillation. For the first time scintillation in a planetarium is truly natural. The effect now is stochastically distributed and does not fade out any star when it is switched off.

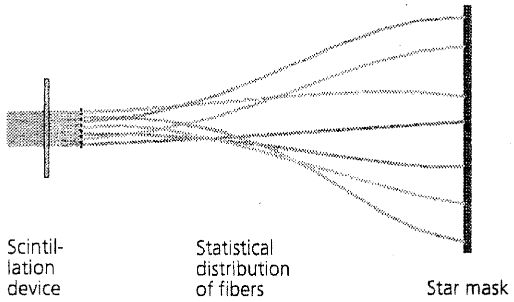


Fig. 4 Principle of the new scintillation method

The stars are represented by their true color. By staining single fibers we are able to coloı stars. Even an exaggeration of star colors is possible. A metal vapor arc lamp is used for fixec star projection. This is the only lamp which provides a pure white light. The arc lamp for the Starmaster is a commercial one, you do not need custom-made lamps for planetarium use an longer.

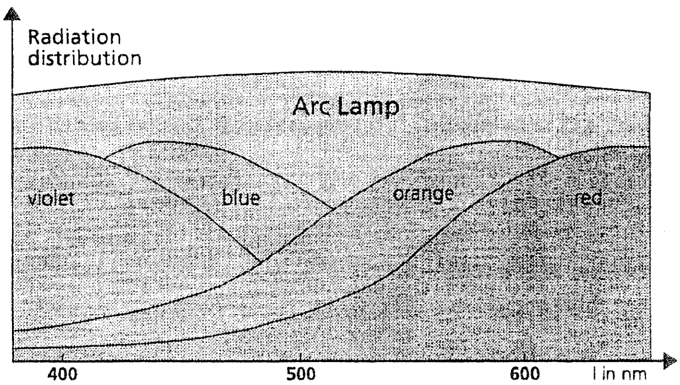


Fig. 5 Star coloration is achieved by staining single fibers

With the Starmaster we also introduce what our American colleagues call the "binoculaı view". With the Zeiss Starmaster you may use binoculars to watch star clusters and nebulae Open star clusters are represented by stars weaker than the brightness limit of the field stars. Tc our eyes the clusters appear in exactly the same way as the natural clusters do. The large nebulae are represented by digitized photographic images. Discover the spirals of the Andromeda Galaxy as well as the characteristic structures of the Magellanic Clouds.

To cut off the projections from the star ball at the dome's springline we offer either gravitational shutters for flat domes or computer controlled shutters for tilted domes. Anyway ir both cases the fixed stars are cut off by computer controlled shutters. This technique prevents projection of stars into a panorama, for instance.

An additional all-sphere projection system is available for the projection of astronomica grids and the constellation figures. A built-in slide change mechanism allows switching oveı between the two patterns.

A third projection system on the star ball covers a ring-shaped zone next to the celestia equator and ecliptic. It is also equipped with a slide change mechanism, for instance to projec the constellation figures of the zodiac.

The projectors for Sun and Moon are integrated in the star ball and get their light from the central arc lamp. This again is a new technique in planetarium design introduced by Carl Zeiss. The combination of sun and moon projectors with the star ball avoids the obstruction of the projections all other star ball designs entail. With the Starmaster the advantages of the classical gear locked mechanism and the star ball design are combined. We call it the "2-in-1 concept".

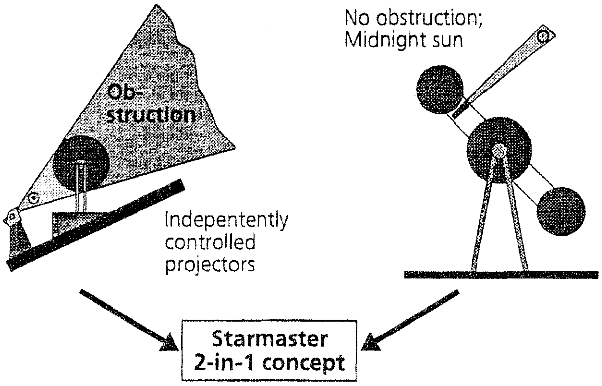


Fig. 6 The 2-in-1 concept combines the advantages of the independent projector control with unobstructed projection

Sun and Moon can be projected with such a brightness that they cast shadows in the dome. The Moon is presented with its surface details and phases. The phase mechanism gives you a correct narrow crescent close to new moon. The sun projector includes a mechanism for presenting eclipses and a planet transit.

The planet projectors are located in the near vicinity of the star ball. Each planet is projected by x-y-mounted high speed lens. These projectors provide a high luminosity of the planet images. The settings of all projectors are calculated by the astronomical algorithm in real-time.

The Zeiss Starmaster is controlled by a multi-processor computer. The user interface is based on MS-Windows. Control PC, synchronization board and interfaces are concentrated in a small control rack under the control desk. The control panel of the size of a PC-keyboard can be used for live presentations without restrictions.

Live run, teach-in programming, edition, automatic run and override are only a few of the integrated operation modes.

多機能天体投映機

MULTI-FUNCTIONAL OBJECT PROJECTORS

吉田孝次
ミノルタプラネタリウム（株）
東海事業所開発部

TAKATSUGU YOSHIDA
R&D Dept., Tokai Div.,
Minolta Planetarium Co., Ltd.

Key Words:ミノルタ　インフィニウム、マルチモード、天文映像データベース、位置制御ソフトウエアー
MINOLTA INFINIUM, multi function mode, astronomical image database, software for positioning servo-control

ABSTRACT

We had developed "MINOLTA INFINIUM" at TSUKUBA EXPO'85 in Japan. Since early model of INFINIUM, four changeable frames of planet images were included in the planet projectors. It has been only avairable for MINOLTA INFINIUM to clear hurdles of hardware and software for positioning servo-control for a long time.

In after model (1986) we added a new function "Multi function mode", which selects reasonable frames in the each planet projector automatically along the point of view in the space.

We have made new concepts of planet projectors and we have thought new posibilities of using methods of planet projectors, and we have always been the first developer, as a pioneer of the new planetarium, new functional-planet projectors in the world.

Now we need no planet projectors as the projectors for projecting only planet images more, and we reach the following new idea!

In this paper we report newly developed "MULTI-FUNCTIONAL OBJECT PRO-JECTORS", which enable to supply the astronomical image database with software for positioning servo-control of the projectors.

1. はじめに

ミノルタの製品においては、筑波エキスポで好評を博したインフィニウムシリーズ当初より、惑星投映機は4コマの惑星のズーム映像を持った7台の投映機から構成されていた。

当時としては、ハードウェアーはもとよりリアルタイム制御用ソフトウェアーにまつわる課題をクリアーすることが困難であったため、インフィニウムだけが達成できるものであった。

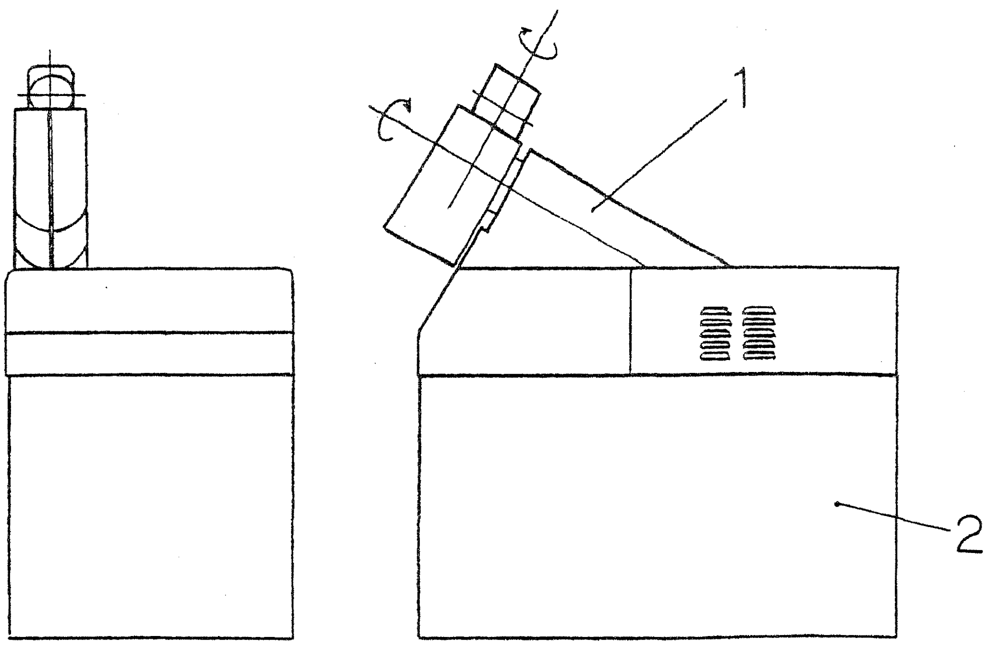
その後さらに、惑星投映機を、マルチモードとして視点天体が変われば、個々の惑星投映機が持つ4コマの惑星映像を自動コマ割り当てする機能が追加された。

このように、我々は惑星投映機のあり方や可能性について、常に先駆者であり続けてきた。しかし、時代のニーズはもはや惑星というくくりの中に収まらない状態にあることに鑑み、駆動用制御ソフトウェアーを伴った天文映像データベースを供給する『多機能天体投映機』を開発するに至り、ミノルタインフィニウムαⅡとして完成したので報告する。

2. 外観と軸構成

本『多機能天体投映機』の姿図を図1に示す。

1～投映部
2～電装部



3．ハードウェアーの構成と特徴

ハードウエアーの構成と特徴を示す。

1）天文映像データベースを供給する手段～８０コマのランダムアクセス可能なスライド投映機

2）天文映像を理想的な位置、姿勢に投映する手段～ＸＹ２軸の回転軸と像回転機構部

3）天文映像の大きさを理想的な大きさに投映する手段～ズーム投映部

4）天体の満ち欠けをさせる手段～位相機構部

5）映像を回転させる手段～像回転機構部

4．制御ソフトウェアーを伴った天文映像データベースの概要と特徴

1）ステラオブジェクト～正確な天体映像
（満ち欠けする惑星、主要な衛星、彗星、小惑星、宇宙船）

2）ディープスカイオブジェクト（メシエ天体、著名な星雲、星団）

3）文字エリア（星座名、天文映像に対応する用語）

4）シンボルエリア（→○＋！？☆◎）

5）ピクチャエリア（天文関係の想像画）

6）フリーエリア（ユーザーのためのフリーエリア）

以上の映像ソフト（スライド原板）と位置制御ソフトウエアーをリンクさせて提供できることを特徴としている。

5．ビデオデモ

完成した多機能天体投映機の姿と動きをご覧戴きたい。

New Developments at Evans & Sutherland and Digistar II

Jeri H. Panek
Digistar Sales Manager
Evans & Sutherland
USA

'he status of the Digistar II digital planetarium system and the new, full dome/full color interactive rojection system, StarRider, will be given. In addition to these products that have been developed pecifically for the Planetariums, Evans & Sutherland is also in the process of adapting their other irutal reality systems for eductaional pruposes. These systems include the CyberFighter cockpit, 'irtual Glider and interactive kiosk products.

A PLANETARIUM CAPTIONING SYSTEM FOR THE HEARING IMPAIRED

Noreen Grice and Darryl Davis

Charles Hayden Planetarium, Museum of Science, Boston, MA 02114

I'd like to tell you about the new captioning system recently installed in the Charles Hayden Planetarium. The person most involved with the project, Noreen Grice, was not able to attend this meeting, so I (Darryl Davis) am presenting this paper in her absence.

In Oct. 1993, Noreen Grice attended a field test of three caption display devices, conducted by the CPB-WGBH National Center for Accessible Media in Boston. The test was held in a local movie theater. Both hearing and hearing-impaired persons participated. One of the devices tested was a Vacuum Fluorescent Display or VFD. A VFD is a small alpha-numeric display, similar in size to a shoe box. In the test, it was mounted with a bracket directly to the back of a seat and allowed a person sitting in the next row behind, to read the narration of the movie.

In early Fall of 1995, the Charles Hayden Planetarium received a grant from The Peabody Foundation, Inc. to install a state-of-the-art captioning system in the planetarium. Noreen contacted Design Continuum, Inc., an innovative engineering and design company in West Newton, MA about working on this project. Although the grant would not be able to pay for much of the design work needed, the Project Engineer was very interested in the idea of working with us to develop a unique captioning system for the planetarium environment.

The engineers of Design Continuum worked directly with Noreen to modify the original design of the VFD captioning units. Rather than attach the units to the back of seats, the units were made modular. The engineers designed four permanently mounted posts where the VFD captioning units would attach when used by deaf visitors. When not in use, the units would be stored away for safe keeping.

After several months of collaboration between Noreen and the many engineers and designers involved, the units arrived at our Planetarium in April 1996. The VFD captioning units are operated by a 486 PC in our Planetarium Control Room. The PC is equipped with an Adrienne LTC IOR timecode-reader card and special software from the WGBH Captioning Center which relays the SMPTE code from our SPICE system to the VFD units in the theater.

Our new captioning system is so user friendly that we can set up the VFD captioning units when a person entering the planetarium requests captioning. Each of the four units can accommodate up to three hearing-impaired visitors allowing us to serve up to 12 deaf visitors per show.

We are very excited about this new captioning system and hope that you will use our facility as a model site for providing a captioning system in your planetarium.

DIGITAL ALL-SKIES PRODUCTIONS

JOHAN GIJSENBERGS

EUROPLANETARIUM - GENK - BELGIUM

All-skies are about to become a standard projection method within planetariumshows. However the way to produce them could be a very expensive
affair. Artists with a good look on doomperspective can make great all-skies but are often expensive. Own creations by copying and dubbing images are nice but not always effective in different shows.

We want the newest Hubble-pictures on our dome or the finest pictures ever made by astronomers. Not an easy task and most of the time we are depended
on what is on the market to buy from.
With the creation of software called DigiDome, developed by the Dutch company Eyecon and distributed by Sky-Skan a lot of trouble in making all-skies are over.

Where DigiDome can make any digitalized images into any size of picture, whether it is a panorama or just al large or small image, the making of all-sky pictures has the most success here.

Since DigiDome needs digitalized picture in Targa-format we need to get our images digitalized. A modern planetarium now a days with a graphics desk can hardly do without a graphic color scanner. It is still the easiest way to get printed pictures digitalized. Slides however can be a problem to scan due to low resolution scanners. Slides can simply be put on photo-CD. You pay the price of a simple photoprint but in the meantime you have a nice digitalized picture on disk you can read from you CD-rom. A lot of planetaria are archiving their slides this way for the future. There are different sorts of photo-CD (professional, archive..). There is certainly one that will fulfill your needs.

Getting your pictures straight from CD-rom (a lot of astronomical software have already beautiful pictures on their disks) or from internet gives you direct digitalized pictures. Whatever format they are in, most of the modern graphical software such as photoshop, photostyler or picture publisher can change them to Targa without trouble.

With so-called plug-in software for f.i. photoshop, your original can be turned into different styles. If you have a dissolve system in your all-sky projectors the real image can for instance appear from a crystallized version of that image. The effect can be astonishing. There are lots of plug-in tools one can use. So your pictures can be 'metalized' first or 'watercolored' before or afterwards the real picture shows up. Using this trick with an all-sky system is a splendor on its own. With more dissolve possibilities one can run a sort of animation with them. All together digitalizing pictures can bring more live onto the dome. Using DigiDome or someone who can produce them for you (see addresses) is in that way a cheap way to make stimulating all-skies. Using your own software gives you the chance to change your image within short notice. Just let your computer do the work.

A few companies are busy with producing all-skies for third parties.

* The people who created DigiDome in the first place, the company Eyecon, have now come up

with what they call circle-pictures. It is a series of images made throughout Europe of well known places with a 4/5 inch camera and 200 degree fish-eye lens on it. Imagine the Paris Eifeltower onto your down or the inside of the Vienna-opera. These images are high-resolution pictures (up to 40 Mb) and delivered on CD-rom so you can run the trough DigiDome by yourselves. Other people can order them as 6 soft-edge slides as far as they have a standard 6 all-sky system installed.
At Eyecon other images on demand are available.
A catalogue is available on floppy-disk and the contents is still growing.

* Laura Misajet from Narberth in the U.S. is using the benefit of DigiDome herself to serve the planetarium community with beautiful all-skies. Her fractals are a very attractive and can simply be ordered.

* Steve Young at Image Ability (Londonderry, New Hampshire) does the same. He has been subcontracted by Sky-Skan to produce lovely all-skies for the National Air and Space Museum in Washington and the McAuliffe Planetarium.

* A growing number of people (Stephen Rider..) are offering more and more DigiDome services as well. Cheque out Dome-L or the Planetarian.

Prices ranges from 100 to 400 US Dollars.

Addresses :

Eyecon
Coninckstraat 20
3811 WJ Amersfort
The Netherlands
fax : +31.33.4700193
or
Europlanetarium
C/o Johan Gijsenbergs
Kattevennen 19
3600 Genk
e-mail : planetar@eunet.be

Laura Misajet
LM Images
PO Box 948
Narberth PA 19072
USA e-mail : lmimages@aol.com

Sky-Skan
51 Lake Street
Nashua, New Hampshire 03060-4513
USA
e-mail : 73700.110@compuserve.com
(Steve Young : tel. 0800.253.1920)

IMPROVING THE MILKY WAY

A P FAIRALL

SOUTH AFRICAN MUSEUM

Photography of the Milky Way reveals a wealth of glowing nebulae, dark clouds, dust lanes and clusters of stars - frequently portrayed as spectacular colour plates in astronomy textbooks. Yet almost all of this is too faint to be visible to the naked eye. Instead, the eye sees the Milky Way as a diffuse band of light, with only a few dark clouds seen in silhouette against it. The general low level of the light makes the eye dependent on the "rod" receptors in the eye's retina and thereby robs it of colour vision and resolution. The only emission nebula that can be readily seen is the Great Nebula in Orion, but its colour is not apparent. The Pleiades and Hyades are similarly the only clusters easily visible. Nevertheless, the Milky Way is a very appealing sight to the dark-adapted eye - particularly if seen, in the absence of moonlight, from a favourable site.

The reproduction of the dark night-time sky, as seen by the naked eye, is the aim of the planetarium. But would it not also be possible to use a planetarium to reveal details normally too faint for the eye - the clusters, glowing nebulae and the multitudes of faint stars? Certain manufacturers have produced planetarium projectors that show stars much fainter than the normal cutoff at magnitude 6.5, but they do not similarly enhance the spatially extended features - the glowing nebulae and clouds of unresolved stars.

At the planetarium of the South African Museum in Cape Town, we have been engaged in "improving" the Milky Way by means of 6-projector all-sky materials that supplement the normal starfield of our Minolta MS-15 projector. The all-sky projection must operate in register with the star pojector (so the star projector cannot, of course, carry out diurnal or latitude motions while this is done).

Since our main interest is with the southern Milky Way, the simplest recipe has been to set the South Celestial Pole at the zenith. The central budge of the galaxy is then elevated almost 30 degrees above the springline of the dome, thus suitably positioned for viewing. Above and to the left of the bulge, the Milky Way runs towards the spectacular Southern Cross region, while much further to the left, and usually behind, even the Orion region is just above the horizon. Since the star projector casts shadows in the bottom centre of the six all-sky projectors, we have avoided having this affect critical regions by centering the 6 panels exactly on Right Ascension 0h, 4h, 8h, 12h, 16h and 20h. The only compromise with this arrangement is that the central budge of the galaxy falls across two panels.

Our first Milky Way all-sky was made in 1989, artist Anina Botha copied photographic materials - chiefly flicking paint off the bristles of a toothbrush to simulate the large numbers of stars. Her paintings showed the gross structures but were not exact in detail.

In 1994, we were stimulated by the sight of the Minolta Infinium sky, with its 26000 stars, as seen at the Brevard Community College planetarium at IPS 94. We tried making our own faint stars by photographing small black dots, as produced by an airbrush with a "splatter cap" fitted. These were painted on white card panels. Hershel Mair, our planetarium photographer, then shot them using Kodalith type 3 film. The results were satisfactory, we could add tens of thousands of faint stars to our planetarium sky. Of course, we were taking some license in that the dots represented general distributions and not the exact locations of individual stars (but who could tell the difference?).

To complement the faint stars, our artist, Margie Walter, used the airbrush (with "splatter cap" fitting) to create a much more detailed and exact "Milky Way" by copying the panoramic photograph from the European Southern Observatory and with reference to all-sky panel mock-ups for location of features.

The result was very satisfactory but the contrast in surface brightness along the Milky Way was exaggerated by the lith film. It was improved by shooting on continuous tone, Technical Pan film. However, the faint stars showed up best when projected at full intensity, while the Milky Way star clouds looked best at much lower intensity. Also, the scene was still only black and white - the colour of stellar populations could not be discerned.

This year, we are again attempting to improve our "Milky Way" using multiple projection all-skies, in register with one another and with the planetarium projector. The general scattering of faint stars, concentrated towards the galactic plane will be carried as before on Kodalith, which will be projected at full intensity.

Margie is respraying the general Milky Way using continuous tone (regular airbrush, no "splatter cap"), in colour, on a black background. Herschel will photograph these with polarized light, on tungsten transparency film and they will be projected at lower intensity. Experiments relating to the general intensity and colour of the stellar populations have been carried out.

In an effort to add more detail and accuracy, we have also invested substantial time going through the photographs of the National Geographic - Palomar Observatory Sky and the British SERC 111a-J Survey. Each of the photographs shows a region of sky 6 x 6 degrees. All smale-scale emission nebulae (red), reflection nebulae (blue), foreground dark nebulae, open and globular star clusters have been drawn on reference panels, and will be used to add accurate details to the all-skies. The star clusters will be added to the "Kodalith" faint star panels. The red and blue nebulae, could be added with a separate bank of all-skies;

since we only have two banks, we will however include it with the airbrushed background. The foreground dark nebulae are duplicated on all panels.

We look forward to seeing these results projected and viewing the Milky Way in its true glory!

REPAIR OF AN EARLY U.S.A. PLANETARIUM INSTRUMENT WITH FIBER OPTICS

JOSEPH M. DE ROCHER

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HISTORY

The Hanna Star Dome was constructed as a planetarium by the staff of Ohio's Cleveland Museum of Natural History in 1936. It is believed to be the second planetarium instrument built in the United States, only predated by the Atwood Globe in Chicago, Illinois. The Hanna Star Dome is a 907 kg, copper, 4.87 m diameter dome, that was illuminated by nearly 3,000 six-volt radio lamps. The dome contains 12 complete star fields, one for each month of the year. During any single month displayed no more than 250 to 300 stars will appear. On the dome the stars had been individually wired so that any month would be displayed by using a 12-position rotary switch.

In 1982, a process of cleaning and identifying the constellations was begun. The dome is only serviceable from the outside and a great amount of time was spent identifying the 48 constellations placed in reverse orientation. The code system used to identify constellations is to distinguish them in alphabetical order starting with number 1-Andromeda and ending with number 48-Virgo. The code as observed on the dome exterior identifies the constellation, the month that it is visible and the individual star in the constellation. This results in some stars such as Sirius appearing 5 times, while other stars such as Polaris appear in 12 locations. Additional code markings were established for the constellations by a painted colored mark and by also installing the proper Greek letter or number identification for each star. The press typing of more than 15,000 individual identifications was finally completed in 1992.

FIBER OPTIC INSTALLATION

In 1994, the process of replacing the 3,000 radio lamps with fiber optics began. The first step was removal of the old copper wire, lamps and wire track from the dome. Next came a total cleaning and a final drilling of the star positions before the installation of nylon clips to hold each fiber optic in place. There also had to be a complete redesign of the star dome's rotating ladder system, so that the fiber optics could pass through the center of the ladder to the primary light source and allow the rotating ladder system to continue to be used.

Only three sizes of plastic fiber optic cable are used. The zero magnitude stars are represented using 1mm diameter fiber. All 1st magnitude stars are represented with 0.75 mm diameter fiber. All 2nd, 3rd, 4th and 5th magnitude stars are represented with 0.5 mm diameter fiber and are varied in brightness with neutral density filters. The bright star Sirius was accomplished by using three 0.75 mm diameter fibers grouped together to achieve the desired effect. On the initial month, 0.25 mm diameter fiber was used for the stars of the 3rd, 4th and 5th magnitude. However, it was discovered that working with this diameter of fiber was too difficult and it could not be installed into the remaining eleven months.

GE LIGHT ENGINE

The illumination of the dome is now accomplished with one light source. The type of light used is the General Electric Light Engine. The 60 watt light source is a totally new lighting technology designed by GE specifically for the illumination of fiber optics. The lamp has an output of more than 2,500 lumens and a lifetime of over 2,000 hours. In the dome application, the lamp is operated in its standard vertical position passed through a series of 12 light pipes into 12 optical couplers and into one of 12 bundles of 250 to 300 individual fiber optics that are representing the stars in the skies. A simple unveiling system is used to turn "on" and "off" whichever month is desired to be displayed.

TESTING

As each month of fiber optics were installed an extensive series of tests was conducted to see that the proper magnitude star was located in each constellation. The tests involved using colored gels identifying the various magnitudes to make sure of their proper installation. The final step of the Hanna Star Dome project will be to color the stars of -1, 0, 1, and 2nd magnitude to be their proper spectral colors. This will be accomplished simply by using permanent marker pens at the exposed end of the fiber.

CONCLUSION

All visitors to the Cleveland Museum of Natural History now can control the Universe with the hands-on switches that are in the main planetarium lobby, placed directly under the Hanna Star Dome. It has been very well received by the visitors to the museum. The Hanna Star Dome is believed to be the only hands-on planetarium instrument anywhere east of the Mississippi River. It is considered to be the only fiber optic display planetarium instrument in the world.

THE VIRTUARIUM PROJECT

KIMBERLY AYERS

GOTO OPTICAL MFG.,CO
US Liasion office

Development Background

When I was a kid, I always thought of museums as places to see neat stuff. A museum consisted of miles and miles of display cases, from gems to animals to tools used by our ancestors. As time went on, participation became the trend in museum evolution. Exhibits you could touch, manipulate and learn from gave the audience the ability to participate. Planetariums and IMAX theaters brought new sensations and lifelike experiences of worlds far away. The introduction of motion platforms and movable seats bring the whole body into the experience. Museums have used multi-media and simulation to explain and help us learn about our universe. This museum evolution culminates with GOTO Optical's VIRTUARIUM; the first large scale dome projection system based on Silicon Graphics' ONYX Infinite Reality and GOTO's video projector system customized for dome theaters ~ *Get ready to experience a totally immersive virtual world!*

Virtuarium System

The Virtuarium System can be thought of as three basic components; the Control Console, the ONYX Infinite Reality and the Dome Projection System. From the Control Console an operator can run a pre-produced show, create cue commands and graphics for a new show or simply run a manual presentation as part of a show specifically tailored to the needs of the audience that day.

The computer system consists of a state of the art graphics processor. The ONYX Infinite Reality brings powerful image and video processing capabilities to the Virtuarium, allowing unlimited possibilities for simulation, multi-media and virtual reality experiences in the dome. Boasting one or more MIPS R10000(RISC processors, the system easily draws over 10 million triangles/ second with textured pixel fill at speeds of 200 million to 800 million a second.

Dome Projection System

Multiple, specially-designed CRT video projectors cover the dome screen. Two configurations; partial or full dome coverage, give cost flexibility. Unique features of the projectors include Scheimpflug Correction, Off-axis Correction and Edge Blending.

This means that all channels are seemlessly blended into one continuious image. The partial projection system utilizes 4 projectors to cover a screen area of 180° by 120° and the full dome system uses 6 projectors to cover 180° by 360° Both systems give a sense of total immersion in the scene. The effect far surpasses any head mounted display or flat screen.

Three aspects of the VIRTUARIUM system

In general the Virtuarium has three main aspects; it is a Simulator, a Virtual Reality Theater and a Multi-media Theater. A simulator is a place where facts or conditions are set and an outcome unfolds according to what the user inputs. Examples would be any kind of flight simulator or other modes of transportation such as a train, ship or car. Or industrial machinery, such as a hydroelectric or nuclear power plant could be run under various conditions to test and compare safety and performance. A specific astronomical example could be a computer simulation showing how the gravitation interaction of two galaxies forms a single spiral armed galaxy.

Virtual Reality reproduces a space or world, real or imaginary, which can be explored. These worlds are actually complex databases depicting outer-space, micro-space, the inner workings of an animal or plant, famous buildings of the past and present, or towns far away in distance or time.

The Multi-media aspect incorporates all kinds of digital imagery onto the dome. Information downloaded from the Internet, or information viewed in real time from a broadcast, teleconferencing with other museums, etc., are just a few of the features possible with the Virtuarium system.

VIRTUARIUM Contents

Contents Supply

VIRTUARIUM comes standard with all the projection capabilities of a standard planetarium such as 10,000 stars, deep sky objects, sun, moon, planets, celestial coordinates, constellation lines and pictures. All planetarium motions; diurnal, annual, latitude, precession and azimuth can be simulated.

The SGI ONYX computer makes it possible to utilize almost all 3D real-time graphics on the Virtuarium system. GOTO is presently contacting and working with a number of the World's foremost content production companies including Infobyte SpA, Coryphaeus Software Inc., Meta Corp & NK-EXA. Our goal is to develop and supply a wide range of content that will take full advantage of the flexibility of the system.

Now more than just a planetarium, the VIRTUARIUM can offer any type of education, from science to history, or it can be used for entertainment as a game or amusement ride.

A show scenario might go something like this;
A galaxy appears far in the distance. As we zoom in on it we aim our ship for one of the spiral arms. Closing in on a yellow star, we cruise by each of the planets looking for a place to explore in more detail. Of the nine, the third one from the sun, the blue gem of the planetary family, strikes our fancy and we enter a low earth orbit. From our new vantage point the continents and vast oceans become clear. Each location has unique land formations and life forms, examples of which are shown on our screen superimposed on a relief map of the entire planet. After examining the geological evidence of drifting continents, the science team decides to investigate the plant and animal life further. Once the outer features are cataloged, our view penetrates the life to the microscopic level, encountering the wondrous structure called DNA....

All of these databases already exist to be scripted in this or many other ways.

Further information can be obtained by directly contacting the author.

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GOTO SPACE SIMULATOR - URANUS

LUCY KING

GOTO OPTICAL MFG.,CO.
International Dept.

Development Concept

The basic concept was to create a compact and flexible planetarium system, that utilized intelligent functions, inherited and condensed from the GSS-HELIOS projector. Throughout development, the over-riding design criteria was to achieve a field of vision, free from any obstruction, inside a medium sized dome.

Compact

The most striking aspect of the GSS-URANUS is that in spite of it's small size it projects so well onto 10 - 18 meter domes. In order to maintain this standard two main objectives must always be met;

(1) The diameter of the enclosure which surrounds the Skyline Projector must be 2,400 mm or less, and the height of the latitude axis has to be equal or under to 2,200 mm.

(2) The GSS-URANUS, upon installation into an 18 meter dome, must have the power to project images equal to the GSS-HELIOS in terms of both clarity and brightness. In comparison with our current product range, these objectives describe "a planetarium which is more compact than the G1014Si and yet has more potential than the G1518Si".

Rich Educational and Entertainment-type presentations.

In addition to compact size, the GSS-URANUS has an advanced program creation support system. The support system assists the operator to combine basic planetarium functions together with slide image projection and is perfectly compatible with both Educational and Entertainment-type presentation shows.

Beautiful starry sky and superior projecting functions

Without doubt, GOTO's most important priority was the fixed stars.

The GSS-URANUS has approximately 10,000 stars down to 6.6 magnitude. The bright stars and Planets keep their natural brightness and color tones to the correct degree even when projected onto an 18 meter dome. A realistic Milky Way, Nebulae and star-clusters are also projected from the fixed-star projector. Independent brightness adjustment of all these projections is possible

A special feature of GOTO's GSS series is a digital shutter mechanism which cuts off all projections below the horizon. Another special feature is the automatic light-bulb replacement unit which allows you to replace any burnt-out bulbs during operation simply by pushing one button at the console.

