Propagation
A Journal of Science Communication
VOLUME 4, NO.2, JULY, 2013 & VOLUME 5, NO.1, JANUARY, 2014

Planetarium at Calicut - Malabar's Astronomy Hub

V. S. Ramachandran, Jayant Gangopadhyay

Abstract

The Regional Science Centre & Planetarium at Calicut, popularly known as the Calicut Planetarium, is the preferred destination of astronomy enthusiasts in and around Malabar. Come any news about a celestial phenomenon, the telephone of this institution starts ringing. For the local public, students, and the press and media people, this institution is the only reliable source of information on astronomical events.

This paper discusses the astronomical heritage of this renowned institution and its technical evolution over time. It focuses on the recent struggle of the planetarium to remain technically up to date and how it succeeded in doing so.

Introduction

Figure 1. Oskar Won Miller

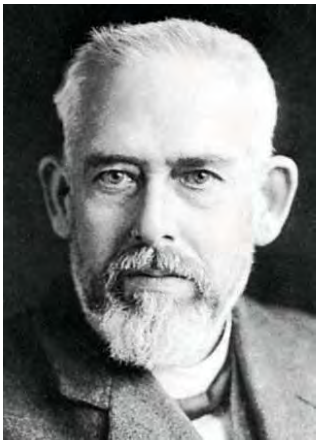

Figure 2. Max Wolf

The Year 1903, Oskar Won Miller, polymath engineer interested in all aspects of science and technology founded the Deutsches Museum. In 1913 astronomer Max Wolf had suggested to von Miller the idea of a device for his museum which would reproduce not only the stars but also the planetary motions. Von Miller approached the well-known optical firm of Carl Zeiss in Jena, who in turn agreed to look into the problem.

Around March 1919, Walther Bauersfeld, chief design engineer and later director of Carl Zeiss, hit upon the idea of projection of the celestial objects in a dark room. On October 21, 1923, Prof. Bauersfeld demonstrated the projector to a congress at the museum, the first official public showing. The professional and public reaction was enthusiastic.

Figure 3. Walter Bauersfeld

Today the planetarium, both as a fine instrument and as an institution, has come a long way since 1923 when astronomer Elis Stromgren wrote : *"Never before was an instrument created which is so instructive as this; never before one so bewitching; and never before did an instrument speak so directly to the beholder. The machine itself is precious and aristocratic... The planetarium is school, theater, and cinema in one classroom under the eternal dome of the sky."*

Cutting across the matrix of geography it took almost three quarters of a century for the distribution trajectory of this coveted device to be drawn over Calicut, a small city of distinct heritage in Kerala; the god's own country. On 30th January 1997, RSC & Planetarium, Calicut, the first planetarium in the Malabar region (northern part of Kerala) opened its doors to the public housing a 250 seater planetarium with RFP DP2 Space flight projector from Carl Zeiss.

Technical Flashback : *An idea – A plan*

Today, the planetarium at Calicut is one of the most successful planetariums of India. But its historical development was not so smooth. It went through turmoil and setbacks. We will briefly discuss the historical background of this institution.

The planetarium was inaugurated in 1997 but its history begins almost a decade and a half before, in 1984. Mr. K. C. Shankaranarayanan IAS and the then chairman of the Calicut Development Authority (CDA), was the

Figure 4. RSC & Planetarium, Calicut

Figure 5. Construction works of Science Centre, Calicut

visionary behind the formation of the planetarium at Calicut.

The Calicut Planetarium Society was formed and registered under the Society Act on the first day of August 1984 and Mr. Sankaranarayanan was one of its members. On 20th May 1985 the former Kerala Governor Shri P. Ramachandran laid the foundation for the Calicut planetarium on the 5.6 acres of land donated by Calicut Development Authority at Jaffer khan Colony. But the Society could not manage the financial requirements to nurture the project. On approaching the state government for assistance, it was handed over to the Calicut Development Authority (CDA) in 1987. The main building of planetarium was then constructed based on a design by architect N. M. Saleem. But the planetarium could not be made functional.

NCSM's Entry

Government of Kerala then invited National Council of Science Museums (NCSM) to take over the project from CDA. NCSM on its part proposed to develop a science park and a science centre in the same compound where the planetarium building was erected.

By 1987, NCSM completed the construction of science centre and the remaining works of planetarium. Further NCSM had a range of negotiations with M/s Carl Zeiss and CDA towards planetarium equipment installation. It was found that due to poor storage of the projector instruments and accessories, the electronic circuits were partially damaged and the computers were fully non functional.

In April-May 1994, the planetarium equipment was installed. During installation Zeiss engineers observed that the master computer had become dormant and so they installed the equipment in manual mode through the slave computer. Thereafter the equipment was on trial run for about a month.

The cloud of uncertainty was still around as the slave computer too had started malfunctioning. Talks were again held with Zeiss for a possible solution. But it was not possible to arrive at a compatible rate for the recovery tasks. Making projection system fully functional required total refurbishing of the equipment involving exponentially high cost compared to the budget estimate.

With the failed master computer and the slave computer malfunctioning, chances were remote that the planetarium projector could be made to work on the auto function mode. Further, frequent breakdowns of electronics were a great hindrance towards inaugurating the planetarium for public show.

