Eighth Annual NASS Conference in Tucson – September 27-29, 2002

Roger Bailey (Canmore, Alberta)

Crested Cactus

For the Annual Conference of the North American Sundial Society, Tucson lived up to its sunbelt reputation. The weather was clear sunny and hot. Our host, John Carmichael explained that it was a dry heat and actually quite pleasant. He was correct; the weather was ideal for studying sundials and cactus.

The conference was held at the Marriott University Park Hotel, on the edge of the quiet tree lined streets of the University of Arizona campus, about a mile from the downtown core and "Old Tucson"

There were 38 participants registered for the conference. California, Texas and Arizona were well represented with eight, six and five participants respectively. Eight came from New England, five from Canada, three from the Pacific North West, two from the mid west and one (John Hayes) from England.

NASS Group at Tohono Chul Park by Carl Trost

As usual the conference started with an informal get together and light refreshments on Thursday evening. This provided a chance to meet old and make new friends and study the displays of shiny new sundials. Bill Gottesman had his Sawyer Equant design on display. Carl Haskett was showing off the model of his patented SunClock. Tom Hughes brought a model of his new Sidereal Sundial. Tom Kreyche displayed his large double horizontal dial and Fritz Stumpges his universal equatorial.

Fred Sawyer brought an excellent collection of door prizes. The unusual Cole altitude dial was won by Tom Hughes, the "Horilegium" book dial by Craig Huber, the set of drawings for the Pilkington-Gibbs heliochronometer by Fritz Stumpges, the Strode book, "A New and Easie Method To The Arte of Dyaling" by Claude Hartman. I didn't note who won the updated NASS Repository CD and the NASS Angel and Madjet sundials. Actually Fritz Stumpges name kept coming up in the draw but he only received one prize, his choice, the Pilkington-Gibbs drawings by Tony Moss. The group then adjourned for an informal dinner at the brew pub around the corner from the hotel.

The proceedings started Friday morning with a welcome by our NASS President, Fred Sawyer. Fred noted that all speakers would be presented with a replica of the “Fugio” cent, America’s first coin issued in 1787. Benjamin Franklin designed this coin showing a sundial and the motto “Fugio” meaning “Time flies” and “Mind Your Business” . This picture is from the web site http://www.collectsource.com/time.htm.

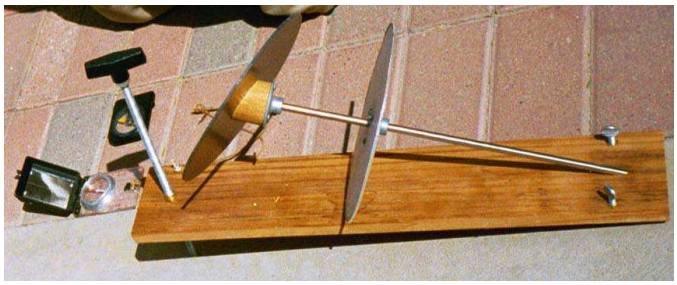
Len Breggren, the first speaker of the day, took us way back in the history of sundials to 200 BCE and the work of the Greek geometer Diocles. In his treatise “On Burning Mirrors”. Diocles seems to describe the earliest Greek sundial, a hemispherical mirror that indicates the hours of the day from a burning trace. Len stated the postulates of Diocles and then went through the geometric proofs and explanations.

1. To find a mirror surface, when placed facing the sun, the rays are reflected onto the circumference of a circle and
2. To find the mirror surface, when placed facing the sun, the rays are reflected to a single point.

