

August 2017

SIDE SHOTS

Professional Land Surveyors of Colorado

Volume 48, Issue 3

SURVEYORS ON DISPLAY AT REDEDICATION OF 40TH PARALLEL MONUMENT IN BOULDER

SEE PAGE 8



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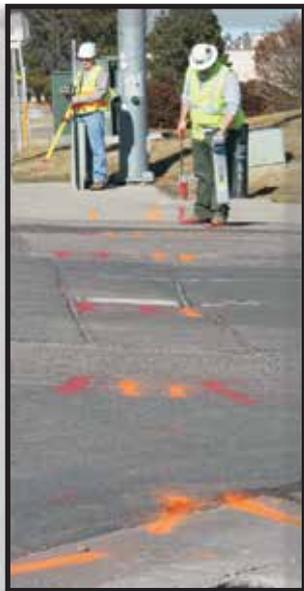
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SIDE SHOTS

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ON THE COVER (from left to right): Warren Andrews, Paul Bacus, JB Guyton, Gaby Neunzert and Pamela Fromhertz

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Dear Fellow Members of PLSC:

Summer will be in full swing when this edition of Side Shots is delivered to the membership. So far we have had some very warm days and we should remind all staff working outside of the dangers of exposure to the sun (wear sunscreen) and to stay hydrated by drinking a lot of water. Debilitating effects from the hot weather can sneak up on folks so please be vigilant this summer and take the appropriate precautions.

The RMSS planning committee has had a few meetings regarding the 2018 conference and we have sent out a call for abstracts. I encourage you to respond to the call for abstracts and if you have any suggestions or input for speakers and topics please contact Steve Parker (Education Committee Chairperson), Becky Roland, myself or send the input to the plsc.net website. This is *your* conference and we always strive to put on a great one that is filled with interesting, current and applicable programs.

A couple of goals for the PLSC are being pursued this year: The funding of a two year surveying program through Colorado Mesa University (CMU) and the establishment of continuing education requirements for Colorado Land Surveyors.

Congratulations to the many folks who have been working very hard to make a surveying program in Colorado a reality. Tom Sylvester, Teresa Smithson, Alan Blair and Patrick Greene, among others, have been working with CMU and have developed a 2-year program in surveying starting in the Fall, 2017. The PLSC endowment will provide the kickoff funds for the program and we hope to be able to offset some of the committed funding with outside donations from companies or interested private citizens. It has been a few years without a survey program in Colorado and we are very excited to have this program in place. The search is on for an instructor for the program so please see the PLSC website if you know of anyone who may be interested.

We are preparing a job posting related to the filling of the position of a Colorado State Geodetic Coordinator. We believe this is a critical position to have in the state and desire it to be filled this year.

The PLSC GPS day morphed into participating at the annual Boy Scout Show held on April 29, 2017 at the National Western Stock Show complex. While the weather was a challenge, the PLSC had a great looking booth and multiple volunteers to help educate the scouts about the surveying profession. Thanks to all of the volunteers who took the time to set up and participate in this important event.

Please don't forget that GIS in the Rockies is just around the corner (Sept. 20-21, 2017) at the Hilton Denver Inverness Hotel. Call for abstracts is out for this conference as well.

Please enjoy the various articles included in this edition of *Side Shots*, and I hope all members have a safe summer.

Sincerely,
Todd Beers, PLS, President



DEDICATED TO THE IMPROVEMENT OF LAND SURVEYING EDUCATION AND PRACTICE.

FROM THE EDITOR



I am pleased to deliver the news from Tom Sylvester that the associate degree program in Land Surveying and Geomatics at Colorado Mesa University/Western Colorado Community College is becoming a reality. Tom's full report appears in this issue. Since the legislature changed the statute to require a

degree to attain licensure, there has been no institution in the state in recent years that offered a board approved degree or certificate program, until now. While there are still some hurdles to overcome, such as DORA approval of the curriculum, recruitment of a professor and students, etc. it looks like this is really happening. Please read Tom's update, and help spread the word to anyone you know who may be interested in enrolling in this new academic program, to prepare to become a PLS.

The PLSC was invited to attend the dedication and opening of a bike/pedestrian underpass on Baseline Road in Boulder. The split rock 40th Parallel monument, which is still there, used to include a graphic depiction of the 40th parallel in the concrete next to the bus stop, but that was removed for the new underpass. So a new and greatly improved line, map and marker was installed. Our group was invited to show off old and new instruments and answer questions about the base line

to the public, from a surveyor's perspective. It was well attended, and a lot of fun.

Control Points No. 37 gives excellent examples of stadia. Notice of this year's Trig Star winner, Jennifer Aklilu, is featured, along with winners from the individual schools. There is another excellent article by Gaby Neunzert on Eupalino's Tunnel that was surveyed in Greece in 530 BC. Earl Henderson was unable to complete a rule of the month in time, but contributed an interesting article called "The Snake," instead.

There is a treasurer's report of asset balances, minutes of the PLSC board meeting held on April 13, 2017, and all of the chapters have contributed their quarterly news. The regular notice of plats from the BLM is omitted this time due to a change in the Federal Register that delayed the public notice process, but will be back.

Our next issue will feature the details and sessions coming up for the 2018 Surveyor's Summit conference, so start making plans to attend. Please see the call for abstracts in this issue.

JB Guyton
Editor, *Side Shots*

Errata

RE: May, 2017 issue, "The Story of Two Limestone Monuments"

Oops - The electronic editing gremlins struck again !

Colorado joined the union on August 1, 1876 and not as stated in the first sentence.

The following chart should have been shown in the original story:

Monuments on Colorado's eastern border

Corner Name	NGS-PID	Lat (D-M-S)	Long (D-M-S)	Type Monument
NE Corner, CO	MN0401	41-00-08.46340	102-03-05.63653	1x1x6 ft. Ls Monument
Boundary CO, KS, NE	LK0774	40-00-11.60021	102-03-06.39188	Brass Survey Disk
Chaffees Corner	LK0526	40-00-05.44125	102-03-06.34448	1x1x6 ft. Ls Monument
Never Set	Never Set	40-00-00.0000	102-03-06.39188	Statutory Location
SE Corner, CO	GL1538	36-59-35.03584	102-02-31.64221	Brass Survey Disk

SAVE THE DATE!

8th Annual Rocky Mountain Surveyors Summit

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Call for Abstracts

The 2018 Rocky Mountain Surveyors Summit Planning Committee is looking for topics that will add to Attendees' knowledge. Presentation times are either 2 or 4 hours. If you have a presentation that you would like to share, please send your presentation title and abstract to broland@plsc.net. **The deadline for submitting an abstract is August 15, 2017.** For more information on submission and up to date information on the Summit, go to www.plsc.net.

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Now the Real Work Begins!!!

An Update on the Status of a Land Surveying and Geomatics Degree Program at Colorado Mesa University and Western Colorado Community College, Grand Junction, Colorado

By Thomas W. Sylvester, P. E. and P. L. S.

We did it!!!!

On May 24, 2017, I got a last minute invitation to make a short presentation to the Colorado Mesa University Board of Trustees regarding our proposed Land Surveying and Geomatics program.

After the presentation, there was a short question and answer period, then a motion, second and unanimous approval for the program.

The Land Surveying and Geomatics Associates of Applied Science Degree program and a Post Baccalaureate Certificate program in Land Surveying and Geomatics will start next fall at Western Colorado Community College under the auspices of Colorado Mesa University. **WE ARE OFFICIALLY APPROVED!!!!**

Human Resources of CMU and WCCC has since advertised for the position of Technical Instructor of Land Surveying and Geomatics with the applications due by July 1. They are under an emergency search, hoping to have the position filled by August 7, 2017.