At this juncture, NCSM decided to take up the work domestically. By the last quarter of 1996, a technical team of NCSM started work at site for fixing the problem. The team thoroughly studied the electronics system of the equipment and made the projection system fully functional in manual mode using relay based switching thereby avoiding the microcontroller circuits and original power supplies.

On January 30th, 1997 the then chief minister of Kerala

Figure 6. Calicut Planetarium inauguration

Mr. E. K. Nayanar dedicated RSC & Planetarium to the people of Kerala marking the golden jubilee of International Council of Museums (ICOM). The Planetarium has since then become the major crowd puller for this centre.

Trouble Shooting of the Machine

Though there were some teething problems, the planetarium gradually picked up steadfast growth. But problem erupted out of the blue. Due to unknown reasons, some insulation layers from the horizontal slip-ring of the central projector burned crippling all the main motions (the diurnal, polar and annular motions). Replacing these burnt slip-rings was an uphill task involving complete dismantling of the projector.

A major repair of the machine was now inevitable. During June 1999, the technical team of RSC & Planetarium Calicut undertook the challenging task of dismantling the system and carrying out the repairs needed. The task went through the whole gamut of overhauling work to bring back all required functions to life. Success was smelt at every stage. Though the functions were retrieved, the absence of automation still remained a handicap. However, the time was ripe for getting the equipment automated.

Automation – Initial Trials

First, few energetic young engineers from National Institute of Technology, Calicut offered to undertake the automation works of this planetarium as a part of their project works under Dr. P. C. Subramaniam,

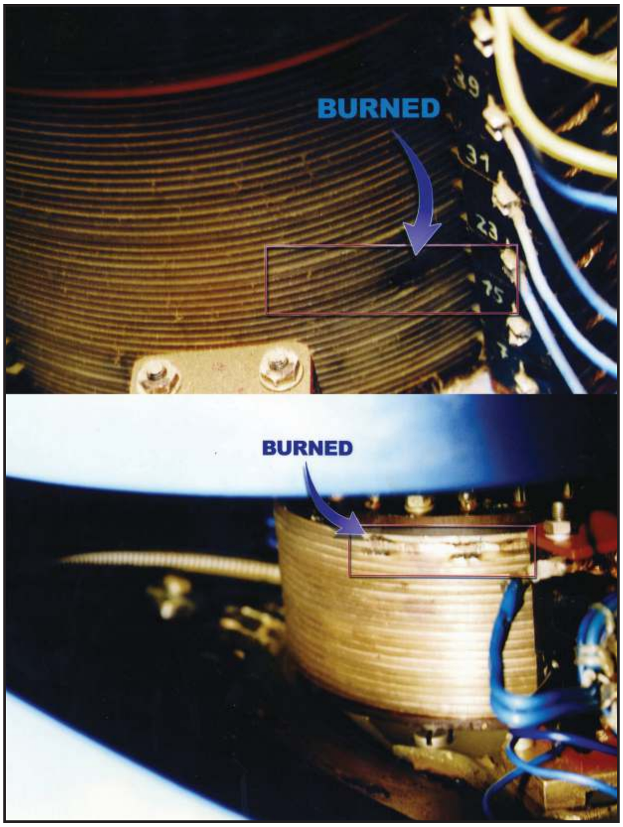

Figure 7. Slip ring Burning

Professor of Electronics & Communication Engineering Department. They developed the prototype circuits. But it was found not meeting the industry standard for further investment on these prototypes.

During 2007, the Centre of Electronic Design & Technology of India (CEDTI), Calicut offered to undertake the automation work in phased manner. In the first phase they proposed to work on the motion control. The job was assigned to them and in the first phase, the four main motions of the opto-mechanical projector were restored.

Subsequently in phase 2, which was undertaken during 2009, CEDTI restored the dimmer circuits for lamp control and automated it using Graphical User Interface (GUI) and Microcontroller technologies. The unit consisted of three modules, namely the Power Module, Control Module & Driver Module.