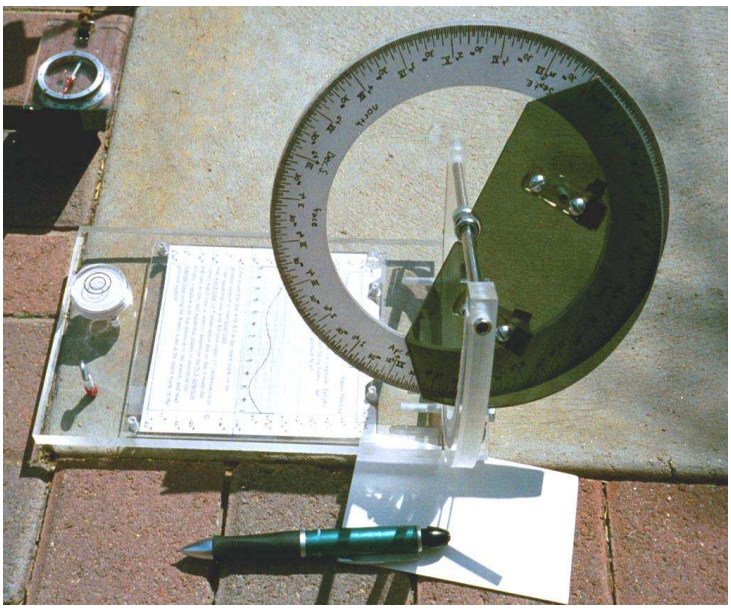
In the questions, Sara Schechner asked if the Greeks could shape these surfaces or was the work theoretical. A lively discussion followed on methods that the Greeks might have used to form concave hemispheres. The Campbell-Stokes sunshine recording instrument using focused sunshine to burn a trace was noted.

Fred Sawyer continued the historical theme in the next presentation, noting the overlap between **Dialing and Cartography**. Both are based on the mathematics of curves and lines in three dimensions projected onto a two dimensional plane. Following the historical overview, Fred discussed the orthodromic or compressed gnomonic projection that preserves azimuth angles measured from either of the two focal points. He then introduced a new family of Bipolar Azimuthal Equant Sundials that he has developed based on this compressed gnomonic projection.

Thomas Hughes presented his invention, **A New Sidereal Sundial**.



With his models Tom demonstrated the concept: “If one adds a plane tipped 23.4° with respect to the equatorial plane of an equatorial sundial and lets these planes be jointly rotatable about the gnomon, the dial can give sidereal time as well as solar and watch times”. This picture of the prototype shows the ecliptic and equatorial discs on the polar axis rotated so the shadow of both discs project as lines. The equatorial disc shadow is a line at the equinox and the date of this picture, 27 September, is pretty close.



This picture shows the more compact version with the partial ecliptic disc attached to the equatorial disc. Again the discs are rotated on the polar axis until the ecliptic shadow projects as a line. Sidereal time is then read from the rotation from the intersection node of the two discs, the Vernal Equinox. Local solar time is read the usual way for an equatorial sundial. The equatorial disc is rotated so noon is the zenith and time is read from the angle of the shadow of the polar axis from the zenith.
In the discussion Roger Bailey noted that a proper armillary sphere with a rotating basket could be used in this way to tell sidereal time. The shadow of the ecliptic ring on itself would be the same as the disc projecting as a line.

John Schilke's presentation **Oh, East Is East and West is West** was a note on the **Prime Vertical,** that great circle which passes through the zenith and nadir and the east and west points of the horizon. The Prime Vertical is thus orthogonal to the meridian and to the horizon. It has a few properties that make it useful for the dialist; several terms of formulae in common use vanish, simplifying calculations. For example, the time angle when an object is on the prime vertical reduces to Cos t = Tan δ/Tan φ. John outlined two methods of establishing the Prime Vertical, the Indian Circle method of equal altitudes and the two string and candle method. He also gave examples of dials for which a readily determined local east-west line is even more convenient than the meridian.
In the discussion Roger Bailey noted a couple of good reasons for using the Prime Vertical rather than the meridian to determine the axis of a sundial. The shadows are longer and the rate of change of azimuth angle with time is less. Unfortunately the Prime Vertical is only available for the sun for half the year, when the declination δ is the same sign and smaller than the latitude φ.