Planet Projectors

The small-size, high-performance, digitally controlled Planet Projectors sit separately from the main projector body. This layout allows space travel experience and lets you view the stars from other points in space and time, for instance, you could see the starry sky on Mars as it appeared over 1000 years ago, or else view future skies from a space ship moving far away from Earth.

By using what Goto terms the 'Shed Function' the Planet Projectors can visually explain the following; characteristic movement of fixed stars, parallax of fixed stars, movement of binary stars, movement of satellites, and so on. In addition, the Shed Function can be used for other kinds of applied studies and presentations by simply inputting the appropriate parameters.

Skyline projector & Descender

The independently rotating GSS Skyline projector is located in the center of the doom and small projectors, which accurately express celestial coordinates, are mounted upon it. This arrangement lets you use the rotation feature to effectively explain directions in educational programs as well as an observer's directional change. The independent rotation function gives you complete control over scenes in both space and time, for instance, you could create a wonderful feeling of weightlessness by moving the stars in one direction while the scene moves in another.

There are two URANUS skyline projectors types available. One is a highly compact model, with a diameter of 2,000 mm and has an optional Descender mechanism. The other skyline type has a slightly larger diameter of 2,500 mm and includes a Descender mechanism which is completely separate from the fixed star projector. Both these two projectors have the independent rotating function.

The GSS Skyline projector is unique. It has two sets of projectors, each with a capacity of 12 scenes which can be randomly accessed and smoothly overlapped to a total of 24 scenes. Illumination on an 18 meter dome is 7 lux and GOTO's Parameterization function will couple the Skyline's dimming to the Diurnal Motion of the fixed stars.

The URANUS Descender mechanism effects a smooth program change to large-sized video screens or Goto's Astrovision large film projections. The Descender will elevate the fixed star projector without adversely affecting skyline projection.

GOTO strongly promotes a natural looking skyline for tilted domes through use of the digital shutters to reveal just the front portion of the projection. However, it is also possible to have a full 360 degrees projection.

Manual operation oriented console

The Control Console has both an operation panel and a display panel which allows manual operation of all basic functions. For more complex presentations, which are impossible to effect by manual operation alone, special GOTO functions, such as Time Warp, Parameterization, Program Branching and the Function Panel, can be freely accessed. In addition, Audience Interactive shows may be manually performed by accessing any number of 'pre-set' automatic programs and then simply inputting the desired time and place parameters. The GSS-URANUS system can be controlled completely in real-time which enables the operator to perform these kinds of manual operation.

SMPTE /SIMUL control function

The SMPTE, or what GOTO terms 'the SIMUL' control function, is used to execute a program from a point somewhere halfway throughout it's length. This function greatly reduces program creation time, as well the time required before automatic shows to confirm that everything is in order.

Total System

The Projector /Console interface synchronizes the fixed stars, planet projectors and all auxiliary projectors inside the dome together with the sound system, thus giving the operator total system control.

Three Installation Types

Type 1 for **Horizontal** Domes

GSS-URANUS with Highly Compact Skyline Projector.

If you wish, an optional Descender mechanism to simultaneously elevate the fixed star and skyline projectors can also be installed.

Type 2 for **Horizontal** Domes

GSS-URANUS with the Skyline projector design which is completely separated from the fixed star projector.

This URANUS type has two Descender mechanisms which allows independent elevation of both the fixed star and Skyline projectors.

Type 3 for **Tilted** Domes

GSS-URANUS with the Skyline projector design which is completely separated from the fixed star projector.

Note: When designing this type of theater it's necessary to thoroughly consider the Astrovision location, seat height and inclination angle of the dome.

Further information can be obtained by directly contacting the author.

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手作りの移動式プラネタリウム
Handmade Movable Planetarium

大平 貴之（Takayuki Ohira）

1 概要 (Outline)

プラネタリウムは、いつでも大自然同様の星空を再現することのできる装置である。それは星好きにとってはたまらない魅力である。

私は、自分で人工の星空を造り、自由に操ってみたいという夢を持ち、プラネタリウムの製作に取り組んだ。そして、私は技術的・経済的困難を乗り越え、完成させることができた。このプラネタリウムの特徴は以下の通りである。1) コンパクトで移動可能である 2) レンズ投影と8.0等まで含む独自の恒星原板により、リアルな星空を再現することができる。3) 投影機、ドーム、ソフトその他すべて学生の手作りである。

私は、このプラネタリウムを各地で公開してきた。今後も、移動式ならではの活用形態を見つけてゆきたい。

Planetarium can reproduce the starry sky as the nature itself. This is the charms for all of the astronomical fan. I had a dream of making artificial starry sky by myself and manipulating it freely. In my school days, I worked at the planetarium manufacturer and got over any economical and technical difficulties which made it possible to complete my trial. The characteristics of my planetarium are as follows. 1) Movable &compact 2) Can reproduce the starry sky (including the stars brighter than 8.0 magnitude) by using original star−plate and projection lenses. 3) All is handmade by the student. (Projector, dome, software & etc..)

I have presented this planetarium to the public in various places. I hope to find much more useful uses in the future, making the most of its movable characteristics.

Star Projector	Form:2-ball /Number of stars:45,000 (-1.5〜8.0mag) / Projection-unit:32 Light source:250W-Tungsten halogenlamp ×2 / Cooling:forced air cooling Motion: 3-axis(Diurnal, Latitude, Cos) Sub-items:Milkyway, Brightstar Size:W=1.2m H=1.7m /Weight:80kg
Planet Projector	Form:Separated from star projector Items:Sun, Mercury〜Saturn, Comet etc..
Effects	Twilight:R, O, C(Auto-sun tracking) Lighting:R, G, B, W
Control	Control:Computer aided Manual or Auto
Etc	Power:AC100V 2.5kVA
Dome	Diameter:10m(32.8ft)/Height:6.8m Material:vinylchloride+polyester-fiber Entrance:Double door air-lock Environment:indoor or outdoor

Table. 1 Specifications

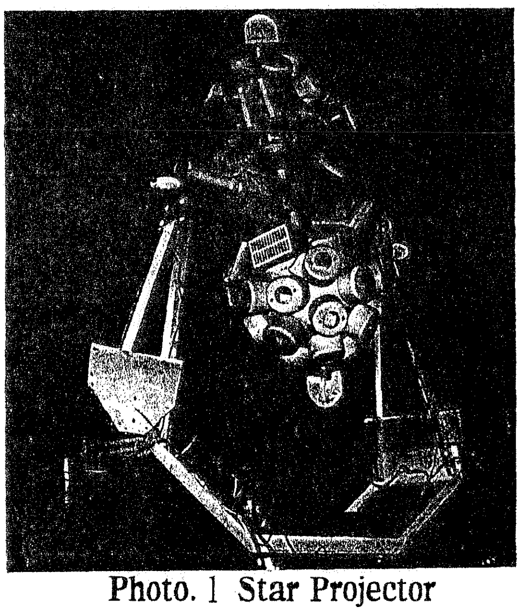

Photo. 1 Star Projector

2 投影機構成 (Construction)

本投影機は、主に恒星を投影する恒星投影機、惑星、太陽、朝焼け夕焼け、照明などの補助投影機、制御システムなどから構成される。

2－1 恒星投影機 (Star projector)

南天と北天用の2つのレンズ投影式恒星球を持ち、32組の投影ユニットで全天の星野をカバーする。独自に開発した恒星原板には8.0等までの恒星を刻んであり、より深みのあるリアルな星空を再現することができる。独自考案の3軸架台を制御して、仮想的に、天球上の任意の位置を中心にした回転が可能である。

2－2 補助投影機 (Sub−Projector)

惑星、および太陽の投影機が本体とは独立して設置されている。各惑星の位置を computer が計算し、それぞれの投影機を所定の方向に向ける。軌道要素を登録することで彗星なども投影できる。朝夕焼け (twilight) 投影機は、常に太陽方位を追尾運動する。その他、場内を様々な雰囲気に照らし出す効果照明などが備えられている。

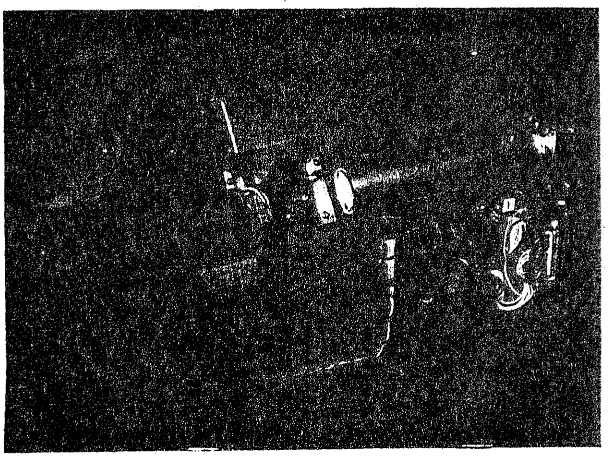

Photo. 2 Planet projector

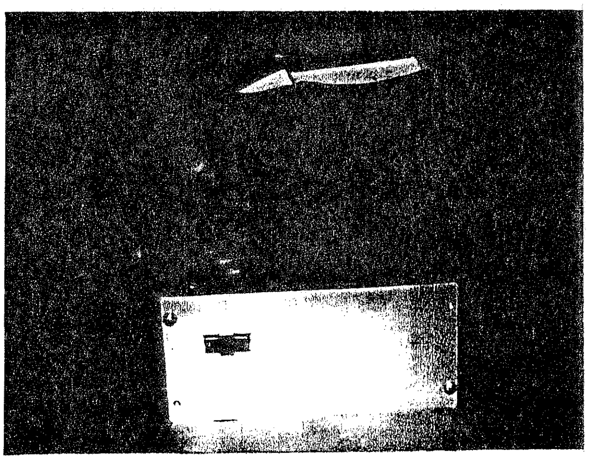

Photo. 3 Twilight projector

2－3 制御システム (Control system)

投影機のすべての機能は computer で制御される。operator がダイヤル操作すると、computer が日付等の parameter を更新し、惑星投影機の複雑な制御や、煩わしい調光を automatic/semi−automatic に行う。また、現在位置は操作台の display 上の仮装計器盤や graphical world map に表示され、時刻や日付、投影機の動作状況などが数値で画面に表示される。digital 制御であるが、analog 的な感覚で操作できるような構成となっている。

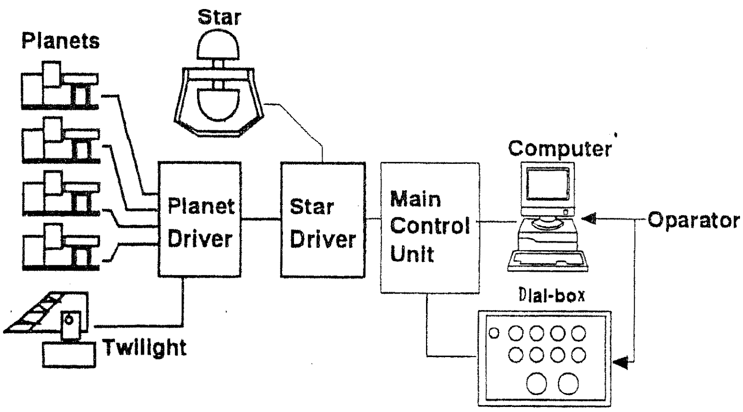

Fig. 1 system−diagram

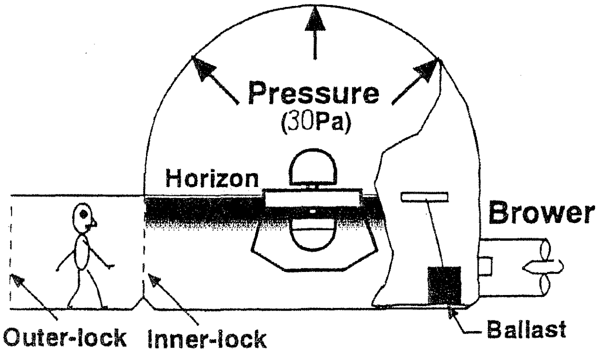

Photo. 4 Air dome(10 meters diameter)　　Fig. 2 Construction of Air dome

2－4エアードーム (Airdome)

直径10m、全高6.8m のドームは、骨格なしのエアードーム (air dome) である。素材は完全遮光性を有する特殊 vinyl 生地で、壁面に設けられた送風機の加圧で、ドーム内圧が30(Pa) 程度上昇し、その圧力がドーム全体を支える。出入口は2重の air lock 形式となっており、出入り時のの空気漏れを防ぐ。折り畳んで自動車等で自由に運搬できる。

3 プラネタリウム移動運用上の問題
Problems of planetarium's moving operation

プラネタリウムの移動運用には常設にはない特有の問題があり、独特の工夫が必要である。

3－1 設営、撤収 (Construction& Removal)

様々な公演依頼に対応するためには、いかに機動性を高めるかがポイントとなる。特に、迅速な設置と撤収が必要である。まず、恒星球を本体から脱着可能にして輸送を容易にした。さらに機器接続に必要な配線数を削減し、設置時間を短縮した。今のところ重さ140kg のドームの軽量化は望めないが、今後キャリングケースなどを完備して作業性を向上させたい。現状では、設営開始から6時間程度で投影開始できる。

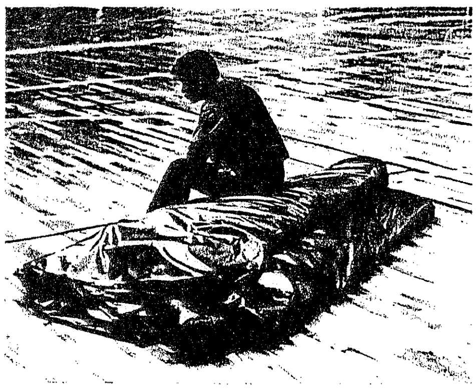

Photo. 5 Folded dome

3－2 投影精度 (Projection accuracy)

固定の建築物である常設ドームとは異なり、ビニール製のドームは球面度が劣る。ドーム設計時に重力変形を補正して真球面に近づけているが、内圧による変動もある。内部の空気圧により地平線高さが変化すると、日出没時の演出に支障がでる。分離式の惑星投影機は、これら

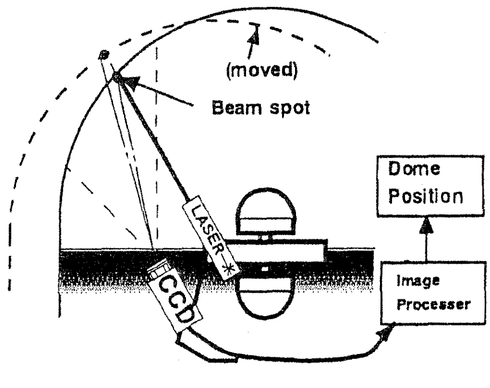

Fig. 3 Laser sensing of dome motion

変動の影響を受けやすく、日周運動時に恒星と惑星像のズレが生じるなどの問題を引き起こす。恒星投影機から観客には見えない波長の赤外 laser を発射し、反射光をCCD で撮像、画像上スポットの位置よりドーム変動を検出する方法を検討している。

3－3空調 (air conditioning)

ドームは密閉性が高く、投影機の発熱や観客の体温により暑くなりやすい。成人一人あたりの代謝量を100Wと考えると、100名入場時の気温を外気同等に維持するには10kw の冷房能力が必要である。これに見あう冷房装置を移動することは難しいので、現状では番組間に interval を設け、換気して雰囲気の悪化を防いでいる。

3－4その他 (etc..)

常設館では、客席には上方を見上げても疲れないようなリクライニングシートが用いられている。しかし、移動運用では難しく、パイプ椅子などの簡素な座席にせざるを得ない。したがって、観客が星空を見上げていられる限界として、番組の長さは20～30 min 以下に抑えるようにしている。

4応用 (Application)

移動可能であることを生かして、次のような応用形態が考えられる。

●天体観望会の補助 (観望の指導、予行演習、曇天時の backup)

●各種イベント、文化祭などの展示企画

●学校行事など

5実績 (Results)

これまで国内全国各地での公演依頼を受け、5年間で計11回移動公演を行ってきた。その半分は天体観望会など天文 fan 向けの企画で、残りは一般の祭りや文化祭などのイベントであった。また、今年3月には、百武彗星の動きを本物同様に再現してみせるシミュレーション投影を一般公開し、好評を博している。

6おわりに (Finis)

以上、私の手作りによる移動式プラネタリウムについて紹介させていただいた。もともと、我が手で星空を作ってみたいという他愛もない夢を、このような形に発展できたことを嬉しく思う。

一般に engineering の成果は一般人には難解で理解しがたいことが多いが、プラネタリウムのそれは、老若男女を問わず、ドームに訪れた誰もを宇宙の神秘で魅了し、感動させることができる。これがプラネタリウム造りの一番の魅力である。本物の夜空には遠く及ばない作り物ではあるが、まさしく天地創造なのである。

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SESSION
"Computer/Network"

名古屋市科学館プラネタリウムのネットワーク活用

毛利勝廣　鈴木雅夫　北原政子　Katsuhiro MOURI　Masao SUZUKI　Masako KITAHARA

名古屋市科学館　天文係　Nagoya City Science Museum　Astronomy section

名古屋市科学館では、1990年よりプラネタリウムにおけるコンピューターネットワークの活用について調査し実践してきた。本稿ではその経緯と現状を報告する。

1．パソコン通信

1990年、日本の大手パソコン通信である、Niftyserve、PC-VAN、Asciinetの３社と法人契約し利用を始めた。天体の発見情報や教育活動に応用できるフリーウエアの入手と活用が主目的である。またこれらのパソコン通信を経由して海外の通信社等のデーターベースに接続しニュースを入手した。たとえば、旧ソ連の宇宙ステーションミールが日本上空を通過し観察できるといった時には、ミールの最新情報をタス通信から入手し見学者に解説した。情報収集の主要手段がインターネットに移った現在も、後述する電子メールの受け口やデータベースシステムへの入り口としてNiftyserveを活用している。

2．スタッフ内システム

プラネタリウムスタッフが各自のコンピューターでスタッフ間に共通な情報を読み出して利用するという、スタッフ内システムを構築した。これはマッキントッシュコンピューターが持つファイル共有システムを利用し、スタッフ内共通のファイルを納めたサーバーに事務所やプラネタリウム調整室などから自由にアクセスするというものだ。その際、統合ソフトのクラリスワークスを事務用共通ソフトとし、スケジュール表や定型文書を共有している。

さらにQuickmailシステムを導入し電子メール環境を構築した。ＩＡＵＣや国立天文台ニュースなど外部からのメールはスタッフ共通の電子メールアドレスに受信し各自に配信している。現在の勤務体制では休暇が順番制で全員が同じ日に勤務することが少なく、プラネタリウム解説や会議で出勤はしていても会って話ができないといった現状であるが、お互いの連絡を電子メールで行うことにより、スタッフ間の連絡がスムーズになった。また出張先や自宅からも自分宛の電子メールをモデム経由で読むことができるようになっている。

3．シューメーカーレビー第９彗星衝突とインターネット

世界的に1994年のＳＬ９彗星衝突は、コンピューターネットワークの大きな実力発揮の場面であった。当館プラネタリウムでは衝突のまさにその月である1994年7月にＳＬ９衝突を取り上げた投影を行った。新しい情報をすぐプラネタ

リウム解説に使うことができるという生解説の長所を利用し、WWWや電子メールで集めた衝突の映像や様子が届き次第、すぐ次の回のプラネタリウムで投影し活用した。プラネタリウムではこの後もインターネットの様々な映像を解説時に活用している。

また、プラネタリウムでの教育用映像資料の作成にもインターネット環境を用いた。名古屋市科学館と通信総合研究所と名古屋大学情報文化学部の3者の協力で、ＳＬ９が衝突にいたるまでのコンピューターグラフィックス（＊１）を作成した際、軌道データや画像をＦＴＰでやりとりし電子メールで互いに連絡を取りながら製作をした。この3者のプロジェクトではその後も同様の方法で、土星の環の消失（＊２）等のＣＧ映像を作成している。

４．インターネットによる情報発信

1995年には名古屋市科学館のホームページ（＊３）を開設した。当館の紹介や行事案内、天文情報の発信を行っている。当館には情報発信の担当者がいるわけではなくプラネタリウムの解説や番組制作の合間に発信を行うという現状のため、全てのニュースを網羅するというわけにはとてもいかない。しかし、先日の百武彗星のようなビッグイベントの時にはできる限りの情報発信につとめている。

ところで、その発信内容の中心は天体等のみつけかたである。どんな風に見えるのか、いつ見えるのか、どこに見えるのか・・・といった文章、地平線から見上げた形のものを日毎に作成した星図など、当館の百武彗星のWWWページの約80％が見つけ方のために使われている。また彗星の写真も大きく拡大したものや画像処理をかけたものをあえて使用せず、肉眼や双眼鏡で実際に見た感じに近いように撮影して使用した。また同じ日の街中と郊外と山奥の写真を並べて見え方がどのように違うかを比較した。

当館がプラネタリウム解説時に大切にしている姿勢は、見学者に、今晩家に帰って本物の星を眺めてみようという気持ちになってもらうこと。これはインターネットによる情報発信でも同じだと考えている。

５．イントラネット・ＪＡＶＡ・ＩＷＥ’96

ホームページで公開する内容は、同時に電話などでの問い合わせの多い内容でもある。そこで質問電話があり、日程や時間など正確を期する内容を答える場合、資料文書を探す代わりに、自分のコンピューターでホームページを確認しながら答えられるようにした。公開用サーバーではレスポンスが遅い時があるため、スタッフ用ＬＡＮの中のワークステーションにホームページをおいてある。またこれは公開しているホームページの動作確認もかねている。さらに現在、天文に関する質問の統計から、多くかかってくる内容をホームページにまとめ始めている。これを公開することによりホームページの利用者も簡単な質問なら自分で探すことができ、電話がかかってきた時も正確に対応できる。また内容に変更があったときもすぐに全員が対応できる。大きな天文現象が

あった場合、１日に200本を超す質問電話がかかるため、このイントラネット的システムは重要である。（図１、名古屋市科学館のネットワーク）

インターネットだけではなくコンピューターソフトウエアの新しいプラットフォームとしてＪＡＶＡが注目されている。当館では名古屋大学情報文化学部との連携により、スカイラインやオールスカイ映像作成のツールをＪＡＶＡで開発しネットワークを経由して画像処理を行うシステムを開発中である。また、インターネットワールドエキスポ'96（＊４）やＮＴＴ主催のワールドネイチャーネットワーク（＊５）では、ホームページの公開とともにネットワークを活用したマルチメディア実験「星空のオルゴール」等の準備を進めている。

６．今後のネットワーク活用

プラネタリウムにおけるネットワーク活用は、まだまだ始まったばかりである。電話やｆａｘ、ワープロ等を使うことそのものにはすでに意味がなく、何をするかに意味があるように、コンピューターネットワークも「使った」とか「つないだ」とかいうことではなく、何をすることができたかが問われる時期になった。インターネットという言葉が普及し個人でもホームページを簡単に持てる今、社会教育施設としてのプラネタリウムや公開天文台のホームページは、スタッフのテクニック等の顕示の場ではなく、利用者にとってどういう情報が必要かを見極める必要がある。

さらにプラネタリウム同士の協力体制も必要であろう。あるプラネタリウムで興味ある活用をしていても、他の地域の人はそれを見ることができない。そこでＩＰＳやＩＰＤＣ、ＪＰＳなどでプラネタリウム間の情報交換やテクニック公開を行っていき、さらにその情報交換そのものをネットワーク経由で行うことができたら良いだろう。ただし、そのためにはもっと使用環境が簡単になる必要がある。コンピューターに強いスタッフだけが使うというのではどうしても内容やコンセプトに偏りが出てしまうからだ。そこで当館では、プラネタリウムスタッフが全員同じ種類のコンピューターをそろえ、全員で使用している。進歩の早いこの世界のことであるから、使用環境の簡易化も近い将来実現されるに違いない。

それぞれの地域の人々や地域を越えた広い範囲の人々に、より天文に親しんでもらうため、ネットワークを活用したプラネタリウムの教育普及活動はさらに重要性を増すことだろう。

＊１　http://www.tokai-ic.or.jp/ncsm/astro/1995/s19.html
＊２　http://www.tokai-ic.or.jp/ncsm/astro/1995/saturn.html
＊３　http://www.tokai-ic.or.jp/ncsm/astro/astro.html
＊４　http://park.org/
＊５　http://www.wnn.or.jp/

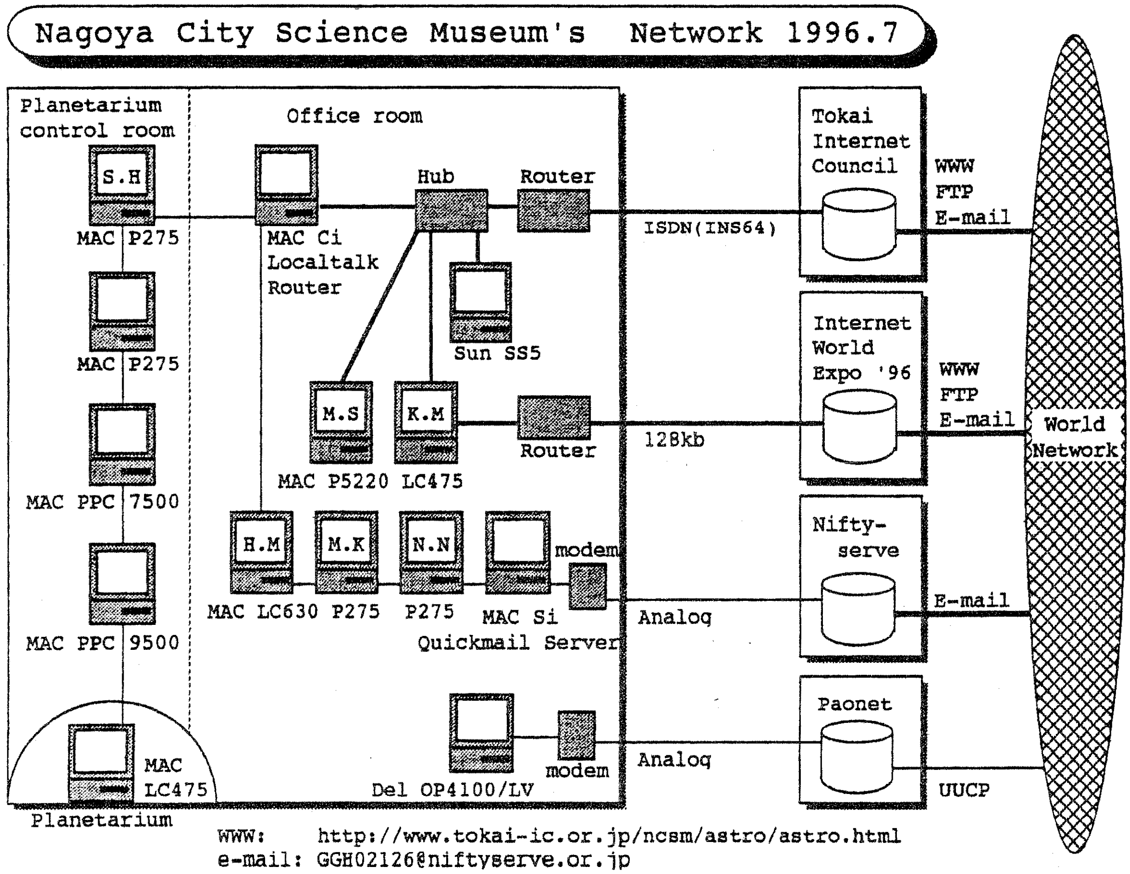

図1、名古屋市科学館のネットワーク

NEW INTERNATIONAL PROJECTS LINKING PLANETARIUMS TO RESEARCH, INDUSTRY, TELEVISION AND THE INTERNET

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A highly successful formula for the creation of children and family programs for planetariums has been the use of a live host or teacher in the planetarium theater who interacts with well known characters from the television or motion pictures industries in the presentation of the subject matter. Having created "Wonderful Sky with the Sesame Street Muppets" in conjunction with The Children's Television Workshop and "Robots in Space with R2D2 and C-3P0" in conjunction with Lucasfilm, Ltd., production is now underway on a new, interactive program for an international consortium of planetariums.

Six years ago, Broderbund Software, Inc., the marketers of "Myst", introduced "Where in the World is Carmen Sandiego?", an interactive computer game destined to become the most popular educational product of its kind in the industry. Since then, Carmen Sandiego has become the basis for a series of additional computer games as well as highly successful and award winning television programs plus numerous lines of merchandise and product.

"Where in the *Universe* is Carmen Sandiego?" will be a fast paced, highly interactive planetarium show featuring full color character animation that will take audiences across the cosmos in search of Carmen and her associates. It will be a fast paced, action adventure in which the entire audience will be called upon to answer questions, solve clues and exhibit critical thinking while learning about the planets, stars and galaxies. The program is scheduled to première in early 1997.

Last year, the author also became involved in a series of international projects, known as Passport to Knowledge, aimed at linking students and teachers in schools, science museums and planetariums around the world with research scientists via television and the Internet. In the fall of 1995, we went "Live from the Stratosphere" connecting sites across the US with scientists on board the Kuiper Airborne Observatory. At NASA's Ames Research Center near San Francisco, we turned a giant aircraft hanger into a television studio for the television broadcasts on PBS. On board the KAO at 41,000 feet were April Whitt of the Fernbank Science Center in Atlanta and Brian Scott, a high school student from Houston, Texas. On the ground, satellite uplink sites included the Liberty Science Center in New Jersey and the Houston Museum of Natural Science. From these and other locations and via Internet around the world, students were able to interact directly with the people on board the aircraft. Students at the Adler Planetarium in Chicago even were able to remotely control the KAO's infrared telescope via the Internet. At Ames, we broadcast a total of seven and a half hours of live TV to over 200 PBS stations across the US. Students from the San Francisco area created large models of the solar system, model comets and even broadcast part of the program in the infrared part of the spectrum.

In the winter and spring of 1995-96, we obtained three full orbits of the Hubble Space Telescope from NASA for use by students around the world. Via the Internet, students from California to Russia

/oted to search for new storms on Neptune and look for new features on Pluto. Then on live TV, the ;tudents got to see their results come down live from orbit under the direction of Dr. Heidi Hammel rom MIT and Dr. Marc Buie from the Lowell Observatory. Again, students interacted live with these ;cientists. Participation included American students with Martin Ratcliffe at the Bulh Planetarium in Pittsburgh as well as German students under the direction of Thomas Kraupe at European Southern Observatory Headquarters in Garching, Germany and Japanese students who gathered with Sho Itoh it the Suginami Science Education Center in Tokyo. Broadcasts came from these locations as well as rom NASA's Goddard Space Flight Center and the Space Telescope Science Institute in the US. Again student activities were featured including the turning of the entire audience into a giant CCD ligital electronic images from space and real time image processing and enhancement of astronomical nages. Students prepared for the broadcasts with correspondence and group experiments on the nternet as well as others featured in Teacher's Guides created especially for the missions.

Our next project in the series, "Live from Mars" is now underway in conjunction with NASA, the et Propulsion Laboratory and the upcoming Pathfinder and Global Surveyor missions to Mars cheduled for launch later this year. A Teacher Workshop will take place in Washington on uly 18, 19 and 20 with virtual links via Internet and NASA-TV occurring from New Zealand to apan. Teachers Guides and related Internet materials will be available by September and four prime ime PBS television specials are planned.