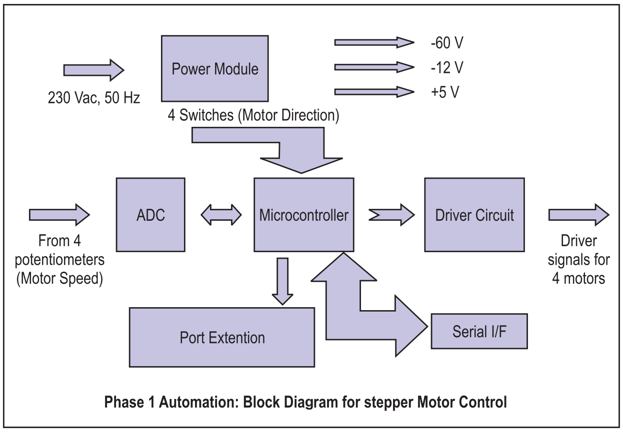

Figure 8. Phase 1: Layout

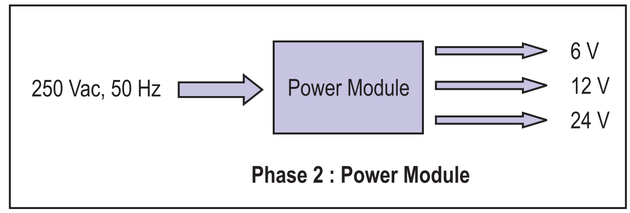

Figure 9. Phase 2: Power Supply

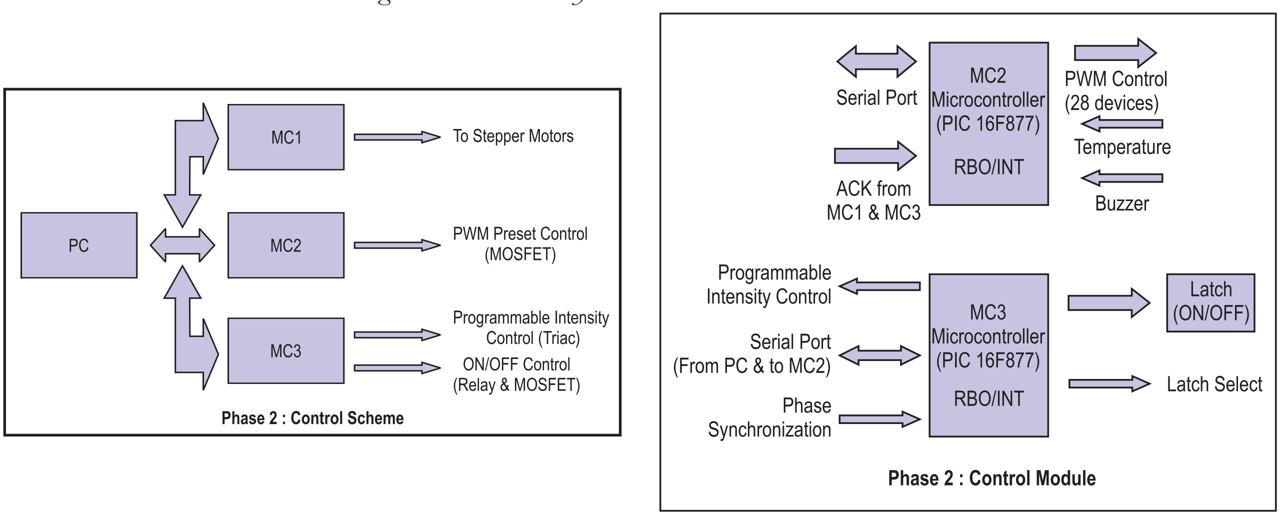

Figure 10. Phase 2 : Control Scheme& Control Module

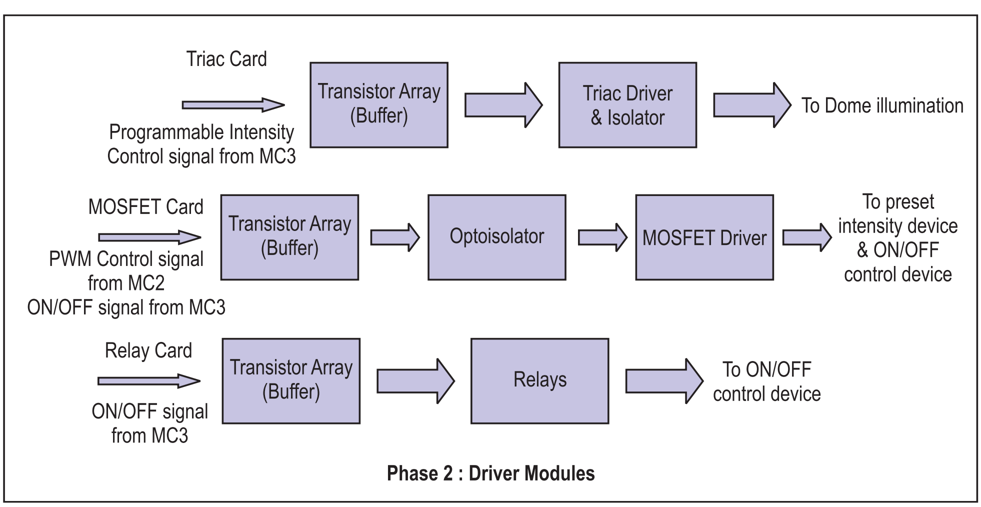

Figure 11. Phase 2 : Driver Module

The Power Module meets the power requirement of the entire unit. The Control Module, which forms the heart of the system, consisted of three micro controllers, namely MC1 (Amtel 89C52), MC2 (PIC 16F877), MC3 (PIC 16F877).

Microcontroller MC1 controlled the speed and direction of the stepper motors. MC2 was used to control the preset control devices with fixed soft start and soft decay. MC3 was dedicated for controlling the programmable intensity devices, and ON/OFF control of remaining devices. Preset controls were implemented through MOSFETs. ON/OFF controls were implemented through relays and MOSFETs.

The planetarium show was configured through the GUI on PC. On running a particular show, the PC transmitted commands to the microcontroller based hardware unit on real-time basis. Data transmitted by PC were received by all the microcontrollers, and the controllers responded depending on the address code assigned to them.

Controllers were associated with Driver modules to meet the drive requirement of the devices controlled by them.

The team from CEDTI did a good job and the system could be automated at last. But the GUI was not powerful as per requirements of a modern planetarium. It still was quite an achievement and a first step towards automation.