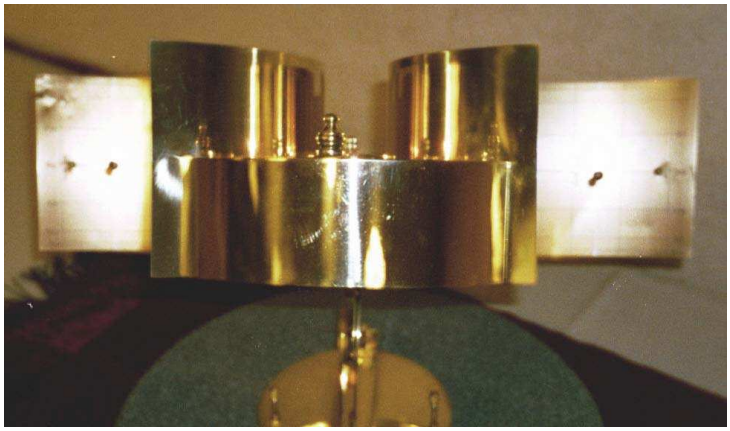
In his presentation**, Stephen Luecking** outlined a method for **Constructing Daylines** using a compass, straight edge and geometry rather than trigonometry. Daylines are trickier to construct than are hourlines. This talk introduced the *point-wise* construction of hyperbolas and its application to daylines. During the Renaissance, artist/scientists such as Leonardo Da Vinci, Albrecht Durer and Piero Della Francesca began experimenting with methods for constructing these curves. Their experiments and those of others led to the point-wise construction of conic curves, a method which was to presage the plotting of curves in analytic geometry. The method outlined enables the constructing of a dayline on a horizontal dial for any particular date.

In the discussion Len Berggren noted that a “Perfect Compass” had been developed in the Moslem world that generalized geometric methods to draw all conic sections similar to those Steve outlined here for hyperbolas.

The **Informal Presentations** were expected to be quick talks on specific topics that did not warrant a full presentation. The reality was different. In most cases these short talks were fascinating and generated interest that made it difficult for the Chairman and speakers to keep within the time constraints.

Bill Walton’s slide show on **Pinholes and Shadow Sharpening** was a necessary prerequisite for the tour on Saturday. Bill went over the pinhole camera effect used to remove the penumbra fuzziness from a shadow. A small hole 1/16” in a card projects a fairly sharp image of the sun. A larger hole, say ¼”, projects a brighter but fuzzy image. In the partial penumbral shadow, both show the eclipsed solar image. As the response of the eye to brightness is logarithmic, people perceived middle of the shadow when about 80% of the solar disc was covered. Bill then went on to show the effects of compound shadow sharpeners, using two holes in series, a dot in a ring etc. These simple devices showed the importance of the partial penumbra shadow and how the accuracy of sundials can be significantly increased using shadow sharpeners.

Carl Haskett showed off his well crafted patented SunClock design, a pair of semi-cylindrical polar dials adjustable for latitude, longitude and equation of time. When set for the location, the SunClock will show clock time of day and the approximate day of the month.

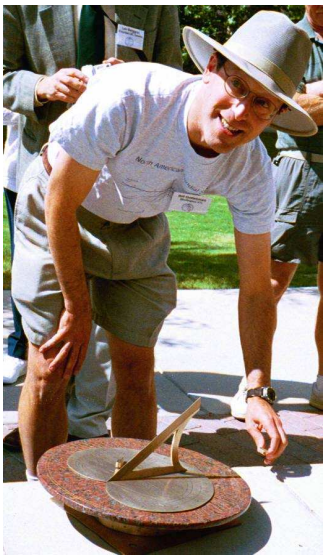


John Schilke then gave a delightful short presentation on **Continued Fractions and Dialing,** those repeating denominator series that can quickly solve for so many transcendental numbers and functions used in dialing calculations. He followed this by taking us on a tour of the sundials at the Jedrzeiow Museum in Poland.

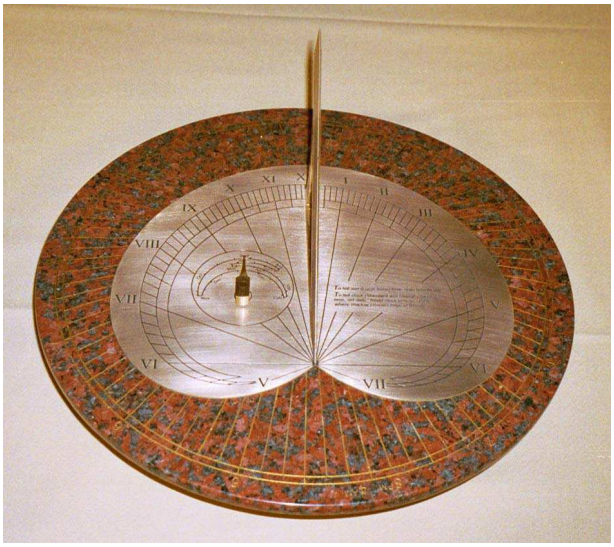
Bill Gottesman then presented a method for measuring **wall declination** using a carpenters’ square. Place the square on the vertical wall with the short end projecting perpendicular to the wall. Orient the square until it is aligned with the sun and casting the thinnest possible shadow. Measure the length of the shadow from the base of the square. Note the exact time. Determine the azimuth (A) and altitude (B) for the sun at that date and time using the NASS Dialists Companion or whatever method you prefer. Calculate the **Wall Declination = A+/- ArcCos[Sin(C)/Sin(B)]** where C is the ArcTan(Height of Square/Length of Shadow). A and B are the azimuth and altitude of the sun. The method seems simple and straightforward. Bill also offered a simple spreadsheet available on his web site www.precisiondials.com to do the calculations including the solar azimuth and altitude.