インターネットを使った科学教育プログラムへの参加

Participation to Science Education Program using INTERNET

伊東昌市、岩下由美、浜村しおみ、木村修、茨木孝雄
Shoichi Itoh, Yumi Iwashita, Shiomi Hamamura, Osamu Kimura, Takao Ibaraki
杉並区立科学教育センター
Suginami Science Education Center

１９９５年１２月から１９９６年４月にかけて、「知識の国へのパスポート(Passport to knowledge)」チームが主催するプログラム「ハッブル宇宙望遠鏡からのライブ(Live from Hubble Space Telescope)」に参加した。Bill Gutsch氏の呼びかけによるものである。

当初、杉並区立科学教育センターにはインターネットを快適に利用する環境が整っておらず、可能かどうか不確定的な要素が強かった。従って例え当センターで実施することが不可能な場合でもどこかで実施したいと考え、理化学研究所主任研究員戎崎俊一氏及びＮＨＫ解説委員高柳雄一氏に協力を仰ぎバックアップしていただいた。

当杉並区は個人情報保護条例により区が保有するコンピュータと外部を接続してはならないと規定されている。例外条項もなく全国的にも最も厳しいものとなっている。区の電算組織管理部門との折衝により、区保有でないコンピューターの使用と仮設的回線の使用なら区当局は関知しないとの非公式の見解を得て、実施することとなった。

コンピューターは九州芸術工科大学の坂井滋和氏から借用し、回線についてはNTT千代田の本間幹人氏の協力でISDNの敷設を、またインターネットへの接続はNTTPCコミニュケーションズの伊藤行正氏の協力によって可能となった。

結局当杉並区立科学教育センターと理化学研究所の二カ所からの参加が実施されることとなった。

児童や生徒による学習活動は杉並側は杉並区立桃井第四小学校教諭の小山　浩氏（現在は同区立井荻小学校教諭)に協力及び指導をお願いし､理研側は東京大学教育学部付属中・高校教諭縣秀彦氏に協力及び指導をそれぞれお願いした。

杉並サイトではGreat Planets Debateにも参加し、１２月１５日締め切り期限から遅れたものの、ハッブル宇宙望遠鏡を使った観測に対する児童の観測希望順、1)海王星、2)冥王星、3)木星をE-mailで報告した。また、１月には呼びかけ（Kraupe氏の？）に応じ、冥王星発見者トンボー氏９０歳の誕生日に送るバースデー・カードを児童達で作成し送った。

３月１５日未明に実施されたテレビによるライブ授業「Making YOUR Observations」では、午前３時からの放映に向けて２時に集合し、プラネタリウム番組「太陽系の七不思議」を見たり、インターネットの勉強、ビデオを使ったコミニュケーション・ソフトである「CU-SeeMe」を使って理化学研究所とつないで相互交信を行うなどした。CU-SeeMeに対する子ども達の興味は大きく印象的であったようだ。

アメリカではNASAテレビやケーブル・テレビで放映されるライブ授業はインターネットを使ってCU-SeeMeで見ることになる。画像はしばしば停止したり音声が細切れになるなど、技術的問題点も多い。けれども全世界同時にしかもどこでも見ることができるのは優れた点である。理研サイトはテスト的にCU-SeeMeよりはるかに優れた画質のＭＢＯＮＥで放送を見ることができた。しかしながら、画像容量が大きく技術的なバックアップ体制が必要なこと回線の独占が生じるために小さな施設では使用が難しい。

４月２５日未明のライブ授業「Announcing YOUR Results」では、CU-SeeMeのみの使用と日本からの子ども達の参加に対応するために、杉並サイトに一本化しての参加とした。当日はプラネタリウム番組「宇宙を広げた人エドウィン・ハッブル」を投影し、惑星科学者の長谷川均氏による惑星についての講演と戎崎俊一氏によるハッブルの研究についての講演を行い、放送を待った。須藤義人、平野理依子の両氏に同時通訳をお願いし、国際電話回線で音声を確保し打ち合わせ及びオンエアーに使用した。画像はCU-SeeMeを使ったが、通信速度が上がらず、しばしば画像凍結が生じた。

技術的問題点や英語からの通訳、さらには未明という実施時間の問題をどう解決したらよいのかという難点があるものの、非常に興味ある教育実験であることは確かなので、この「知識の国へのパスポート(Passport to knowledge)」プログラムへの参加を続けていきたいと考えている。

From December 1995 to April 1996, we, Suginami Science Education Center and Institute of Physical and Chemical Research (RIKEN), have participated science program "Live from Hubble Space Telescope" carried out by Passport to Knowledge team, supported by National Science Foundation, NASA and PBS. Suginami side had some critical problem that Suginami Government does not permit to connect computers which belongs to our government to external or out side computers for keeping personal information of citizen in law. So we have to ask a lot of volunteers to help our plan to join Live from HST program.

Fortunately a lot of people such as Dr. T. Ebisuzaki at RIKEN, Y.Takayanagi at NHK, M. Homma at NTT, Y. Itoh at NTTPC Communications and others assisted us with technical supports for connecting INTERNET through Integrated Services Digital Network (ISDN) of NTT in temporary condition. H. Koyama, science teacher at No.4 Momoi Elementary School in Suginami City and K. Agata, science teacher at Attached high school, University of Tokyo, prepared the opportunity for students participation to this program.

On March 14's Live "Making YOUR Observations", Suginami Science Ed. Center and RIKEN participate separately. Suginami side received NASA TV images using CU-SeeMe via INTERNET which has projected from video projector to our planetarium screen and students from No.4 Momoi Elementary School joined, and RIKEN side, which has 1.5Mbps lines for INTERNET, also received them using MBONE technics via INTERNET at RIKEN's conference room and students from Attached high school at University of Tokyo joined, respectively. Undoubtedly video images of MBONE looked fine, but there didn't exist no possibility for interactivities like usual TV broadcasting. Students loved CU-SeeMe very much. And another problem of MBONE was it occupied too many circuit lines, about 0.5Mbps. So, technicians of computer network didn't like to use it any more. Then RIKEN team decided they will joint to Suginami side on April 24, though it can connect to INTERNET only via 64Kbps ISDN.

On April 24's Live "Announcing YOUR Results", the conditions of CU-SeeMe for watching NASA TV via Internet was not well rather than March 14's Live and frequently images have frozen. But international telephone connections kept good ones for phone sounds from STScI which was supported by K. Sudoh and R. Hirano, voluntary interpreters. On both Lives we also prepared special programs for students. They were planetarium shows named "7 wonders of the solar system" and "Edwin Hubble, a man who expanded our Universe", and astronomy lectures about solar system and about Edwin Hubble.

As results, almost students and parents delighted and excited to participate this program with real time, real science and real scientists, thought it was done at midnight or very early in the morning and students joined with sleepy eyes.

We could know there exist big possibilities for science educations to use On-line interactive programs such as Live from HST, though it still remains a couple of problem that it was done at midnight because of difference in time and it was done with English language. We hope to continue to participate further programs presented by Passport to Knowledge team, if equipments such as ISDN connection will be completed permanently.

Using the Internet to Create Learning Opportunities

Phyllis Burton Pitluga

Adler Planetarium & Astronomy Museum, Chicago

INTRODUCTION

Thinking back several decades ago to discussions about the planetarium of the future, no one foresaw the Internet. Yet, this has become a major link between many of us and our audiences, both within our facilities and outside. The Adler's first opportunities came from the university community. They had created and were actively using the Internet and saw the potential for public education. Since then, using the Internet to its fullest is becoming as essential to Planetarians as operating a planetarium projector, reading ephemerides and sharing the latest discoveries of the Universe.

INTERNET LEARNING OPPORTUNITIES

The learning opportunities that The Adler Planetarium now offers are the basis for this paper. They are meant for you to use and to inspire you to add to these opportunities. The are presented in chronological order, which approximates an increasing complexity as well.

Collecting Images and Information

In the 1980's, the University of Chicago astronomers were planning a new major research observatory that would be located far from most of the consortium universities (Chicago, Princeton, Washington State and the Universities of Washington and New Mexico). They planned to operate the telescope remotely with their own software via the developing Internet. In the planning stages, they approached The Adler about having a remote station on our exhibit floor where the public could see "over the shoulder" of an astronomer operating the telescope, see the latest technology and the most recent discoveries. We enthusiastically agreed. Our observing station was complete before the telescope saw "first light." As soon as we were connected to the Internet, we began displaying images that were posted elsewhere. Today, the wealth of fabulous new images and latest information is astounding.

Our next Internet use came via the "Hands On Universe" (HOU) educational program developed at The University of California, Berkeley with funding from the National Science Foundation and the Department of Energy. In this application, images are requested and downloaded via the Internet to classroom modems. Software is provided to classes that allows students to manipulate astronomical images in the way astronomers manipulate images to analyze them. We began teaching teachers here, have had some public guided-learning opportunities and are working with the Boston Museum of Science in making this accessible to the public. The HOU information is available at:

http://hou.lbl.gov/

Creating Educational Internet Lessons

By the early 1990's the World Wide Web (WWW) made the Internet user-friendly. Astronomers at University of California, Berkeley's Center for Extreme Ultraviolet Astronomy approached us with National Air and Space Administration (NASA) funding. We were invited to partner with them and with three other museums (including our colleagues at Lawrence Hall of Science) and with teachers in each of the regions. We would develop lessons that make use of the latest astronomical data available on the Internet. As a result of this project the schools were connected to the Internet and the participating teachers learned to access sites and write their own lessons incorporating links to the Web sites. This was our first experience in writing documents for the WWW in the HTML language. Since then, Adobe PageMill Web Authoring Software makes this much easier. Also, powerful search engines are now available to locate sources of astronomical images and information on the WWW. This project was named "Science On Line" and is accessible at

http://
www.cea.berkeley.edu:80/Education/sol/sol_homepage.html

As consequence of the Science On Line project, the Adler acquired a server - the piece of equipment needed to create and put our own Homepage on the WWW. This provided the opportunity to get the word out about our programs. The Science On Line lessons are linked into our "Resources" button.

http://astro.uchicago.edu/adler/

This past year we set up the Cyber Space Learning Center with two dozen computers linked to the Internet. Through partnerships with the

Teachers Academy of Math and Science and Argonne National Laboratory, Cyber Space is heavily used for teacher training. My own experience with teaching classes this way is that people are fully engaged in their learning experience. At break time and at the end of a two-hour session, no one was ready to leave.

The Illinois State Board of Education awarded The Adler a grant to partner with a dozen schools throughout the state to develop learning opportunities with teachers and students. The classrooms were equipped with computers linked to the Internet and with Flexcam video cameras. Using this equipment I was able to video conference with students and show them, for example, a model of the Sun, Earth and Venus. They saw the above-Solar System view as Venus orbited between the Earth and Sun on June 10, 1996, then the from-Earth view and finally a diagram of the changing position of Venus in the sky. Each class picked a theme, gathered information and images and then developed lessons that are posted at Connecting to the Universe.

http:// www.adler.uchicago.edu/universe/

This summer we have a grant from the Department of Energy to develop learning guides to accompany the television series "The New Explorers." These guides will be available to Internet-linked computers. A couple of the programs in the series are about archaeoastronomy in Peru, South America. The guides will include links to appropriate Web sites on Peruvian archaeology and on archaeoastronomy. When ready this guide will be posted on Adler's Homepage under resources.

This has inspired me to develop post-visit experiences to our sky shows. Currently we have shows running that are about comets and the Hubble Space Telescope. The autumn show will be about the high-energy universe. All of these themes have constantly updated images and information available on Web sites so that students and visitors can extend their Adler visit via computer from their homes and schools.

This year we have actually been conducting research with the 3.5-meter telescope at Apache Point in New Mexico 3000 kilometers from Chicago. The computers in our remote station on the 2nd floor are connected to the observatory via a T-1 line. With the appropriate software and the access code, we are aiming the telescope/infrared camera to mid-range galaxies and taking CCD images to search for supernovae hidden by dust lanes. We will be adding to the building store of data about exploding star to assist in determining whether or not they can be used as "standard candles" in distance determination across the Universe.

Finally, we are just now investigating the feasibility of partnering with planetariums half a world away because most of our audience is here when we have a day sky overhead; it is night half a world away. We are looking for colleagues with a telescope that could be automated to run remotely and take CCD images that would then be transmitted over the Internet to us to display as "live" images in real time. We would then reciprocally have our half-meter telescope available during our night and our partners' day. This would be a fantastic use of the Internet for planetariums.

CONCLUSION

Over the past decade we have gone from collecting learning opportunities via the Net to creating them, from opening our doors daily to nearby visitors to opening our Homepage doors continuously worldwide, and from receiving images from other observatories to actually operating telescopes remotely to be in constant contact with the real universe beyond our planetarium skies. Care to speculate about the next ten years?

ｺﾝﾋﾟｭｰﾀｰを利用したｽﾗｲﾄﾞ制作

鈴木雅夫　毛利勝廣　北原政子　Masao SUZUKI Katsuhiro MOURI Masako KITAHARA

名古屋市科学館　天文係　Nagoya City Science Museum　Astronomy section

名古屋市科学館では、毎月テーマを変えて生解説でプラネタリウム番組を投影している。また、その内容は館内スタッフが自主制作している。1993年からはコンピューター画像処理をスライド制作の一手法として用いている。本稿では当館で蓄積してきたスライド制作のノウハウを報告する。

1．画像処理とスライド制作

プラネタリウムスライドは「フレームレス処理」や「スカイライン用のシフト撮影」などの特殊処理が要求される。従来の制作手法のノウハウを画像処理にも応用することで作業の単純化・能率化ができないかを試した。結果は良好で、プラネタリウムでの使用に十分耐えるものを制作できた。

2．画像処理を用いて制作したスライド

スライドの種別では、解説用・物語用・スカイライン用・オールスカイ用のものを制作した。現在では当館で制作・使用するスライドのおよそ2／3は画像処理を用いたカラースライドフィルムである。

3年間でスカイラインスライドは35シーン以上。解説用スライドは1000コマ以上を制作した。

3．スライド制作に必要な機材

最近のパーソナルコンピューターは「マルチメディア化」が進んだため、ほとんどのものがCD-ROMを内蔵している。従って最低限パソコン本体と画像処理ソフトがあれば、CD-ROMで供給される画像素材や撮影したフィルムから現像所に依頼してPHOTO CDを製作することによってコンピューター画像として取り込み処理できる。できあがった画像を三脚に固定したカメラでモニター画面を撮影すればプラネタリウムスライドは完成する。当館の試みはこうした最小限のシステムで始まった。

時代と供にコンピューター機材は低価格化、高性能化が進んだ。現在当館では入力装置として「フラットベッドスキャナ」「フィルムスキャナ」「PHOTO CD」を目的に応じて使い分けている。出力は「モニター」をマクロレンズで複写している。この出力方式は当初から存続している。最近までスタッフ個人自宅のコンピューターを用いて撮影していたが、館の暗室に専用の装置を設置した。これが3年間で最大の進歩かもしれない。やっと夜を待たずに画像の複写撮影ができるようになった。画像データの移動・保管には光磁気ディスクを用

いている。

4．効果と今後の方針

従来の方法でオペイクでフレームレス処理をしたり、シフト撮影でスカイラインスライド複写を行っていたころに比べると1/10程の作業時間で完了するようになった。これには画像処理上では再処理が簡単に行えることや、一度手法を開発してしまえば繰り返し作業は単純化する効果が出るためある。

当館ではプラネタリウム補助装置として今年２月にAllsky装置が導入された。画像処理でも簡単な情景スライドを制作してみたが、今後はAllsky用のスライドの変形処理など新たに3Dソフトを用いて制作に活用していきたいと考えている。

（参考）使用機材リスト

＜画像処理関連＞

・PowerMacintosh 7500/100	（コンピューター本体）
・Macintosh Centris610	（コンピューター本体）
・Canon IX-4015	（入力装置：フラッドベットスキャナ）
・Minolta QuickScan35	（入力装置：フィルムスキャナ）
・MediaInteligent MM0230V	（記録装置：光磁気ディスク）
・Sony RMOS360	（記録装置：光磁気ディスク）
・Sony Multiscan17SF2	（出力装置：17インチモニター）
・IDEK MF8317J	（出力装置：17インチモニター）
・Adobe Photoshop3.0J	（画像処理ソフト：フォトレタッチ）
・STRATA STUDIO Pro	（画像処理ソフト：3D）

＜画面撮影用装置＞

・Nikon F3	（カメラ本体）
・Nikon F4	（カメラ本体）
・AF MICRO NIKKOR 105mm2.8D	（レンズ）
・TAMRON SP90mmF2.5	（レンズ）
・FUJICHROME Velvia	（フィルム）
・Kenko TV-CC	（フィルター）

（参考）制作スカイラインスライドリスト

画像処理制作スカイライン（全周）スライド一覧

1	白川公園	19	御岳山の見える風景
2	白川公園（ｼﾙｴｯﾄ）	20	御岳山の見える風景（ｼﾙｴｯﾄ）
3	長崎ハウステンボス	21	赤紫うにょうにょ
4	富士山	22	赤紫うにょうにょ（変化）
5	バリ島	23	文字の白亜紀
6	バリ島（夜景）	24	文字の白亜紀（変化）
7	種子島発射台	25	セントヘレンズ火山ＣＧ
8	ハワイマウナケア山頂	26	セントヘレンズ火山ＣＧ（夕景）
9	ハワイマウナケア山頂（夜景）	27	セントヘレンズ火山ＣＧ（夜景）
10	秋の白川公園	28	グランドキャニオン
11	秋の白川公園（夜景）	29	グランドキャニオン（夜景）
12	パロマ山	30	街明かり
13	パロマ山（夜景）	31	街明かり（変化）
14	パロマ山（線画）	32	ＮＨＫビルから見た名古屋夜景
15	パロマ山（疑似カラー）	33	北極圏
16	ハワイ海岸ＣＧ	34	北極圏（夜景）
17	ハワイ海岸ＣＧ（夕景）	35	ヨーロッパの家並み
18	ハワイ海岸ＣＧ（ｼﾙｴｯﾄ）	36	ヨーロッパの家並み（色変化）

画像処理制作スカイライン（部分等）スライド一覧

1	世界の電波望遠鏡	6	大気と電磁波の種類
2	オゾン	7	花火
3	オゾン（変化）	8	土星環の消失
4	たくさんのサンタクロース	9	サンタクロースの部屋
5	たくさんのサンタクロース（変化）		

USING COMPUTER SIMULATION OF PLANETARIUM FOR A PERFORMANCE PROGRAMMING IN THE PLANETARIUM

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1. PROGRAMMING OF PLANETARIA

The majority of medium- and large-size planetaria and some newer small planetaria are programmable. That means that they are repeatedly able to perform programmed shows. In the principle there are two ways of programming: a direct programming and a teach-in programming.

At the direct programming the programmer writes directly the instructions for the control system. Without special supporting systems this way of programming can be used for the simpler systems as it puts large demands on the experience of the programmer.

At the teach-in programming the machine alone stores in its memory particular instructions step by step just in the same way they were given from the control console. At the play back the machine carries out all memorized cues including the errors made during the recording.The teach-in programming is simple and easy to learn by the user but not suitable enough for complicated programs. Changes in program code are difficult, especially the changes of motions. Usually it is necessary to record the whole motion once more. At recording of motions a larger number of redundant instruction is stored. The record of the show needs always to be realized in the planetarium theater.

2. PLANETARIUM SIMULATOR

The planetarium simulator is a software system enabling creation of performances for planetarium easily outside the planetarium theater including programming of motions. Our simulator is fitted to the possibilities of the model COSMORAMA produced by Carl-Zeiss Jena. Cosmorama is a electro-mechanical planetarium with six main drives - diurnal and annual motion, motion in latitude, azimuth, precession and vertical circle. It has approximately ninety special projectors. The planet cage is used in this planetarium.

2.1 Projectors

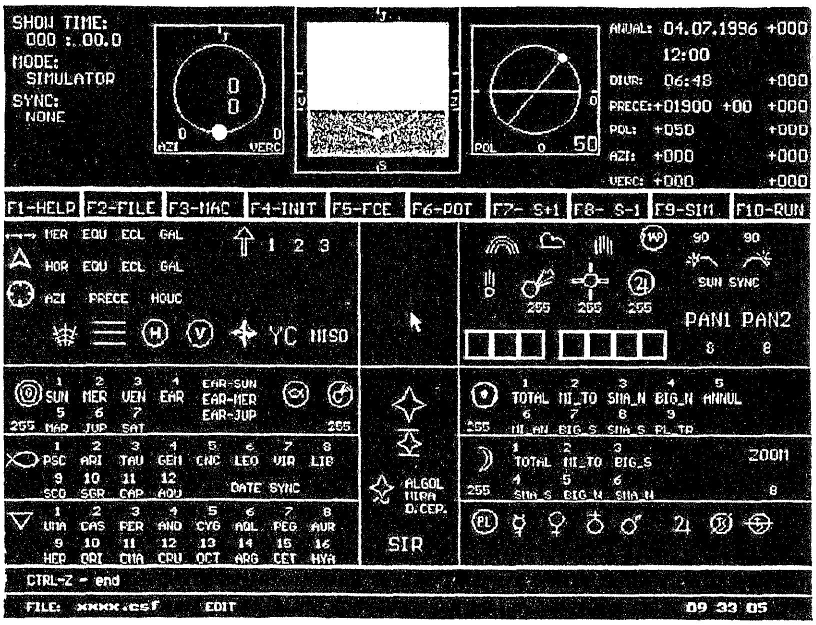

Fig. 1 - The main screen of simulator - projector control

The control of projectors is very simple. On the main screen (Fig.1) are icons of particular projectors. In the course of programming the programmer selects icon-projectors by the mouse. In the dialog box, which is opened, the programmer fills up requested parameters. At the majority of projectors it is the given brightness of the lamp, time in which the brightness should be reached, and the absolute time of the program when the instruction should be carried out. For special projectors the velocity of the motion is assigned, selection of the eclipse, zoom and so on.

The projectors are in the logic groups according to their function. The display is permanently updated. The main screen of simulator is identical with the main screen of the control system. Therefore, it includes also data on the present position of the machine and their graphical interpretation.

2.2 Motions

The motion is described in two steps. In the first step the end position is chosen, in the second one the way of reaching this position. Two special screens are used for the motion programming. The first one (Fig. 2) is used for the setting of the required end position of the motion. It is a simplified planetarium sky with the brightest stars, constellation asterisms, Sun, Moon, planets and additional astronomical and non-astronomical objects. Moreover, the ecliptic, aequator, main compass points, vertical circle, and position of slide- and video-systems frames are displayed. Displaying of particular elements may be enabled or disabled by the user. The simulator displays in a dark circle all what is seen on the planetarium sky. Outside this circle can be seen what will appear straight afterwards the motion in the particular direction.

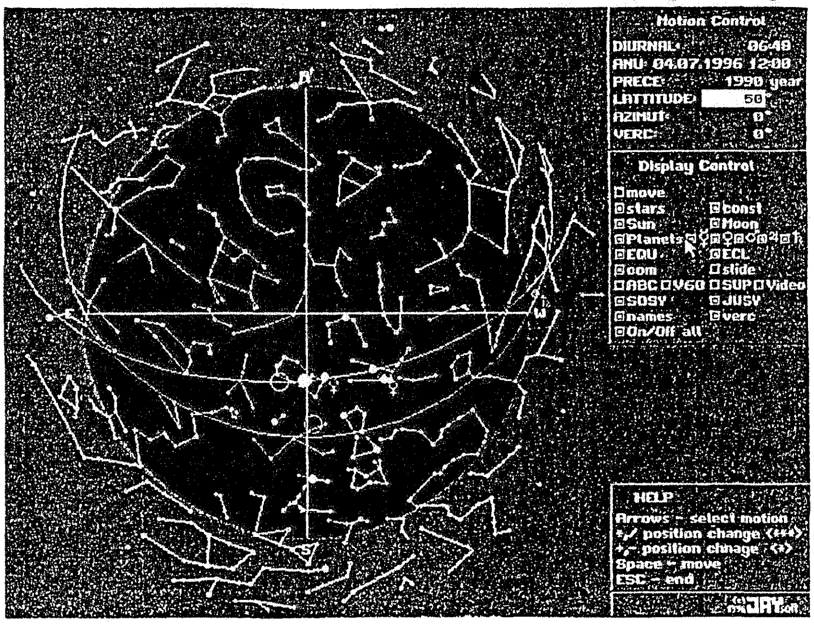

Fig. 2 - The motion control - selection of end position

The appropriate final or end position can be set numerically by the user (by means of parameters - for the diurnal, annual, latitude, precession, azimuth, and vertical circle) or using rotation of the sky by the cursor arrows. Usual it is the combination of both manners of setting - rough setting numerically, soft setting by arrows. To find out a characteristic position in the performance is of a great importance. It is possible to let the simulator to realize the preset motion automatically and the user can choose the optimum position.

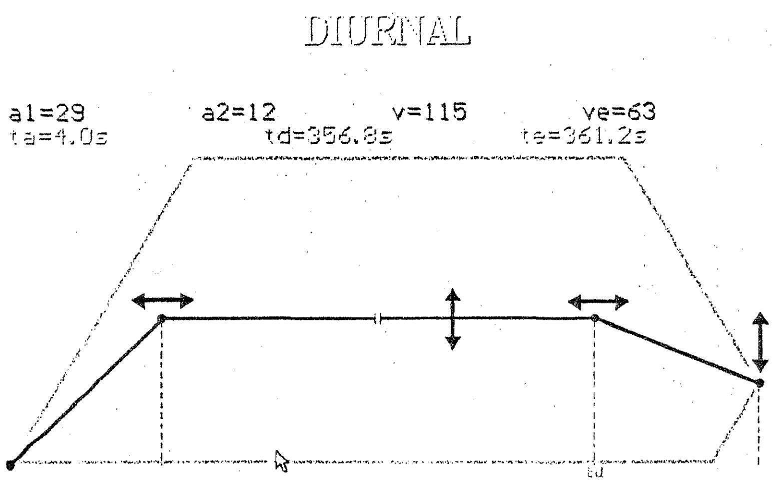

Fig. 3 - The velocity profile control

The second phase is the adjustment of the velocity and its profile. The simulator uses the trapezoidal profile of the velocity (Fig. 3). The parameters are acceleration, velocity, deceleration and end velocity. The simulator automatically calculates relevant times t_a, t_d, t_e. Simultaneously it controls the parameters to be in the permitted interval. All the paramerers are chosen with the mouse. The end velocity of the motion must be equal zero. When the end velocity is different from zero, the simulator requests setting of the next position and further trapezoidal profile. This is repeated as long as the end velocity does equal zero. In the practice it makes possible to create arbitrary velocity profile. The user usually gets along with the basic trapezoidal profile for the majority of motions.

When the combination of more motions for reaching of the requested position is necessary, the parameters of all motions are set one after another in the same manner (Fig 4).

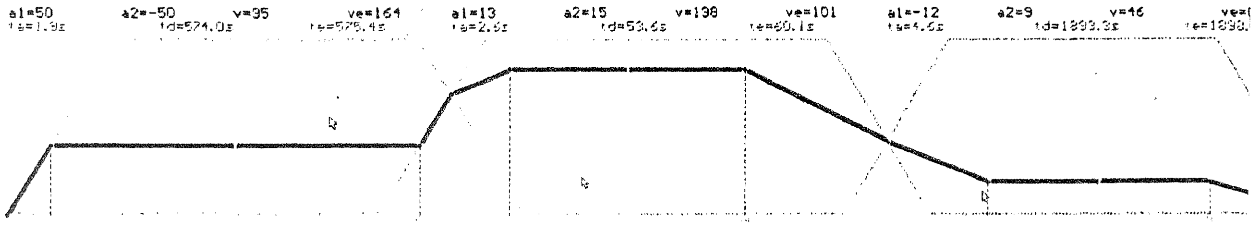

Fig. 4 - Adding of the velocity profiles

2.3 Special Functions

The simulator includes software for special functions as the permanent sunrise, sunset, analema, maintaining of the ecliptic's constellations in the dependence on the Sun position and so on. This enables to the user to choose and immediately use particular function only, without complicated programming.

2.4 File Operation

The code generated by the simulator can be reloaded into simulator and modified. The modifications may be carried out directly in the simulator or in a simple editor. The usage of the editor puts higher requirements on the user. In the editor we can use the functions as insert file or merge file. It can carry out also the automatic time correction.

3. THE USAGE OF THE SIMULATOR

The simulator is applicable for the majority of types of the electro-mechanical planetaria. The knowledge of planetarium technical parameters and its programming language are necessary only. The simulator is always the same, only the compiler module for converting simulator control language into the planetarium control language changes. When the particular type of planetarium has some other possibilities, they can be included in the simulator. On the other hand, if some functions are not implemented, in some cases they can be replaced by the software.

Combined motion functions can be used directly from the planetarium, if they are implemented, or replaced by a software interpretation from the simulator.

Although the simulator was designed for the planetarium with the planet cage it is also possible to use it for planetaria with free standing planets.

3.1 Demands on the Programming Accuracy and the Accuracy of Program Execution

The demands on the programming accuracy and the accuracy of the program execution are two quite different parameters. Under the programming accuracy we understand the accuracy demanded by the author of the performance at the recording of the program. This accuracy can approach in extreme to the program execution accuracy. It can never be greater than the program execution accuracy. The programming accuracy is usually higher in educational performances, lower at show performances.

The program execution accuracy is given by the quality of the planetarium control system, and the mechanical state of the planetarium. The time deviations are usually not greater than 0.1

second, deviations in the position adjustment are not greater than one degree. This accuracy warrants that each repetition of the performance is visually the same.

When the technical description of the planetarium is correct, the simulator enables to create performances within the accuracy very near to program execution accuracy .

3.2 Problems with coupling of diurnal and annual motions

At some types of planetaria with a planet cage the diurnal and annual motion is realized by a complicated gear box. It may cause problems with the accuracy of the annual motion. The difference can be one or two days. In general it is better when the coupling is realized electronically.

3.3 Compatibility

The program in simulator programming language is universal. The simulator programming language is compiled by the compiler module which is unique for every type of planetarium. The creation of a compiler module for every planetarium type is possible provided we know the instruction set and planetarium parameters. Consequently, this enables the full software compatibility of programs generated by this simulator to each planetarium having translation module. Of course, ithe limiting parameters of the planetarium might not be exceeded. In the present the compiler modules are for disposal for the Model COSMORAMA with the original control system, Model COSMORAMA with a new control system, which is installed in Prague, SKYMASTER with a new control system installed in Brno. (Both products of Carl-Zeiss Jena.) The original control system of the Model COSMORAMA is the classical teach-in system, the system in Brno enables a parametric control of motions (end position and profile), the new system in Prague enables full motor control in the whole time.

4. WHY SIMULATOR?

- Possibility of programming outside the planetarium theater
- Time reducing of programming
- High accuracy of programming
- Simple operation
- Program compatibility with other planetaria

HOW TO SQUEEZE THE UNIVERSE INTO A SMALL SPACE

James G. Manning

Museum of the Rockies

The potential of planetariums and astronomy exhibits to complement each other is well known, and many science education facilities use both to present a varied program of astronomy to their public. But what do you do if you have a planetarium and a very limited space for permanent astronomy exhibits?

The Museum of the Rockies in Bozeman, Montana USA faced this problem in 1994 when plans were developed to create an exhibit space in the entrance area of its Taylor Planetarium--an area of just several hundred square feet, perhaps 50 square meters, which accommodated traffic flow to and from the planetarium.

The development of this area needed to meet four objectives: 1) to attract attention to the planetarium; 2) to incorporate the museum's theme of "One Place Through All of Time," which examines the history of Earth as exemplified in the Northern Rocky Mountain region; 3) to provide educational value; and 4) to maintain traffic flow. We found a workable solution by making maximum use of wall space and by using computer technology and a partly interactive philosophy to create a small exhibit "island" which fit within the traffic flow pattern.

On the curved walls flanking the planetarium entrance, we created a representation of the evolution of the universe, starting with a depiction of the Big Bang and evolving to the creation of atoms, the formation of the first galaxies and quasars, an assortment of galaxy types in the developing universe, a close-up view of the Milky Way spiral--with a position indicated for the location of our solar system two-thirds of the way from the center--and a decrease in the density of galaxies beyond to represent the continuing expansion of the universe.

A panel describing each section of the mural was located on an adjoining wall to provide interpretation of the mural without marring the mural itself as a work of art.

The mural served as a backdrop for the exhibit island in front of the entrance and incorporated within the natural traffic flow. This island consisted of a cabinet supporting three elements. The first was a small display of meteorite types, including a touchable iron-nickel specimen. The other two elements were a pair of interactive computer stations we called "Space Stations,"--which used touchscreen technology to offer visitors user-friendly access to a variety of astronomical information and activities.