Modern planetarium software has the capabilities to integrate the advantages of the opto-mechanical and the digital full dome projection system. Our planetarium lacked the digital full dome projection system. Further, the power of the modern planetarium software lies in the in-built library functions, which facilitates creation of virtual projectors for spot projection in any part of the dome, animate text and graphics and the throw area covers the total dome area. Thus, though we have made some improvement through the works of CEDTI, ours was no way comparable to a modern planetarium.

Major Technical Up-gradation

Finally, NCSM wanted the planetarium to be upgraded with the latest technology from reputed planetarium equipment developers and transform the equipment to a hybrid one. This was done through a global tendering process. The jobs were to fully refurbish and upgrade the equipment and also to provide a full dome shadow-free digital projection solution to the existing system. M/s Carl Zeiss emerged as the successful bidder in the process.

Carl Zeiss in fact undertook a technical challenge. They were supposed to work on a fully altered old system, which had in course of time become a testing ground for trials and experimentation towards finding alternative economic technical solutions. This equipment had to be restored and upgraded to attain the capability of an advanced planetarium system.

The job involved repairing of mechanical parts, optics, electricals, electronics, calibrations etc. New control system had to be designed, slip rings had to be replaced. Dimmer and soft start had to be redesigned and switches had to be changed. A modern interface was to be designed, which could be integrated with the Zeiss Planetarium Software Powerdome® system. This was necessary to integrate this opto-mechanical system with the full dome digital solution. Further, because Zeiss had stopped making this particular model of the opto-mechanical machine, the task became all the more challenging.

Carl Zeiss engineers Mr. Sven Huthuff, Mr. Dima Aljechin, Mr. Andre Frenzel along with an Indian Technical Team faced the challenge successfully. While Mr. Sven worked on the electronics in the opto-mechanical side, Mr. Dima put tremendous efforts in calibrations as well as in optics and Mr. Andre was the man for looking after the digital projection system. Indian team supported them enthusiastically.

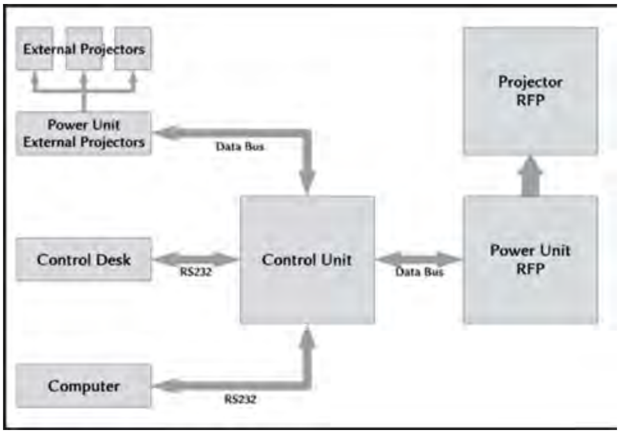

Figure 12. Plan of the Upgraded System

For a full dome digital projection system, the already commissioned large size RFP DP2 at the centre of the planetarium put hindrance towards creating a shadow free projection on the dome. The number of digital projectors required for the same had to be optimized, which could cover the full dome so that no shadow of the central equipment fell on the dome at any orientation. This required the use of simulation technologies. Zeiss engineers simulated the dome of the Calicut Planetarium on their computer system, using their own simulation software, so that depending on the light cone, the number of projectors could be optimized. On doing so, the optimum number turned out to be nine.

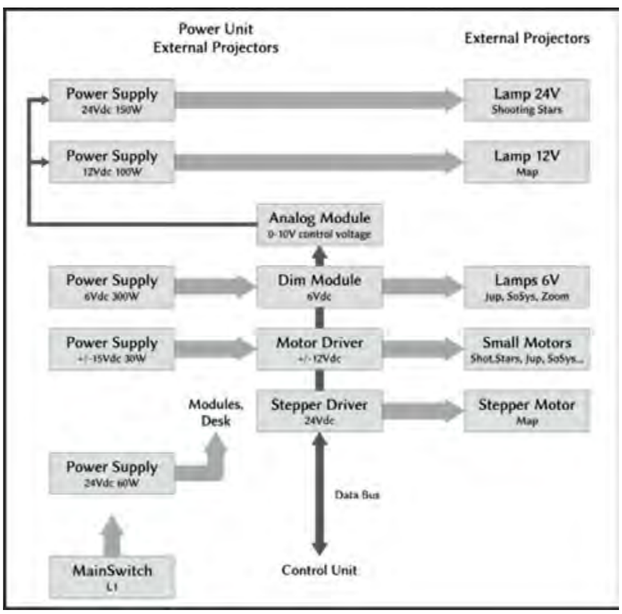

Figure 13. Power Unit Layout for External Connection

Carl Zeiss used nine channel full dome projection system, consisting of nine number of JVC DLA RS60 projectors having resolution of 1920 X 1020 and brightness 1200 ANSI lumen, with customized lens shutters for image blending and black level; nine channel image generator with Powerdome® software, NAS Data server (Network Attached Storage). This unit consisted of PC cluster with software for image generation, distortion correction and blending, Powerdome® configuration, editor, player, PDA (*Personal Digital Assistant*), libraries etc.