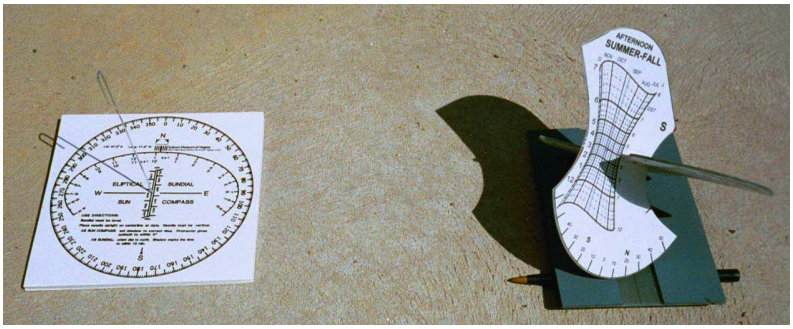
After lunch, the dials on display were brought out to the sunny courtyard for testing and display.

Claude Hartman demonstrates his model that incorporates ten separate sundials. These dials can be read on the walls and inside the stained glass structure.



Here **Bill Gottesman** shows off his Sawyer Equant dial with the adjustments for latitude, longitude, equation of time and daylight savings time.



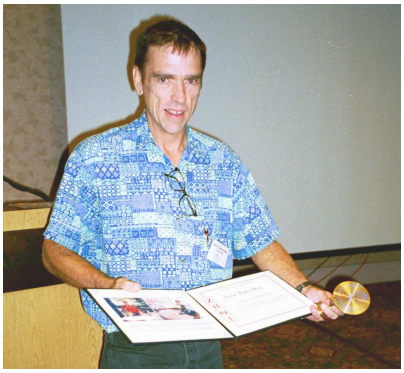


Bill Walton displayed an analemmatic “Sun Compass” and an interesting Pelekinon (double axe) dial.

After lunch the **Annual General Meeting** was held. Minutes of this meeting are included elsewhere in this Compendium.

Fred Sawyer's talk on **Dialing Scale Techniques - Old & New** was based on the dialing scale and instruction set published by E.C. Middleton early in the 20th century. Fred showed how to use the Middleton scale and then went on to demonstrate a new technique for drawing vertical declining dials using only dialing scales.

Tom Kreyche then presented a paper on **Projections of the Sphere for Astronomical Instruments**. His inspiration was the planispheric astrolabe. He showed how the planispheric astrolabe and double horizontal dials are closely related "kissing cousins". Tom displayed his large brass double horizontal sundial that incorporated this math through computer based design and machining techniques.

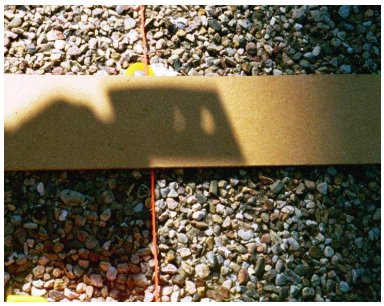


Following the break, the winner of the **Sawyer Dialing Prize** was announced and the prize presented to **John Carmichael. "**In recognition of his efforts to bring dialing to the high tech world of a leading solar observatory, and his demonstration that it is still possible in the modern world to prosper as a traditional craftsman of high quality heliochronometers"

John then presented his paper on **"Polar Axis Gnomons with Multiple Styles"** This outlined the project to utilize the structure of the McMath-Pierce Solar Telescope as the gnomon for a sundial. Although the telescope tube is at the correct polar angle for use as a gnomon, the design was complicated by its size and thickness. The "style shift" as the shadow was projected from different edges of the structure and the fuzziness of the penumbral shadow were complicating factors in the design.