By following the screens' invitation to "touch me," visitors could access the main menu screen and choose a variety of options for exploration. Options included calculating your weight on different solar system bodies: by touching numbers to record a weight and then touching the "calculate" button, you could learn what you would weigh on the sun, moon or planets. This program has proved to be the most frequently accessed by visitors.

Other options included accessing information on the solar system and its constituents--which is the next most popular program; learning about objects beyond the solar system; reviewing a brief history of manned and unmanned space exploration; and taking "space quizzes" on either the solar system or the universe. We also included an option on the museum itself, allowing visitors to call up a museum map, to learn about specific exhibits or facilities, to review visitor services, or simply to find out where the restrooms were located. This program is the third most popular after the weight program and the solar system.

In the future, we plan to add additional options, including a program on current events, allowing visitors to access pictures and information on the latest from Hubble and Galileo to celestial events that catch the imagination of the public.

In completing this exhibit plan, we even found a discreet corner in which to keep our geochron--which has remained a popular exhibit--so that it is available to visitors without impeding on the larger cosmic theme that now dominates the space.

The exhibit opened in the late spring of 1995 and has been very well received by our visitors. And we think that the simple, uncluttered design meets its objectives quite well: 1) it draws attention near the museum entrance and front desk by providing a dark and colorful contrast to the light colors of the main lobby, through the colors and shapes of the mural and the computer stations which invite interaction; 2) the area supports the museum's theme by providing, together with the planetarium, a cosmic context in which to consider the subsequent examination of the Earth; 3) it provides educational value as demonstrated by studies of its use and visitor reaction; and 4) it preserves the flow of traffic into and out of the planetarium itself. I think it also manages to include a remarkable amount of astronomy, in the concepts of the mural and in the powerful storage and retrieval capabilities of the computer stations.

Perhaps our solution to the problem of limited space for "space" will offer some ideas to others who have minimal exhibit areas for astronomy or wish to create exhibit elements in their planetarium entrance areas. It is one example of how to squeeze the universe into a small space!

Universe: Computerized Theater for Scientific Education

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1 Introduction

Universe is a computerized theater system for scientific education in Science Museum at Kitanomaru Park in downtown Tokyo. It is developed in collaboration of Japan Science Foundation and RIKEN under the supervision of Science and Technology Agency of Japanese government. Main features of *Universe* are a real time operation of numerical simulations of galaxy collisions with a super-high speed special-purpose computer and daytime observations of stars with a remote telescope connected through a global computer network. Figure 1 is a an artist picture of *Universe*.

GRAPE (GRAvity pipE) is a special-purpose computer for gravitational many body systems such as galaxies [1]. It can perform simulations of galaxy collisions with two thousands particles in several minutes. A graphic workstation, connected to GRAPE, instantaneously visualizes the results. The computer-generated images of galaxies are projected to a 200-inch screen to be shown to the audience at the theater.

The graphic workstation is also connected to the Internet. It makes observations of stars even in daytime using a 75 cm telescope located in Leushner Observatory of University of California. The telescope is used in the Hands-On Universe project directed by Dr. Carl Pennypacker at Lawrence Berkeley Laboratory [2]. An image taken by a CCD on the focal plane of the telescope is sent back to *Universe*. The image is projected to the 200-inch screen. Because of the time difference between Japan and West Coast (7 or 8 hours), audiences in *Universe* enjoy the image of night sky even in daytime.

In *Universe*, a scientist gives two scientific shows of 30 $\sim$ 40 minutes in every Saturday afternoon for general audiences.

This paper is organized as follows in section 4. In section 2, we describe the hardware set up of *Universe* System. The contents of a live show are described. In section 3, and the future plan is presented in section 4.

2 Hardware Set Up

The major part of hardware of *Universe* includes a graphic workstation, *Power Onyx* (Reality Engine 2), a special-purpose computer for galaxy simulation, GRAPE-3AF/8, an HDTV

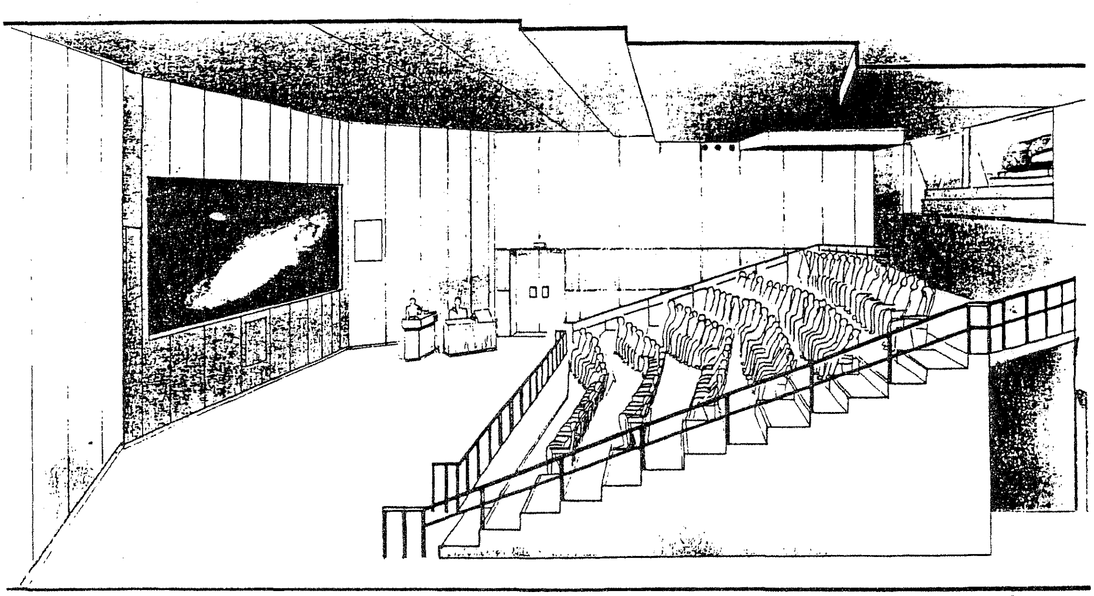

Figure 1: an artist picture of *Universe*

projector (ILA-M320S), and terminals in an operator table, as shown in figure 2. The graphic workstation is the heart of the *Universe.* It performs the simulations of galaxy collisions with GRAPE. The images, generated by *Power Onyx*, are projected to a 200-inch screen in front of the theater by the HDTV projector. It is connected to Internet through a 128 kbps ISDN line. It allows us to send commands to HOU telescope and received the observed images. The operator controls Power Onyx from a workstation (4D/INDY 4600PC) at the operator table located in the front side of the theater. The workstation is connected to *Power Onyx* Ethernet (10BASE-T). Operator also prints out the images from a color printer in the operator table.

3 Scientific Live Show

A scientist, called *Host*, gives two scientific live shows of 30 $\sim$ 40 minutes in every Saturday afternoon in cooperation of two operators. Figure 3 is a snap shot photograph of the Live Show. A show is divided into five corners, *i.e.*, *Introduction*, *Astronomical Observation*, *Galaxy Simulation Live*, *Guest Corner* and *Gravitational Lens Simulation.*

In *Introduction*, *Host* briefly describes the major features of *Universe* using computer graphics demonstration. In *Astronomical Observation*, *Host* shows the several candidates of astronomical objects to observe. One of the operators sends a command to the telescope according as the request of the audience.The image of the stars is shown on the 200-inch screen as soon as it is sent back to *Universe.* It usually takes several minutes from the request to getting the image. When observation is impossible due to a bad weather at the observatory or hardware trouble, *Host* gives a talk using archived images in stead of live images.

In *Galaxy Simulation Live*, *Host* briefly describes what is a galaxy and presents the pictures of various types of galaxies. Then *Host* presents images of peculiar galaxies, such as Cartwheel Galaxy or Antenna Galaxy. *Host* tells audience that their peculiar shapes can be explained by galaxy collisions, using computer graphics movie generated by off-line simulations, with a hundred thousands particles. The simulations were performed by Mr. Yoshizawa at Tohoku University, Japan. At the live simulation mode, two disk galaxies are shown on the screen. *Host* chooses one audience and asks to him or her to specify the initial conditions of the galaxy collision, *i.e.*, the inclination of the disk and the relative velocity between galaxies. The simulation of two disk galaxies with two thousands particles ends up to the merging of two galaxies within several minutes. The snapshot of a highlight scene of the simulation is printed

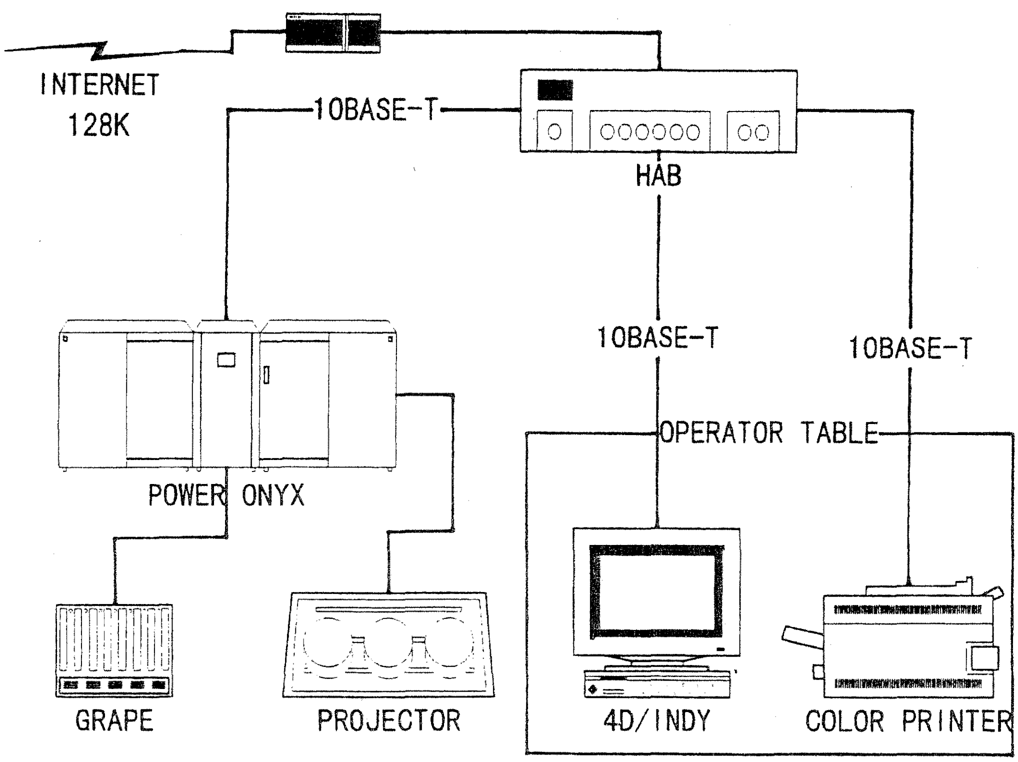

Figure 2: Harware Set Up of *Universe*

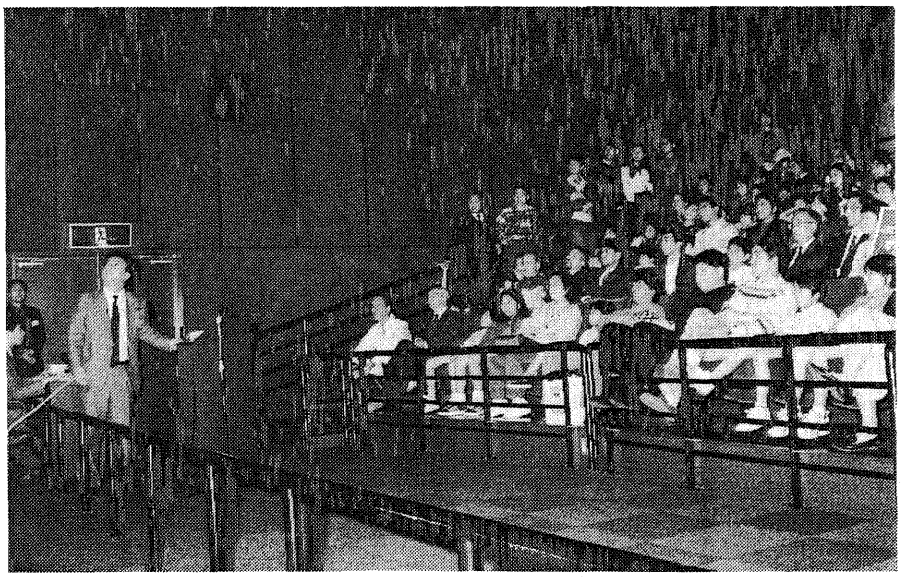

Figure 3:

by a color printer. The audience who specifies the initial condition, can keep it as his or her souvenir.

In *Guest Corner*, we invite a scientist or a person, who is doing science related works. *Host* makes a 10 minutes conversation with the *Guest* on the topic concerning the guest.

In *Gravitational Lens Simulation*, we show how the images are deformed by the gravitational lens effect. Any astronomical object acts as a kind of lens because it deflects light paths due to their own gravitational potential. *Host* picks up an audience and takes a picture of him or her, and uses it for the deformation by a gravitational lens effect. The picture of the deformed face is given to the audience as a souvenir.

All the operations of the system are done by two operators on the operator table according as the request from *Host*.

4 Future Plan

So far, the subject in the live show tends to limit to the astronomical field. However, it is obvious that the ability of the *Universe* does not limit to the astronomically. For example, if we install *MBORN* to the workstation, we can make a video conference session with any place both inside and outside Japan. Audiences in *Universe* can talk each other with researchers or students in foreign countries. We also plan to perform a play related to the scientific topics. Furthermore, we plan to make a *Virtual Experiment Room* in computer, in which we can change physical constants freely. Using this *Virtual Experiment Room*, audience would learn what happens when gravity, light velocity, or other physical constants are different from the current values. *Universe* is evolving.

References

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SESSION

"Literature/Mythologies"

Relations of Constellations and Psychological Mind Structure
星座と心の構造の関係について

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Abstract

Traditional planetarium show is consists of some typical components as sunset, constellations guide myth or legends, some astronomical topics, and sunrise. We used to think about what does audience requires in our planetarium show. Of course, many people demands popular astronomical informations from our show, but apparently, people expects something other elements, at once. It seems that the audiences enjoy a kind of atmosphere in the starry sky. I tried to reserch the relations between this atmosphere and human mind. World wide famous psychologist Carl.G.Jung saids "From ancient times any relationship to the stars has always symbolized eternity. The soul comes "from the stars" and returns to the stellar regions"[(1)], in his literary work. The starry sky -even the planetarium sky- produces a resonance to our mind. This psychological resonance makes these atmosphere to many audiences. Jung's Analytical Pshychology gives us some attempts to this problem. There are some relations between constellations or heavenly body and our internal deep mind. Recent new planetariums -especially in Japan- have a tendency to taking in many brand new audio-visual equipments, but almost their programs are made by outside productions. Therefore recent many Japanese planetariums taking full-automatic show with narrations by audiotape and computer controlled projectors, but without live-voice explanation. Certainly, the automatic show is so fantastic and dramatic one, but it is important for us to notice that the mind relations being exsistent in the traditional planetarium show.

This presentation is originate from thesis which I submitted to ""Institute for the Study of Languages and Cultures of Asia and Africa, Tokyo University of Foreign Studies" *in 1996.*

概要

一般的かつ古典的なプラネタリウムの投影では、日の入り、星座解説、神話や伝説、天文の話題が語られ、日の出で終わるというパターンが多い。最近の新設館では新鋭の機器が取り揃えられ非常に迫力に満ちた番組展開が観られるようになった。これらの番組は確かにドラマテックであるがその反面、本来の伝統的なプラネタリウムの持つ一種の静的な「雰囲気」が失われつつある。星と音楽の夕べなどの投影においても明らかなように、観客は単に星座や天文学の知識のみをプラネタリウムに求めてきているわけではない。満天の星空がかもしだす独特の雰囲気を楽しんでいるようにも見える。プラネタリウムの投影の一連の流れの中には観客の深層心理に関係する要素が見受けられる。一つ一つの投影の要素が観客の心の構造とどのような関わりをもつのか考察してみる。スイスの世界的な深層心理学者カール・グスタフ・ユングは著書の中で『星座との関係は古来「永遠なるもの」をシンボライズする。こころは「星より」来たりて、再び星空に帰る。』[(1)]と述べている。ユングによる分析心理学の立場からこの問題を探ってみる。

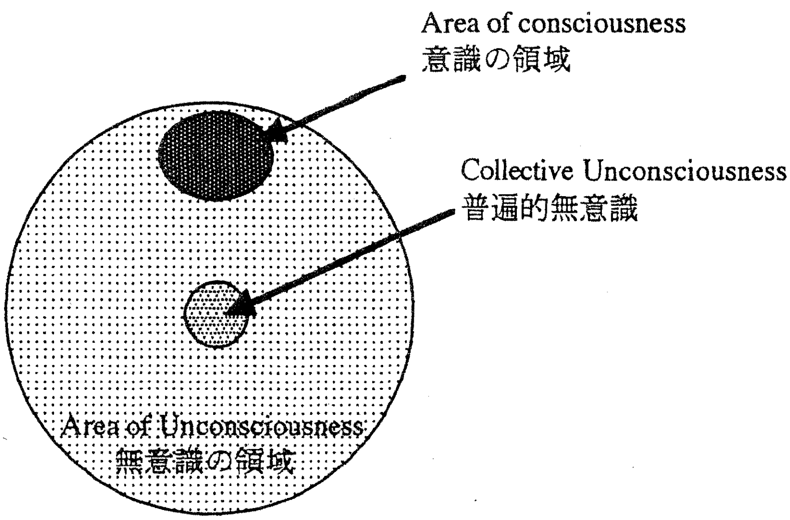
※この発表は筆者が1996年に東京外国語大学アジア・アフリカ言語文化研究所に研究生として提出した論文に基づきます。

Mind Structure and Characteristics of Japanese People

Everyone has either of consciousness and unconsciousness in their mind. The Collective unconsciousness exists on the central area of our mind.(2) On the circumference of our mind, there's a area of consciousness. In our daily life, we never notice the existence of unconsciousness. But, when we dream or doing some creative activities the mind energy flows into unconsciousness from consciousness. We call this phenomenon as "going backward of mind energy". There are many mind complex among the internal unconsciousness. C.G.Jung calls this complex structure as "Constellation of mind".(3) A Japanese psychologist Hayao Kawai advocated a unique theory "empty structure of Japanese mind". According to his theory, the boundary of consciousness and unconsciousness in Japenese people is so vaguely rather than European or American people. That means Japanese audience has a mind structure which is easy to occurs the "going backward of mind energy". This is because that the Japanese audience requires good atmosphere and many elements except for astronomical knowledge in our planetarium show.

心の構造と日本人の特徴

我々の心の構造は意識の領域と無意識の領域に大別できるが、その位置づけは心の中心部に無意識(普遍的無意識)が存在し、周囲の一部に意識領域が存在する。(2)無意識の領域の中には複数の心のコンプレックスが布置されている。このコンプレックスの布置をユングは「コンステレーション」と呼んでいる。まさに星座の"Constellation"からきた名前である。日常社会の中では観客も我々も意識の領域に支配されており、自分の無意識の領域は認識できない。しかし夢をみたり何らかの創作的な活動をする場合には、無意識の領域の方向へと心のエネルギーの変移が生じる。意識領域から無意識領域への心のエネルギーの移行を「心的エネルギーの逆行」と呼んでいる。この心的エネルギーの逆行がプラネタリウムの観客の心の内部に生じるものと思われる。深層心理学者の河合隼雄は日本人の心の構造論の中で「中空理論」を提唱した。(3)日本人の心の中心には中空の象徴性がみられ、意識と無意識の境界が欧米人に比べ曖昧であると指摘している。したがって日本人の場合は欧米人に比べて心的エネルギーの逆行が生じやすい構造にあると言える。



Mind Structure
心の構造

Planetarium Projection and Psychological Projection

C.G.Jung named the immanent characteristices in male(female) mind as "Anima(Animus)". The progressing stages of Anima takes following steps.

Biological Stage→Romantic Stage→Spiritual Stage→Wisdom Stage

Jung called this progress of Anima as "individuation process" or "self-realization process". While audience looking a starry sky, they will make a psychological projection against their individuation process. When the planetarian traces the stars in planetarium sky, audience traces the complex in their unconsciousness as same as the planetarian does on the sky. This is the relation of stellar constellation and psychological constellation. A French religionist Roger Cailois saids about triangle of sacredness-worldling-play.[4] The sacredness corresponds to the starry sky, and the worldling to the audience, the play to the planetarium show. Cailois continues, the current society have been lost the sacredness, and there are no festivals or no plays in our society, anymore. He writes, therefore there's no something to drop our eyes in the society. People demands these sacredness and play on the stars or our planetarium sky as their psychological compensations. Then we planetarian have to treat carefully with these important matter while our planetarium show.

星空の投影と心の投影

ユングは男性(女性)の心の中に潜在する女性性(男性性)を「アニマ(アニムス)」と名付けた。アニマの発達段階は次のように考えられている。

生物学的な段階→ロマンチックな段階→霊的な段階→叡知の段階

ユングはこのアニマの発達段階を「個性化の過程」と呼んでいる。我々がプラネタリウムの投影で星々を辿るとき、観客はそれに応じて心のコンプレックスに星々を対応させて心理的に投影する効果があると考えられる。従って個性化の過程を助長することで心の成長や安定に効果がある。星を観て心が和むなどというのは、心理的にはこのような効果により説明することができる。フランスの宗教学者ロジェ・カイヨワは「聖ー世俗ー遊び」の三者関係を著書の中で説明している。[4]実人生は世俗であり、そこから聖なるものと遊びへの移行が生じると論じているが、観測以外の目的で星や星座を見ることは、カイヨワの述べる「遊び」に相当するだろう。同時に、『現代社会は聖性を失った世界である。祭りも遊びも存在せず、それゆえ一定の節目になるものもない。』と付論に記している。観客がプラネタリウムに求めるものの中で特に最近注目されているのが「エンターテイメント」の要素であると言われているが、現社会において欠落した遊びの要素をプラネタリウムにも補償的に求めているものと考えられる。静的なプラネタリウムの投影にもこのように観客の深層心理との関わりが存在することを、我々は十分に留意しつつ投影を行わなければならないだろう。

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宮沢賢治の世界

田島利子

葛飾区郷土と天文の博物館

今からちょうど百年前、１８９６年の８月２７日、東北、岩手県の花巻に一人の詩人が生まれた。宮沢賢治である。存命中は、まったく無名だった賢治だが、今では日本中にその名を知られ、全集やさまざまな研究書が出版されている。

宮沢賢治は、その短い生涯の中で、多くの詩や童話を残している。また賢治は、星を愛した詩人としても知られ、星や惑星、星座などを題材にした作品をたくさん残している。賢治の興味は天文にとどまらず、植物、鉱物、地質、農業、言語、音楽、演劇、美術など多方面にわたっている。地質学専攻の科学者であったが、生涯を通じて熱烈な日蓮宗の信徒でもあった。その独特の思想と美意識に貫かれた作品の数々は、彼の死後、高く評価されることとなり、今では日本全国の多くの人々に愛読されている。

生誕百年の記念の年にあたり、特に、星や天体を扱った賢治の代表作をとりあげながらひとりでも多くの方々に、魅力あふれる賢治の世界を紹介したい。

まず、賢治そのひとについて、年譜を追いながら、見てゆきたいと思う。そのあとで、賢治の代表作について論じてみたい。

宮沢賢治は、１８９６年（明治２９年）、現在の岩手県花巻市に生まれた。家業は質屋・古着商。冷害や飢饉に苦しむ東北の過酷な農村地帯に比べると、大変富裕な商家の長男であった。２年後の明治３１年には、妹のトシ（とし子）が生まれている。のちに多くの詩のなかで詠われることとなる最愛の妹である。恵まれた環境のなかで、すくすくと成長した賢治は、幼い頃から、礼儀正しく、自然を愛する、多感な少年だったようだ。また、父、政次郎は、家業のかたわら、高僧を招いて、自ら仏教講習会を企画するなど、若い頃から熱心な仏教徒であった。家族が朝に夕に唱える読経の声を聞きながら賢治は育ったわけで、幼少時のこのような家族の宗教的雰囲気や、経文に含まれた無常観などは、のちの賢治の人格形成や作品に、さまざまな影響を与えている。

小さい頃から学業優秀だった賢治は、岩手県立盛岡中学、そして、盛岡高等農林学校へと進む。父は学業よりも家の商売を継ぐ事を希望したが、本人の意思を汲んで、進学を許したといういきさつがある。しかし、貧しい農民たちからの搾取を余儀なくされる家業の古着商を嫌悪していた賢治は、宗教的問題もあって、度々父と衝突。１９２１年（大正１０年）１月、突如上京（実質上の家出）し、国柱会という日蓮宗系の宗教団体に押しかけたりしている。ここで、文芸による仏教の普及を諭され、童話によって自己の信ずる仏の精神を伝えようと決心したとみえる。賢治のこの年の１月から９月までの童話創作はめざましく、大変なスピードで多くの童話が書き進められていった。

生活を心配した父親からの支送りも頑なに断っていた賢治だが、９月に、妹とし子病気の報

を受け、急遽花巻に戻る。翌年、１９２２年（大正１１年）、とし子病により他界。大変な衝撃を受けた賢治は、半年以上もまったく詩が書けなくなるほどであった。

この後、さまざまな童話や詩をすこしずつ発表しながら、賢治はしだいに自己の世界を確立してゆく。いったんは、花巻農学校の教師という定職に就き、ユニークな授業を行いながら、かなりの高給を得ていたが、これも５年もたたぬうちに退職。

「農業を芸術の域まで高めるのだ！」という高い理想をもって、１９２６年には、「羅須知人協会」を設立。農村青年らに稲作法、科学、農民芸術概論などの講義を始める。しかし、この活動も志半ばにしてにして挫折。慣れない農業のために体を酷使したり、凶作に苦しむ農民たちのために、山のような肥料設計書を無料で作成したりと、無理を重ねた賢治は、やがて身体が衰弱、ついには病床生活を送ることになる。

１９３３年（昭和８年）９月21日、喀血ののち永眠する。享年３７歳だった。
死の直前まで、自宅に訪れた農民の肥料相談に応ずるなど、最期まで、自己の信じた
仏の意志を忘れない，求道者としての生を貫いた。

同時に、自然界のあらゆる物に、躍動する“命”と“美”を感じ取った賢治は、その豊かな詩的感受性と独創的なイマジネーションの力によって、他に類を見ない、すばらしいファンタジーの世界を創作し、後世の私たちに残してくれたのである。

『銀河鉄道の夜』

宮沢賢治の代表作と言われる、かなり長編の作品である。賢治は、自分の作品の原稿に何度も赤ペンを入れ、くり返し推敲を重ねた作家として有名だが、特にこの『銀河鉄道の夜』に関しては、１０年にわたり、死の直前まで、つねに身近におき、手を加え続けていたそうである。それほどまでに、賢治自身にとっても、この作品は特別な意味を持つものだったに違いない。

（あらすじ）

貧しい少年ジョバンニは、病気の母を抱え、父は遠洋漁業へ出たままもう何年も帰ってこない。そのため、彼は学校に通いながら朝に夕に働かざるを得ない、厳しい毎日を送っている。親友カムパネルラだけはそんなジョバンニを気遣ってくれるのだが、他の友達からは父親の不在をもとに、心無いいじめにあっている。銀河のお祭りの夜、再び友人たちのあざけりに合い、いたたまれなくなったジョバンニは、ひとり、街はずれの丘の上へとむかう。そこで星空を眺めているうちに、いつしかジョバンニは、天を旅する空の軽便鉄道に乗り込んでいた。向かいの席には、親友カムパネルラがなぜかずぶぬれになってすわっていた。ふたりは、かわるがわる汽車に乗り込んでくる不思議な星空住人たちに出会いながら、美しい銀河の光芒のなかを、この銀河鉄道に乗って走ってゆく。

まず、普段は地上の鋼鉄の線路を走っている列車が軽やかに天空を走ってゆくという、発想のすばらしさに驚かされる。この作品が書かれて７０年を経た現在でさえ非常に斬新なみずみずしいイマジネーションである。

次に、この銀河鉄道が、天の川にそって進んでゆく中で出会う天体たちは、実際の空と照らし合わせて、非常に正確に描写されている。はくちょう座（北十字）のあたりにはじまって、アルビレオ、わし、インディアン、さそり、ケンタウルス、そして南十字、石炭袋と、銀河鉄道は夏の天の川にそって、南へ、南へとかけてゆくのだ。いかに賢治が星空を愛し、正確に知っていたかがよくわかる。

そして、最後に、この物語全体にこめられた深遠なテーマ…それは賢治の宗教観であり死生観であり、哲学であり宇宙観でもある。彼の思想のエッセンスが、この作品全体に、まるで、きらめく宝石のようにちりばめられているのだ。いわば、宇宙、天体、宗教、哲学、すべてを包含しているような、広大で深遠な世界が、ここには広がっている。

プラネタリウムに携わる者として、宇宙、天体の面から見てみると、これは大変興味深い作品である。実在の天体や星座たちが、実名で登場するほか、アルビレオは天の川の水の流れの速さをはかる観測所として、また南十字、北十字は目もさめるような美しい天の十字架として描かれ、さそり座は、いっぴきのさそりが改心して水死した後、夜空を照らす赤い火となった、という実に美しく神秘的なエピソードの中で語られる。賢治独特の天体のとらえ方が興味深い。天文ファンとしては、まるで自分たち自身が、星座たちを眺めながら、きらめく銀河のなかを汽車に乗って旅しているような軽快な気分にさせられる。

しかし、一見楽しく明るいこのイメージとはうらはらに、この物語はさびしい。この作品全体には、なんともいいようのないさびしさ、哀しさ、せつなさのようなものが、まるで流れる水のように、あるいは、途絶えることのない旋律のように流れ続けている。私自身は、この作品のキーワードは、「さびしさ」であると思う。きらめくように美しいこの作品全体に流れる、このものがなしさは、いったい、何なのだろうか？

この作品を書き出す少し前に、賢治の最愛の妹、とし子が病気で亡くなっている。二つ年下のこの妹を、賢治はことのほか深く愛していた。宮沢家の優秀な長女とし子は、学校でもずっと主席を通し、信仰の面でも、家族のなかにあって、唯一、賢治のよき理解者であった。女学校卒業後、東京の日本女子大学に進学したとし子は大学生活のさまざまな悩みや出来事を手紙で賢治に相談し、賢治も兄らしく励ましの言葉を送ったりしている。しかし、この賢く美しい妹は、わずか２４歳の若さでこの世を去ってしまう。この時の賢治の悲しみは尋常でなく、とし子の臨終を描いた「永訣の朝」ほか二編の詩を書いたあと、半年にわたって、ぷっつりと詩作が途絶えている。

とし子の死のあと、賢治は北へむかい、樺太まで旅している。このとき、「青森挽歌」など、とし子の死を悼むいくつかの挽歌が生み出されている。この旅は、教え子の就職の世話という名目上の理由はあったが、ほんとうは、亡くなったとし子の魂のゆくえを求めた鎮魂の旅でもあったようだ。この時のさまざまな深い思いが、のちの作品、「銀河鉄道の夜」になんらかの影響を与えていると考えても、まちがいではないだろう。

あの世へ行ってしまった愛しい者との交信を、賢治は心から求めていた。とし子が亡くなってしまっても、彼はどうしてもその死を受け入れられなかった。とし子の魂は確かに今も何処かに存在していて、その方法さえわかれば、交信（通信）するのが可能なのではないか…この必死の思いが、賢治を北へ、北へと駆り立て、さいはての地への旅へ旅立たせたのかもしれな

い。

「銀河鉄道の夜」においても、主人公ジョバンニひとりを除いて、この列車に乗り込んでくる人々は、ほとんどすべて、乗っていた船が氷山にぶつかったために、海に沈んだり、友達を助けようとして、川で溺れてしまった、“死にびと”たちである。あるいは、すでに宇宙の何処かに住んでいるらしい、星空の住人たちである。そのほとんどが天に召されて、旅の途中で列車から降りていってしまう。そして、二度と帰ってこない。ジョバンニの目の前にすわっていた親友カムパネルラも、実は、すでに水死しているのである。