In the meantime, Teresa Smithson has been coordinating with Joyce Young and Rita Carey to keep DORA and the AES Board up to speed with our progress. She has made arrangements for a presentation to the AES Board on July 14. Unfortunately, she and most of the other main members of the ad hoc committee for the program had conflicts that week, so J. B. Guyton has volunteered to make the presentation, with Paul Bacus as backup if needed. The goal of this presentation is to get the blessing from the AES Board that the curriculum will meet their educational requirements for licensure as outlined by statute and Board Rules.

CMU has also made arrangements for a signing ceremony on July 18, 2017 of the Memorandum of Understanding for the PLSC's commitment to raise \$250,000 over five years for an endowment to help fund the program. The PLSC is planning on presenting a check for \$100,000 as our first contribution at the signing ceremony.

Even though mention has been made in past articles crediting some of the key individuals for their hard work on getting the program to this stage, it is important to recognize them again for a lot of hard work and a job well done:

Our ad hoc committee has been Alan Blair, chairman, Teresa Smithson and me, with significant contributions

from Ed Bristow, Gaby Nuenzert, Paul DeGraff, Patrick Green, Peter Krick, Rick Mason, and Becky Roland. Now, J. B. Guyton and Paul Bacus are stepping up to go before the AES Board. Todd Beers, as the signatory president of the PLSC will be heading the PLSC contingent at the signing ceremony.

On the CMU/WCCC side, the key players have been Dr. Gigi Richard, a licensed Civil Engineer in the Geology Department, Jean Adkins, consultant, and Christine Murphy, Developmental Education Director/Director of Instruction for CMU who got the ball rolling. Then, Jean Adkins carried the ball to prepare the evaluation for President Tim Foster. Christine Murphy escorted the program through the maze of the collegiate bureaucracy to get our approval. Liz Mayer, CEO and VP of Development for the Colorado Mesa University Foundation got us through the various iterations for the endowment MOU. Now Dennis Bailey-Fougner, VP, Community College Affairs at WCCC is preparing to bring us under his wings. As on the PLSC side, there were numerous behind the scene players helping at each stage. President Foster will be the signatory president for CMU at the signing ceremony.

I am sure that I've left out other key players for which I apologize for my short sightedness and short memory, but the effort took a lot of hard work from a lot of talented people on both sides of the equation. Congratulations, and Thank You!

Now the real work begins. To make the program a success, the PLSC and the rest of the Colorado surveying community will need to get behind the program with recruiting efforts, advice and support for the Instructor, ongoing financial support, job placement of graduates. A strong PLSC oversight committee will need to be put into place to help these efforts along.

Once we get the program off the ground, there will be a lot of work to ensure ABEET accreditation. Then as the program grows, we will want to push to include a 4-year BS program to expand the AAS program.

In just a few years, I would like to see this program, Colorado Mesa University, and Western Colorado Community College become the regional center of excellence for Land Surveying and Geomatics education, attracting students from throughout the country and beyond to provide the next generation of professionals. ■

Dedication of the new 40th Parallel/Baseline Monument and Underpass

By JB Guyton, PLS

On June 15th, a contingent of surveyors representing the PLSC assembled on Baseline Road in Boulder, next to the CU Law School, for the grand opening ceremony of the redesigned monument to the location and history of the 40th parallel, part of a \$5.4 million project to construct a new bicycle and pedestrian underpass beneath the heavily used Baseline Road.

In the May, 2008 issue of *Side Shots*, "A Line Runs Through It" featured the split granite rock with the inscribed description of the survey of Todd and Withrow in July, 1859, as well as an NGS control point in a stone bench next to the rock, both of which are still there. This was featured nationally in the March 2009 issue of *The American Surveyor* as well.

When the planning for the new underpass was underway, Alex May, a project manager with the City of Boulder, worked with members of the PLSC to incorporate a new and artistic "baseline" and world map in the concrete, to replace what used to be on the sidewalk next to the former street-level bus stop. Local artist Christian Muller came up with a new design, which is shown in these photos.

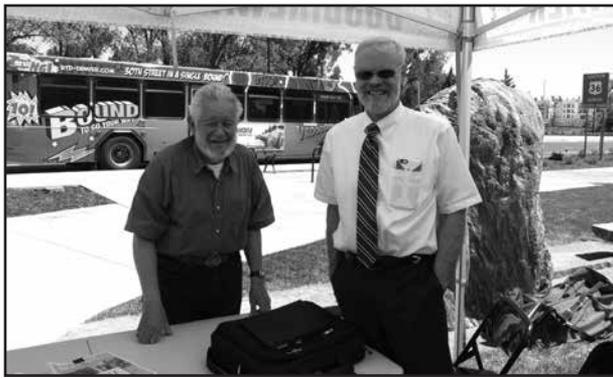
As part of the dedication, a group of PLSC surveyors were invited to attend, and have a display of 19th century and modern survey equipment, some posters explaining the 40th parallel, and people on hand to talk to members of the public. The PLSC volunteers included Gaby Neunzert, Warren Andrews, Bill Wright, Jason Emery, Pam Fromhertz, Paul Bacus, and me.

While the ribbon cutting, speeches by local dignitaries, and a serenade by the Boulder Underpass Singers was going on below the street level, we were at the top of the hill by the 40th parallel surveyor's monument, answering questions and representing the importance of the line and helping to shape a positive impression of surveyors. ■

For more information on the underpass, see:

<https://boulder.colorado.gov/transportation/baseline-road-underpass>





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Control Points – Number 37

Stadia Examples

By Warren Andrews, PLS

In Control Points number 35, in Figures 2 and 3, were diagrams of the stadia principle. Professor Gaby Neunzert suggested that I failed to give numerical examples of the three possibilities of measuring by stadia which is true, I didn't. To correct that omission he kindly provided diagrams shown as Fig. 1, Fig. 2, and Fig. 3 to go along with numerical examples plus Fig. 118 from Harry Bouchard's 1956 Surveying textbook (which is gratefully acknowledged) to show the full formulas, including the stadia constant, C.

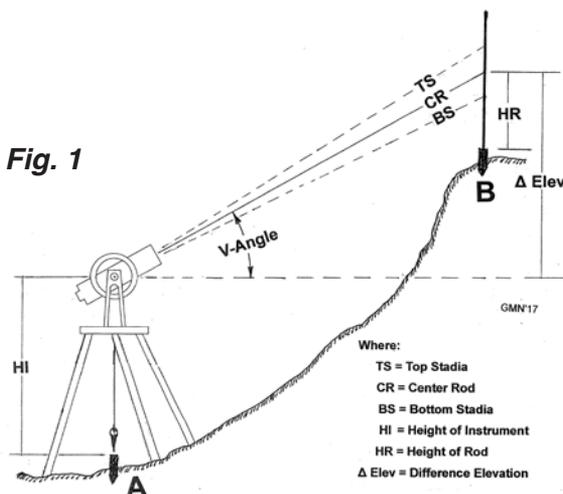
The three numerical examples would be:

1. Horizontal stadia;
2. Inclined Stadia Upward; and
3. Inclined Stadia Downward.

These are compared with the published factors given in Table 6, Stadia Coefficients, Vertical Rod of the BLM Standard Field Tables (little red book). The examples are also compared with Bouchard's full formulas.