Saturday was tour day, starting at the **Kitt Peak National Observatory**, an hour's drive from Tucson. Kitt Peak is home to the world's largest collection of optical telescopes. Located high above the Sonoran Desert, Kitt Peak presently has twenty-two optical and two radio telescopes and offers astronomers some of the finest observing to be found in the world. Here we had a special guided tour of the famous McMath-Pierce Solar Telescope Facility, the 7m Solar Vacuum Telescope and the Mayall 4m Telescope.

At the solar telescope we observed the sundial time scales laid out by John Carmichael and Bob Hough. Key to accuracy was the use of shadow sharpeners to fix the center of the solar shadow. This picture was taken at the time of the style shift when the shadow moved from one edge of the gnomon to another.



Here Fred Sawyer points out the features of Robert N. Mayall's equatorial sundial to Fritz Stumpges and Bill Walton

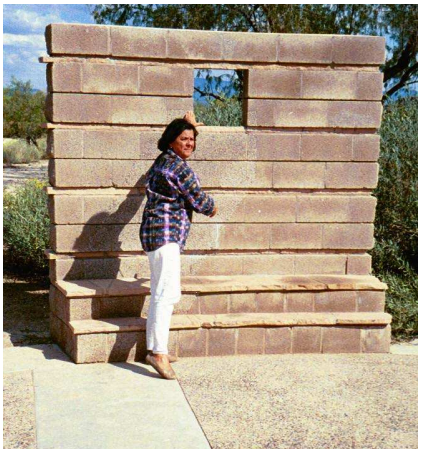
We then went back to Tucson for lunch at Tohono Chul Park, a beautiful desert botanical park. Here John Carmichael showed us his 53" Horizontal Sundial.

John Carmichael points out some of the features of his dial to Carl Haskett, Fred Sawyer and Claude Hartman.

We then went on to the **Nanini Sundial,** a large metal south wall vertical dial with adjustable time scale, built in 1987. The designer is unknown. This group picture is by Carl Trost.

Next on the tour was the **Sun Circle**, a large 50 ft. Stonehenge type sun ring built from colored cement blocks and flagstone. The artist Chris Tanz explained its design and interesting history.

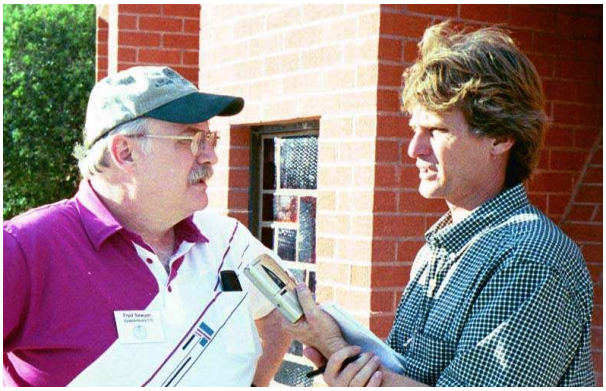
The inspiration for the Sun Circle comes from recent discoveries about the ceremonial life of one of the great native cultures of the Southwest, the Anasazi, who lived in Arizona and New Mexico a thousand years ago. The structure consists of eight interrupted curving walls which together imply a circle. Six of the wall segments have small ports oriented toward sunrise and sunset at summer solstice, winter solstice, and



the spring and fall equinoxes. At sunrise on the critical days, light pierces through the sunrise wall and projects its window on the facing wall (the height of the Image determined by the height of the horizon). At sunset, light comes through the sunset window, tracks along the floor and up the facing wall, projecting an image of the window that climbs toward its matching window and winks out as the sun dips below the horizon. Every day, solar noon is marked when sunlight coming through the slot in the South wall lines up with the track on the floor.