Also, Uniview® was installed in the Planetarium machine. Uniview® is 3D astronomy software. Uniview could run on ZEISS Powerdome® as special

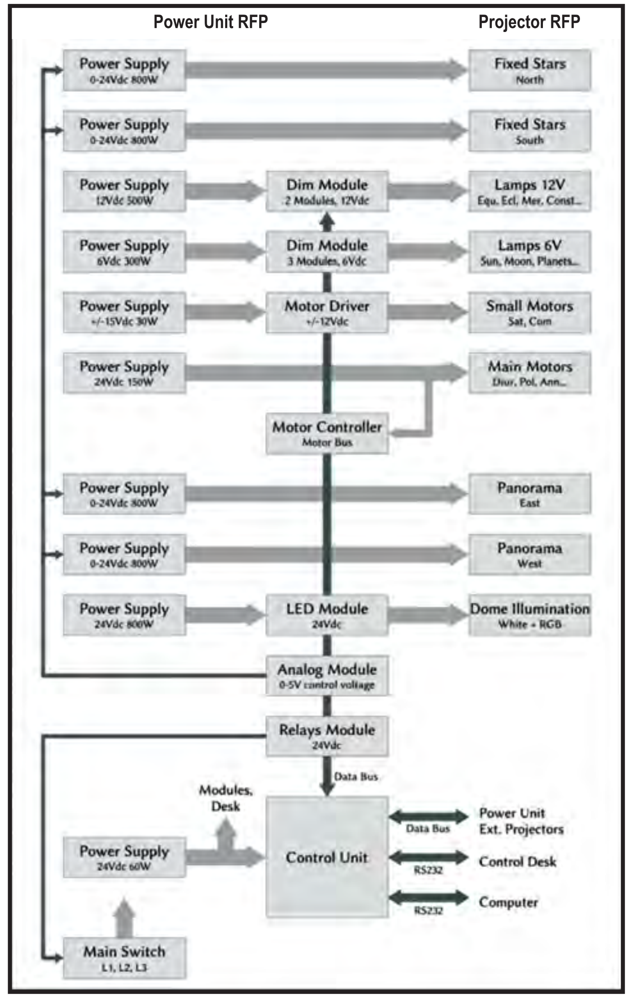

Figure 14. Power Unit Layout for Refurbished RFP DP2

adaptation was incorporated for multi-channel blending of Powerdome®. As Uniview® is separate real-time software, it was possible to run Uniview independent of Powerdome® for full-dome displays. Since Uniview would only get access to the graphics boards if Powerdome is switched off, Carl Zeiss programmed a special interface to integrate Uniview with Powerdome®, so that it could run while Powerdome® is open. The interface took care of the corresponding access to the graphics board.