“さびしさ”とともに、この作品のキーワードは、“死の世界”であるかもしれない。死にびとたちの天上への旅に、生者でありながら、ただひとり参加することができたジョバンニは、たったひとり、生きて、この世へ帰ってこれたのである。しかし、友人たちのいじめに合い、丘の上の草原に身を投げ涙した、傷つきやすく繊細な少年ジョバンニは、この銀河鉄道の旅で、さまざまな人々との出会いと別れを通して、多くのことを学び、その心に内包した。そして、旅の終わりには、「僕たち、しっかりやろうねえ」と自覚し、ついには「僕はもう、あのさそりのようにほんとうにみんなの幸いのためならば僕のからだなんか百ぺん灼いてもかまわない」と言い切るような、しっかりした力強い少年に生まれ変わっている。この銀河の旅によって、彼は、大きく成長したのだ。

もしかしたら、この幻想に満ちた美しい銀河の旅は、あの世へと旅立ってゆく親友カムパネルラが、最後に、傷つき、心痛んだジョバンニに贈った、心からの贈り物であったのかもしれない。さいごに、親しかった友人に、勇気と力と希望を与えて、カムパネルラは去ってゆくのだ。

賢治の求めた「ほんとうのさいわい」というテーマが、くり返し、くり返し、寄せ来る波のように、この作品のなかで語られる。「ほんとうのさいわい」とは、いったいなんなのだろうか？

この深遠で難解な作品を、おそらく、わたしは一生かかっても、理解できないだろう。まるで、ひとつの宇宙を観るようである。しかし、人生のなかで、心痛んだ時、うちひしがれて、こころ悲しい時、なぜか、この作品は、非常に心を励まし、勇気づけてくれる。乾いた砂に清水がしみこむように、清らかな美しいおもいが、しみじみと心にしみるのだ。

かつて、若い大学生たちと、賢治の「よだかの星」を読んで、意見を交わした事がある。その時、この作品を読んで、非常に勇気づけられたというひとたちが幾人もいた。彼らは、いずれも、かつてのいじめられっ子たちだった。賢治の作品には、そんなふしぎな力が宿っているのだ。

いずれにせよ、「銀河鉄道の夜」は、数ある賢治作品の中でも、ひときわあざやかな光芒を放つ、忘れ得ぬ作品といっていいだろう。この、世にも美しい物語をのこしてくれた宮沢賢治に、心からの感謝を捧げるとともに、ひとりでも多くの方々に、この作品を読んでいただきたいと、切に願うものである。

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曼荼羅に見る星神

山本　誠

大塔村　「星のくに」

はじめに

９世紀初頭(AD806)、弘法大師「空海」によって、本格的な真言密教が中国唐より日本へと請来された。

真言密教が最も重要とする経典に「大日経」「金剛頂経」という二部の経典があるが、この経典を元に描かれた観想図に両部曼荼羅または両界曼荼羅と呼ばれる二幅の曼荼羅が有り、大日経に従って作られた曼荼羅を「胎蔵曼荼羅」、金剛頂経に従った曼荼羅を「金剛界曼荼羅」と呼んでいる。

真言密教においては、胎蔵曼荼羅と金剛界曼荼羅は一対のものとして扱われ、表現に違いはあるものの、共に密教の重要な教義をあらわしたものとして「金胎不二」とされている。共に数百にも及ぶ如来や菩薩、明王その他の仏が描かれているのだが、この両部の曼荼羅のうち、胎蔵曼荼羅の最外院と呼ばれる区画には星を神格化した尊像が描き込まれている。

胎蔵曼荼羅に描かれている星神は、九曜星、十二宮、二十八宿の三種に分けられるが、「流星」や「霹靂」として描かれた尊も星神と呼べるだろう。九曜星とは、すなわち日月五惑星に日食や月食をおこすとされる「羅喉」と、彗星と考えられる「計都」を加えた九つの天体を神格化したもので、十二宮は黄道１２星座を、二十八宿は中国やインドで月の巡りから考え出された２８の星座をそれぞれ神格化したものである。

曼荼羅は、真言密教の重要な教義に関わる上記の両部曼荼羅以外にも様々な種類が伝えられているが、主尊が大日如来でない曼荼羅は「別尊曼荼羅」と称されている。

別尊曼荼羅で星神が描かれている曼荼羅としては、密教占星術の修法に使われる「星供曼荼羅」（北斗曼荼羅）がある。星供曼荼羅では胎蔵曼荼羅と違い、上記三種の星神に重要な役割が与えられ、加えて北斗七星の星々も中国道教風の尊像となって加わり、中央の北極星を神格化した主尊を取り巻くように配置されている。

今回のＩＰＳ‘９６では、これら曼荼羅に描かれた興味深い星神図像の紹介を通し、あまり知られていない東西文明の接点を見てゆくことにしたい。

胎蔵曼荼羅の構造

中国道教の影響を色濃く受けた星供曼荼羅を見る前に、より古い時代の図像形態を示す胎蔵曼荼羅の星神から見てゆくことにしたい。

胎蔵曼荼羅は、正式には「大悲胎蔵生曼荼羅」と言われ、全ての世界が大日如来の慈悲の心から生じていることを表現している。

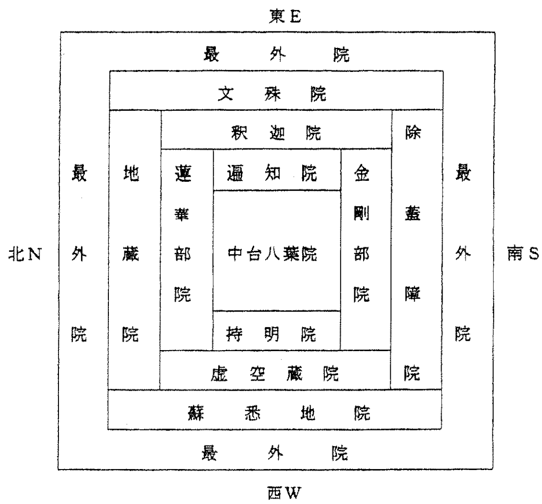
構造は（図１）のように計１２の院（区画）によって構成されており、主尊大日如来がいる中央の「中台八葉院」を取り囲むように１１の院が四方に配置されている。

胎蔵曼荼羅の四辺形の各方位は上を東として時計周りに右が南、下が西、左が北となり、最外周となる最外院には各方位に対する門が与えられている。

各院の名称

中台八葉院　Chûdaihachiyôin
遍知院　Henchiin
持明院　Jimyôin
金剛部院　Kongôbuin
蓮華部院　Rengebuin
釈迦院　Shakain
虚空蔵院　Kokûzôin
文殊院　Monjuin
蘇悉地院　Sositsuchiin
除蓋障院　Jogaishôin
地蔵院　Jizôin
最外院　Saigein

〈図1〉



胎蔵曼荼羅における星神の配置

胎蔵曼荼羅に描かれた星神は、最外周部となる「最外院」の中で、他の天部の諸尊に混じって配属されており、各方位に対する振り分けは次のようになっている。

★東方（East.）★

九曜星(9 Luminary)　＝計都（Comet？）・日曜（Sun.）
十二宮(12 Sign)　＝夫婦宮（Gemini.）・牛密宮（Taurus.）・白羊宮（Aries.）
二十八宿(28 Lunar Mansion)　＝昴・畢・觜・参・井・鬼・柳
その他(other)　＝流星・霹靂（Meteor・Meteorite？）

★南方（South.）★

九曜星(9 Luminary)　＝羅喉（eclipse）・木曜（Thurs.）・火曜（Tue）
十二宮(12 Sign)　＝双魚宮（Pisces.）・賢瓶宮（Aries.）・摩竭宮（Capricorn.）
二十八宿(28 Lunar Mansion)　＝星・張・翼・軫・角・亢・

★西方（West.）★

九曜星(9 Luminary)　＝土曜（Sat.）・月曜（Mon.）・水曜（Wed.）
十二宮(12 Sign)　＝弓宮（Sagittarius.）・蝎宮（Scorpio.）・秤宮（Libra.）
二十八宿(28 Lunar Mansion)　＝房・心・尾・箕・斗・牛・女

★北方（North.）★

九曜星(9 Luminary)　＝金曜（Fri.）
十二宮(12 Sign)　＝少女宮（Virgo.）・巨蟹宮（Cancer.）・獅子宮（Leo.）
二十八宿(28 Lunar Mansion)＝虚・危・室・壁・奎・婁・胃

以上の星神の配置を見た場合、二十八宿は曼荼羅の方位の巡り方、東→南→西→北の右回りに順じ、昴宿から始めて順序に狂いなく配属されているのに比し、十二宮は二十八宿とは逆方向に配置されていることがわかる。そのため、現実の星空の十二宮と二十八宿の関係のようには、これら星神は対応していないと言える。

二十八宿は中国のほかインドなどでも使われていたが、共通の起源によるものかどうかは判断が難しい。胎蔵曼荼羅に描かれている星神は、密教占星術の経典「宿曜経」からのものと考えられているが、宿曜経は唐の粛宗皇帝の命を受けてインドに経典を求める旅をした不空三蔵によって西暦７００年代に中国へ伝えられた経典であるため、

二十八宿の方角に対する割り振りもインドの方法に従っている。また、諸尊の巡りが昴宿（クリッティカー）から始められているところを見ても、これを農耕の指標としていたインドの二十八宿が胎蔵曼荼羅に描かれたと考えられる。

十二宮の巡りが二十八宿と逆になっている理由は定かではないが、宿曜経が西洋占星術の影響を受けたインドの占星術を元にしているため、西洋占星術のホロスコープに多い左回りの星座配列がそのまま影響したのかもしれない。８世紀前半の「胎蔵図像」やそれに続く「胎蔵旧図様」に見られる十二宮の姿の多くが、天球儀の星座絵のように左右が反転していることも、これに合わせて考察する必要があるだろう。

九曜星の配置には特に法則が見つけられず、どのような考えに基づいたものなのか不明である。九曜星は太陽系の天体を扱っているだけに位置が定まらないのも確かだが、もし意味が有るとするなら曼荼羅制作時期の実際の惑星配置に関係しているのではないかと考え、当時の惑星配置を調査してみたが、同定が難しく成功しなかった。

空海が請来した原図胎蔵曼荼羅以前の８世紀前半の胎蔵曼荼羅では、他の星神が存在する中で五惑星が存在していないことも気になるところである。また、前述の通り胎蔵曼荼羅は大日経に基づいて作成されてはいるが、それに従った初期の胎蔵曼荼羅では、九曜星、十二宮、二十八宿の星神は登場しない。

星神の図像形態

これら星神の内、私たちプラネタリウム関係者にとって興味深いのは、メソポタミアに起源を持つ黄道十二星座を神格化した十二宮の尊像であろう。

十二星座の内、おとめ座、ふたご座といった人物形の星座は、「女宮」「男女宮」と称されて、その姿は星座絵の原形を留めない仏の姿に変えられているが、他の動物形の星座は少なからず原形を留めており、注目に値する。

原図胎蔵曼荼羅に描かれた九曜星の内、羅喉、計都と、九曜星ではないが流星と見られる尊像も、現実の天文現象を姿で表現しようとしているところが面白い。

二十八宿は、元来黄道十二星座のように姿を想像した星座とは違い、天空での位置を教える星々の小群に名前が与えられたものであるため、十二宮のように尊像の元とする形が無く、原図胎蔵曼荼羅においては全ての尊が蓮台に赤い玉を乗せた蓮華を持つ菩薩形で表現され、各尊の差は手を若干動かしている程度である。

ただし原図以前の胎蔵図像、胎蔵旧図様では星宿ごとに持物が変えられているなど、各尊に差違が見られ、後述の星供曼荼羅ではさらに各尊の違いが大きくなっている。

星供曼荼羅の星神

密教占星術に基づいて、ほとんど星神のみで構成されている「星供曼荼羅」は、これまでに紹介してきた星神以外に北斗七星を神格化した尊を加えるため、「北斗曼荼羅」とも称される。

星供曼荼羅の形には方形の曼荼羅と円形の曼荼羅があり、どちらの曼荼羅も構成は中壇の主尊に北極星を表す金輪仏頂（釈迦）、または妙見菩薩を置き、その周囲に北斗七星が描かれ、続いて九曜星、十二宮、二十八宿の順で、中壇を取り囲むように星神の配属された壇を設けていることが多い。

星供曼荼羅に描かれる星神は、基本的には胎蔵曼荼羅に見られたのと同じインド密教の占星術に基づいた星神だが、新たに加えられた北斗七星の各尊像は、明らかに中国風の様相を見せている。元より北斗七星に対する信仰は道教の思想に基づくものな

のだが、尊の名称は道教の呼び名ではなく、仏教での呼び名が使われている。

各尊像は、黄道十二星座を元にした十二宮では胎蔵曼荼羅の尊像からそれほど変化しておらず、逆に簡素化されているようにも見えるが、九曜星と二十八宿の尊像は胎蔵曼荼羅のそれに比べて、各尊像ごとに大きな差違を与えられていることがわかる。

九曜星の内、五惑星に当たる五曜の星神像にはギリシャ神話の神々の特徴を見ることができ、水曜は女神ではあるが伝令神ヘルメースの影響から紙と筆を持つ姿で表されていたり、火曜は戦いの神アレースの性格を引き継ぎ憤怒の形相の明王として描かれているなど、インドの占星術がギリシャの占星術を取り入れて発達したために、曼荼羅の星神にも西方の影響が思いのほか大きく表れていて興味深い。

これら五曜の尊像は、中国敦煌第１７窟より出土した仏教美術「熾盛光仏と五惑星の図」中の五惑星の姿に酷似している。絵に記された年号は西暦８９７年にあたることから、この絵は星供曼荼羅の制作が日本で盛んとなった平安後期より１～２世紀古い時代に書かれたことになり、大阪市立博物館に所蔵されている唐の「五星二十八宿神形図鑑」に見られる西方の影響が少ない五惑星の姿から、星供曼陀羅の五曜の姿に到るまでの尊像変化や伝播経路を知る上で重要な資料と言えるだろう。

星供曼荼羅に描かれた九曜星の羅喉と計都は、胎蔵曼荼羅とは尊像がかなり異なり共に憤怒の明王像となっているが、胎蔵曼荼羅の羅喉と計都は食神と彗星であったものが、星供曼荼羅ではどちらもが食神として表現されており、こうした違いがなぜ生まれたのかは明らかにされてない。インドに、酒を飲んで不死身となった竜がビシュヌに首を切られ、頭が羅喉、尾が計都になって飛んでいるという説話があるため、本来計都は食神であったと考えられるが、宿曜経では計都と言わずに「彗星」としてあることから、胎蔵曼荼羅で計都と思われていた星神は彗星で、星供曼荼羅の計都は食神と見るべきなのかも知れない。

仏様を呈した星神の中で、北斗七星の各尊像は明らかに中国風の装束を身につけた姿として描かれているが、肉眼二重星として有名なミザールの横のアルコルまでもが、小さな尊像となってミザールに当たる武曲星の横に描かれていて面白い。名前は「輔星」と称されている。

星供曼荼羅における尊像の配置には様々な種類があるが、九曜星の配置などを見ると中国道教の占星術の影響が色濃く現れていることがわかる。このことから、星供曼荼羅はギリシャの占星術を元にインドで成長した占星術と、中国の道教占星術とが融合した密教独特の占星術ホロスコープと言うことができるだろう。

こうしてバビロニアに発祥した星の文化は、西に進んで発達するとともに、再び折り返して極東をも目指し、はるかシルクロードの終着点にまでやってきたのだ。

参考文献

①小坂真二著、「式占」、別冊太陽７３巻占いとまじないｐ２６　②高野山霊宝館、第十二回高野山大寶蔵展図録「曼荼羅と星」　③高野山霊宝館、第十五回高野山大寶蔵展図録「天部の諸尊」　④永井晋著、「星占い」、別冊太陽７３巻占いとまじないｐ３４　⑤長澤和俊責任編集、ＮＨＫ大英博物館第５巻　、「中央アジア・東西文明の十字路」　⑥錦織亮介著、「天部の仏像辞典」　⑦野尻抱影著、「星と東方美術」　⑧定方晟著、「インド宇宙史」　⑨佐藤任著、「古代インドの科学思想」　⑩菅野礼司著、「物理的科学」、東の科学西の科学、第二章

THE LAPP (SÁMI) SKY: THE COSMIC MOOSE HUNTING SCENE - A NEW STARLAB CYLINDER

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Transparent Nr. 1. Lapp people: Two Sámi children

Two Norwegian Sámi (Lapp) children arrayed in the usual colourful Sámi costume. The total number of Sámi is estimated to more than 60,000, ca. 38,000 live in Norway, 17,000 in Sweden, 6,000 in Finland and 2,000 on the Kola Peninsula/Russia.

Transparent Nr. 2, 3 and 4. Sámi, Sámiland, Lapland, Geography and Language

A map of the languages of the world with the Finno-ugrian language group, named by the number 11. Trp. number 3 shows the Sámi language area in more details. From the map we can se that the Scandinavian languages belong to the Teutonic group and have almost nothing in common with the Sámi language.

Lapland or Sámiland are indistinct names wich denote the same region. The Lapp/Sámi region includes the northern parts of Norway, Sweden, Finland and the Kola Peninsula of northwestern Russia. The southern boundary is indistinct, Laplanders living as far south as 62°north latitude, but Lapland proper is generally understood to lie north of the Arctic Circle. Trp. Nr. 4 shows that the Sámi speak nine different dialects, that some of them are so different, that even Sámi themselves cannot communicate with another.

Transparent Nr. 5 and 6. The Reindeer Farmers

Occupationally the Sámi may be divided into four classes: Forest Sámi, River Sámi, Coast Sámi and Mountain Sámi. Important changes have occured in the way of life of Sámi during the 20th century. (Nr. 6) Reindeer sledges have been replaced by modern snowscooters. The basic difference in the present reindeer husbandery is that the Sámi family does not follow the herd all year round. The previously nomadic families now stay in permanent settlements and only a few herdsmen follow the reindeer herds, which have been greatly increased in number to groups of 5,000 to 10,000 head.

Transparent Nr. 7. A picture of historical Sámi culture

The Forest Sámi live in permanent settlements, fishing, hunting, and raising reindeer. The River Sámi dwell in the extreme north, particulary along the Tana and Alta river, and divide their time between fishing and farming in the summer and tending reindeer in the winter. The Coast Sámi live along the Norwegian coast; their main occupation is ocean fishing, but they also carry on part-time farming and raise reindeer, sheep and goates.

Transparent Nr.8 The Front Cover Page of the important Sámi Study by Ph. D. Bo Lundmark

Bo Lundmark[1] describes and analyses the pre-Christian sun- and moon-cult among the Sámi. Their conceptions of stars and celestial phenomena are also treated.

The most important sources for information about the Sámi are the reports of missionaries from the seventeenth and eighteenth centuries. The symbols of the Shaman drum have been analysed and linguistic studies have been done. More recent documented materials have also been used where older sources are on the whole silent concerning stars and Northern Lights (Aurora borealis).

Transparent Nr. 9. The Shaman Drum

The sign of the sun has a central position in the symbolic world of the Shaman drum. The moon and stars are usual symbols on the drum. Worship of the sun plays an important role among the subartic peoples. The sun is worshipped because of its light, heat, and fertility, and also with respect to various types of illnesses, especially mental illnesses.

Transparent Nr.10. Twentyfour Hour Midnight Sun

This 360° panorama shows the sun's cycle north of the Arctic Circle on the island of Loppa from July 21, 19.00 o'clock till July 22, 18.00 o'clock.

[1] Bo Lundmark: *BÆI'VI MÁNNO NÁSTIT*. Sol- och Månkult samt astrala och celesta förestallningar blandt samerna. Acta Bothniensia Occidentalis. Skrifter i västerbottniska kulturhistoria. Västerbottens läns hembygdsförening. Västerbottens museum Umeå. 1982 ISSN 0347-8114.

Transparent Nr. 11. The Moon in "Broad Daylight" at Arctic Winter Midday

Moonlight on the Giljartinden, the peak - at Midday - during the Polar Night. The moon cult is found all over the world. It conforms to the traditon of most peoples, and also that of the Lapps, that the moon brings good as well as evil to the people.

Transparent Nr. 12. The Northern Light

This phenomenon was already delt with by Aristoteles. The Northern Lights (Aurora borealis) did play and still plays an important role as an indication of the weather. Silence was given as an offering on the very brilliant Northern Lights. Accordingly, the bells were removed from the Reindeer when driving sledges.

Transparent Nr. 13. The oldest representation of the Northern Light

This drawing is the oldest known realistic representation of the Northern Lights from Finmark and shows men hunting a fox by the aid of their illumination.

Transparent Nr. 14. Jåmpa' brave protest against the "Montain Troll"

This picture comes from an Norwegian book of fairy Sámi tales. It shows the famous Sámi boy Jåmpa making brave protest towards the Troll-Mountain. Maybe the artist have had inspiration from the sight of Giljaren peak which we have just seen with the moon at Midday.

Transparent Nr. 15. The Cosmic Moose Hunting Scene A New Starlab Cylinder

The dominant constellation in the Lapp Sky is *Sarva*, the Moose. It is made up of: Cassiopeia, Perseus and Auriga. *Sarva* refers also to a cosmic hunting scene with several hunters. Among the pursuing hunters are the "skier stars" Castor and Pollux and the three stars in Orionis belt, called "Dogs of Stallo". *Favtna* (Arcturus) with his bow is one of the moose hunters. According to some accounts, the world will perish at the laying down of *Sarva*.

The astral Sarva myth is evidence of the extraordinary importance that hunting had for the Sámi. It also follows from the drawings on the shaman drum that the moose was very desirable game. The moose also belongs to the group of animals favored in the "joik", the monotone chant sung by the Sámi.

The Fixed Star Polars with the Pillar Carrying the World have many Sámi names, for example "sky nail" and "pot nail". The sky is thought of as an overturned, vaulted pot, in which the North Star is the wooden plug in the bottom of the pot. This pillar has also been symbolized in a cultic way as a raised stake or a pillar, where the sacrifical act proceeded. The Sámi view was that a disturbance of the World Pillar or the North Star causes the sky to fall down and the earth to perishe.

The Cosmic Hunting Scene will be performed "live" at the I.D.E.A.S. workshop Interactive/Interdisciplinary Didactic Experiences with Adwanced Starlab on Tuesday 16 July at Science Museum of Osaka from 9:00 to 12:15.

The Cylinder Constellations:
1. The Moose - *Sarva* 2. The skiing Moose-hunters - *Cuoighahægjek* - Castor and Pollux 3. The three hunting dogs - The Orion Belt - *Galla-bardnek.* 4. The six pack hunting dogs and the old wife - The Pleiades - *Sutjenes-råuko.* 5. The bow and arrow hunter - *Fauna davgge* - Ursa Major - The Big Dipper. 6. Bow and arrow hunter - *Favtna* - Arcturus.
7. The World Pole - *Boahje-navlle* - Stella polaris. 8. The Morning - and Evening Star - *Guovso naste* - The Planet Venus. 9. The Birds' Track - The Milky Way. The birds are cranes (Grus grus lat.). 10. The weather forecast chart of The Milky Way. a) The glove "vott" telling where the wintertime is coming, b) A cresent moon - the dangerous "youle-moon" at the christmastime and c) the "X" were they could read the weather in the late winter.

Transparent Nr. 16. The Genuine Norwegian Moose Sign

I invite you all to come to Norway to experience the Midnight Sun during our summer, the adventure of Crimson Dawn meeting the Purple Dusk at astronimical midday in our Arctic Winter. But most of all have an winter tour with the Coastal Express Let your eys taste an "drink" of the Northern Light "live", and watch the Sarva-Moose in the Sky from the Linders deck.

And driving by car - be careful, drive slowly when you meet this sign along the Norwegian highways, - and byways.

日本の星の伝承について

北尾浩一

ミノルタプラネタリウム（株）

1．はじめに

日本各地において、数多くの星の伝承を収集することが可能である。1978年からの調査で収集したもののなかから、いくつかを紹介させていただき、星の伝承をもとにしたプラネタリウム文化の創造について提言を行ないたい。

2．北極星が動くという伝承

（1）各地の伝承

①大阪府泉佐野市のケース

本ケースは、次のように、トクゾウとおくさんの両方とも北極星の動きを発見したと伝えられている点、トクゾウボシが北極星の呼び名になっている点が注目すべき伝承である。

「北極星いうのは、三寸あがって三寸さがったら夜明けるいうて…。あれ、トクゾウボシ言うて、昔はクワナイトクゾウいう人があの星を見つけたいうんだ。ええ、トクゾウボシいうんだ。それがキタノヒトツボシなってやなあ。今の学問から言ったら北極星や。大阪の築港に松の木を植えて、北極星見て、北極星見ても位置わからない。かめあわして…、一晩に三寸動いた」

「トクゾウのおくさんが針仕事してて、障子の破れたのを見て、障子の桟だけしか動けへんのやった。その星さん。それから三寸いうんかな」

②兵庫県相生市のケース

本ケースは、北極星の動きの発見者が、次のように天竺徳兵衛の嫁はんだったと伝えられている点が注目すべき伝承である。

「それも、うそかほんまか知らんで。昔、天竺徳兵衛いう高田屋嘉兵衛みたいなえらい船乗りがおったんじゃ。船乗りは、たいがい夜走りした。そうし

たところが、またその嫁はんがえらかったんじゃ。婿はんが夜さり夜走りしよるから、自分も夜さり機織る。それでおやじさんと問答する。動かん星がネノホシさんだいうし、そしたら嫁はんの方がえらかったんや。ネノホシさんを障子の桟とあわしたんや。そして、三寸動くいうことを……」

（２）北極星の動きの発見者

次のように、船乗り自身が北極星の動きを発見したという伝承と、嫁はんが発見したという伝承に分類することができる。

①船乗り自身が北極星の動くのを発見した……愛媛県魚島村魚島

②嫁はんが北極星の動くのを発見した……三重県阿児町安乗、兵庫県相生市・北淡町富島・家島町坊勢島、愛媛県魚島村高井神島

③船乗りと嫁はんの両方が北極星の動くのを発見した……大阪府泉佐野市

（３）北極星の動きの大きさの表現方法

北極星の動きの大きさの表現方法についてまとめると、次のようになる。

●三寸……大阪府泉佐野市、兵庫県相生市・御津町室津、愛媛県魚島村魚島・高井神島

●障子の桟あるいは軸……三重県阿児町安乗、兵庫県家島町坊勢島

●瓦１枚……兵庫県北淡町富島

●瓦３枚……大阪府岸和田市中之浜町（但し話者の出身地は堺市）

３．カノープスの伝承

（１）各地の伝承

①広島県福山市のケース

本ケースは、カノープスを伊予の横着星と呼んだケースで、次のように伝えられていた。

「四国のな、沖にな、夜明けにちょっと出るんですよ。そのしこなし（ふるまい）が横着星。ここらのものがつけとるのです」

②兵庫県神戸市のケース

本ケースは、カノープスを紀州のみかん星と呼んだケースで、次のように伝えられていた。

「紀州の方、和歌山の方、まあ大きい星出まんのや。紀州のみかん星いう。

南の山のちょっと上に、紀州の山の上に見えるから紀州のみかん星」

（２）伝承の北限

カノープスの伝承が伝えられていた北限は茨城県である。

（３）地名に関する伝承

次のように地名がカノープスの呼び名になったケースが多い。

①紀州星　②淡路星　③鳴門星　④家島星　⑤讃岐星　⑥薩摩星

４．沖縄における伝承

（１）各地の伝承

①石垣市新栄町

次のような星の歌「ムリカブシユンタ」が伝えられている。

「ハイナナツブシ、歌があるでよ。ハイナナツブシヤヨウ、天ヌアージマイカラ…」

②竹富町竹富

星と造船の話等が伝えられている。

（２）星見石等

竹富島の赤山公園に星見石がある。人頭税時代、星見石の下の方にあけられている穴からムリブシを観察して作物の播種を行なった。また、石垣島に星見石だけでなく、星見場がある。

５．提言－星の伝承をもとにしたプラネタリウム文化の創造

生涯学習の時代に、天文学の最新の感動を伝えることはもちろん大切なことである。しかし、それと同時に忘れてはならないのは、地域社会に基盤をおいたプラネタリウム文化の創造である。地域の調査で収集した星の伝承をプラネタリウムによって市民に公開し、さらに世界へ発信するということがＩＰＳ’９６をきっかけに実現できればこの上ない喜びである。

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THE IPS ARCHIVES: WHAT ARE THEY? WHAT DO THEY CONTAIN?

John Hare

Ash Enterprises
IPS Historian

The International Planetarium Society (IPS) came in to existence following an organizational meeting held in Baton Rouge, Louisiana, in the United States on March 27 & 28, 1971. That meeting was really a culmination of efforts that began with the first large-scale meeting of planetarium professionals at the Conference of American Planetarium Educators (CAPE) hosted by director Von Del Chamberlain and the staff of Abrams Planetarium at East Lansing, Michigan in October 1970.

The Society was originally known as the International Society of Planetarium Educators (ISPE) and in 1988 became IPS.

Professor Paul Engle not only served as first president of the Society, but was its historian until stepping down from that position in 1989. Paul was also very active in the efforts to form the Society, and in his roles as president and past president, which spanned nearly four years, accumulated a large file of correspondence and publications that relate to our beginnings. For the next decade and a half Paul continued to accumulate materials, organizing them into what is now the IPS archives.

Sometime back in the early 1980's having an interest in photo-documentation, I began to accumulate a file of mostly slides from various planetarium conferences. Discussions with Paul at that time led to the photo archives becoming an informally recognized part of the IPS archives. The photo archives were initially maintained separately from the other archives....Paul having the correspondence files, publications, and other materials in Little Rock, Arkansas, and I having the photo materials in Bradenton, Florida.

In 1989 I was appointed as Paul's successor. A year earlier Paul, who was in failing health, was relieved to learn of my interest in continuing his efforts. Paul provided valuable assistance in the transferring of materials from Little Rock to Bradenton, as well as continued help in understanding his methodology.

What exactly are contained in the archives? Since the volume of the contents would furnish reading material that would alone consume several months, I have yet to peruse the entire collection. This situation has been further complicated because of having received large amounts of additional materials as well as having to file materials that Paul was unable to get to in the final years of his tenure.

The file of publications from IPS is fairly complete. Most issues of the journal, *The Planetarian,* are there along with the special reports which include directories, *Special Effects Handbook*, conference proceedings and others. Various administrations also published *President's Newsletters* and other periodical bulletins relating to the business of the society and are fairly completely contained.

Paul began files containing publications and correspondence regarding affiliate organizations. There are substantial materials relating to U.S. affiliates, but little related to non-U.S. affiliates.

Various financial records have also been included, but most of these are in the boxes in which they were sent, mainly from Mark Petersen and earlier treasurers.

IPS conferences are well documented with a variety of correspondence between officers and conference hosts as well as printed conference materials.

Various other correspondence relating to the business of the society is organized by each administration.

There is a collection of "trinkets" containing such things as name badges, tote bags, and miscellaneous promotional items.

Mailings to IPS containing printed materials, CD's and tapes from various outside sources are included in a totally unorganized box.

Publications from various affiliate organizations, mainly journals and newsletters, are included. These are mostly from U.S. affiliates and are very incomplete.

There are also miscellaneous files concerning various historical aspects of planetariums - meetings that pre-date IPS, files on particular individuals, institutions, and specific programs at various institutions.

The photo archives contain both slides and prints, with slides comprising the vast majority. These are mostly *people* shots and more than 50% of the people contained have been identified. The slide archive alone has over 2000 slides.

Additional materials relating to IPS, or for that matter any aspect of planetariums, is welcome. Please forward materials to me at the address listed in *The Planetarian* and be sure to identify what it is you are sending.

At some point in the future I hope to publish an index of materials contained. This will allow quicker access to information of interest.