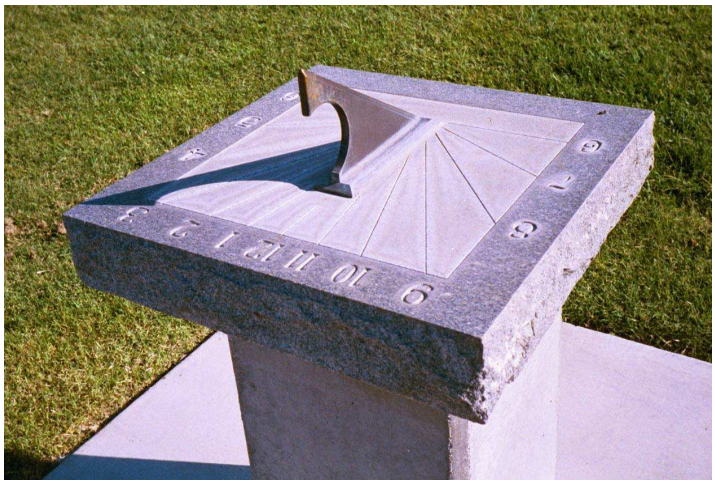
Then **John Carmichael** invited us into his studio to see several of his finished dials and other sundials under construction. Here John is demonstrating his design and stone carving techniques. Below is a tabletop analemmatic dial that John recently completed. Note that it incorporates the “Seasonal Sun Rise and Set Markers”.

Following refreshments and the demonstration at the Carmichael Studio we moved on to the last stop on the tour, the **Flandrau Planetarium** to see John’s large Horizontal Monofilar Heliochronometer. Here Fred Sawyer was interviewed by a reporter.



The Flandrau planetarium also has a “Sidewalk Sundial”, an interactive analemmatic sundial where this passing U of A student was persuaded to check the time indicated by her shadow. John Carmichael and Robert Hough have recommended changes to this dial to remove some errors in the current design.

The final dial was a classical horizontal dial at the Stewart Observatory across the road from the Flandrau Planetarium.



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The unofficial dinner on Saturday night was at the El Charro Mexican restaurant in old Tucson

Sunday morning we started with an informal presentation by **Fritz Stumpges** on his **“Portable Equatorial Sundial and Spherical Compass”**. Here Fritz is seen demonstrating the features of his dial to Craig Huber. Level the base plate, align to north, adjust for latitude, rotate the dial for the date setting and read the time. Or if you know the time, use the dial to find north when the dial and your watch show the same time.

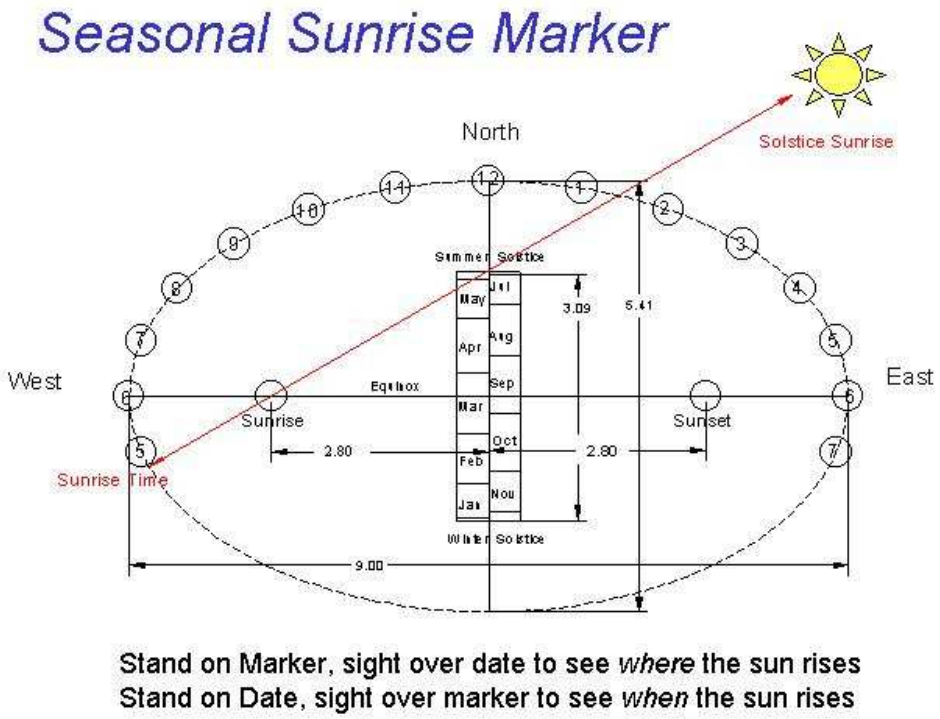
The next informal presentation was a slide show on **Sundials of France** by **Warren Thom.**

This was followed by **Claude Hartman’s** talk **Back to Basics,** sundial topics by a novice for novices, a

series of articles he is writing for the Compendium. These articles outlining basic sundial design information and techniques are aimed at non-mathematical novices interested in making a sundial. One tip was how to fold a dollar bill for use as a sundial. Claude asked people to send him tips like these for his Compendium articles.