Propagation
A Journal of Science Communication

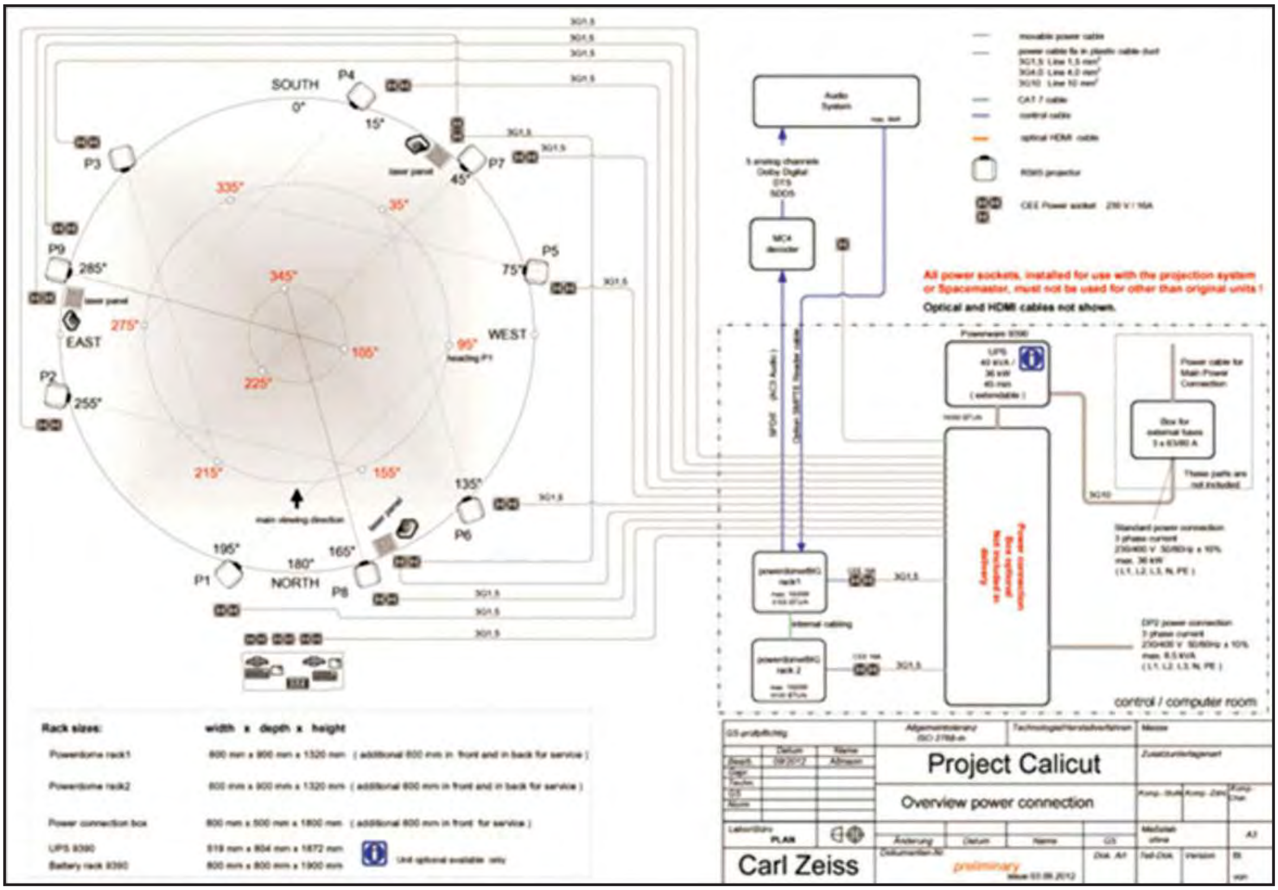

Figure 15. Projector arrangement for Shadow Free Projector

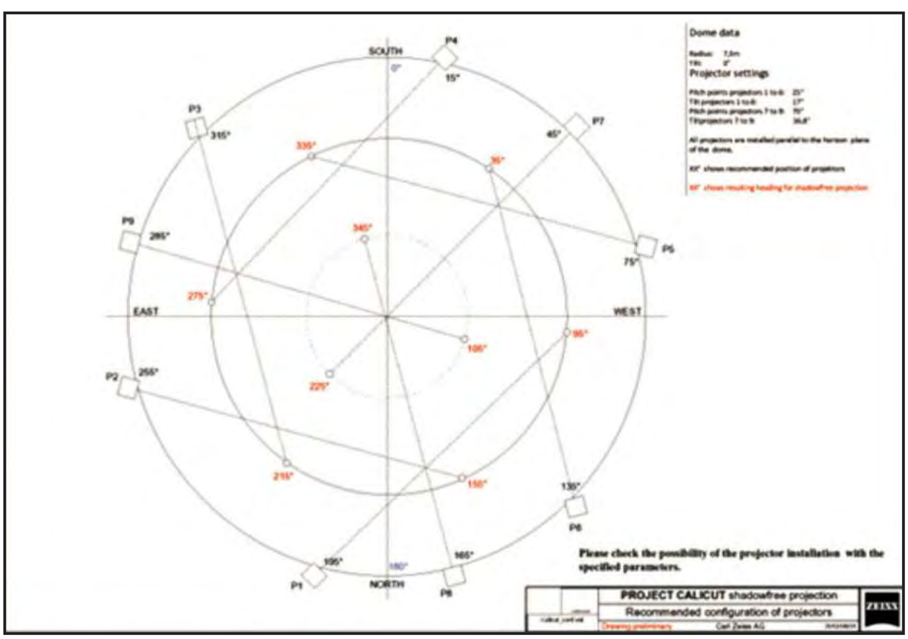

Figure 16. (i) : Shadow Free Geometry

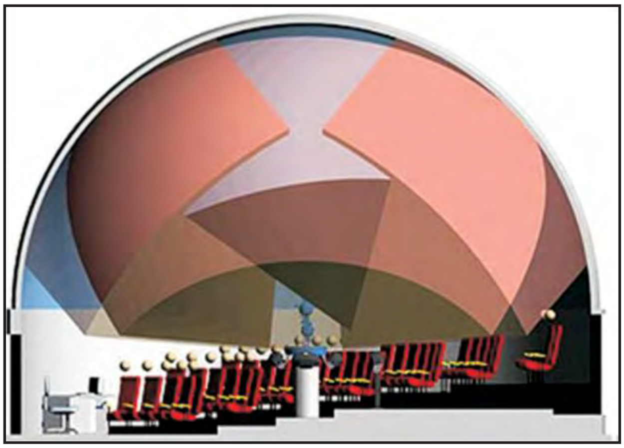

Figure 16. (ii) : Shadow Free Geometry

By means of the Powerdome - Uniview interface, live Uniview presentations were possible, as was the integration of Uniview presentations (sequences) in automatic shows.

Audio is an important component for a planetarium show presentation. Calicut Planetarium was equipped with 5.1 audio system with Denon audio processor and decoder. As a part of this upgrade, lot of other subsidiary works were undertaken which included fixing of lightning arrestor for the planetarium building, a new 40 KVA UPS, treatment of the dome wall with glass wool and gypsum board, laying of new floor tiles etc. The seating arrangement was altered from concentric seating to unidirectional seating. This was done to cater to the requirements of the new projection system.

With this major technical upgrade, Calicut planetarium became equipped with a hybrid projection system comprising nine channel digital Powerdome system with nine JVC DLA RS65 projectors and fully refurbished RFP DP2 Space Flight Opto-mechanical Projection system from Carl Zeiss, Jena, Germany.

In the remaining part of this paper we will discuss the in-house planetarium show developmental aspects and astronomy popularization as undertaken by this institution.

Planetarium Shows

The first three shows were procured from B M Birla Planetarium, Hyderabad. Then we started developing in-house planetarium shows. This involved development of script, visuals, music, recording and synchronizing. In a span of seventeen years of its history, the planetarium has conceptualized and developed as many as sixteen main shows with 'Dona and the universe' being its debut attempt.