1. Horizontal Stadia. Given, relative to Gaby's figures:
 TS = Top Stadia = 5.78 feet (Philadelphia rod)
 CR = Center Rod = 4.32 feet
 BS = Bottom Stadia = 2.86 feet
 HI = Height of Instrument = 4.10 feet
 Elevation of Instrument Station = 6237.09
 Stadia Ratio = 100 to 1 (set at factory)
 C = Stadia Constant = 1 foot (set at factory)

Therefore, $TS - BS = 5.78 - 2.86 = 2.92$ feet. Two point 92 times the stadia ratio of 100 = 292 feet horizontal distance. If you want theoretical accuracy, then add 1 foot for C as shown in Fig. 118 for 293 feet. (I never



251. **Inclined Stadia Measurements.**—When the line of sight is inclined, a correction must be applied to the observed distance to obtain the horizontal distance. In Fig. 118, where the line of sight ED is inclined, the intercepted distance AB on the vertical rod will be too great, since the line of sight ED is not perpendicular to the rod. If $A'B'$ is drawn perpendicular to

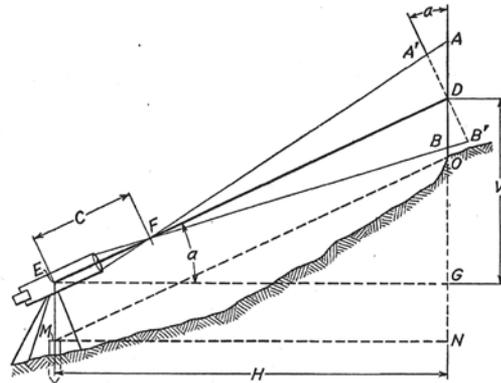


Fig. 118. Inclined stadia measurement.

ED , the angle $A'DA$ will equal the vertical angle $DEG = a$. As the angle AFB is very small, no appreciable error will result if the angles at A' and B' are considered right angles. The distance $A'B'$, which would be the intercepted distance if the rod were perpendicular to the line of sight, equals $AB \cos a$, and

$ED = \frac{f}{i} \times AB \cos a + C = R \cos a + C$, where $R = \frac{f}{i} \times AB$. In the right triangle EDG the horizontal distance EG or H and the vertical distance DG or V can now be found. Thus,

$$H = R \cos^2 a + C \cos a = R - R \sin^2 a + C \cos a \quad (68)$$

$$V = R \cos a \sin a + C \sin a = R \times \frac{1}{2} \sin 2a + C \sin a \quad (69)$$

For any vertical angle likely to occur in practice there will be little difference between $C \cos a$ and C , and $C \sin a$ will be a small quantity; hence, for most work, the following formulas may be used:

$$H = R \cos^2 a + C = R - R \sin^2 a + C \quad (70)$$

$$V = R \times \frac{1}{2} \sin 2a \quad (71)$$

If, in Fig. 118, the position of the middle horizontal wire is such that OD equals ME , the height of instrument, the triangles EDG and MON are equal and $ON = DG = V$. Hence, if, after the stadia reading has been obtained, the middle cross-wire is placed on the reading corresponding to the height of instrument and the vertical angle is then observed, the difference of elevation between the instrument station and the point where the rod is held is obtained directly.

When, for any reason, the point on the rod at the height of instrument cannot be seen, the calculations will be simplified if the middle cross-wire is placed a whole number of feet above or below the height of instrument before the vertical angle is read.

Harry Bouchard, 1956; Surveying; International Textbook Company, Scranton, PA

bothered with adding C because it's difficult to read the level rod to one hundredth of a foot anyway, and stadia with a transit is not really that precise!)

For the elevation of the Rod Station, it's just the elevation of the Instrument Station plus the HI minus the Center Rod reading (if the line of sight is still horizontal and hasn't been moved to get an easier rod reading) which is $6237.09 + 4.10 - 4.32 = 6236.87$ to two decimals. There are no corrections for the horizontal and vertical distances.

2. Inclined Stadia Upward.

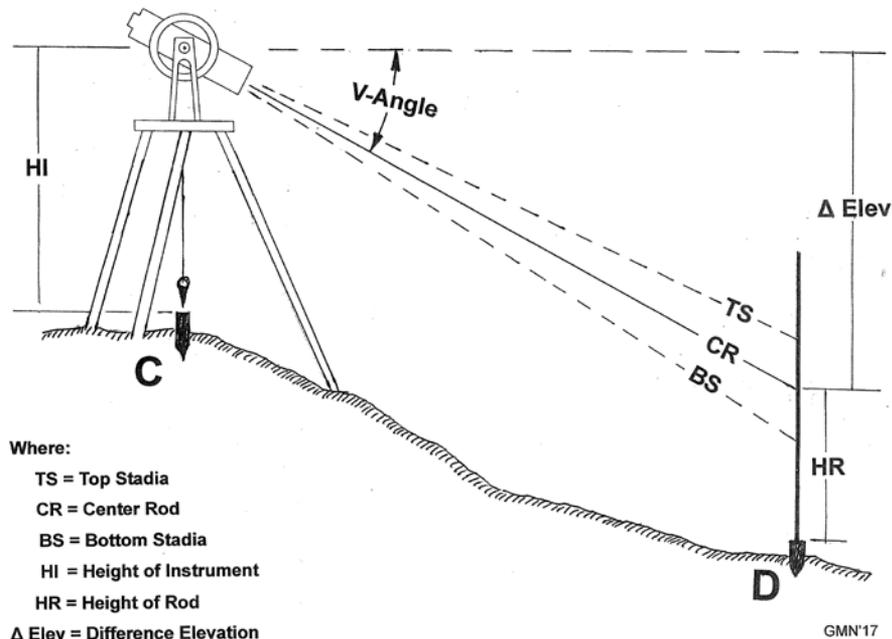
Using Fig. 1 where there is a plus vertical angle then corrections need to be made. For example, the numerical problem could be as follows:

TS = 7.84 feet
 CR = 6.12 feet
 BS = 4.40 feet
 HI = 3.95 feet
 HR = 6.12 feet
 V angle $\alpha = 10^{\circ}32'$
 Elev. Of Sta. A = 5132.77
 Stadia Ratio = 100
 C = 1 foot.

The full stadia reading on the rod (see Fig. 1) is $TS - BS = 7.84 - 4.40 = 3.44$ feet. The stadia reading times the stadia ratio = $3.44 \times 100 = 344$ feet supposedly to the rod. But there is a correction factor for the rod not being at right angles to the line of sight as shown in Fig. 3. A - B of 3.44 feet needs to be corrected to A' - B' by the cosine of the vertical angle α . The cosine of $10^{\circ}32' = 0.98315$. The small triangles ADA' and BDB' are assumed to be right triangles even though they actually differ from 90° by the tiniest amount due to the angle between the top (or bottom) stadia hair and the center crosshair in the instrument. This essentially makes no difference. $AD = \frac{1}{2}$ of 3.44 = 1.72 and $A'D = (1.72)(0.98315) = 1.69$ and doubled for A'B' = 3.38. So instead of 344 to the rod it's only 338 feet. (If you want to be theoretically correct, add 1 foot for C which would then be 339 feet on the slope to the rod).

The horizontal distance then is 338 times the cosine of the vertical angle α (Fig. 1) which equals $(338)(0.98315) = 332$ feet. (If you add C, then it would be 333 feet). The vertical distance is 338 times the sine of the vertical angle α (Fig. 1) which equals $(338)(0.18281) = 60.75$. Therefore, the elevation of the rod station equals the elevation of the instrument station plus the height of instrument plus the vertical distance minus the rod center reading; namely, $5132.77 + 3.95 + 60.75 - 6.12 = 5191.35$ to two decimals (which is beyond the accuracy of the field measurements!)

Fig. 2.



3. Inclined Stadia Downward

This numerical example is similar to 2, except watch out for your different algebraic signs for elevations. The numbers could be as follows:

TS = 6.93
 CR = 5.67
 BS = 4.41
 HI = 3.79
 HR = 5.67
 V angle $\alpha = 7^\circ 49'$, $\cos = 0.99071$, $\sin = 0.13600$
 Elevation of Sta. A = 5376.12
 Stadia Ratio = 100
 C = 1 foot.

