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LINES & POINTS

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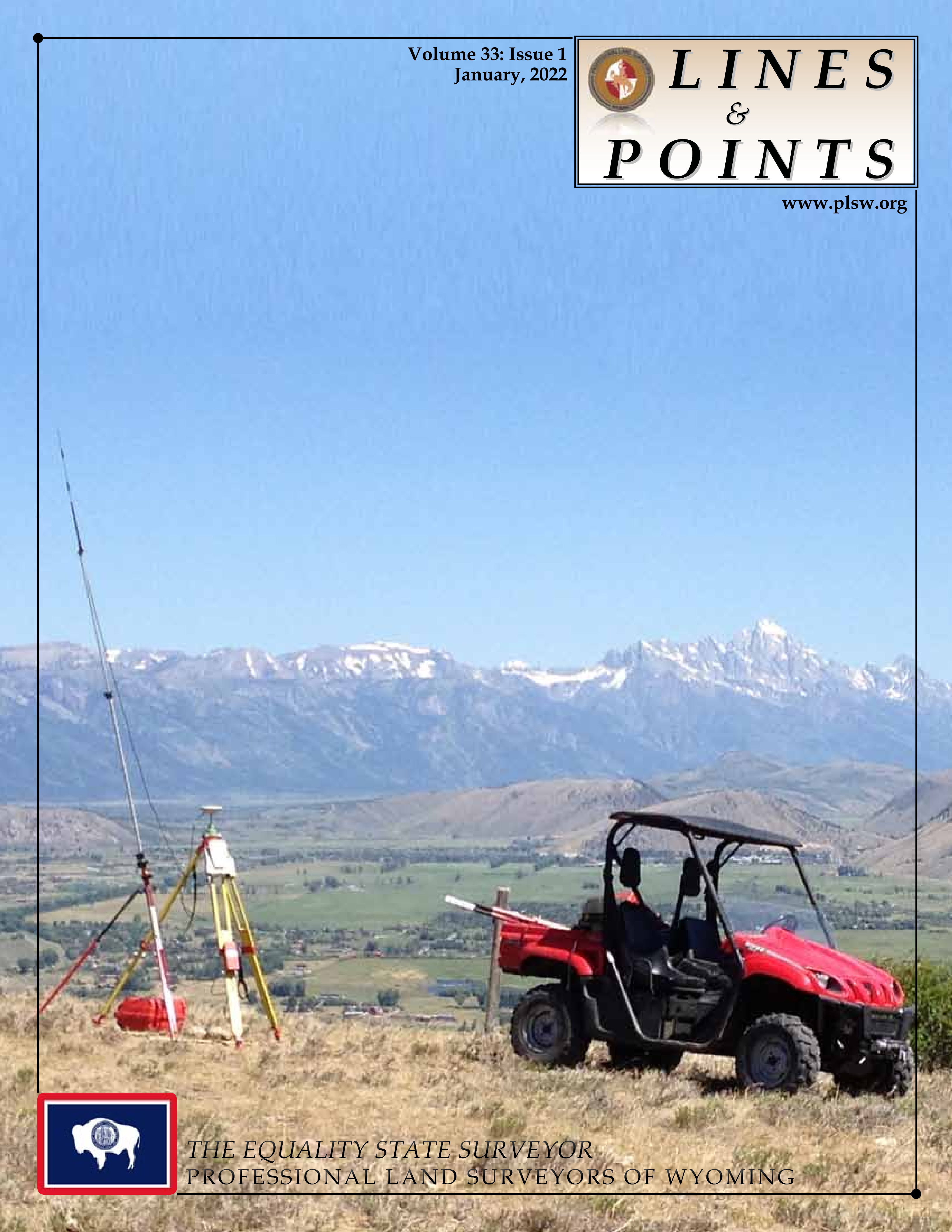

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On The Cover

GPS Base Setup

photo by Matt Gotham

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PLSW (Professional Land Surveyors of Wyoming; PO Box 8, Cheyenne, WY 82003) is a statewide organization of Land Surveyors registered to practice in the Equality State of Wyoming. PLSW is dedicated to improving the technical, legal, and business aspects of surveying in the State of Wyoming. PLSW is affiliated with the National Society of Professional Surveyors (NSPS) and the Western Federation of Professional Land Surveyors (WestFed).

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PRESIDENT'S MESSAGE

Here we are in January; there is another year in the rear-view mirror and (maybe) we have time to reflect on the past year of work. As I write this, I've just finished my annual employee evaluations which thankfully forces me to both reflect on the past year and look toward the future. I'm lucky to have a very good team to work with, but there is always a common theme: we need more people.