Further, in order to make planetarium shows interesting to students from lower and upper primary sections who thronged the centre after winter vacations, and who were too young to follow the regular astronomy shows, we developed special shows using cartoon slides. This enabled them to have a better appreciation and understanding of basic astronomical ideas. Subsequently, eight new shows for primary school groups, two community-centric shows on RAMADAN and ONAM and one special show on Indian astronomy were developed. The variety of programmes offered at the centre has pushed the number of shows conducted in a day, and touched a record figure of nineteen shows in one day.

Hall of Astronomy

Astronomy through realistic sky simulation in the planetarium dome is a powerful method of mass education on the subject, which is running very successfully at the Calicut planetarium. But this planetarium has an added advantage - it is having a science centre attached to it. We took advantage of this and created a 4100 sq.ft gallery titled 'Hall of Astronomy' to complement the planetarium experience. The gallery has a rich display of visual information on various aspects of astronomy besides having thirty seven interactive models that explain various aspects of astronomy. The gallery was inaugurated on 7th March 2010 by Shri T. K. A. Nair, Principal Secretary to the then Prime Minister of INDIA.

Figure 17. Hall of Astronomy

The gallery is divided into four sections :

1. Pre Telescopic Era
2. Post Telescopic Era
3. Sun & Solar system
4. In Search of Cosmic Truth

Figure 18. Inside Hall of Astronomy

The pre telescopic era takes us through the antiquity when astronomers were mostly thinkers, philosophers and mathematicians. It depicts Aristotle's earth-centric universe (popularly called geocentric universe), Ptolemy's explanation of the complex motions of the planets through epicycles, and the Copernican model of the heliocentric universe.

Figure 19. Exhibiting Kepler's First Law of Planetary motion

Slowly the trend shifted towards observational astronomy. The most prominent figure of this era was Tycho Brahe. A prototype of the sextant developed by us following Tycho Brahe's design is displayed in the gallery. Brahe's young assistant Johannes Kepler, who carried out a thorough theoretical analysis of Tycho Brahe's observational data for 16 years, gave the world his famous laws of planetary motion. The gallery houses two working exhibits on Kepler's laws of planetary motion.

Figure 20. Galileo Galilei – Inside Astronomy Gallery

The post telescopic sections starts with homage to the architect of modern science, Galileo Galilei's revolutionary act of pointing the telescope to the sky and observing the details of heavenly objects changed our perception of the universe. Also in this section, there are a few models showing how reflectors and refractors work.

Modern telescopes evolved due to technological developments. Adaptive optics and Active optics are common terminology among professionals. There is an exhibit highlighting the principle behind these concepts. Radio telescope has opened a new window to the universe. Some celestial objects may not be observable in visible light but can be detected using radio telescope. A working model of a radio telescope in the gallery gives us insight into the working of these instruments.

In the section on Sun and solar system, topics relating to celestial events as observed from earth and facts relating to the sun and solar system are highlighted.

There are exhibits showing the effects of Precession and Nutation. Eclipses, transits and occultation are very dramatically exhibited through a participatory exhibit which people can play with and learn from about these celestial phenomena.

Figure 21. Electromechanical Orrery

An animated model of the sun discloses the internal structure of the sun. An electro mechanical model of the solar system (orrery) shows how the planets move around the sun. Also there is an exhibit which tells the visitors how much he or she would weigh in different planets. In addition, there is a working Foucault pendulum whose plane of oscillation changes with time. This in effect proves that the earth is rotating. The model on 'Celestial sphere' is another attraction in this section.

Coming to the last section, there are exhibits on pulsar, astronomical spectroscopy etc. There is also an 'Astro Quiz Corner' where people can test their knowledge in astronomy, and a computer kiosk that tells about the various career options available in India in the field of astronomy and astrophysics.

Astronomy Projects – Nurturing Young Minds in Astronomy

University Grant Commission (UGC) has rightly perceived that a scholar, whether in undergraduate studies or post graduate studies, will fully comprehend a concept if he/she undertakes a project in the subject. So, all courses under UGC have a project aspect in their curriculum of studies.

Innumerable request comes to this institution from students and teachers of diverse courses to undergo project work in astronomy. Having sophisticated telescopes, digital cameras and necessary technical expertise at its disposal, the centre took up this challenge too. The main task was to perceive novel project ideas in astronomy and astrophysics at various levels. As a result, nearly 300 students at various levels (School, UG, and PG) have carried out project works in this centre. The projects ranged from measuring the height of lunar mountains and crater depths, estimating the velocity of Galilean moons to determining the drift velocity of sun spots and much more.

One of the most highly rated projects is discussed here. It's measuring the height of the lunar mountain through image pixilation using MATLAB®.

Figure 22. Data for Measuring Lunar Mountain Pico

Here we take the shadow cast by mountains as observation parameter. Available astronomical data such as diameter of moon, distance from observer to moon at the time and date of measurement, latitude and longitude of the feature under consideration, etc. are used together with the measured length of the shadow of the mountain for the computation of the required results. For achieving this, an image of the area of the lunar surface containing the feature is captured using Canon 450D DSLR, Sony Camcorder and 11" CPC reflector; the image is then processed with RegiStax software, number of pixels of shadows counted, boundary errors eliminated using MATLAB® software, scale factor for the correspondence between one pixel and linear dimension in kilometers ascertained and then calculations made applying relevant formulae for results as well as for error corrections.