Then the full stadia intercept = $6.93 - 4.41 = 2.52$.
 Uncorrected slope distance = $2.52 \times 100 = 252$ feet.
 Correction to slope distance = $1.26 \times 0.99071 = 1.25$.
 Doubled for corrected slope distance = $2.50 \times 100 = 250$ feet. $250 \text{ feet} \times 0.99071 = 248$ feet horizontally.
 If you add C, it would be 249 feet.

For elevation of the rod station, $(250)(0.13600) = -34.00$ for vertical distance, then $5376.12 + 3.79 - 34.00 - 5.67 = 5340.24$.

A much easier way and quicker way to calculate is using the BLM Table 6, Stadia Coefficients Vertical Rod. For Example 2. Inclined Stadia Upward, the $10^\circ 32'$ coefficient for correction to horizontal is 0.9666. Therefore, $344 \times 0.9666 = 332.5$ which checks the 332 (or 333 with C) of the long way around, given above. Also, for the vertical coefficient of 0.1797 from the table times 332 equals 59.66 vertical distance which reasonably checks the 60.75 or if you used C added on would be 333×0.1797 which equals 59.84 (even theoretically closer to tolerance).

A second way of checking is by using the full formulas given in Fig. 118 of Bouchard. (Incidentally, these are the ones used in total station instruments to electronically give you the horizontal and vertical distance to the prism or reflector. Because they can measure to a ten-thousandth of a foot to the center you can get a reportable hundredth in distance because of the hundred to one stadia ratio).

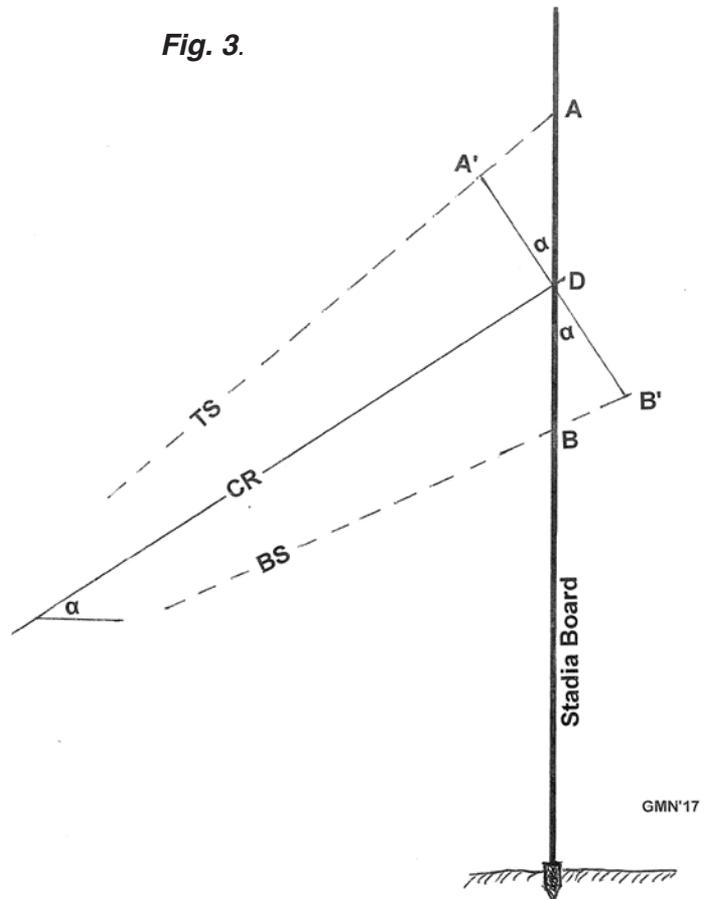
In Example 2, if you use the full formula No. 68 from Bouchard, then $H = R \cos^2\alpha + C \cos \alpha$ where $R = f/L \times AB$ which in Example 2 is the stadia ratio of 100.

$H = 344 (0.98315)^2 + 1(0.98315) = 344 (0.96658) + 0.98315 = 333.5$ which equals the 333 of the long way of computing if you include C of 1 foot.

In Example 3, using formula 68 from Bouchard, then $H = R \cos^2\alpha + C \cos \alpha = 252(0.99071) + 1(0.99071) = 252(0.98151) + 0.99071 = 248.3$, which checks 248.

If you want better accuracy, use an EDM or tape the distance. ■

Fig. 3.



GEOMETRY of INCLINED STADIA

where:
 TS = Top Stadia
 CR = Center Rod
 BS = Bottom Stadia
 α = Vertical Angle

Jennifer Aklilu

Colorado's 2017 Trig Star Champion

By Thomas W. Sylvester, P. E. and P. L. S.

Trig Star is a contest sponsored by National Society of Professional Surveyor's (NSPS) of surveying mathematics administered to high school students to introduce them to and intrigue them with the fascinating field of surveying and geomatics. The PLSC is the Colorado Sponsor for NSPS.

Each year, students from throughout the United States sit for a 1 hour examination to solve a series of math problems dealing with equations and concepts used in the field of surveying. The test typically consists of four main problems with sub-questions concerning the various derived elements of each problem. The first problem usually consists of some straight forward right triangle manipulation. The second problem uses mostly right triangular formulas for another series of questions. The third problem gets much more difficult often bringing in the concepts of the Law of Sines and Law of Cosines. And then there is the fourth problem, which is always quite a challenge. Because of the fourth problem, this year nobody in Colorado got over 88%, INCLUDING ME! I always like to take the test so that I know what the students are up against. It took me more than an hour to finally get all of the challenging elements correct and



Congratulation to Jennifer Aklilu, Colorado's 2017 Trig Star Champion.

to be able to answer several of the teachers' question on whether the published answers were correct or not (they

The other Colorado school's Trig Star Champions are:

<u>Champion</u>	<u>School</u>	<u>City</u>	<u>Teacher</u>
Ryan Slocum	Rangeview High School	Aurora	Shawn Palmer
Austen Mazenko	Cherry Creek High School	Greenwood Village	Dotty (Dorothy) Dady
Andrew Starr	Grandview High School	Aurora	Robert E. Fitzpatrick
Mónica Cárdenas	Denver Center for International Studies at Montbello (DCIS @ Montbello)	Denver	Julie Stremel
Spencer Hurt	Central High School	Grand Junction	Julie Christianson
Christopher Khoo	Cherokee Trail High School	Aurora	Lara Tabola
Anandro Sinaga	Hinkley High School	Aurora	Craig Thompson
Olivia Parapat	Gateway High School	Aurora	Olaf Siverson

were). This year's scores demonstrate how challenging the exam tests are.

Colorado had 9 schools participating this year. The highest score in each school is the Trig Star Champion of that school. In most cases, there are numerous ties, often with scores of 100% (not this year, though). Then the deciding factor is the student with the highest score in the least amount of time is declared the Trig Star Champion. Each school's Trig Star Champion's score and time are all compared with the other school Champions. The highest score in the state completed in the least amount of time is declared the Colorado Trig Star Champion. The PLSC awarded each school's Trig Star Champion with a \$100 cash award, an award letter, and an award certificate.

Each state's Trig Star Champion is then sent a national test to compete for first, second, and third place National Trig Star Champions. First place wins a \$2000 award, second place wins a \$1000 award, and third place wins a \$500 award. The trigonometry teachers of each of the place winners are awarded Teacher Excellence Awards of \$1000, \$500, and \$250 respectively.

We are proud to announce **Colorado's 2017 Trig Star Champion – Jennifer Aklilu**, a junior at Overland High School in Aurora, Colorado. Her teacher is Cyndee Wooden. Jennifer is a DECA State Qualifier, NHS Social

Committee Officer, varsity volley ball player and high honor roll. Her parents are Lulu Woldegabreal and Miski Ahmed. Our hearty congratulations and we wish her the best of luck with the National contest. I expect to get the National results sometime in July.