The archives are available for access by researchers through arrangement. I will also do my best to respond to individual requests from IPS members to locate information contained therein.

Until January 1996 the archives resided at Bishop Planetarium where I served as director. I resigned my position earlier this year to devote my efforts to full time consulting and technical services to the planetarium community as a partner in Ash Enterprises. The archives are now housed in a large portion of my new office.

A large number of materials still remain to be organized and filed and more materials are being received from time to time. I view my responsibility as historian as a never ending effort. Not only will there be materials from future events, but there is another unfinished facet. The modern planetarium has been in existence since the early 1920's. Should it not be the responsibility of IPS to provide a look back to the very beginnings of our profession? As planetarians we already have a wealth of knowledge about the "early days".

As with anything though, as time passes, more and more is lost if efforts aren't put forth to preserve information. The idea of producing an historical record has been discussed by the History Committee at the past two IPS conferences without any clear mandate resulting. I believe it is time to move ahead with such an effort and therefore will be contacting the various committee members in order to formulate the best approach to this large task. I would like to extend an invitation to any of our new Japanese members to join the History Committee to assist in this and other future projects.

The IPS archives have expanded beyond just an historical record of our society. Indeed what they have come to be is a growing compendium of materials that chronicle the individuals, organizations, projects and efforts of our profession. These archives serve to document our role in advancing humanity's understanding and appreciation of science in general and astronomy in particular.

七夕の民俗と星

木村　かおる

天文博物館　五島プラネタリウム　学芸課

七夕の星、織女と牽牛とは、こと座のヴェガとわし座のアルタイルである。毎年、七夕の頃になると各地のプラネタリウムでは、七夕の話を交えた幼児番組や七夕のイベントがおこなわれる。当館でも毎年７月７日に、特別投影「七夕の集い」を開催している。過去の講演会や、日本の年中行事などから、七夕の民俗についてまとめてみた。

織女・牽牛の登場

織女、牽牛の名がはじめて書物に表れたのは、紀元前 770 年前後とされる。東周のはじめ、「詩経」小雅の「大東」篇の一部に登場する。この中では、「織女・牽牛は天の川にある星で、ともに仕事を成就できずにいる。」とある。また、この詩からは、牽牛が人でなく牛であることもうかがえる。後に牽牛は男に、そして二人が相思相愛の恋人、あるいは夫婦に設定されるのは、漢代になってからのことである。やがて、七夕の日に天の川を渡って相逢する物語へと発展するのである。なお、中国で七夕に牽牛・織女を祭る風習は、後漢時代（１～３世紀）からである。

また古代中国では、織女星は糸や針の仕事を司る星と考えていた。その織女星にあやかり、女性が針仕事の上達を願い、月に向けた針孔に糸を通す、乞巧（きっこう）という行事が広がっていった。このように初めは女性の祭りだったものが、南宗時代（13 世紀）には、男子が文字や詩文の上達を願うようになった。このように願いをかけるという風習は、牽牛・織女の二星聚会から発生したものという。思慕しあう二星がその願いを成就する日、その二星に願いを叶えてもらうのである。

なぜタナバタと読むのか

「七夕」をどうしてタナバタと読むのであろうか。古くより日本には、棚機（タナバタ）信仰というものがあり、棚に設けられた機によりかかり、神の降臨を待ち、一夜を神に侍して過ごす行事があった。その聖なる乙女を棚機女（たなばたつめ）と言った。

それが中国から織女と牽牛の物語が伝わると、日本独自の棚機信仰と結びつき、織女星・牽牛星の逢う夜を「タナバタツメの逢う夜」と呼びはじめた。やがて、「タナバタ」と読むようになった。今の段階では、この棚機信仰で神の降臨を待つ日が、７月７日であったかは定かではない。

七夕祭り

日本に七夕が伝えられたのは、奈良時代であるという。七夕説話と共に乞巧奠が日本に伝えられ、宮中の行事として取り入れられた。乞巧の儀式は、７月７日に限った行事ではなかったが、陽の数の重なる日の７月７日に固定したものという。延喜式（平安初期）に

は、この節供を織女祭と記している。

このように七夕の祭りは、宮中の行事として行われるようになった。それは次のようなものである。

清涼殿（平安京内裏の殿舎の一つ）の東庭に長筵を敷き、朱塗りの高机四脚をすえ、南二脚に桃、梨、なす、うり、大豆、大角豆、干した鯛、蒸したあわびを添える。また、北二脚に楸（ひさぎ）の葉に金・銀の針を各七本さし、五色の糸と鏡を置く。琴一張を二脚の机に架かるように横たえ、香をたく。さらに机の周囲やその間に九本の灯台を置く。天皇は庭中に椅子を出されて、二星の星逢いのさまをご覧になる。夜がふけると室内で、天の川に見立てた白い布をはさんで男女が向かい合い、扇にのせて和歌を詠みあう。藤原定家（1162-1241）の子孫にあたる冷泉家では、現在でも当時の古式ゆかしい七夕の行事をとりおこなっている。

室町時代に入ると、将軍が七夕の歌七首を詠み、芋の葉の露で墨をすり七枚の梶の葉に歌をしたためた。御殿の棟の上には座を作り、梶の木に歌を結び、広蓋に硯、墨、筆、梶の葉をのせて、木の下に置き時季の物を供える。その御供え物は、屋根に投げ上げる。その他に、七遊とか七物という行事がおこなわれた。例）歌、鞠、碁、花、貝覆、揚弓、香など。

江戸時代になると、幕府は七夕を五節供の一つと定め、各大名は6日に七夕の祝儀を献上し、当日は城中に出仕し、祝儀をのべることとなっていた。なお、宮中では天皇が、芋の葉の露を用いて墨をすり、梶の葉に和歌を詠まれる。さらに江戸末期になると、上流社会で行われた乞巧奠の儀式が、民間とくに農村部に広がった。農村部での七夕行事は、豊穣を願う祭りとなり、この頃に今のような竹飾りが作られるようになった。また、七夕はお盆に近い事もあり、お盆との一連の行事として行っている所も少なくないようである。逆に、民間の七夕のならわしも宮中に取り入れられ、宮中での七夕行事の様子も、少しずつ変わってきた。これらの供物や竹飾りは、七夕が過ぎると屋根に投げ上げたり、海に流したりする。それは日本古来の棚機信仰にある、穢れを払うということなのである。

さらに付け加えるとするならば、七夕行事は太陰太陽暦で行われた行事であり、現行の太陽暦の7月7日は天候も悪く、さらに宵空ではこの二星は、東の空に低く見えにくい時期でもある。

今に伝わる七夕の風習・伝承

七夕説話では、牽牛・織女の逢う日、雨が降ると天の川を渡れないとある。そのため、竹飾りにテルテル坊主を下げるところもある。しかし地方によっては、一粒でも雨が降る方がよい、とするところもある。できるなら、短冊が流れるほどたくさん雨が降るのが望ましいという。前者は中国の説話に基づくもの、後者は、この日を祓いの日とする棚機信仰によるものである。

各地にのこる七夕行事は、大別すると次の通りになる。

1．邪気を祓う

ねぶた流しは、夏の睡魔を祓うためのものであると考えられる。（青森市、弘前市）

竹飾りを畑に立てる事により虫除けとする。（埼玉県新座市）

7日の朝、竹飾りを海に流し、大漁を願う。（神奈川県大磯）→七夕流し。

七夕人形を軒下にさげ、虫干しや着物をたくさん持てるようにと願う。（長野県大町）
七夕の竹を物干しに使うと、病気をしない。（佐賀県）
この日に、女性が髪を洗う（東北地方）
人や家畜が水浴びをしたという。（近畿地方）

2．農耕の豊作を願う

河原に生える、まこもという草を乾かし、七夕馬を作る。その馬は、七夕の二星に捧げられる。（関東地方 荒川流域や利根川流域）
七夕馬に、新鮮な野菜や団子、果物を供えたり、子供たちが馬を引いて田や畑に草刈りに出かる。（千葉県北部）
七夕馬を田に連れて行くと、田の神が馬にのって田巡りをする。（新潟県北蒲原郡）
七夕の日に種まきをする。この日にまいた種からできる野菜は、薬になるという。（奄美大島）

3．お盆行事と習合

胡瓜の馬、茄子の牛、茗荷の雛を七夕にささげる。（岡山県上房郡）
七夕馬にのってご先祖様がやってくる。（宮城県栗原郡）
井戸さらいをして墓洗い、墓道の手入れをする。（茨城県）

4．伝承

七夕様は、大豆畑で子どもを育てるため、この日は畑に入ってはいけない。また、七夕様は子だくさんのため貧乏であるから、衣類を供える。（大分県）
七夕様が逢っているため、七日にはささげ畑に入ってはいけない。（長野県北安曇郡）
七夕に雨が降ると、虫になって作物にたかる。（長野県）
七夕の星は、カササギにのってあずき畑に降り、その夜七人の悪い病気を持った子どもを産む。そのため、当日は雨が降るように願う。（茨城県）
この日、瓜を食べてはいけない。（高知県）

七夕の二星の和名

アルタイル：彦星、牽牛、牛引き星、犬飼星、イヌヒキドン、インコドン、オンタナバタ、アトタナバタ、オタナバタサマ、かいぼし。
ヴェガ　：織姫、織女星、女星、妻星、棚機津女、メンンタナバタ、サキタナバタ、メタナバタサマ、朝顔姫、糸織り姫、桃子姫、薫き物姫、ささがに姫。

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DEMONSTRATION

THE NEW ZEISS STARMASTER PLANETARIUM

Volkmar Schorcht

Carl Zeiss Jena GmbH, Germany

In August this year, the first Zeiss Starmaster Planetarium will be installed in Wolfsburg, the German city, in which the headquarters of the famous Volkswagen company are situated.

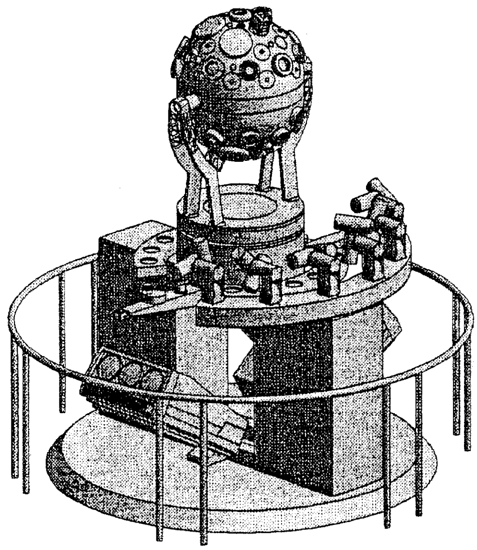


Fig. 1 The new Zeiss Starmaster *incorporates plenty of new technologies for modern planetarium presentations.*

The Starmaster represents a new generation of Zeiss medium size planetariums for both flat and tilted domes of 12 m to 18 m in diameter. It incorporates plenty of new technologies for modern planetarium presentations, technologies that are unique in planetarium history.

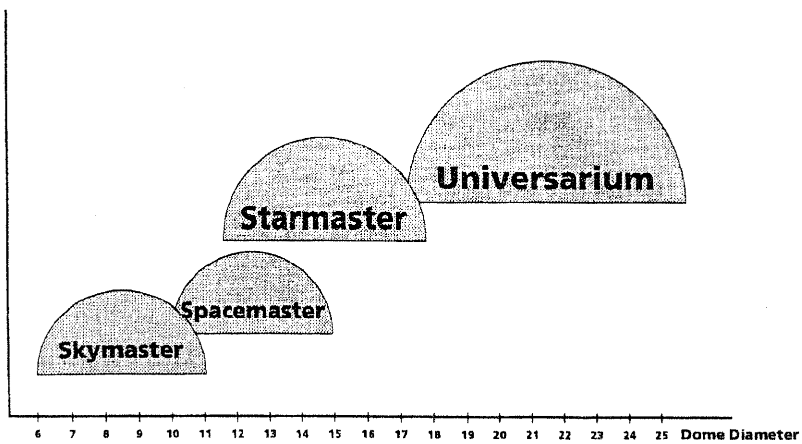


Fig. 2 The Starmaster *fits readily into domes of 12 m to 18 m dia.*

Which are the main new features of the Starmaster?

In the past nearly all optical planetarium projectors used the division of the celestial sphere into 32 fields introduced by W. Bauersfeld in 1923. The Starmaster design is based on 12 projectors with wide-angle lenses.

This new sky division has some important advantages: We save space on the star ball to add other projection systems, and the diameter of the star ball has been reduced to less than three quarters of a meter. That figure corresponds to only 5 % of the dome diameter.

For the first time the meanwhile legendary Zeiss fiber optics projection of the starry sky is available to medium sized domes. Each star projector consist of up to 900 fibers for the projection of stars of unsurpassed brilliance.

Please come to see our demonstration of the fiber optic projectors during the visit to the Osaka Science Museum. Seeing is believing. Our cordial thanks to the IPS officials and to our Osaka Planetarium friends who invited us to present the fiber optics sky.

The gain in brightness of the projected stars allows us to reduce their diameters. Even the bright stars can now be generated with an angular diameter below the resolution power of our eyes. And the method of indirect seeing – well known to sky watchers – is applicable to detect the faintest stars of the fiber optics projection.

Time to adapt the visitor's eyes is something you never have to consider again. What happens to your stars when you project a panorama? They just vanish. With the fiber optics sky this problem belongs to the past.

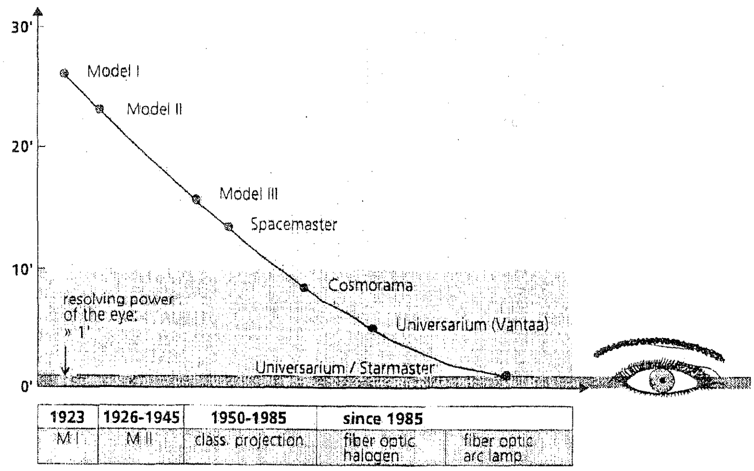


Fig. 3 Reduction in diameter of 0 magnitude stars with Zeiss planetariums since 1923

The fiber optic projectors come with a new method to simulate scintillation. For the first time scintillation in a planetarium is truly natural. The effect now is stochastically distributed and does not fade out any star when it is switched off.

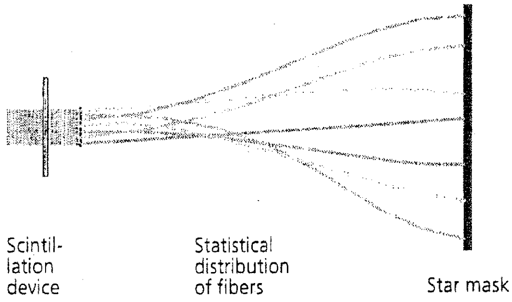


Fig. 4 Principle of the new scintillation method

The stars are represented by their true color. By staining single fibers we are able to color stars. Even an exaggeration of star colors is possible. A metal vapor arc lamp is used for fixed star projection. This is the only lamp which provides a pure white light. The arc lamp for the Starmaster is a commercial one, you do not need custom-made lamps for planetarium use any longer.

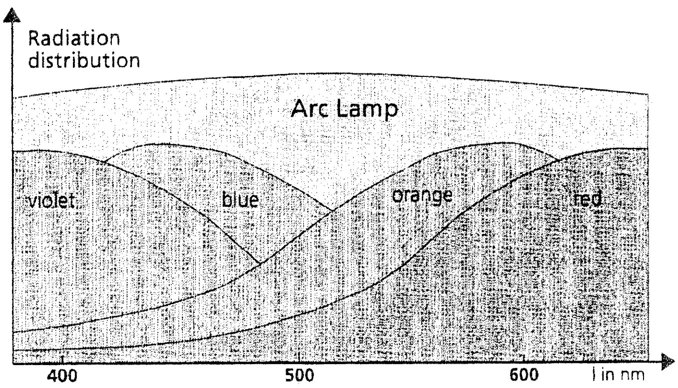


Fig. 5 Star coloration is achieved by staining single fibers

With the Starmaster we also introduce what our American colleagues call the "binocular view". With the Zeiss Starmaster you may use binoculars to watch star clusters and nebulae. Open star clusters are represented by stars weaker than the brightness limit of the field stars. To our eyes the clusters appear in exactly the same way as the natural clusters do. The large nebulae are represented by digitized photographic images. Discover the spirals of the Andromeda Galaxy as well as the characteristic structures of the Magellanic Clouds.

To cut off the projections from the star ball at the dome's springline we offer either gravitational shutters for flat domes or computer controlled shutters for tilted domes. Anyway in both cases the fixed stars are cut off by computer controlled shutters. This technique prevents projection of stars into a panorama, for instance.

An additional all-sphere projection system is available for the projection of astronomical grids and the constellation figures. A built-in slide change mechanism allows switching over between the two patterns.

A third projection system on the star ball covers a ring-shaped zone next to the celestial equator and ecliptic. It is also equipped with a slide change mechanism, for instance to project the constellation figures of the zodiac.

The projectors for Sun and Moon are integrated in the star ball and get their light from the central arc lamp. This again is a new technique in planetarium design introduced by Carl Zeiss. The combination of sun and moon projectors with the star ball avoids the obstruction of the projections all other star ball designs entail. With the Starmaster the advantages of the classical gear locked mechanism and the star ball design are combined. We call it the "2-in-1 concept".

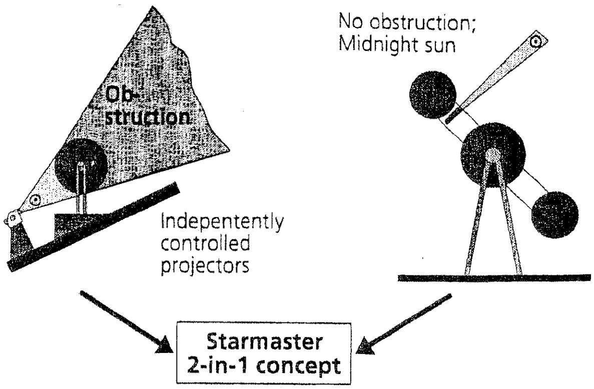


Fig. 6 The 2-in-1 concept combines the advantages of the independent projector control with unobstructed projection

Sun and Moon can be projected with such a brightness that they cast shadows in the dome. The Moon is presented with its surface details and phases. The phase mechanism gives you a correct narrow crescent close to new moon. The sun projector includes a mechanism for presenting eclipses and a planet transit.

The planet projectors are located in the near vicinity of the star ball. Each planet is projected by x-y-mounted high speed lens. These projectors provide a high luminosity of the planet images. The settings of all projectors are calculated by the astronomical algorithm in real-time.

The Zeiss Starmaster is controlled by a multi-processor computer. The user interface is based on MS-Windows. Control PC, synchronization board and interfaces are concentrated in a small control rack under the control desk. The control panel of the size of a PC-keyboard can be used for live presentations without restrictions.

Live run, teach-in programming, edition, automatic run and override are only a few of the integrated operation modes.

"Comet Hyakutake" Astrovision Film.

Kenji Nobukiyo.

GOTO Optical MFG,.Co. Planning Dep't.

Image of a great comet taken by a large format film system.

We succeeded in taking for film images in "Astrovision" format of the Comet Hyakutake that excited and impressed many astronomy fans around the world. Kunihiro Shima(International Dep't) was the main cameraman and I was the assistant cameraman.

First, I will explain about Astrovision and the Short-film category in which this film will be sold.
Astrovision is 70mm-10perforation film format.
There are 40 theaters including 35mm8p system around the world.
IMAX and other projectors can project films taken by Astrovision-camera by using an optical process.

Next is an explanation about Short-film.
Short-films run are from some tens of seconds to several minutes.
Short-films provide impact in planetarium programs.

For the actual shooting we choose GOTO's Yatsugatake observatry in Nagano prefecture as our shooting location site.
We used an Astrovision-Camera was set 70mm-10p format.
And most special is the fact that we carry the camera on the equatorial mount MXII.
The conbination resulted in a shooting success of not only beautiful image but also the comet moves across the star field.
We are proud of this film, both for it's beautiful image and educational value.
We are proud of the film valuable appreciatory image and for education.

WORKSHOPS

液晶プロジェクターの可能性
POSSIBILITY OF LIQUID CRYSTAL PROJECTOR

鷲巣　亘　Wataru Washizu

株式会社　リブラ　LIBRA Corporation

プラネタリウムに於けるビデオプロジェクターと言えば三管式（ＣＲＴ）を選択するのが順当であると思われます。画質や、暗部の黒沈みを液晶式と比較すれば明らかに判断がつくはずです。映像のバックグラウンドを星空に溶け込ませ、フレームレス映像を実現するためにはＣＲＴ方式をお薦めします。

しかし、敢えて液晶式の可能性を模索するのには理由があります。軽量、コンパクト、安価で、設置調整しやすいという理由は勿論の事ですが、その最大の理由は将来性にあります。過去数年間をみても、ＣＲＴ方式の技術革新が非常に緩やかに進んでいるのに対して、液晶方式のそれは急速な進歩を続けています。最近１年間は特に新製品ラッシュが続き、ビデオ機器の情報誌などを賑わしています。今後の液晶方式に対する期待は高まらざるをえません。そこで、今回は幾つかの新商品を使ってみることにしました。選択した機種とその理由は以下の通りです。

1. 三菱電機の液晶ビデオプロジェクター　ＦＶ－１００
   映像イコライジング機能を内蔵しており、液晶方式の弱点である黒浮きや白飛びを改善できる上、マッキントッシュやＶＧＡのパソコン入力も持っています。

2. 日本ビスコムのビデオイコライザー　ＶＳＳ－７０００
   Ｓ－ＶＨＳ映像の入出力を持ち、イコライジング機能を持たないプロジェクターの映像も改善できます。今回はＳＯＮＹの液晶プロジェクターＶＰＬ－３５１ＱＪに接続してみました。

3. パイオニアの液晶ビデオプロジェクター　ＸＧ１
   新開発の反射型液晶素子によって従来の液晶プロジェクターが持つ問題点（格子模様の映像）を解決しており、９８万円という低価格ながら１，０２４×７６８ドットフル表示を実現しています。

ＩＰＳワークショップ当日に会場へ持ち込めたのはＶＳＳ－７０００とＶＰＬ－３５１ＱＪだけでしたが、幸いにもＳＯＮＹの三管式プロジェクターＶＰＨ－１２７０ＱＪを使用することができ、液晶とＣＲＴの比較をする事が出来ました。ＦＶ－１００は事前に平塚市博物館で試写させていただき、ＸＧ１はパイオニアの内覧会で見せていただきましたので併せてご紹介します。なお、入力映像は主にマッキントッシュとビデオ、ビデオＣＤを使いました。

パイオニアのＸＧ１は画期的に画質が向上しています。液晶パネルの構造として、電流を送るソースラインや画素を組み上げるためのゲートラインがあり、それらが格子状に現れるわけですが、この問題点を解決しています。

ＳＯＮＹの３５１ＱＪと日本ビスコムのＶＳＳ－７０００の組み合わせも画質的にはすばらしく、同時に投映したＶＰＨ－１２７０ＱＪと比較しても遜色ありません。会場の２５０インチスクリーン一杯に映しても十分な画質を保っていました。

ＶＳＳ－７０００とＬＶＰ－ＦＶ１００の映像イコライジング性能については十分な成果は得られませんでした。デジタルガンマコントロールにより映像の暗部から明部までの素晴らしい階調が得られるため、映画「バットマン」や「エイリアン」などを鑑賞する上では素晴らしい効果をもたらすであろうことは想像できますが、プラネタリウムの星空に於ける理想の黒沈みには程遠いものがあります。理想に近づけるには新しいデバイスの開発が必要であり、各メーカーからは今後の開発の中で検討していただけるというお話をいただけました。今回の試みがその開発のきっかけにでもなれば幸いです。

レーザーディスクを継ぐもの

鳫 宏道
平塚市博物館

WHAT WILL SUCCEED TO THE LASER DISK'S FORTUNE

Hiromichi Gan
Hiratsuka City Museum

ABSTRACT

The LD(laser Disk) system is using by many planetariums in the world as project video movies to the doom screen. It is very effective and has a high trusty .We expect to use video,CG ,such as sky-skan's LD in many facilities simpler than now . The other side , SONY's LD professional type player had stopped to produce. Perhaps PIONEER will follow when DVD(Digital Versatile Disc) spread for the future. It cause is to change into new media,video CD, CD-ROM and DVD.These have good affinities with computer and huge capacity .We must consider what to do in this time.

はじめに

プラネタリウムで投影されるビデオ映像として最も普及しているレーザーディスクは、誕生してからすでに15年が経過し、信頼性の高いメディアとして普及している。この世界中のプラネタリウムで使われているＬＤがＤＶＤの登場とともに消えゆくのでは、という危惧がもたれている。SONYは業務用レーザーディスクプレイヤーの製造を95年12月に中止した。パイオニアはしばらく製造を続けるが、おそらく数年後、DVDの普及が進んだ段階で中止するだろう。しかし、DVDはコンピューターとの親和性が高く、また、はじめから書き込み可能な型を仕様に入れている等、次世代の大容量配布媒体として期待できる。

アナログからデジタルへ

LDは、映像はアナログ・音声はデジタル方式で記録したパッケージ・メディアである。これに対してDVDは、映像・音声ともにデジタルで記録できる次世代のメディアといわれている。

動画像を比較すると、LDはCLV方式で１フィールド（ディスク半周）で１画像、CAV方式では２フィールド（ディスク全周）で１画像（１フレーム）をアナログで収録している。その仕様は１インチのビデオテープのフォーマットそのものであり、画質も放送局レベルのものと同等である。

DVDは、これまでのアナログの記録方式とは考え方を変え、基準となるメイン画像を15フレームごとに収録し、その間の画像は動きを予測した画像が圧縮された形（MPEG2という世界規格の圧縮方式を採用）で収録されている。その画像の圧縮率、音声データ、字幕データ等の容量を決めてデータ化するためにオーサリングと呼ばれる作業を行う。DVDは、単層（片面）のシングル・レイヤー で4.7GB（4.7ギガバイト＝CD-ROMの約７倍のデータ容量）の容量を誇るメディアなので、圧縮するといっても元々の容量が膨大なためLDの画質に劣るということはなく、むしろ上回るといっても良いかと思う。

プラネタリウムとの相性

当然プラネタリウム用に映像の質を優先すれば、LDよりも高画質になるだろう。また、静止画はJPEGを用いたり、3D-CGにはmotion-JPEGなど、最適なフォーマットでパッケージ可能である。音声は最大8チャンネル、CDを上回る高音質のPCM記録が可能でもある。

一方、プラネタリウムにおいては、動画像をプレーヤーで再生する場合、決して最初から最後まで映し出す必要はなく、一部を取り出して使ったり、途中の一コマを静止画として映し出したりして見せたりもする。LDの場合、CAV方式で記録されているものは任意のフレーム単位でサーチする事ができるが、DVDの場合、MPEG方式で記録された映像では不可能である。したがってDVDに納められている映像を編集して使う必要性は残る。

プラネタリウムソフトの配布媒体としての期待

LDは今後も使う価値は薄れることはないが、業務用LDはメーカーのサポート次第でその寿命が決まってくるだろう。我々はDVDをコンピュータとセットで導入し、プラネタリウムで使う画像や音声を、DVDから取り出して別のメディアにコピーして使ったり、より積極的には書き込み可能なDVDに投影ソフトを書き込んで、配布したりできるようにしていくことが未来を開く鍵となろう。

USING 3DCG, PRODUCE IMAGE FOR PLANETARIUM PROGRAM

Shigemi Numazawa

Japan Planetarium Labolatory inc.

Recently, the speed up and the cost down of the personal computer has brought a real CG that was not able to do a few years ago. I will introduce about the process of the making 3D-CG by Macintosh Computer.

3DCG making process

"Modeling" "Rendering" "Animation"

Each process

Modeling

It means a making a structure of a solid. Using "Combine", "Rotate", "Booleans", "Joining" and "Grouping", you can make from some simple objects like a rectangular solid or a sphere to more complex model. Or if you use "Surface" or "Mesh", an unevenness is made on a flat paper, as a topographical map. "Metaball" is the way that spheres join to make more complex model, like as soap bubbles. There is a method that transform freely an assembly of triangular "Polygons" into imaged model.

Rendering

Rendering is a process that apply surface attributes to the object that was made by Modeling. As surface attributes, there are "color", "diffuse", "anvient", "specular", "reflectivity", "transparency", "luminance", "edge density" etc. You set these surface attributes, the real object can be made.

Photographs or Illustrations can be pasted on the designated part of the model. It is called "Mapping". And "Bump Mapping" is the way that make unevenness due to pasted density.

You can set freely light sources, shadows, etc. When you use Sun light, once you indicate the latitude and the longitude, date, direction, then the Sun's position is reproduced automatically at that time at that place.

Rendering Level : There are many kinds of the way of the application of surface attributes. They are the following; "Flat or Glow Shading" "Phong Shading" "Raytracing " "Raydio Sity (Radio Sity : Cornel Univ.) " They apply surface attributes of completely different quality to the model. "Raytracing" automatically calculates and reproduces the solid's distortion when see it through lens or reflected on the mirror. "Raydio Sity (Radio Sity : Cornel Univ.)" can do more complicate calculation to make higher

;rade model, but it needs longer time to do.

\nimation

[o indicate the change of objects or the moving camera angles, you can make an animation. There are ;ome software that have special effects. If you use them, you can indicate an acceleration or gravity of he celestial bodies. And there are provided with "Explosion", "Smoke", "Ripple", "Warp" that stars fly 'rom forward to backward,etc. from the first.

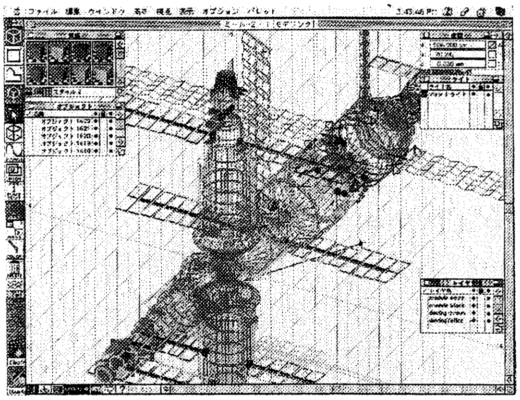
Vow using hardware system

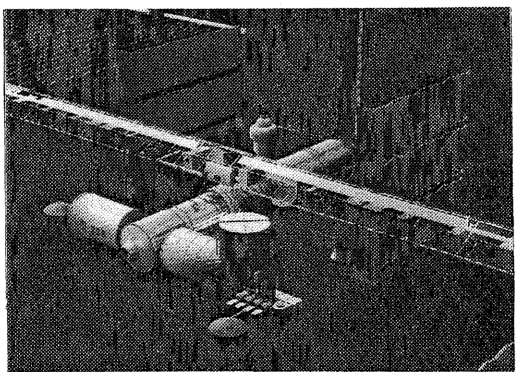
ıardware Power MAC 7100/80AV, 7600/120AV RAM148MB

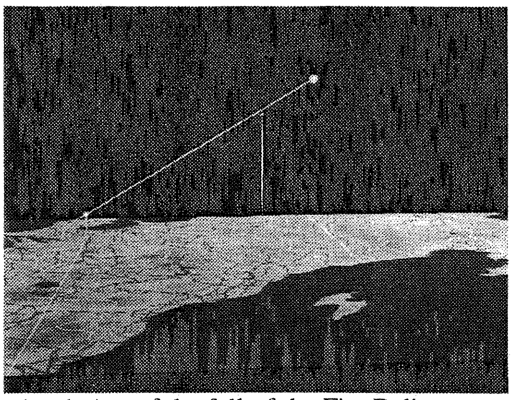
Vow purchasable 3D software for MAC

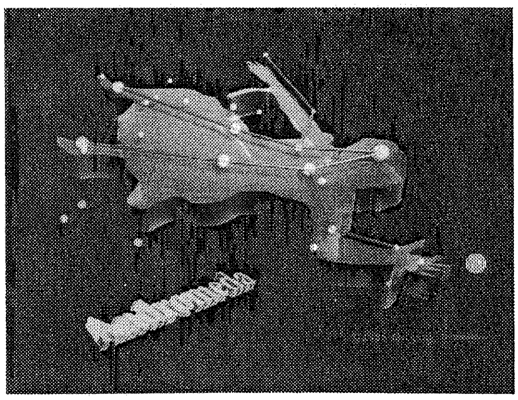
INFINI-D" "Strata Studio Pro" "Presenter Pro" "Shade" "Sketch" "Extreme 3D" "Form Z" "Electric mage" "Sculpt3D" etc.