Sara Schechner then showed us what a **Savvy Traveler** in the Renaissance might carry as portable, packable items to guide them in their travels. Sara gave us a look at pocket sundials and astronomical compendia, with their remarkable components (including gazetteers, specialized hour scales, astrolabes, quadrants, nocturnals, maps, and travel guides). Most of the items described are from the Collection of Historical Scientific Instruments at Harvard University, where Sara is the curator.

Roger Bailey then outlined the development of **Seasonal Sun Rise and Set Markers** for analemmatic sundials. There is a point on the east/west axis of analemmatic sundials that can be used with the date table on the north/south axis to show where and when the sun rises or sets. Stand on the seasonal sunrise marker and look past the date mark to see where on the horizon the sun rises or sets. Stand on the date mark and sight past the seasonal marker to the hour ellipse to determine the time of sunrise or set. These marker points are an excellent addition to analemmatic dials to demonstrate the seasonal changes of the sun's position. The presentation outlined the discovery of this brilliant idea, the theory and calculations to determine the points, the construction of the first seasonal dial using these markers, and techniques to improve the accuracy to compensate for periodic error and horizon pollution.



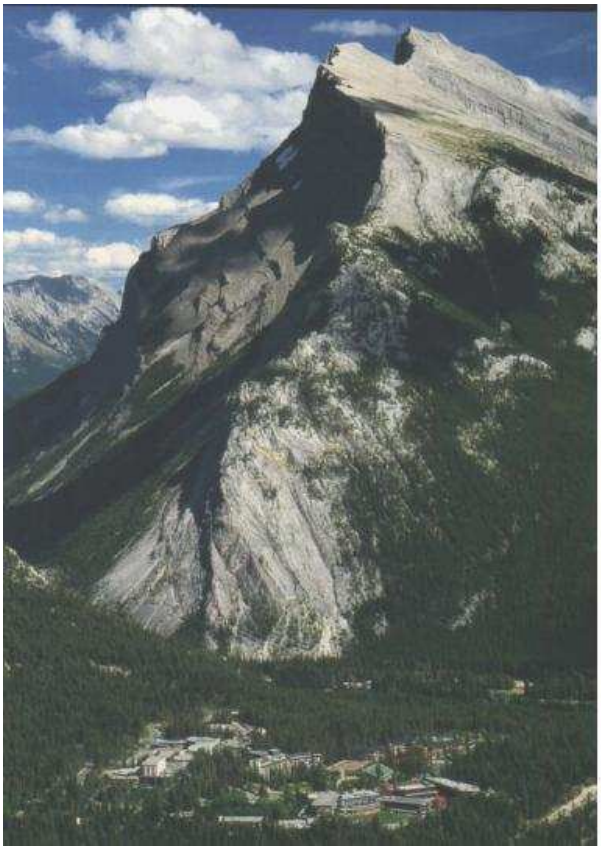
In the Informal Presentations **Paul Lapp** described **A Practical Application Of Dialing Knowledge,** the alignment of solar cells to recharge batteries for market stalls in Boppal, India.

Ken Clark told of his efforts to publicize NASS and sundials.

In his presentation **A Mandl Abac Sundial**, **Fred Sawyer** told us what he did on his summer vacation. As he hiked along, he thought of how to develop a new universal altitude sundial from a simple nomogram or abac by J. Mandl.

The final presentation was by **Stephen Luecking** on **Projective Medians and Sundials**. This talk focused on the aesthetics of public sculptures, specifically sundials. His historical perspective reminded us of how solar orientations at the solstice are built into the architecture of many civilizations, from the Great Kiva at Casa Rinconada, Stonehenge and standing stones to the cathedrals of Europe. He then outlined design proposals for large projective sundials including these elements.

Fred Sawyer was able to close the conference on time in spite of the interests raised and discussions started. He thanked John Carmichael for being an excellent host and invited us to come together at the NASS Conference next year, 21 to 24 August at the Banff Centre where Roger Bailey will be our local host.



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THE BANFF CENTRE

August 21- 24 2003