I want to thank all of the students in the state that took the test and their teachers for their participation. Although some teachers make the test part of a requirement for one of the math classes, many participants are volunteers, taking the test during a free time in the day. We had one school that participated where the morning was spent sitting for their SAT tests. Now that's dedication. A special thank you goes to Jan Sterling. Jan had been the State coordinator for several years, but decided she needed to start phasing out (or so she thought). However, she still took the main roll of coordinating all of the Front Range Schools and helping to organize the process. She is always a Trig Star Champion. Thank you! ■

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Eupalino's Tunnel Revisited Or What, No Math!

By Gaby Neunzert, PLS

This is a revisit to an article written several years ago, which set out the facts but never addressed the “how” it might have been done. Further, the presentation below is based on the premise that the ancients were very keen observers of nature and time was not of the essence. Given the lack of mathematics and the limited sophistication of surveying equipment over 2300 years ago, the paradigm of the tunnel alignment by Eupalino has to be changed from the fixed 2 portals and a straight line between them, to one portal and a straight random line in the direction of the second portal. But first, a little historical backdrop.

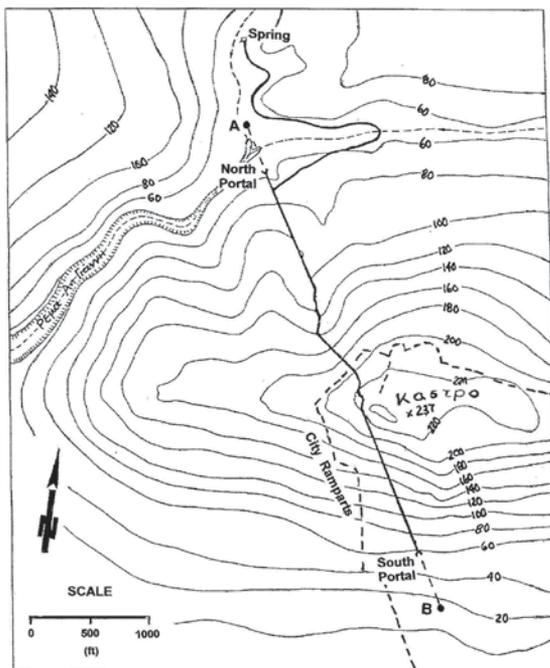
About 2350 years ago, or roughly 530 BC, Polycrates (570-522 BC) was the ruler of the Greek island of Samos in the Aegean Sea, just off the coast of Turkey. He ordered his surveyor/engineer to start construction of a tunnel to provide a secure water supply for the capital city now called Pythagorion (in honor of Pythagoras) who was born on the island. Under the direction of Eupalinos of Magara, construction started about 530 BC and lasted some 5 to 10 years.

On paper (or maybe on papyrus), the project is rather simple and it involves driving a straight tunnel from both ends, ultimately 3400 ft long, under Mount Kastro (see map). With but very few exceptions, tunneling from both ends was not used again until some 2300 years later, when the need arose for shipping canals in the early 1800's. The accepted antique “quanta method” of tunnel and shafts every 60 ft to 100 ft would have involved a detour generally following the contours around the mountain to the west and roughly twice as long. With GPS for field work, the modern solution is fondly called a “missing course traverse” and is quickly executed on a computer; but especially without trigonometry and trigonometric functions, this project definitely was a major accomplishment.

What the ancient surveyors did is a mystery, since probably no field notes were kept, or at any rate, no written record has survived. Over time, many well intentioned individuals have attempted to describe the methodology employed by Eupalinos, usually based on modern mathematics. Unfortunately most references lived after the event, thus leaving only a physical solution. Mathematically, Hipparchus (190-120 BC) calculated a table, about 140 BC, with the sine of the angles expressed as chords. The cosine and tangent functions were not invented until 500 years later by the Arabs. Pythagoras (570-495 BC) was teaching his theorem, but had no way to solve a square root. Euclid's “Elements” was not written until some 200 years later and Heron of Alexandria, ca. 10-70 AD, (remember Heron's formula for the area of a triangle when the sides are known!) developed the concept that a line can be broken down into its rectangular components, i.e. latitude and departure. His “solution” was faithfully accepted for 2000 years after the event! In summary, Eupalinos had NO mathematical tools to help in the alignment or length of the tunnel and hence had to rely on a physical or non-mathematical “natural” solution.

Now, to the physical tools and surveying. Like all public works of the time, the work most certainly was done by slaves, who chipped by hand with picks, hammer and chisel under candlelight or the light of an oil lamp. There was no ventilation and the muck had to be carried out by hand.

In the old days, there were no optical instruments, not even a predecessor of a transit, no distance meters,



EUPALINOS TUNNEL

Note: alignment stakes “A” and “B”

levels or even a Gunter chain. There might have been a dioptra, a basic carpenter square, and very definitely a plumb bob and sighting rods were known. As presented below, the initial alignment and grade of the tunnel does not require the measurement of distances and angles.

Conceptually, for alignment the surveyors had 2 choices, see map:

- a) Select both portal sites, “wobble in” on the crest of Mt. Kastro, set the alignment stakes at A and at B and proceed to mine. There are 2 major difficulties with this approach; first, given the equipment of the day and lack of mathematics, establishing a straight line between the portals is difficult or nearly impossible; second, there is no practical way to establish a downhill slope in the tunnel.
- a) The second option is considered to be the more likely method used. It is assumed that the downhill portal was to be located inside the city ramparts, but initially its specific location was immaterial. With this constraint in mind, it is comparatively easy to run a random line from the north portal over to top of Mount Kastro into the city. The only tools necessary are several plumb bobs and sighting rods. Ultimately, in order to start excavation, it is absolutely necessary to locate the “backsights”, points A & B at each portal during the initial survey, as shown on the map. Undoubtedly frustrating for a modern surveyor would be that sights without optical magnification are at most 50 ft, thus requiring at least 80 setups for the length of the tunnel.

And now to elevations and the specific location of the exit portal. Without a level, Eupalinos had no choice but to observe that water will flow downhill thus starting at the upper (north) portal, the slaves would dig a small ditch and divert the plentiful supply of water into it. As long as the water gently flowed, the ditch was propagated and when necessary clay pipes were suspended on barren rock faces. Based on pure imagination, it is assumed that a very small manhole was dug under the city’s ramparts in order to get the “elevation” inside the city. Finally, the southern (lower) exit portal was uniquely located at the intersection of the “elevation” ditch with the “tunnel” line. A very



unusual “level bow”, invented by mathematics professor Mamikon Mnatsakanian, a colleague of Tom M. Apostol at the California Institute of Technology, is shown. The leveling tool is a “long wooden rod, suspended by a rope at the central balancing point, so that its ends are at the same horizontal. The bow need not have uniform thickness and is about 8 m (about 26 ft) long” (T. Apostol, 2004).

Lastly, it must be noted that the proposed procedure does not require any distance measurements until probably within the last 50 ft prior to breakthrough. Especially in competent limestone, the sound of a hammer blow can be heard quite well for some distance and can be used for the final alignment. ■

Bibliography:

- Apostol, Tom M. 2004, The Tunnel of Eupalinos; Engineering and Science, Vol.1
Hughes, Dan, 2002, The Tunnel of Eupalinos; Homepages.cwi.nl
Kienast, Herman J. 1977; Das Tunnel von Eupalinos
Lahana, Michael, 2006, The Eupalinos Tunnel of Samos
Olson, Ake, 2012, How Eupalinos Navigated His Way Through the Mountain. Anatolia Antiqua

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The Snake

by Earl F. Henderson, PLS

Looking back on the whole experience, from the relative safety of the emergency room, I probably would have been better off if the snake had just bitten me. You know that startling feeling you get for an instant when you first spot a snake, no matter what kind it is? That instantaneous adrenaline rush? If you have your wits about you, and can identify what kind of snake it is quickly enough, you can either hop quickly to avoid being bitten, or act like you weren't startled at all, if the rest of your crew is around. Well I thought I was lucky that my crew wasn't right there because I jumped back rather abruptly and quite a ways too. I'm not sure why I was so startled by this snake. I've seen thousands. I guess I was so into the experience I was having I was just extraordinarily surprised when he broke my euphoria. I had almost stepped on him and he was pretty startled himself and reacted. I didn't just stop with one jump either. If my crew had been there at that moment they would have thought I had something up my pants because I took several hops to get clear and well down the slope from the snake.