ɔroduce examples


Modeling of Mir space station on the screen


Rendering image of Station Alpha


Simulation of the fall of the Fire Ball


Andromeda

'f you want to see more samples, please access to our home page.

http://www1.nisiq.net/~numazawa/JPLhome.html

ウィンドウズでつくるデジタル・ビデオ映像

蓮井　隆

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Making Digital Video Movies on Windows

Takashi Hasui

Kyoto Astrophysical Laboratory

Abstract

Future planetarium must need new basic functions. For example, projecting the revolution of planets include many asteroids, and the rotation of planets changing their surface look. So I made one computer program for Windows making digital video movies of like that. Using a personal computer with this program and a video projector, you can realize future planetarium functions right now.

はじめに

これまでに、筆者は平塚市博物館と共同で、コンピュータとＣＲＶ（追記型ビデオディスク）を用い、いくつかのビデオ映像をつくってきた。それは、ＪＰＳの研究会においても、発表されている。

しかし、この方法では、ＣＲＶのような特殊なハードウェアを必要とし、多くのプラネタリウム館で手軽に利用することはできない。また、画質の面においても、コンピュータ画面を直接投映するのと比較して、かなり劣化することは否めない。

そこで、ＣＲＶに記録するのではなく、デジタル・ビデオとして、ハード・ディスクに記録する方法を試みることにした。これにより、一般的なパーソナル・コンピュータとビデオ・プロジェクタがあれば、簡単に利用できることになる。また、直接コンピュータ画面を投映するため、画質の面においても有利となる。

なぜビデオ映像なのか

まず、なぜプラネタリウムでビデオ映像を必要とするのか、明らかにしておこう。

そもそも、プラネタリウムが備えている基本的機能とは何であろうか。それは

天体とその運行を映しだす

ことである。すなわち、プラネタリウムは恒星と惑星を投影し、且つ同時に、日周運動や年周運動など、その（プトレマイオス的）運行の様子も映しださなければならないのである。しかし、それだけでは、十分とはいえないのはもちろんである。天体は、恒星と惑星だけではない。その運行も、プトレマイオス的運動表現だけではなく、コペルニクス的運動表現も必要である。

つまり、それらを実現しようとするならば、必然的に動画が要求されるのである。その一つの手段として、デジタル・ビデオ映像の可能性を探ろうとしているわけである。

ただ、ここではっきり認識しておいてもらいたいのは、何もかも動画にしようということではなく、プラネタリウムの基本的機能である、天体の時間的変化を表現する手段としての動画であることを忘れてはならない。天体以外のものを動画にするようなことはしてはならないのである。

プログラムの概要

ここで、簡単にプログラムの概要を説明する。

このプログラムはウィンドウズ上で動作し、作成されるビデオ形式はウィンドウズＡＶＩファイルである。

まず、天体映像の種類を選択する。現在はまだ試作段階であるので、選択できるのは、小惑星を含んだ太陽系と地球のみである。次に、視点の位置と期間およびフレームの時間間隔を入力する。後は自動的にコンピュータが一枚一枚連続した映像をつくりだす。今のところ、コンピュータが自動的につくるのは、連続したビットマップ・ファイルなので、その後ビデオ・エディタでウィンドウズのＡＶＩファイルにする必要がある。

以上の操作でデジタル・ビデオ映像ができあがる。

映像の評価

作成した映像は、一つは、木星までの惑星とその軌道および５００個程度の小惑星の公転の様子を表わすもので、もう一つは、地球の自転する様子を表わしたものである。

その映像の評価であるが、小惑星を表示した太陽系の場合、ほとんど問題ないスムースな映像を再生することができ、小惑星の点像もシャープに投映できている。

また、地球の自転の映像の場合、３２０×２４０では問題なくスムースな再生ができる。６４０×４８０のフルサイズでは、若干スムースさに欠けるところはあるが、ある程度実用になると思われる。

デジタル・ビデオの可能性

現在、ウィンドウズＡＶＩファイルの標準スペックは、３２０×２４０・１５フレーム／秒である。しかし、理想的には、６４０×４８０・３０フレーム／秒が望ましいところである。これを実現するには、今のところハードウェアＭＰＥＧが考えられ、画像の種類によっては、利用価値があるであろう。ただ、小惑星の画像のような点像では、かなりの画質劣化があり、実用的とは言い難い。このような場合は、ＡＶＩの方が実用的映像が得られる。

もっとも、現在のコンピュータの進展を考えれば、他の映像でもＡＶＩで十分な成果が得られることが期待でき、デジタル・ビデオの可能性はかなり大きいと思われる。

今後、プログラムをある程度完成させ、実際のプラネタリウムでの使用を試みることとしたい。

Cancelling Spherical Distortions with 3-D Rendering Software
3Dマッピングによる実写パノラマの製作

Toshiya Kaga
加賀 俊哉

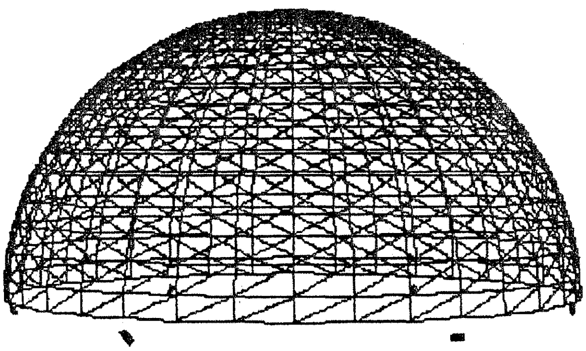
Tatebayashi Children's Science Exploratorium(JAPAN)
館林市子ども科学館(群馬県)

Abstract

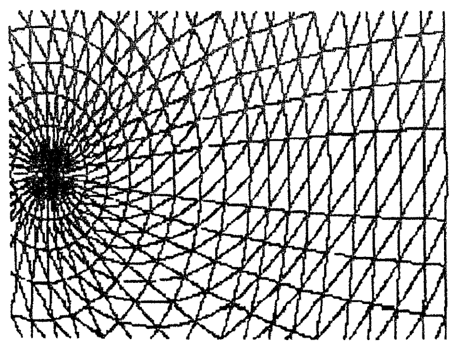
When we make photos for panorama projectors or all sky we can not ignor the spherical distortion and offset distortion. A software "DigiDome" solves this matter automatically, but I currently tried another way to solve them by using a typical 3-D rendering software. I took "Strata Studio Pro" to transform the original photos. This workshop represents the abstract process for how to cancel these distortions on the planetarium dome. Even processing a large scale panorama photo for the tilted dome is available with high accuracy and low costs. For further technical informations, please contact at E-mail address " kaga@mango.ifnet.or.jp "(no quotations).

概要

実写のパノラマやオールスカイ用のスライドを自作する場合、問題になるのがドームの球面スクリーンに対する歪み(球面歪み)の補正と、投影位置による形の歪み(オフセット歪み)です。パノラマの場合は今までは原画に傾斜と湾曲を与えて撮影するのが一般的でした。また、オールスカイはデジドームというソフトウェアで解決してきました。今回筆者はStrata Studio Proというソフトウェアでこれらの問題を解決する方法を開発しました。基本的には、ドームの形状をモデリングし、そこへ写真やイラストをマッピングします。さらにモデル内の投影機の位置に仮想のカメラを設置して撮影します。これだけの行程で球面歪みとオフセット歪みの両方を自動的に且つ正確に補正します。出来上がった画像をスライドにしてマウントすればパノラマやオールスカイ用のスライドが簡単に自作できます。詳細は筆者宛(E-mail: kaga@mango.ifnet.or.jp)へお問い合わせ下さい。



Simple Dome Modeling for All Sky



Produced Alignment Grid for All Sky

Planetariums Prepared for Hearing or Visually Handicapped Persons

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We are trying to present the planetarium programs to the handicapped in order to provide them entertainment and give them scientific knowledge concerning the recent development of astronomy. I show you various examples of new method of presentation in Japan and USA.

Programs for the hearing-impaired

We know there are many kinds of people who lose the sense of hearing; some of them lose completely the sense, while the other can listen our voice a little. We should pay attention to all of them, when we are going to present the program. We should perform by means of methods other than what we used to do for the non-handicapped; in order to let them understand the program, the talking is prepared and presented in a form easy to listen for them.

Saji Observatory (Tottori, Japan)

In 1995, we had a special program to the hearing- and speaking-impaired at the Saji Observatory by introducing a method of talking with the hands (sign language). The titles of the talking were "Suggestions to the visitors in the planetarium", "Flow of the images of projection in the dome of the planetarium - Star spangled sky after the sunset", or "The story to be presented is outlined in the pamphlet given to you". During the projection, the slides on which the titles or captions are described such as "Vega" or "Olpheus" or "Tonight sky at 8 O'clock" are projected for reference of the handicapped visitors.

Omiya Space Theater (Saitama, Japan)

In these months, the Omiya Space Theater presents the special programs understandable for people who can hardly listen the tutor's explanation in the planetarium by inserting many telop-type slides, which have been held on the 4th Saturday (12:00-, 15:00-) of every month. One of these programs entitled "Let's Stargaze" is recommended to the handicapped by the Ministry of Health and Welfare of the Japanese Government. This program was planned and made up with the help of many teachers of schools and associations for the handicapped in the city and the prefecture. Discussions had been extended mainly to the method of presentation such as the size of the letters in the slide, the font of the letters, the length of one sentence of talking, the height of the projected pictures, the duration of one program presented. The next of this special program will be held on July 27th, 1996.

Charles Hayden Planetarium (Boston, USA)

In the United States, the Charles Hayden Planetarium in Boston has recently installed a new state-of-the-art captioning system for hearing-impaired visitors. The system uses Vacuum Fluorescent Display (VFD) units in four areas inside the planetarium theater. Each VFD can serve up to three people, allowing us to accommodate up to 12 hearing impaired visitors per show. The units were specially designed for our planetarium by Design Continuum of West Newton, Massachusetts and the captioning software was developed by the WGBH Captioning Center in Boston. This system would be useful for other planetariums, particularly theaters with concentric seating.

We have many planetariums in Japan where the programs are prepared for the hearing-impaired visitors as follows: Sendai Astronomical Observatory (Miyagi), Itabashi Science and Education Center (Tokyo), Fuchu Municipal Museum Kyodonomori(Tokyo). We always exchange our ideas of how-to-do for the hearing-impaired visitors.

Programs for the visual handicapped

Similarly, the programs for the visually handicapped or people who can hardly watch the movie or projected images have to be planned by paying special attentions.

Sound Craft INC. (Tokyo, JAPAN)

In recent years, the programs of the planetarium are made up with the special sounding facility by which we can trace of moving source of the particular sound. One of the good example is a scene that a spaceship is moving from the left to the right in front of someone's seat of the theater. By using this facility, we give a source of sound to the sun, for instance; as a result, everybody can trace the moving source, the sun, on the dome screen off the planetarium from the sunrise, noon and to the sunset. The effect of the sound is strongly dependent on the position of the seat in the theater, the diameter of the dome, the tone of the sound, and so on. The research work on this system is now carried out together with a teacher of The National School for the Blind Tsukuba University.

Special methods developed for the visually handicapped visitors are as follows: An audio- system of moving source of the sound, a laser projector for the people who can watch only a star spot when projected with the bright light like laser light, a special scenario and the improvement of presentation One of the best way stressed in our discussion is that preprint in braille is prepared and given to visitors outside the planetarium in advance; in addition, explanation of exhibition should be displayed not only by drawing but by voice, and an easy-touching corner where everybody can touch solid-material such as meteorite should be prepared.

Conclusively, we should discuss the method, and we should try to do; if we can do it well for the handicapped, we can do it much better for everybody.

障害者のためのプラネタリウム Programs for Handicapped

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一口に「障害者」といっても障害箇所やその度合いは、人によって様々です。ここでは情報障害である聴覚と視覚の障害を取り上げ対応例や実験についてご紹介します。

聴覚障害者への対応

佐治天文台（鳥取県佐治村）

昨年、９月に「手話」を使った「ろうあ者向けのプラネタリウム」投影を行いました。手話で通訳したのは「プラネタリウム内での注意事項」「投影の流れ（日の入り→星空→物語）」「物語についてはお手もとのパンフレットをご覧ください」といった内容で、投影開始前にビデオでご覧いただきました。（事前にプラネタリウムの内容を印刷物にして手渡します。）投影中は文字スライドを「今夜８時の星空」「ベガ」「オルフェウス」など、必要最低限のものを投影しました。手話通訳士がいなくてもいつでもすぐに対応でき健常者と一緒にプラネタリウムを楽しめるように考えた結果です。

今後も要望があれば随時対応します。

大宮市宇宙劇場（埼玉県大宮市）

現在、埼玉県の大宮市宇宙劇場では、毎月第４土曜日の12時からと15時から「厚生省推薦番組『星空を見ようよ！』」と題して「文字スライド」を多用した、聴覚障害者にもわかるオート番組を定期的に投影しています。番組制作に当たっては、県立大宮ろう学校、大宮市福祉協議会、手話通訳派遣事務所、全国ろうあ協会などに協力をいただき、聴覚障害者への情報伝達方法を模索しながら行いました。「文字スライド」を利用するだけでも「文字の大きさや書体」「１文の長さ」「使用する漢字」「投影位置」「投影継続時間」と検討することはたくさんありました。

次回の投影は７月27日です。入場料は 600円、障害者手帳を提示すれば入場料金は半額でご覧いただけます。

チャールス・ヘイデン・プラネタリウム（アメリカ合衆国　ボストン）

ボストンのチャールス・ヘイデン・プラネタリウムでは、新しく聴覚障害者のための文字による解説システムを導入しました。プラネタリウム内４ヶ所に真空蛍光式表示装置（ＶＦＤ）を備え付けたのです。１台のＶＦＤは３人で利用できるので、一回の投影で合計12人の聴覚障害者にサービスすることができます。この器機は、われわれのプラネタリウムのためにマサチューセッツ州の会社“Design Continuum”で特別作成され、解説システムのソフトウエアはボストンの“WGBH Captioning Center”が開発したものです。このシステムは、特に同心円座席配置のプラネタリウムで有効に利用されるでしょう。

仙台市天文台（宮城県仙台市）

年２回程度「手話通訳」と「要約筆記」を加えた投影を行っています。手話は、別の部屋で生通訳したものをドーム内にビデオプロジェクターで投影します。
次回は、８月４日（日）に実施予定です。

板橋区立教育科学館（東京都板橋区）
年１回「文字スライド」を多用した「聴覚障害者向け特別投影」投影を実施しています。その日には、特別にドーム内に磁気ループを敷き「難聴者の補聴器」に対応します。
今年度は、５月12日に実施しました。

府中市郷土の森（東京都府中市）
一般投影の中で聴覚障害者への対応（文字スライドによる解説を行う、など）を検討中です。早ければ、今年の秋番組から実施される予定です。

聴覚障害者への情報提供の工夫
内容をプリントして事前配布／手話（録画・生通訳）／文字を投影（スライドなど）／磁気ループ（補聴器に電波を飛ばす）／レスポンス・アナライザー（聴覚障害者からの情報収集）／聞き取りやすいナレーション（シナリオ・声質、ＢＧＭの配慮など）／ＦＡＸサービース（文字による情報提供）／パソコン通信（文字・画像による情報提供）

視覚障害者への対応

株式会社サウンドクラフト（東京都）
最近のプラネタリウム演出では「音像移動」というシステムがあります。これは、例えば「宇宙船が目の前を横切るシーン」などで映像と共に音も動かすシステムです。
プラネタリウム・ドームに設置された複数のスピーカーから出る音の配分を自在に行い違和感のない音の移動をつくり出すシステムをを利用して、天体の空での位置や移動を表すことを考えました。例えば、太陽の日周運動です。朝、東から上って南の空を通るとき最も高くなり西へ沈むといった動きを移動する音で表せたらと考えたのです。
実験してみるとドーム径やドームの形式、そして、座席の位置によっても移動の様子の感じ方が異なることがわかりました。また、音の種類によって位置の特定の難しいものもあります。これについては、現在、筑波大学附属盲学校の地学教諭らと研究中です。

視覚障害者への情報提供の工夫
音の移動システム（天体の位置や動きを音の位置で示す）／レーザー光線（明るい物なら見られるという弱視の方への指示）／シナリオの検討（代名詞を避け具体的に）／指示の工夫（充分に明るい矢印をゆっくり移動。大きな円を縮めて指示）／立体星図の用意（凹凸で示した星図）／点字による表示（リーフレットや案内板）／音声による表示（館内案内など）／触れられる展示（隕石の展示など）／音による展示（宇宙線など）／天体望遠鏡（弱視の方の中には「惑星など明るい天体なら見える」という人もある）／パソコン通信（電子データによる情報提供）

おわりに

今回の発表の中には大がかりな設備を必要とするものもありましたが、明日からすぐにでも利用できるようなアイディアもあったと思います。皆様の館でご活用ください。
障害者サービスは、障害者だけでなく健常者にとっても有益なものが多くあります。字幕解説は、耳慣れない天文用語や星の名前を知らせるのに役立ちますし、文字を拡大したパンフレットは弱視者だけでなく老齢者へのサービスと共有することができます。
私たちは、視覚・聴覚・触覚などあらゆる感覚に訴える情報提供方法を考えていかなければならないでしょう。

Newインフィニウム（INFINIUM） 紹介と技術解説

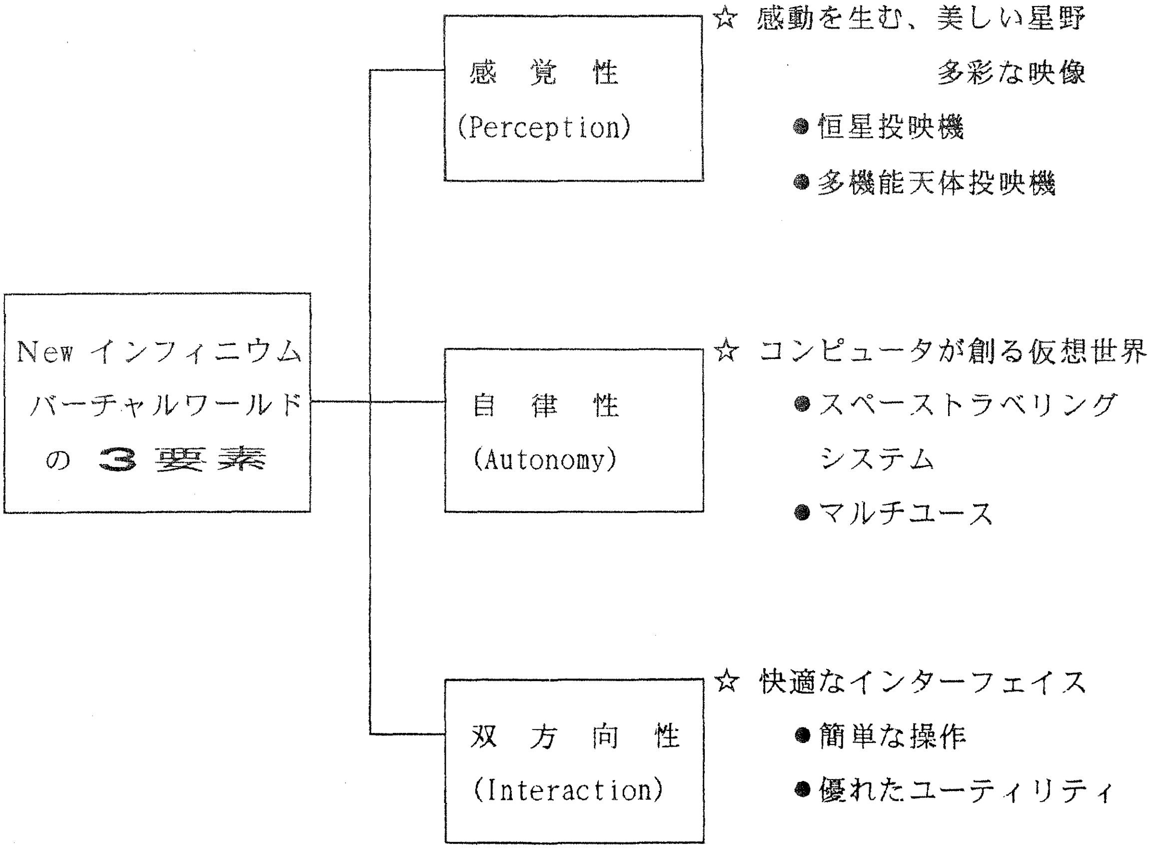
ミノルタプラネタリウム株式会社

鈴木孝男、吉田孝次、松原理江

1．基本コンセプト

(1) プラネタリウムの世界は元々ドーム内に初歩的なバーチャルリアリティの世界を創り出していたのですがＮｅｗインフィニウムではソフト、ハードともに高度な技術を駆使して、コンピュータ時代にふさわしい、科学性豊かなバーチャルリアリティを実現しています。
私どもはこれに“バーチャルワールド”と名ずけＮｅｗインフィニウムだけが創り出す仮想宇宙旅行の世界、と位置付けています。

(2) 私たちは新しいインフィニウムを開発するにあたり、バーチャルワールドを表現する、３要素を次のようにまとめ開発を進めてきました。



２．感動を生む美しい星野、多彩な映像

⑴ バーチャルワールドを実現する恒星投映機。

① 「実際の星空と同じようなリアルな星空を再現する」ということはプラネタリウムの永遠のテーマです。

② 星空を理想的に再現するためには、明るい星はキラリと輝き、暗い星は小さくほのかに見えるように投映することが大切です。

③ 明るい星から暗い星まで、階調を正しく投映するために、ミノルタでは世界で初めて、超微細穴明け加工技術の開発と、マイクロファイバーレンズの開発を行い、この理想に一歩近付くことができました。

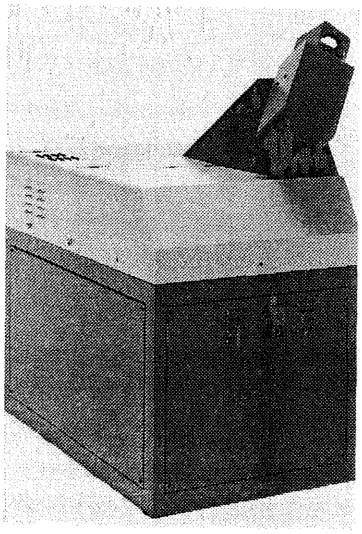
④ その結果、これまでタブーとされてきた、ドーム内で双眼鏡を使った観望会も可能となったのです。暗い星は勿論、星雲、星団などもこれまでと比べ、はるかにリアルに再現されるようになりました。

⑵ バーチャルワールドを多彩な映像で表現する多機能天体投映機。

① 従来は惑星投映機と呼ばれていた投映機が、大幅に機能アップして、多機能天体投映機となりました。

① ７台の投映機に、最大５６０シーンの天文映像をデータベースとして収納、演出の幅を大きく広げました。

② 投映機は６倍ズーム、像回転機構（映像の姿勢を正しく保つ機構）、位相機構（満ち欠け機構）などを装備、科学的で臨場感あふれる演出を可能にしました。



多機能天体投映機

3．コンピュータが創る仮想世界

⑴ スペーストラベリングシステム（ステラオブジェクトの場合）

① 快適な宇宙旅行のため、発展性に富んだ新しい宇宙交通システムを構築しました。

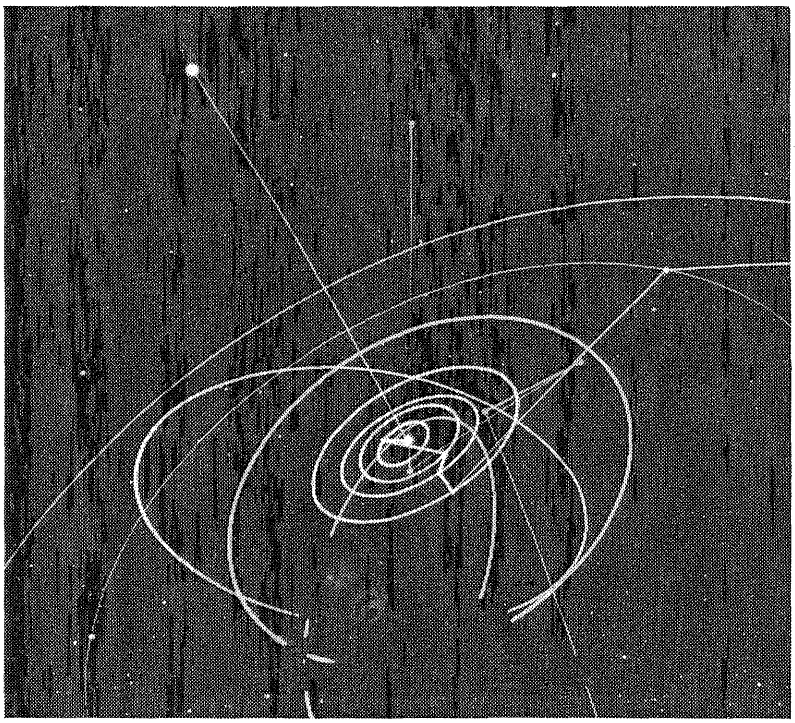
② それぞれ行き先、目的別に専用の宇宙船が準備されており、宇宙旅行を簡単に楽しむことができます。

③ 従来ややもすると、宇宙旅行のシーンは、科学的なシミュレーションの世界ではなく補助投映機などによる雰囲気作り的な映像によって演出されていましたが、多機能天体投映機と、スペーストラベリングシステムにより、ほぼ完全なシミュレーションの世界として演出できるようになりました。

⑵ マルチユース（ピンナップオブジェクトの場合）

① 恒星固有運動、季節太陽など活用度の高いシーケンスをワンプッシュで呼び出し、演出することができます。

② この結果、これまで大量に準備してきた専用の補助投映機の多くは必要なくなりました。



スペーストラベリングシステムの一例

4. 快適なインターフェイス

(1) 簡単な操作

① 多機能な機器ほど操作は複雑になり、それを使いこなすには多くの熟練と専門知識が必要になりがちです。
私たちは“バーチャルワールドは簡単な操作から”を合い言葉に、どなた様にも簡単に操作できるインフィニウムをめざし開発を進めました。

② インフィニウムでは、コンピュータを上手に使う、簡単に扱うという発想から、オペレータが自分のイメージした映像やシーンをコンピュータに支援されて簡単に表現できる（Computer Aided Function）という機能を持たせようと、発想の転換が行なわれています。

③ 具体的には、各種機能の連動、グラフィカルインプット・アウトプット、ナビゲーションシステムなど、オペレータを支援する機能を豊富に装備しています。

(2) 優れたユーティリティ

① 簡単な操作はさらに、インテリジェントエディタをはじめＣＲＴ上での各種シミュレーション機能により、プログラムの作成、修正時間を大幅に短縮させるとともに初心者にも間違いのない入力を可能にしました。

5. ミノルタがめざしたもの

(1) ミノルタがプラネタリウムという機器の開発を通じて根底の部分で目指していたものは、

- 人々に、星の世界を体験し、感動することを通じて、
- オペレータには、簡単な操作を通じて、

“使う人のハートに優しく”

“観る人のハートに響く”

ハートフルテクノロジーでした。

(2) 皆様が、インフィニウムを通じて、私たちのハートフルテクノロジーに接して頂ける日を楽しみにしています。

IPS Workshop ：How to gather visitors プラネタリウムにいかに人を集めるか。

Kimberly Ayers／Masaharu Suzuki

GOTO OPTICAL MFG.CO.

Panel Chairmen： Kimberly Ayers (Goto Optical)
Masaharu Suzuki (Goto Optical)

Panelists： 1.Larry Schindler, Hayden Planetarium, Boston Museum of Science.
2.Jon Elvert, Lane ESD Planetarium,Eugene,OR.
3.Martin Ratcliffe, Buhl Planetarium, Carnegie Science Center, Pittsburge, PA.
4.Thomas Kraupe, IPS Incoming President, Munich, Germany.
5.Noboru Kubo, Urawa Youth Space Science Museum,Saitama, Japan.
6.Takayuki Honma, Fuchu Municipal Museum, Tokyo, Japan.