There seems to be no lack of discussion around this topic at the local, state, and national levels. PLSW and the University of Wyoming have partnered for quite a while now to encourage surveyors around the state to reach out to their local schools and provide a presentation to students during National Surveyors Week (March 20-26 this year). In the West Chapter, we have found that the spring is a busy time in the schools as teachers are trying to make sure they get everything in before the end of the school year and it sometimes works better to get into classrooms in the fall. BUT don't wait for March or even October next year; there's no time like the present and I strongly encourage all of you to make some time to talk to students. Fortunately, we have some good programs to help you with these efforts. Cindy Jones, the K-14 Outreach Coordinator at the U.W. College of Engineering has a wonderful online GIS program, "GEOInquiry", and supporting materials and lesson plans to use (thanks to Geno Ferrero for his efforts on this project as well). Or make your own plan and bring some of your newer technology like a UAV or a scanner and show the kids the cool tools we get to work with. It's never too early to inform students of the surveying profession; I remember a local surveyor coming to my classroom when I was in third or fourth grade. I didn't think too much of it at the time, but the memory came back to me when I was near high school graduation. The rest, as they say, is history.

It was good to see so many of you in person at the Fall Tech Session. We now have the WESS conference just around the corner. A year ago, in the interest of promoting a better partnership and to be more inclusive of their better halves, the Wyoming Engineering Society decided to add an additional 'S' to their acronym, making it the Wyoming Engineering and Surveying Society.

Let's reinforce their decision with a good turnout in Sheridan next month. Carl Carmichael has worked hard to find a good speaker for us, and I look forward to welcoming Warren Ward from Fraser, CO as our presenter. Warren has had a long and successful career; he operates his own firm in Grand County, he is a contributor to "xyHt" magazine, he wrote the text for the informational displays at the four corners monument, and he has presented on several topics to surveyors around the country. I look forward to his presentation and I look forward to seeing you all in Sheridan.

Get some rest and enjoy the winter!

Matt Gotham, PLS
President - Prefessional Land Surveyors of Wyoming

ANNOUNCEMENTS

CONGRATULATIONS!

The members of the Professional Land Surveyors of Wyoming would like to recognize the achievement of the following new Wyoming registrants:

LS 18627 - Eric Rollston, Collinsville, OK

LS 18711 - Dustin Schmaltz, Jackson, WY

LS 18712 - Thomas Osen, Williston, ND

SI 184 - Nicholas Hummel, Cody, WY

"Journeys: One Individual's Excursions into the Surveying and Mapping Professions: Volume I"

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NOAA's National Geodetic Survey Update

By Brian Shaw, brian.shaw@noaa.gov

GPS on Benchmarks

GPS on Bench Marks is a crowd-sourced GPS data collection effort for surveyors and other geospatial professionals to help communities prepare to transition to, and reap the benefits of, the modernized National Spatial Reference System (NSRS) that will be released in the near future. One crucial component of NSRS modernization is for NGS to provide tools, such as the 2022 Transformation Tool, that will enable users to transform their existing data between the current system and the modernized one. NGS has extended the cut-off date to submit GPS on Bench Marks data for use in the 2022 Transformation Tool until December 31, 2022. This extension reflects NGS's commitment to include as much local data as possible in the transformation tool.

On January 13, 2022 NGS hosted a webinar GPS on BM: NSRS Modernization Campaign Continues through 2022[1]. For anyone that missed this webinar it was recorded and can be viewed at the link provided.

Horizontal Time Dependent Positioning (HTDP) Software Update

Last year NGS released a new version of the HTDP utility. This new version 3.4.0 is now available on the NGS website[2] as well as Github[3]. Although HTDP v3.4.0 includes several significant updates, the intent is to minimize change in output for land areas covered by the previous version, except for areas affected by new earthquake models, and for transformations involving the original ("Transit") realization of WGS 84.

The HTDP User Guide[4] has been extensively revised, including new figures and tables, updated instructional exercises, and more details on how reference frames and transformations are implemented. Cross-references have also been added to related definitions in the widely used ISO Geodetic Registry[5] and EPSG Geodetic Parameter Dataset[6].

Beta OPUS Projects 5.0 Available for Testing

Users can now upload GNSS vectors into OPUS projects[7], including vectors derived from either a single-base real-time kinematic (RTK) setup or from a real-time network (RTN), for evaluation, quality assessment, and inclusion in a GNSS survey network for least squares adjustment. Use the new GNSS Vector Exchange (GVX)[8] file format to transfer data from various manufacturer hardware to OPUS Projects 5.0. The latest update to Trimble Business Center v5.60 can now export GVX files and most other vendors plan to have this ability in their software this year if not already by the time of this publication.

NGS is working to publish new guidelines and best practices for RTK/RTN data collection. At this time when collecting data it is recommended to collect two independent 5-minute occupations. Recent analysis has shown that occupations with a minimum of 3 hours time between collections can be considered independent. If the first two occupations do not agree by 3 cm horizontally and 5 cm vertically then a 3rd occupation should be done to check for agreement. You can contact me for any further questions and information about these recommendations and keep a lookout for when we send out new guidelines and best practices.

Beta NGS Map

In the last issue I wrote about a new application calling it the Beta NGS Data Explorer. Before that application was released to the public it was decided to give it a new name to distinguish it from the current NGS Data Explorer. It has been renamed the Beta NGS Map[9] and includes plotting the published NGS Datasheets, NOAA CORS Network sites and the OPUS Shared Solutions. This new application provides many new tools and capabilities such as measuring on the map, filtering stations by attributes, selecting and exporting data and sharing distinct locations via a URL using the share widget. Please provide any feedback about this new application to ngs.feedback@noaa.gov.