Now I'm not sure if you feel the same way but once I spot a snake, I want to keep it in sight for a while to make sure that I don't have another similar encounter again in the very near future. I kept my eyes on that snake even through those leaps and once I stopped, my eyes were glued to him while I caught my breath. I was so intent on watching that snake I didn't even see the ground bees clouding up around me or feel them starting to crawl right on up my legs. I was so dumbfounded when they started stinging me, for a couple of seconds I couldn't seem to figure out what was happening. I guess the adrenaline hadn't quite gotten out of my system when it finally struck me and my legs just started carrying me as fast as they could go down the slope through the woods.

I haven't even told you that we were in the middle of a 120 acre boundary traverse through beautifully wooded rolling terrain. It was the kind of job we all got into surveying originally to do. I had left the crew to continue traversing while I scouted ahead for evidence, cut line, and flagged items for them to side shoot. I was probably about 800 feet ahead of the crew and up to this point, enjoying a transcendent surveying experience.

Anyway, right about the time that I was realizing that running from the bees was not such a good idea, I tripped over some small stump or log or something and began to stumble down the slope trying in vain to regain my balance. In actuality I was running at an even faster

pace and out of control. As you can possibly imagine, this didn't really do much for calming that adrenaline rush. I somehow managed to stumble straight into a mass of greenbriars.

I'm not talking about blackberry briars here. I'm talking about the greenbriars that grow bark on them and form those huge clumps and have large needles. I was freaking out by now and for the first time started to utter audible noises that I hadn't even heard on Wild Kingdom. It scares me even now to recall the sounds that came out of my own throat. The bees were happy though. They could quit chasing and get down to real business. I was thrashing at them and in doing so was tearing myself and my clothing to pieces on the briars thinking that it was more bees. My mind was completely confused by the apparent volume of stings I was receiving and the sensation of being wrapped up in barbed wire for no known reason. As I continued to thrash I became more and more entangled in the briars and my torn clothing and so could move about less and less. As my movements were forced into slow motion my mind began to slowly focus on my situation and I finally realized my best course of action was to stop moving all together and just let the bees finish what they started. It was truly a painful decision to have to make.

I had become a bloody ragged mess. The crew had heard my guttural cries and came running up in anticipation of finding me fighting off some bear or mountain lion. There is nothing quite so humiliating as finding yourself in a position where the people you have been trained to lead are so overwhelmed by the sight of you that they can no longer remain standing from doubling over in laughter and you can't even move let alone walk away. I might as well have been tied up.

By the time they were able to compose themselves and begin to think about lending some assistance, the bees had finished their dirty work. The only course of action was to use the brush axes to cut away the briars. Everyone was concentrating heavily at this point so as not to cause more injuries. I had made that point quite clear I can tell you that for certain. About the time that my upper body was free of it's trap, my instrument operator noticed that the briars were interlaced with poison ivy.

We agreed that at this point it really didn't make much of a difference, so the crew just kept on cutting away. By the time they were finished and I was freed from the pen, most of my cuts and scrapes had begun to clot and my

JUST A SURVEYOR

By Dean Glorso, PLS

I like to keep my mind open and body active
Strolling the alleys hunting for evidence
A little like Sherlock Holmes, but not quite as popular
The markings I seek are not of blood, however I watch for clues certain
In the concrete and soil, I confirm measurements true
Deeds with legal and diagram, I ponder often
As I slowly saunter along, eyes to the ground
My toil is for clients with special vision
I caress their lands by metes and bounds
So they can fix and flip, or scrape-off and rebuild
A shelter for persons of high standing
The process beyond me sometimes will squeeze
The current tenants deeper into poverty
Often my work to measure, is in "vacant" urban areas
Dirty and greasy is the pavement
Evidence I uncover in my search
Homes among what look like trash
Fencing and shrubbery conceal, often a roof of cardboard
In my quest for boundary evidence, I try not to startle the humans
And respect the makeshift homes, as I respect their way of life
I do not judge the living they make
Their stories have not been told to me
And I am but a surveyor of land

D. Glorso – May 1, 2017

The Snake from page 19

clothing looked like the remains from the transformation of the Incredible Hulk. I looked like Bill Bixby left in the rags created by Lou Ferrigno.

I've had plenty of time to reflect on those events while hiking back to the van, riding to the hospital, and being treated. I didn't have to wait at all when we got there. The nurses took one look at me and knew I needed immediate attention. Luckily, I haven't required too many stitches. It was mostly scratches, scrapes, and puncture wounds. Removing the broken briars from my

skin has been pretty painful. My ankle is only sprained and not broken. The doctor has put me on steroids for the bee stings and poison ivy, even though the ivy hasn't had time to show signs yet. A precautionary step he told me. On top of it all, while the nurse was cleaning me up, she managed to find and remove a few ticks. It's not too surprising with all the blood around.

Do you want to know the worst part of the whole ordeal? It was a black snake. ■

PLSC Board of Directors

April 13, 2017

Conference Call Minutes

Call to Order, 5:03PM

Present: Todd Beers, Steve Parker, Alan Blair, Becky Roland, Paul Bacus, Teresa Smithson, Leif Joy, Ralph Pettit, Tom Sylvester, J.B. Guyton. Guests: Pam Fromhertz, Kevin K

2. Determination of Quorum (6 voting), determined

3. Approval of Minutes from previous Meeting, Blair

MOTION: To approve (Bacus/Pettit)
Approved unanimously

4. Financial Items, Beers/Blair/Roland

- a. 2017 Budget to Actual Review
 - a.i. Little remaining income to post in 2017
- b. 2017 Membership Numbers
 - b.i. Chapter Dues Payment – transfer this week
 - b.ii. Becky to resend script and list to the Chapters
 - b.ii.1. North Central has no status report
 - b.ii.2. Central Chapter split list to 17-18 per person – will find out results on 27th
 - b.ii.3. Please forward any email bounces to staff
 - b.ii.4. Southern Chapter sent out the list – made several phone calls – not much response
 - b.ii.5. NW 1/4 has no status report
 - b.ii.6. Western Chapter has not followed up with their President
 - b.ii.7. Southwest Chapter not on the call
 - b.ii.8. Todd and Becky to send a reminder to all Chapter Presidents
- c. 2017 Summit Numbers
 - c.i. Chapter Dues Payment

MOTION: To pay the full chapter distribution for the summit. (Blair/Smithson)
Approved unanimously

- d. Update on Investments – Review of Performance
 - d.i. Alan and Becky to meet with Personal Benefits and provide a proposal back to the Board at the next meeting.
- e. Request for support of 2017 Boy Scout Jamboree
 - e.i. Consensus is not at this time due to commitment to Colorado Mesa University.

5. K-12 and Scouting Outreach, Beers/Dennis

- a. Printing assistance needed
 - a.i. Todd and JB offered to assist in printing the flyers.