「いかにしてお客様を呼び込むか」という問題は、洋の東西を問わず、プラネタリウムに於ては最大にして究極のテーマである。このワークショップでは、アメリカ合衆国、ヨーロッパ、アジア（日本）の3地域に於て、どの様な努力が成されているかを、6名のパネリストに発表して頂き、その情報をもとに指針を探ろうという企画である。

【座長からのスピーチ】

まず、Ayersからアメリカ合衆国に於けるプラネタリウムの状況について報告があった。現在アメリカ合衆国では1,000ヶ所以上ものプラネタリウムが稼働しておりその77%が教育機関で使用されているが、教育カリキュラムに於ける天文学に割当てられた時間が削除されたり、予算削減が深刻な問題となっている事が指摘された。

また、Suzukiからは日本の状況についての報告があった。日本には現在6m径以上のプラネタリウムが350館あり、密度で考えると世界一高い密度になり、この高密度の中で、いかにして自分の施設に客を誘致するかが大きな問題となっている。また、95%以上が地方自治体の運営で、「行政の効率」という面で収益の向上を求められている。

【各パネリストからの発表】

ボストン市ハイデンプラネタリウムのシンドラーは、館のマーケティング部門のリサーチに基づき、番組企画や広告計画が成され、例えば、「スターレック」特集では非常に成功をおさめ、「マーティンの神秘的な宇宙」という番組では大々的な広報活動を展開した。その結果、その前4～5年間の入館者数に対して36%もの増加を実現した、との発表を行った。

オレゴン州レーンESDプラネタリウムのエルバートは、地域学区からの財政援助が突然打切られてしまい、運営が行きつまってしまったが、観客数を増加させ、収益を増加させる計画を立てて実行したと報告があった。その内容はプラネタリウム番組の質の向上、地方メディアへの情報提供、学校向けや各種事業用プログラムの充実、レンタルシアタ

ー、レーザーやパイパーメディアの活用といった事が挙げられる。この努力の結果、同プラネタリウムは財源の打切り以前より健全な予算運営ができる様になった。
カーネギー科学センターブールプラネタリウムのラトクリフは、プラネタリウムショーのタイプに焦点を絞って解説を行った。観客はショーの題名にひかれてプラネタリウムにやって来るので、題名や内容が最新の情報や話題に沿っているかが、非常に重要である。また、プラネタリウムショーと科学館に於ける展示をタイアップして開催する事も有効であり、そのためのマーケティングが非常に重要である事を、具体的な事例をもとに発表した。
元ミュンヘン市技術フォーラム・プラネタリウム館のクラウペは、同館の美しい写真を基に、ヨーロッパに於ける最新鋭プラネタリウムの現状について報告した。特に最新の話題を取り込んで番組作りを行う事と、それをいかに広報活動に取り込んでゆくかが、非常に重要である事を、具体的な事例をもって解説した。
府中市郷土の森、Honmaからは、比較的交通の便の悪い施設にいかしてお客を呼び込む努力をしているかが報告された。特に同施設は京王線という私鉄の沿線にあるため、この沿線地域にある遊園地や文化施設が集まった「京王アラカルト」と呼ばれるコミュニティに加盟し、それを広告の核として成功を収めている事例が報告された。
浦和市青少年宇宙科学館,Kuboからは、リピーターの増加を目標として、娯楽性と科学啓蒙を両立させたエデュテイメント・プラネタリウム番組を企画し、その第一段として「セーラームーンスーパーズ in プラネタリウム」というイベント+プラネタリウムショーを実施した報告があった。わずか3日間のイベントで、客の少ない冬場に1.5ヶ月分の集客を達成する事ができた。

【まとめ】

1.集客力を上げるには「戦略」が必要であり、それを企画し、実施するシステムがなくてはならない。専門のマーケティング部門や担当者のいる施設は集客力が高い。
2.話題性のあるテーマ設定。
3.通常の番組とは違ったイベントも有効。特に展示とのタイ アップは有効な方法。
4.館のアイデンティティーを高める広告、マスコミへの情報提供などが不可欠。
5.新しいメディアの導入。

<プラネタリウムのためのコンピューターネットワーク>

（財）横浜市青少年科学普及協会　山田陽志郎

世界的に急速に普及してきた情報環境が「インターネット」です。プラネタリウムの世界でも、研究成果や発見情報の入手やプラネタリウムの広報、普及活動としての情報発信など、利用が始まっています。
構内コンピューターネットワークやインターネットの導入について、計画中の施設に役立つ留意点を、以下に示しました。

● ネットワーク管理者

構内に閉じたネットワークであれ、インターネットにつながったネットワークであれ、ネットワーク環境を管理する人間が必要です。
休暇や出張を考えれば、ひとりよりもふたりの方がが望ましいでしょう。
ネットワーク管理者の主な役目は、ネットワークを障害なく運用するです。このためには、どの職員がネットワークを使っており、どのような形態の利用が多いか、いま問題となっていることははなにかなどに常に気を配る必要があります。
また、初心者を指導するのも大切な仕事です。

こうした業務を、コンピューター関係の業者に委託することも可能ですが、相当の出費を覚悟しなければなりません。また、コンピューターを一台追加したいとか、別のコンピューターの内容を共有したいなど、日々発生するネットワークへの要望をすぐに実行、対処するわけにもいかなくなくなるかもしれません。

ネットワーク管理は、コンピューター（特にワークステーション）に関しての知識と経験を要求される仕事です。
専任者をおくことができれば一番ですが、本業のかたわらやっている、という場合もあるかもしれません。ある程度のコンピューター経験者ならば、メーカーの相談サービス（たいていのメーカーが電話相談サービスを有料で行っています）を活用することで多くの問題を解決することができます。
コンピューターの世界はソフトウェア・ハードウェアともに進歩がはやいため、専門雑誌の購読もかかせません。どんな雑誌を購読すべきかは、他館の経験者にたずねるのが一番です。

● ネットワークの工事

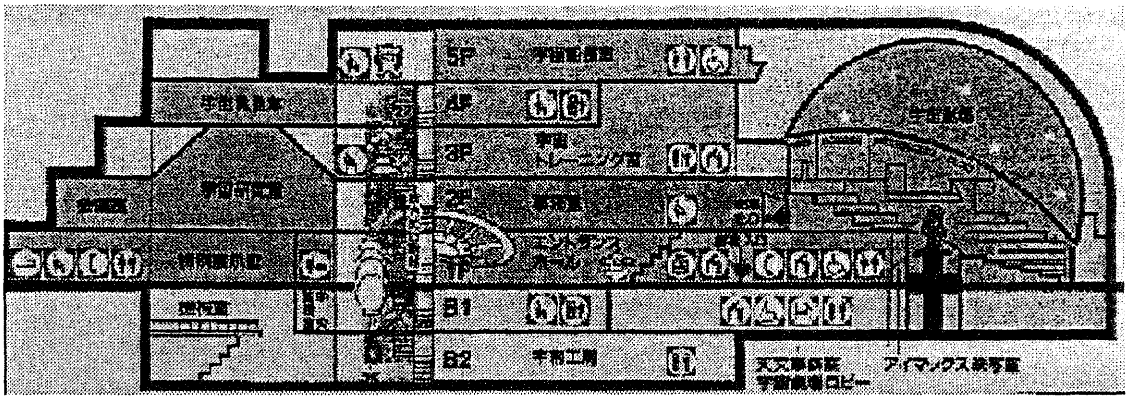


図１：横浜こども科学館断面図

図１は横浜こども科学館の断面図です。１階から５階までの床下に、ネットワーク用同軸ケーブルが這わされており、その一部が写真１に示されています。

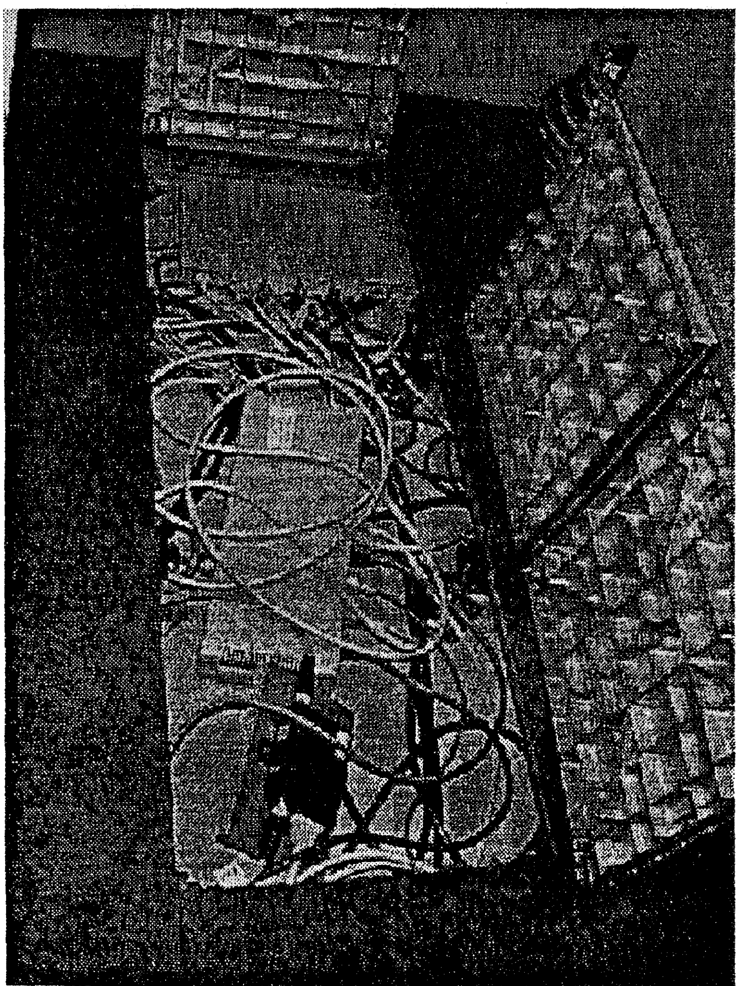


写真１：床下のネットワーク用ケーブル

床あるいは天井にコンピューター同士を接続するケーブルを這わすことになりますが、可能ならば館を建設する時に、基本的な配線工事をすべきです。将来必要になりそうな階や部屋にも、あらかじめ配線してしまうほうがよいでしょう。

構内ネットワークの技術としては、「イーサネット」というものが現在標準です。その配線で、最近利用が増えているのが、電話線のような細いケーブル（10BASE-T:テン・ベース・ティーと読みます）です。
横浜こども科学館でも、幹線部は太いケーブルを使っているのですが、末端部では10BASE-T が普通になってきていっています。線が細いため、配線工事が楽で、工事費用も安くなります。

● 構成機器や接続方法

構成機器や接続方法は、どんなふうにネットワークを使うのかによりますし、建築構造にも関係してきます。

しろうとの判断では限界があるので、複数の専門業者にも相談して最適なプランをまとめるのがよいでしょう。

単純な構成のネットワークのほうが管理は楽です。ただ、幹線の部分が一カ所でも切断されますと構内ネットワーク全体がマヒ状態になるという欠点もあります。

安くて高性能なパソコンが普及するにともない、パソコンを通じてネットワークを使う、という形が今後も増えそうです。
共用ファイルを置いたり、インターネット利用を支援する中核的な役割を持つコンピューターとしてはワークステーションも重要です。

● インターネットへの接続

構内ネットワークに、ルーターという専用コンピューターを接続し、ルーターから電話回線を通じて別のルーターに接続することができます。こうして別組織のルーター同士がつながることになり、ネットワークのネットワーク、すなわちインターネットができていきます。

基本的にインターネットは専用線で結ばれたネットワークですので、ＮＴＴ回線料金が高くつきます。専用回線の維持費は、接続先までの距離と回線の速度によって違います。
詳しくはＮＴＴに問い合わせてください。

接続先としては、博物館やプラネタリウムの場合、近くの大学の協力が得られる場合があります。
そうでなければインターネットへの接続を商用サービスとして提供している会社（そうした業者をプロバイダーといいます）があり、そこに接続を申し込むことになります。

インターネットに接続するためには、コンピューターのアドレスの取得やコンピューターの設定が必要になりますが、商用サービスの場合にはこれも代行してくれます。

いずれにしても、本格的にインターネットに接続するにはかなりの技術力・予算が必要ですから、まず、パソコンとモデムでもできるダイヤルアップＩＰ接続という方式から始め、インターネットについて少しずつ経験を増やしていくのがよいでしょう。

また、近くの大学やプラネタリウムでインターネットに接続しているところを見学させてもらったり、あるいはインターネット書籍や専門誌などで研究してプランを練ることも重要です。

実際にインターネットに専用線で接続する段階では、不心得な侵入者から構内ネットワークを守る技術についても十分研究しておく必要があります。

本稿は、全国科学博物館協議会／平成７年度資料情報のネットワーク化に関する調査研究報告書のための原稿をもとに加筆したものです。

（筆者E-mail: yamada@ysc.go.jp）

Interactive Planetarium

Tatsuyuki Arai
Katsushika City Museum
Japan

Recently, more and more planetariums throughout the world have introduced interactive programs. The audience is encouraged to participate in the programs through voting, quizzes and other methods using a response analyzer answering button installed on their seats. Another attempt is made to link their own facilities with other planetariums, science museums, and world-wide research institutions via the Internet and other networks so that students can learn science through direct communication with researchers.

Some planetariums add interactivity to their programs without a response analyzer using the teachers' ingenuity.

This workshop will present these examples in Japan and abroad, and discuss this new potential of planetariums.

Whether you have a response analyzer or not, please join our workshop.

I.D.E.A.S.
INTERACTIVE/INTERDISCIPLINARY DIDACTIC EXPERIENCES WITH ADVANCED STARLAB

Loris Ramponi
Centro Studi e ricerche
Serafino Zani
Lumezzane, ITALY

Susan Reynolds
OCM BOCES
Planetarium
Syracuse, NY, USA

Torbjorn Urke
Volda College
NORWAY

This workshop is designed to inspire creative uses of Starlab as a multi-disciplinary teaching laboratory. Demonstrations include practical and interactive activities using slide projections, available cylinders and homemade cylinders. These activities can be used during and after the hemispheric projection, inside and outside the dome.

"Starlab as a Versatile Teaching Tool" by Susan Reynolds:

A variety of interactive experiments may be conducted using markers attached to the horizon (by velcro) or above the horizon (using tape). Cultures throughout the world use the occurrence of horizon events as a calendar. Markers such as poles, rocks and buildings were used to mark such things as equinox and solstice sun positions or extreme positions of the moon or planets. Students can experience this process as well as utilize markers for comparing apparent and real celestial motion at many latitudes. Even the outside of the dome can be used to demonstrate how people discovered the world was round not flat.

Sixteen interchangeable cylinders are available for use with Starlab. These projection capabilities allow for an enormous variety of interdisciplinary presentations. Students and teachers can design lessons and experiments to augment studies in all areas of the curriculum. A choice of Northern Hemispheric or Southern Hemispheric perspectives are available for most cylinders. The available cylinders include: Starfield; Constellations; Celestial Coordinates; Deep Sky Objects; Greek Mythology; Native American Mythology; African Mythology; Chinese Mythology I; Chinese Mythology II; Lapp (Sami) Mythology; Earth; Plate Tectonics; Biological Cell; Weather; Ocean Currents; and Transparent (clear cylinder for creating homemade projections). Design, creation and production of new cylinders is an ongoing process.

"The Lapp (Sami) Sky: The Cosmic Moose Hunting Scene" A New Starlab Cylinder by Torbjorn Urke:

The Lapps in Norway, Sweden, Finland and Kola call themselves Sami. They have special sky lore and constellations related to their own unique culture. The dominant constellation in the sky is "Sarva," the moose, which can be found using the stars Cassiopeia, Perseus and Auriga. Sarva refers to a cosmic hunting scene. Among the pursuing hunters are the "Skier Stars" (Castor and Pollux) as well as "Fatvna" (Arcturus) with their bows. They all hunt the moose but the world will perish at the laying down of Sarva. For the Sami, Polaris has many names: "The Northern Nail," "Sky Nail" and "Pot Nail." In the Lapp region it was common observation that the sky, so to speak, turned around the North Star. Since that star formed the "fixed point," it was natural to see it as an embodiment of the world pillar which carried the sky. This pillar has also been symbolized as a raised stake or pillar where sacrificial acts occurred. A disturbance of the world pillar, or Polaris, would cause the sky to fall down and the earth would perish.

This cylinder, along with other mythology cylinders, can be a wonderful addition which will enhance multi-cultural lessons in Starlab.

"Interdisciplinary Experiences with Starlab" by Loris Ramponi:

Interdisciplinary uses of Starlab began after five years of astronomical projections under the inflatable dome. Thanks to the geology background of the late president of the local association of amateur astronomers, the first Starlab lessons with the tectonics cylinder were offered. At the beginning, the structure of the lesson was traditional and completely developed under the dome. The complexity of the tectonics cylinder forced us to also use some slides introducing the main concepts of the lesson. The occasion of an Interactive Science Exhibition pushed further development of the content of the geology lesson and also initiated the use of the cell cylinder. A biologist, who had just completed university studies, was contacted to develop a lesson about the cell. Therefore, two domes are used: one only for astronomical planetarium projections and the other for non-astronomical programs.

The Exhibition contained displays built following the famous "cookbooks" of the San Francisco Exploratorium as well as original ideas. Since the public appreciates involvement in interactive experiments, practical activities were also introduced during the cell and the tectonics Starlab lessons. Therefore, some biology microscopes, a collection of samples for microscopes, some microscopes for geology and a collection of rocks were purchased. With these instruments the operator can involve the public in observations of different kinds of cells and rocks.

The lessons were divided into three parts:

1. Introduction: an introduction outside the dome that explains, with the support of slides, the main scientific content of the lesson;

2. Starlab Experience: the setting up of the inflatable dome with students; under the Starlab, the operator describes the main parts of the cell and their functions; or the distribution on the earth of plate tectonics, oceanic dorsal, seismic areas, volcanoes, hot spots and so on;

3. Culminating Activity: the lesson ends outside the dome with observations through microscopes of animal and plant tissues and single cell organisms; or the observation of characteristics of volcanic rock samples.

The results obtained with this first experience promoted further development of non-astronomical programs. In our Astronomical Center three Starlab school programs began to be presented: astronomy, biology (the cell) and geology (tectonics). When classes come for a visit, morning activities with the students are managed by at least two operators: one trained for the astronomical program; the other (depending on the lesson reserved by the school) would be a natural science specialist, biologist or geologist. Two classes are involved simultaneously for at least three hours. In one morning each class can follow the astronomical planetarium lesson, one Starlab lesson of non-astronomical interest, visit the exhibit collection and follow a final slide presentation. For example, when one class has the cell lesson in the big room, the other uses the small exhibit room or does other activities. These same activities can be carried out directly in the school.

The success obtained encourages development of new non-astronomical programs. By using not only the available Starlab cylinders but through continuously creating new hemispheric projections using the transparent cylinders, an endless number of programs can be conceived.

"Introduction of Transparent Cylinders and Methods of Making New Hemispheric Images with Transparent Cylinders and Photographic Film" by Loris Ramponi and Susan Reynolds:

What do you think would be the best subjects that can be developed with hemispheric images? (Suggestions taken and recorded.)

Our experience suggests the following ideas:

Hemispheric Panorama: Examples: (1) one imagines they are in a woods, from the ground to above the trees, and characteristic animals of this environment are depicted in a 360 degree landscape; or, (2) one can imagine being in an archipelago of volcanic islands.

Comparison/Contrast: Various figures can be shown which illustrate characteristics that can be examined and compared for similarities and differences. Examples of this include types of: human cells, insects, plants or leaves.

Evolution of Phenomena: A comparison can be presented showing stages of evolution or a historic process. For example, the evolution of prehistoric art or perhaps the history of life on earth.

Inside Something: Examples of this are: (1) inside a cave where prehistoric stone engravings are in evidence (this could be used in connection with the evolution of prehistoric art); or, (2) a view of underground or under water which shows the life forms present at different depths in longitudinal sections.

The images are first prepared on paper which shows the cylinder on a flat plane: equatorial part (size 78 x 26 cm), zenith part or the top of the cylinder (diameter 24.7 cm), and nadir part or bottom of the cylinder (diameter 24.7 cm). Then the negatives of these drawings are reproduced on a film (usually white drawings on a black background). The negatives are fixed with tape on a transparent cylinder. The zenith can be transformed into a "zenith window" where a variety of images can be shown. For example, different hypotheses about the "Christmas Star" (comet, supernova, planetary conjunction) can be shown in this window. If the nadir section is not covered, the film is more easily separated from the transparent cylinder. (Loris can provide any Starlab user with the single parts of the cylinder, ready-made, that can easily be temporarily mounted on a transparent cylinder. The subjects currently available are the following: "Evolution of Prehistoric Art," "Journey in the Human Body" and "Volcanoes.")

"The Use of a Double Projector System Under the Starlab Dome" by Loris Ramponi:

The availability of a "double Starlab projector set-up" is extremely helpful when complementary cylinders are used inside the dome. It is best to use two Starlab projectors under the dome in order to pass quickly from one image to another. When using two projectors under the same dome it is possible to work continuously in the dark with easy transitions made between cylinders. A cylinder change can be done on one projector while the other is projecting. Examples of transitions might include: from Earth to the starfield; from tectonics to a transparent colored cylinder with figures of dinosaurs; from the northern starfield in the equatorial position to the southern starfield cylinder in the equatorial position, which allows for a complete journey from North Pole to the South Pole.

The first results after using two projectors have been very interesting. Passage from the Northern sky to the Southern sky is perfect. As the Northern cylinder is slowly turned off, the light on the Southern cylinder is slowly brought up. This is accomplished with one console in front of the operator while the other is opposite. The simultaneous use of two cylinders produces some reflections of the main stars under the dome. These reflected images are like meteors. (A special effect is obtained without auxiliary projectors!)

Simultaneous use of the geography cylinder with the other "Earth" cylinders (tectonics, ocean currents, meteorology) is very useful. In fact, these last cylinders are complicated and it is important to begin the lesson with simple geography of the globe and then show the geology, oceanography or meteorology details on the map.

The possibility of combining, for example, the Greek mythology cylinder, with the Native American cylinder increases the spectacular impact of Starlab. This contemporary use of two cylinders is very exciting when also combined with the production of homemade cylinders. This method allows for using many cylinders during a lesson with the possible fast comparison between two different cylinders at a time. For example, a prepared cylinder about tissues of the human body could be used with the biological cell cylinder.

"Experiments":

Participants can view examples of homemade cylinders: Loris' "Evolution of Prehistoric Art" cylinder; and Susan's "Native American Sky Traditions." Participants can experiment with making their own homemade cylinder designs and projecting them.

"Finale" by Loris Ramponi and Susan Reynolds

Announcements will be made relating to two newly created opportunities:

1. A "Starlab Transparent Cylinder Contest."

2. An "Adventure for American Planetarians in Italy."

UTILIZING A PLANETARIUM FOR CLASS LESSONS OF 40 STUDENTS

FOR ENJOYABLE LESSONS IN ASTRONOMY

J. Kyoji Saito

Seibo Gakuin Junior and Senior High School, Kyoto, Japan
Society of Teaching and Popularization of Astronomy

1. Introduction

Many domes of school-planetariums are 2 or 3 meters in diameter. The maximum number of persons admitable to such a dome is 10 to 15 - too small a capacity for use in a normal lesson. As a result, these school-planetariums are hardly ever used for any classes, and are only fully utilized during the school festival for the science club's exhibition . There are planetariums at the public science centers, but it isn't possible for teachers to freely use them when they need to. If a teacher utilizes a planetarium for class lessons, a dome of 5-6 meters in diameter that can accommodate one class of at least 40 is necessary. The author has been using a 6-meter-diameter-dome for several years. The dome was hand-made, has a capacity of 50 students and is usable in full class size planetarium lessons. The dome enables us to plan highly efficient and enjoyable lessons. We discuss the possibility of various forms of lessons in a planetarium dome, and also discuss some problems.

2. A dome that can be utilized as a planetarium for class lessons.

The dome which can accommodate 1 class of 40 students has a diameter of 5 or 6 meters (Saito 1989, 1990, 1991). The author began a study of low cost prefabricated domes in 1983. Several domes have been produced with various materials. The basic structure of these domes is of the Fuller dome type.
Dome 1 (1983): The first dome had white vinyl sheet on a frame of paper pipe with a diameter of 5.7 m. The whole room needed to be darkened.
Dome 2 (1985): The dome had a screen of cloth which was coated with aluminum attached to a frame of metal pipe with magic tape. This dome also required needs the whole room to be darkened, too. It had a diameter of 6 m.
Dome 3 (1989): The dome had panels of corrugated cardboard which were joined by cloth tape. It had a diameter of 5 m.
Dome 4 (1993): The dome was made of prefabricated plywood panels. It has a diameter of 6 m.

These domes were each produced by a club or a class of students over the span of a month. It takes approximately one day to assemble one. The projector used is a pinhole type for a 3 m dome. Although the star images were twice as large as usually, each constellation was distinguishable, so it didn't pose a problem at the time.

3. A planetarium class lesson

(1) class lesson

In doing class planetarium lessons, the program and its direction are very important. A dome is regarded as an audio visual space convenient for 1 class. When audio visual equipment is used in combination with a planetarium a variety of lesson plans become possible.

(2) The devices which are used

Star image projector (pinhole type)	Audio cassette deck
Signs of the 4 directions (N-S-E-W)	Slide projector
Twilight and sunset device[1]	Video projector
Constellation picture for a projection[2]	Over head projector (OHP)

(3) The basic pattern of a planetarium class

i. Background music (BGM) and twilight
ii. projection and explanation of the starlit sky (introduction)
iii. A contemporary theme
iv. A projection of the starlit sky
v. Twilight (ending)

I choose which stars to explain based on the theme of the day.

(4) The planetarium program

i. Explanation of a constellation: Viewpoints of coordinates of the celestial sphere (direction, zenith, meridian, celestial North Pole), constellations of the evening, constellations of the each season, and of the major stars.
We produce a 15 minute slide show which contains a Greek myth about a constellation. Club members produce such works annually, and I use them in class. They are useful for students to get accustomed to the constellations. I use such stories as "Perseus' Story", "The 12 Adventures of Hercules" and "The Lyra of Orpheus."

ii. Physical nature of major stars: evolution of a star, giant stars, white dwarfs, neutron stars, black holes, binaries, color and the surface temperature of stars etc. I explain certain stars little by little, at random.

ii. Diurnal motion of a fixed star: a different view of starlit sky by latitude (the world trip). I reproduce starlit sky and the diurnal motion that is visible from various places on earth by simply changing the inclination of the pole axis of the projector.

v. Zodiac and the apparent motion of the Sun

v. The solar system:

i. The moon: waxing and waning of the moon, the rotation and the revolution, the condition of the surface of the moon

ii. Our galaxy and the universe: structure of a galaxy, clusters of galaxies, the universe.

I use color cellophane on the stage of OHP to regulate brightness.

I reflect a picture of the constellation which is copied on a transparent sheet with the OHP

4. Planetarium classes

(1) A pleasant class

When the time comes for teaching in the planetarium which we assemble in the earth science room, using a planetarium, students often ask me "where do we will have today's class?" When I tall them in the earth science room, they are glad to hear it. No student comes late to the class. In the dark dome, students can sit on a carpet and take enjoying part in the class in a relaxed mod. Slide film and videos can attract students attention and we can teach more effectively than using ordinary classrooms.

(2) Students discipline themselves. Students begin chattering in this relaxed situation Because sound doesn't go out of the dome, it sometimes becomes very noisy. When this happens, I wait till some students tell each other they should be quiet. Although Japanese students seldom discipline their peers, this is the case in my class. The students become very receptive to learning in this situation.

(3) A Student comes to ask it positively. Students often ask me, "Where is _____ ?" ' Which is _____ ?" These constellations are on their primary textbooks or they are their favorite stars.

(4) It is difficult to point out objectively how much educational effect I could make but I can say following things. By showing constellations or stars, teachers can teach students as much as they need. Videos or slide films help students to visualize astronomy Such audio visual materials increase interest in astronomy. Students often ask me to have a "Star Watching Meeting." The dramatic presentation in our school festival is very popular. There are various reactions from students, such as, "I saw Orion last night," "What is the brightest star in the west evening sky?"

(5) Every time we make a dome, and I teach using the planetarium, the number of the astronomy club increases. As the number of the members grows, the senior class students come to show their leadership.

(6) I often take the club students to the science center nearby and we visit the planetarium there. Watching their presentation is very useful for us. For me their teaching materials, slide shows, computer graphics are really impressive.. I'd like to keep on producing something that has some stories, such as "The Beginning of the Earth," "The History of the Universe," " the Various Stars and Constellations" " The Earth, the Oasis of the Universe." Highly advanced producing, such as BGM illuminations, narrations, and some technique for producing would be necessary Effect of BGM is quite big.

5. Other points

(1) I distinguish between what they should recognize and memorize and what they should ignore. I prepare a preparatory sheet, where students can write down what they learned. Thus the average of their examinations is around 70 points, which is rather high. I emphasize that students should learn without tears. Students rather than have learn everything by heart. They should acquire their knowledge through their interests. I hope my class can attract students attention and motivate and encourage their desire to learn more.

(2) Each dome should be fitted with the proper size star-image projection machine . It

possible, one which can represents apparent motions of the planets, colorize some stars, project the Milky Way and coordinate axis, besides being low in cost.

(3) How and where to build the dome.

A dome which can be built easily at low cost is desirable. I recommend a cardboard dome, because it will cost about 60000 yen and anyone can easily get the materials everywhere. Besides students can take part in building it. (Saito 1991,1994) The cardboard dome as it is, 5-6 meters in diameter dome, is very big, but, students are willing to help me make it (Yamazaki 1990). Where to build the dome is another problem. The dome becomes approximately 3.5 m - 4.5 m tall, and there should be enough height in the room. A gymnasium or a lecture hall, would be suitable, however the instructor should ask get an agreement on a time limit beforehand.

6. Epilogue

I mentioned that a planetarium is useful and effective for obtaining a basic knowledge of astronomy . One of the biggest problems is that many schools cannot use a large planetarium dome. If you can get a bigger dome, students can experience much more attractive and effective classes. Each school should have its own big dome.

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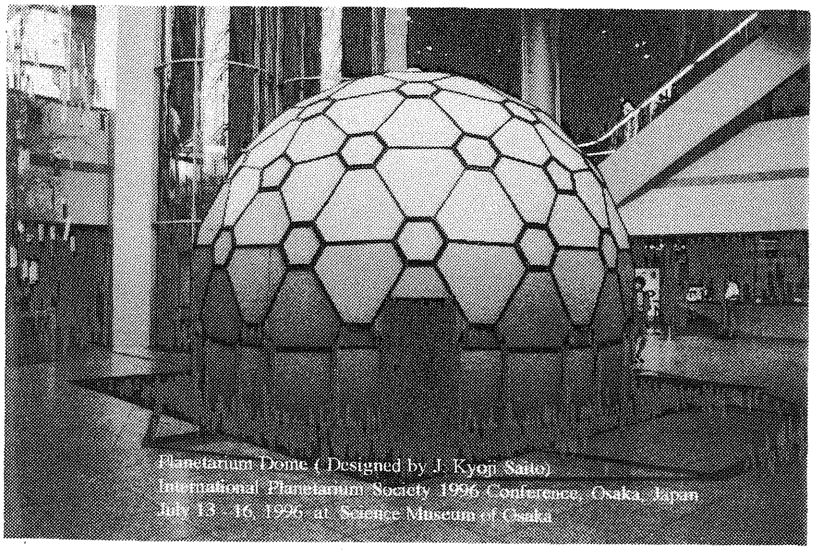

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Osaka City Government Affiliates

2) Foreign Corporations

Astro-Tec Manufacturing, Inc.
Audio Visual Imagineering, Inc.
Carl Zeiss Jena GmbH
Castle Lane Productions
DSC Laboratories
Dyckerhoff & Widman
East Coast Control Systems
Evans & Sutherland
Helping Planetariums Succeed
HI-Tech Motion Picture Systems
Laser Fantasy International
Laser Production Network
Pangolin Software
Sky-Skan, Inc.
Spitz, Inc.
Technical Innovations

Science Museum of Osaka Team Members

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Tadahiro Yoshida, Megumi Kishida, Masami Hashiguchi, Singo Kawakami,
Sadayoshi Inoue, Eiko Kawazoe, Toshikatsu Tanaka

Volunteers

We Preparatory Committee members wish to express our sincere appreciationfor their talents in making conference a success.

Members of Star Club / Science Museum of Osaka, Ken-ichiro Takashiba, Noriko Nakagawa,
Maki Okube, Kaoru Morita, Satomi Awano, Toshiya Kaga, Tikako Kaga,
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Naoyuki Nishitani, Toshiro Iwai, Junko Onoda, Masao Suzuki, Reiko Nakagaki,
Sumiko Kawanishi

Performance

We Preparatory Committee members wish to express our sincere appreciationfor their talents in making conference a success.

Drummers Group ONIGAWARA
Tea Ceremony Club/Osaka City Government
Noboru Miyajima

Secretariat

Inter Group Corp.

Noriko Hirose, Ryo Kishima, Michiyo Hashimoto, Kyoko Matsuoka

THANK YOU LIST

協賛団体

下記団体より協賛をいただきました。ありがたく感謝申し上げます。

1）日本国内団体

日本万国博覧会記念協会	(株)エルモ社	(株)エンコム
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三洋電機(株)	(有)スタジオ・イーハトーヴ	(株)竹中工務店大阪本店
ティアック(株)	(株)電通テック名古屋支社	(株)西村製作所
日本ビクター(株)近畿ｼｽﾃﾑ支店	能美防災(株)大阪支店	(株)乃村工藝社
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ミノルタプラネタリウム(株)	ヤマハ(株)音響システム事業部	(株)理経
大阪市関係団体		

（順不同）

2）海外団体

Astro-Tec Manufacturing, Inc.	Audio Visual Imagineering, Inc.	Carl Zeiss Jena GmbH
Castle Lane Productions	DSC Laboratories	Dyckerhoff & Widman
East Coast Control Systems	Evans & Sutherland	Helping Planetariums Succeed
Hi-Tech Motion Picture Systems	Laser Fantasy International	Laser Production Network
Pangolin Software	Sky-Skan, Inc.	Spitz, Inc.
Technical Innovations		

（順不同）

大阪市立科学館スタッフ

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北谷　清一	桑村　康昌	村上　美恵子	菊岡　秀多	粟田　政志	高芝　義幸
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山脇　直子	掃部　左也加	嘉数　次人	長谷川　能三	渡部　義弥	白旗　章子
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橋口　雅美	川上　新吾				
井上　貞美	川添　英子	田中　利勝			

ボランティア

大会にご協力いただきましたみなさまに感謝申し上げます。

大阪市立科学館星の友の会		高柴　健一郎	中川　則子	奥部　真樹	森田　薫
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出演

大会にご協力いただきましたみなさまに感謝申し上げます。

太鼓集団「鬼瓦」

大阪市役所茶道部（表千家）

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＊五十音順に掲載（日本語原稿掲載者のみ）