Astronomy Outreach Activities

Figure 23. (i) & (ii) : Sidewalk Astronomy

The centre has an enthusiastic Astronomy Club. The membership is open to all astronomy enthusiasts. Members include professors, scientists, teachers, engineers, medical practitioners, businessmen and farmers.

Figure 24. Astronomy Club Members measuring Diameter of Earth during a Venus Transit

Various astronomical activities like sky observations, seminars, workshops, visit to observatories, short and long term astronomy courses, astrophotography, astro drama, innovative astronomy outdoor experiments, workshops on telescope making, road side astronomy, citizen science astronomy, Messier marathon, eclipse & occultation watch, meteor shower astronomy etc. are arranged periodically. Further the planetarium conducts exhibitions in schools and engineering institutions with various astronomy related exhibits and desk top models, charts, slide shows, panels etc.

Figure 25. (i) & (ii) : Astrophotography

Members come and spend about two hours on weekends, reading and discussing astronomy. Also they learn how to handle telescopes and make observations. Calicut Planetarium also organizes summer and winter Astro camps.

Figure 26. Simulated Moon Surface Exhibition

Conclusion

Calicut planetarium has marched a long way ahead from its humble beginning. It can now boast of an astronomical heritage, an ultra modern hybrid planetarium and in-house technical expertise for utilizing the facility for public education on astronomy. The Powerdome® digital system enables full dome displays. Hybrid system facilitates simulation of real sky. Seasoned by experience, the RSC & Planetarium at Calicut is on the move to expand its boundaries of services to the nation in general and Malabar in particular for edutainment and also serious astronomy. This has resulted in attracting a record footfall of about five lakh (500,000) people to the Regional Science Centre and Planetarium at Calicut annually.

Bibliography

1. Chartrand Mark R. ; *A Fifty Year Anniversary of a Two Thousand Year Dream* [The History of the Planetarium]; Planetarian, Vol 2, #3, September 1973
2. *Press Report-The Visionary behind Kozhikode Planetarium*; The New Indian Express, 18 May 2012
3. http://www.moreheadplanetarium.org/index.cfm?fuseaction=page&filename=history2.html
4. Ramachandran V S; *Hall of Astronomy – A unique Gallery;* Science Reporter; Vol. 47(9); September 2010; pp 33-35
5. Lang Wifred; *Quo Vadis, Planetarium?; Innovation Special Planetariums*; Edition 97/2012; pp 22-23
6. Hamacher V Carl , Zovonko G. Varnesic, Safwat G. Zaky; *Computer Organisation*; McGraw Hill International Edition;2001
7. K Udaya Kumar, B S. Umashankar; *The 8085 Microprocessor*; Pearson; 2012
8. Hasse Ralf, Schlager Christian; Powerdome – II; *Innovation Special Planetariums*; Edition 97/2012; pp 8-13
9. Letter dated 14th March 1996 from Director, NCSM to MD, Planetarium Division, Carl Zeiss, Jena.
10. Gangopadhyay Jayant; *Measuring the height of the lunar mountain through image pixilation using MATLAB®*; IAPT NCICP Contest proceedings; 2012
11. CEDTI planetarium automation Project proposal for phase 1, 2007
12. CEDTI planetarium automation Project proposal for phase 2, 2009
13. Carl Zeiss proposal for up gradation and refurbishment of Calicut Planetarium projection system, 2011
14. Carl Zeiss Powerdome® Manual
15. http://en.wikipedia.org/wiki/User:Doeacc
16. Carl Zeiss Site preparation document for Calicut Planetarium, 2013

Keyword Glossary

Sextant : Astronomical instrument to measure angular separation in the sky

Road Side Astronomy : Using telescope in public places to show astronomical objects in the sky through telescopes to passer-by.

MATLAB® : A proprietary commercial software for matrix manipulation

PC : Personnel Computer

GUI : Graphical User Interface

Additional Information

I. As per the decision of Govt. of India vide its Office Memorandum (OM) dated 29.11.2002 and subsequent OM dated 08.01.2003 erstwhile CEDTI (Centre for Electronics Design & Technology of India) Centres (except Mohali Centre) and Regional Computer Centres(RCCs) Kolkata and Chandigarh have been merged with NIELIT (National Institute of Electronics and Information Technology) w.e.f. 14.12.2002, which is an autonomous body under Ministry of Information Technology, Government of India.

Accordingly, the erstwhile CEDTI Centres (except Mohali Centre) and RCCs have been renamed as National Institute of Electronics and Information Technology (NIELIT) (formerly DOEACC Society).

II. Web site of RSC & Planetarium, Calicut : www.rscpcalicut.org
III. Virtual visit to Hall of Astronomy, RSCP, Calicut: http://p4panorama.com/panos/planetarium/index.html

V. S. Ramachandran, Project Coordinator
Regional Science Centre & Planetarium (NCSM), Calicut.
Email : vsramachandran@yahoo.com

Jayant Gangopadhyay, Technical Officer
Regional Science Centre & Planetarium (NCSM), Calicut.
Email : jayantgang@gmail.com