6. Reports

- a. NGS, Fromhertz
 - a.i. Geodetic State Coordinator Update
 - a.i.1. Questionnaire/survey – 6 responses
 - a.i.2. Smithson presenting 21st
 - a.i.3. CDOT is checking their support
 - a.i.4. There is interest from PLSC membership to serve/apply for this position
 - a.i.5. Need to change May 8 meeting date
 - a.ii. Geospatial Summit April 24-25 – Board is encouraged to participate in person or by webinar
 - a.iii. Steamboat CORS Station – two quotes \$7500 and \$9200 plus rails – still need more information/input from city
 - a.iv. CBL – new policy has been signed and will have a webinar in the near future
 - a.v. Montana Meeting – WSFS meeting
 - a.vi. National Surveyors Week
 - a.vi.1. NSPS needs to do more to celebrate this and promote surveyors
 - a.vi.2. Capital display? Pizza party and education?
- b. Scholarship
 - b.i. Tom would like to see each Chapter submit for CMU and be more active in recruiting applicants
 - b.ii. Need to review protocols for in-state vs. out-of-state requirements
- c. Membership Committee, Smithson/Parker/Roland
 - c.i. Nothing to report yet
- d. Rocky Mountain Surveyors Summit, Parker/Roland
 - d.i. Add Alan Blair to Planning Committee
 - d.ii. Shawn Clarke Central Chapter Representative
 - d.iii. Don Hulsey Southern Chapter Representative
 - d.iv. Meeting next week
- e. Lobbyist/Legislative Committee, Bacus
 - e.i. As of Monday there are no new resolutions allowed.
 - e.ii. Electronic Plats
 - e.iii. Continuing Education
 - e.iii.1. Board consensus is to get DORA involved and signed on

- e.iii.2. Need to look at retention of instruction language
 - e.iii.3. Todd lobbying with other States at the NSPS Meeting to submit letters of support
 - e.iv. 2022 Datums
 - e.iv.1. NSPS has the draft language – send the language to Paul
 - f. Education Committee, Parker/Blair/Beers
 - f.i. University/Community College Requisitions
 - f.i.1. Other states are requesting funding support
 - f.ii. Program Review
 - f.ii.1. Suggestions for surveying classes – yes
 - f.ii.2. Licensing requirement – send to DORA
 - f.ii.3. Create a subcommittee to be this resource and utilize the CMU group for this (Pam will also assist)
 - f.ii.3.a. Develop something for the website on the PLSC recommendations and resources
 - f.iii. Survey Equipment Inventory – How do we best use?
 - f.iii.1. Send list to Tom for Trigstar
 - f.iv. Revamp Refresher Course
 - f.iv.1. Live and online
 - f.iv.2. Alan and Randy will look at this
 - g. Ethics and Fair Practices Committee
 - g.i. Ralph would like guidance – Becky will send Patrick Green’s contact information
 - h. Trig Star Report, Sylvester
 - h.i. \$100 to each school winner – Tom will send names for checks and the teacher name to send it to.
 - h.ii. Board is fine for Tom and Jan to decide on who gets \$10 participation fee. If there is great demand, Tom and Jan can come back to the Board for input.
 - h.iii. Wrapping up in next week or two.
 - h.iv. There will not be an award ceremony in Aurora this year. Each school is encouraged to award students at a school function.
 - h.v. Need a replacement for Jan Sterling (retiring)
 - i. GIS in the Rockies, Parker
 - i.i. September 21-22 at Inverness Hotel
 - i.ii. Earlybird registration is now open
 - i.iii. Abstract submission deadline is May 1
 - i.iv. Keynote – Peter Beatty - Ubisence
 - j. GPS Day – cancelled for Boy Scout event
 - k. NSPS Delegate’s Report, Guyton
 - k.i. JB, Todd and Becky attended.
 - k.ii. NSPS is going to have a booth at the high school councilor conference in July. JB and others will present and assist with the booth.
 - k.iii. News and Views has a lot of great information, so JB is going to promote it.
 - l. WSPS Delegates’ Report, no report
 - m. CMU Surveying and Mapping Program Report
 - m.i. Just finished a meeting with CMU
 - m.ii. Tom just sent out an update on the program
 - m.iii. We just received approval and have two more meetings to complete before all approvals are received.
 - m.iv. Dennis Bailey and Becky will work on brochure
 - m.v. Beginning document for search for instructors
 - m.vi. Agreed to correct the program title to delete “Licensed”
 - m.vii. Will send article tomorrow for Side Shots
7. Chapter Reports
- a. Southern
 - a.i. Holiday party at Castle in Manitou
 - b. Central
 - b.i. No report
 - c. Northern
 - c.i. Laine is doing well
 - d. NW ¼
 - d.i. No report
 - e. Western
 - e.i. Spring Seminar May 5
 - e.ii. Still working on date for Chapter Summit
 - f. Southwestern
 - f.i. No report
8. Next Meeting Date and Location – need to wait for information on Chapter Summit on the Western Slope – August 18 (TBD) 5:30-7
9. Adjourn (Blair/Smithson) 7:02 ■

PLSC Asset Balances, July 1, 2007

Financial Institution	Purpose	Holdings
Key Business Savings	Operating Funds	\$216,438.92
Key Business Checking	Operating Funds	\$31,365.87
AssetMark Investments	Education funds	\$240,839.24
Total Assets		\$488,644.03

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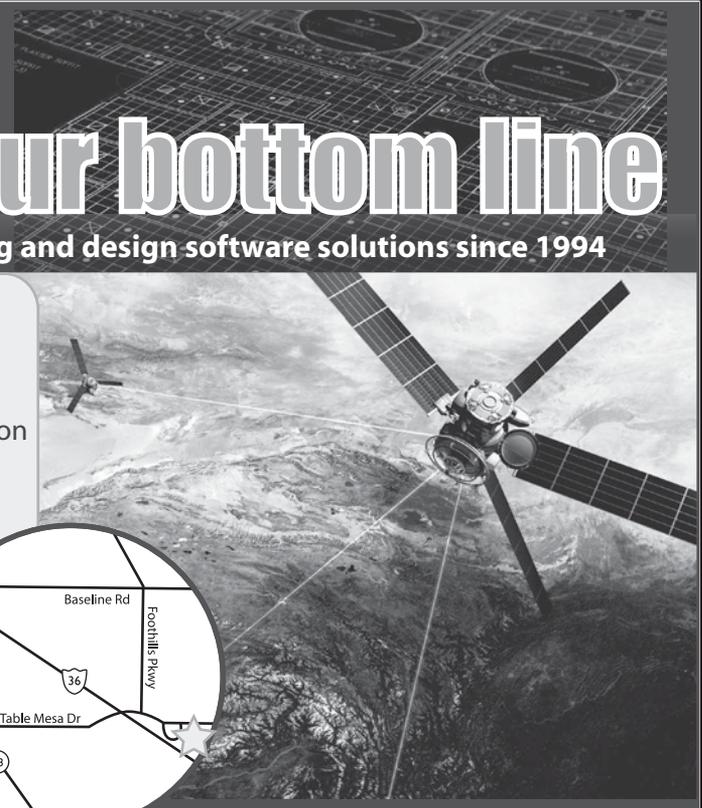
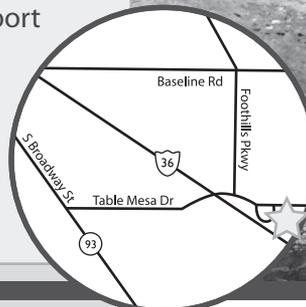
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CHAPTER NEWS

CCPS

Greetings everyone. I'd like to thank Bryan Baker from Leica and those who attended the June general meeting at the Table Mountain Inn located in Golden. Bryan gave a very interesting and informative presentation on UAV use for surveying.

CCPS is trying to keep a current email list of all members. If you are not receiving emails about the upcoming meetings and/or social events please email me at colocentralsurveyors@gmail.com and I will add you to the distribution list. Also, feel free to email if you are interested in speaking at the general meeting or have an idea for a topic.

We will be holding this summer's Surveyors Social at Topgolf in Centennial on August 24th. This event will be a lot of fun, so please plan on attending. You do not have to be a golfer to enjoy yourself! An email invitation will provide the details.

Get out there and enjoy the Colorado summer. Be safe everyone!

Kevin Kucharczyk, PLS
CCPS President

NC-PLSC

The Northern Chapter met in April in Johnstown for a presentation from Pam Fromhertz. She discussed the slope validation project headed by NOAA and the upcoming vertical and horizontal datum changes.

May brought us to King Surveyors for a discussion from Todd Beers about High Density Scanning as well as a request from Jennifer Muha from Front Range Community College for a qualified instructor in their GIS & Survey department. Paul Bacus lead a discussion about the future of recorded documents, which always brings up a lively and common juxtaposition with surveyors of respecting the past while making way for the future.

There were no meetings in June or July for the summer, but we anticipate getting back to business in September with a schedule of meetings and topics. Please feel free to contact myself or anyone in the Northern Chapter if you have suggestions.

Steven Parks, PLS
President NC-PLSC

NW 1/4 CLS

The NW 1/4 met at Clarion Inn in Craig, Colorado on May 18th. This was immediately following a substantial spring snowstorm that had resulted in postponing the meeting a week when common sense broke out. It also made field surveying interesting as we accumulated snowpack for a week in mid-May after having lost it entirely some six weeks prior. Use those tall stakes!

The principal topic after the normal Treasurer's

business and review of late fall and spring business was the evening's topic- the growing list of County and municipal planning regulations and ordinances that seemingly have accelerated since the end of the great recession. It appears that from 2010 to 2013 several of the planning departments in NW1/4 region - Routt, Grand, Eagle, Rio Blanco, Jackson and Moffat Counties - have passed a series of ordinances and regulations that had poor prior public notice but substantial impact in the years that followed.

Specifically, these new "rules" add substantial wording and limitations to all plats, and five years later short staffed planning departments either enforce the new rules differently or not at all in a timely fashion. Logic would dictate that some of these new rules and regulations should be revisited and prioritized, but that seems unlikely in the short term. Most of them have an immediate financial bearing, such as the added time to type in and add on the new rules, or for the title company to add charges for their increased liability with the public recording of Exception B of a formerly private title commitment. What we are trying as a profession is to figure out their longer term impact on our clients and our businesses. And what is (are) the impacts on our communities?

What have other locations in Colorado seen in the realm of planning recently?

Brian T. Kelly, PLS
President NW1/4

SC-PLS

Well, it's been a quiet week at Lake Wobegon..., wait...no.

Great news! Southern Chapter is having their Christmas Party at the Miramont Castle in Manitou Springs this year, Friday, December 8th. Also, the Southern Chapter is very proud to have presented an academic scholarship to Sean Maik. Graduating top of his class in Ja Junta, Sean is pursuing his bachelors of science in civil engineering degree from CSU - Pueblo, and he plans to earn his Cadastral Surveying Certificate, and eventually a PLS license while he continues to work at the Pueblo County Engineering Department. Join us every third Tuesday at our board meetings or member meetings, and keep an eye on our website for details at www.scpls.net.

Steve Parker, PLS
President Emeritus, SC

SWC-PLSC

At the 2017 Rocky Mountain Surveyors Summit, one of the Technical/GIS Tracks was the presentation of the Geoid Slope Validation Survey 2017 by project manager Derek van Westrum and Pam Fromhertz, the Rocky Mountain Regional Advisor for National Geodetic

Survey, NOAA. Pam and Derek were in Durango on June 20th to meet with CDOT Region 5 regarding the gravity data collection portion of the program (GSVS17). The SW Chapter had the unique opportunity to have Derek and Pam along with Brian Shaw, who is leading one of the GPS crews, stop by our chapter meeting and give us an update on the progress as well as discuss some of the gravity measurement techniques that are being undertaken. Of course, the real fascinating gravity measurement conversations happened after the meeting over pizza and beer!

Many of our chapter members have seen the GPS base stations set up along Hwy 160 as well as the leveling crews, which are making their way over Wolf Creek Pass. Not your typical leveling exercise; imagine running up and down the pass twice with your high order leveling equipment!

It's an exciting project and a glimpse into the future of the next generation gravity model for GPS use. Many thanks to Derek, Pam and Brian for taking time out of their busy schedules to meet with us and relax over some beer

Here's a quick summary of the general program that was provided by Pam:

NGS Survey along US 160 this summer

NGS is developing a new vertical datum by 2022 based on gravity data. Airborne gravity data is being collected across the US, through the GRAV-D program, with the goal of developing a gravimetric geoid model with a sustainable absolute and relative accuracy of 2 cm wherever possible. In order to evaluate the accuracy of the geoid model, independent tests of the model must be conducted, referred to as the Geoid Slope Validation Survey (GSVS). The first independent test of the geoid model was GSVS11, which was conducted in Texas; and the second, GSVS14, was conducted in Iowa.

GSVS17 is now being conducted in the Rocky Mountains, from Durango to Walsenburg along US 160, to test geoid accuracy in extremely rugged terrain. Similar to GSVS11 and GSVS14, this line will test the differential modeled geoid accuracy between points, that is, it will test geoid slopes. Two methods for deriving geoid slopes, aside from gravimetric geoid modeling, are underway: (a) co-located, minimally constrained geodetic leveling (of which gravity is an integral part) and GPS, and (b) astro-geodetic deflections of the vertical (DoV).

The next SW Chapter meeting will be on September 20th, the third Tuesday of the month. Speaker and location TBD.

Parker S. Newby, P.L.S.
President – SW Chapter PLSC

WCLS

The deadline for the Side Shots quarterly chapter update hit right as Peter Krick was taking his summer vacation, so he reached out to me to give an update. I hope that I can do the chapter and Peter justice regarding the events of the last quarter, but if I have left out something important, my apologies. Some claim it's because I am getting older, but I insist that it's just because I have so much stuff in my head, I can't be expected to remember it all.

On May 5, we had an excellent spring seminar. Jill T. Norris, Esq. of Dufford, Waldeck, Milburn & Krohn, LLC, gave a presentation on surveyor ethics. With some of her questions and ethical insights, she generated quite a lively discussion. She was followed by another excellent presentation by the BLM on "To accept or reject local corners". We were honored to have Bob Dahl give the presentation, supported by Mike Boeckman, and Sean Mullen. Again we had some lively discussions. As often is the case with surveyors, when we broke up into groups of about 4 or 5 to discuss some particular evidence, we generally were able to come up with at least 5 or 6 opinions on the proper decision to make. A big thank you goes to Rick Mason and Mike Grizenko who did the lions share of organizing the seminar.

The WCLS chapter is attending a Grand Junction Rockies baseball game en masse on July 20 as our summer meeting. The Grand Junction Rockies are a farm team for the Colorado Rockies. We often get to see some of the stars before they are stars. Brian Bowker has been coordinating this effort and a big thanks goes to him as well.

The chapter is looking forward to hosting the PLSC Chapter Summit again this year on August 18. That should give some of those astronomically minded surveyors time to travel to the total solar eclipse passing just north of Colorado on August 21.

And last, but not least, we are delighted that Colorado Mesa University through the Western Colorado Community College approved their Land Surveying and Geomatics Associate of Applied Science Degree program starting this fall. Colorado again has an institution where we can get our requisite education for our Colorado PLS licensure. We want to extend a big thank you and congratulations to all of those locally, with the PLSC, throughout the state, and NSPS, that worked so hard to bring this program to fruition. As the "local" chapter next door to CMU/WCCC, we are looking forward to giving them as much direct support as they need to ensure the success of this program.

Thomas W. Sylvester, PLS
President Emeritus, WCLS

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