[1] https://geodesy.noaa.gov/web/science_edu/webinar_series/gpsonbm-nsrs-campaign-continues.shtml

[2] https://geodesy.noaa.gov/TOOLS/Htdp/Htdp.shtml

[3] https://github.com/noaa-ngs/HTDP

[4] https://geodesy.noaa.gov/TOOLS/Htdp/HTDP-user-guide.pdf

[5] https://geodetic.isotc211.org/

[6] https://epsg.org/home.html

[7] https://beta.ngs.noaa.gov/OP-bluebook/OpusProjects.shtml

[8] https://geodesy.noaa.gov/data/formats/GVX/index.shtml

[9] https://noaa.maps.arcgis.com/apps/webappviewer/index.html?id=190385f9aadb4cf1b0dd8759893032db

Pythagoras

Thoughts About the Creation of a New National Spatial Reference System

by Herbert W. Stoughton
Geodetic Engineer

Surveying and mapping are multifaceted activities having their origins in prerecorded history. Archaeologists and anthropologists studying the early human settlements and sites have found prerecorded surveying activities these peoples developed agrarian and commercial societies.

We now know that the inhabitants in Central and South America, Northern Africa, Asia Minor, India, and China independently developed surveying procedures/programs for agrarian development and commercial transportation. By the time civilizations were fully flourishing, they understood running rudimentary land boundaries, constructing highways and canals, and designing/ building elaborate monuments.

By 4241 B.C., the ancient world had determined that a calendar year was comprised of 365 days. By the first millennium B.C., philosophers were presenting theoretical statements to accurately describe many of the activities, and explain the existence of worldly phenomena. Pythagoras developed the theory of numbers and proposed that the earth was a sphere. A few centuries later, Euclid set forth The Thirteen Books of Elements, which were the foundation of geometry and the process of problem solving through deductive reasoning and analysis.

Following shortly after Euclid was the Greek philosopher Erastothenes (of Cyrene). Eratosthenes developed a method of measuring the magnitude of the earth's radius employing the sun's shadow at a specific instance in time. Although the approach was very crude by modern standards, the concept was brilliant! Eratosthenes's approach is considered the origin for the discipline of geodesy. From ancient Greek, geodesy meant to "divide the earth". This was because the word geometry literally translates "to measure the earth". Over the next few centuries, other philosophers attempted to verify and/or improve the knowledge of the magnitude of the earth's radius. Although the results were a subset of surveying, the results did not directly support the other types of surveying for water transport systems (aqueducts, canals, etc.), land boundary retracement, and highway construction.

Also, other philosophers were developing graphical forums to pictorially display points on, or near, the earth's surface maintaining the same geometrical interrelationships. This latter discipline became known as cartography or map making.

By the time of the collapse of the Roman Empire (c. 476 A.D.), these disciplines of surveying and mapping were well established. Through the medieval period (sometimes referred to as the Dark Ages) there was little development in surveying and mapping in Europe. Finally, with the rise of commercial ventures and decline of the feudal land tenure system, new interest in surveying and mapping arose. As colleges and universities formed, the study of arts and letters, the law, and religion were expanded to "natural philosophy". Until about 1850, the academic endeavors of developing and educating in the disciplines of surveying and mapping were within the domain of the philomath - "lover of mathematics".

While the expansion and development of surveying programs for engineering projects and land surveying were progressing to address more complex projects, geodesy and cartography were separately and independently expanding their activities. The developments in cartography were closely associated with the requirements for map products, particularly nautical charts, to support commercial ventures. The principal aspect was to present on a horizontal plane a true depiction of the relative location of points and features, which could not be physically observed from above by the map reader.

When the age of exploration commenced in the fifteenth century, people were hungry for knowledge about the newly discovered lands. For the next four centuries, cartographers addressed the procedures and styles of presentation of information, and the publication and distribution of the final products.

The discipline of geodesy was more or less dormant with respect to developing enhanced theories and technologies. However, from the time of Erastothenes, the development of geometry and trigonometry continued. This was accelerated with the adoption of the Arabic numbering system. Also, astronomers continued to monitor the heavens, and expand their knowledge of the cosmos. Copernicus, Galileo Galilei, Halley, and several others contributed significant insights into various phenomena which required a unified explanation.


Euclid of Alexandria

Enter Isaac Newton! Newton's contributions addressed numerous subjects generally known as "natural philosophy". His study of light became the basis of the book Optiks (1703), which described the nature of light, and the geometry of "light rays". Around 1665, Newton developed the theory of fluxions (an early form of differential calculus) which could continuously describe mathematically physical phenomena. In 1684, he demonstrated his theory of gravitation in De Motu Corporum. This subject would be completely presented in Philosophiae Naturalis Principia Mathematica (1687) (generally called Principia). Besides mathematically describing the nature of the law of gravitation, Newton posed a series of problems/solutions which would initiate programs to substantiate these theoretical proposals. One of these proposals was the exact size and geometrical shape of the earth. Newton's proposal was that an ellipse whose major axis lay in the plane of the equator, the minor axis coincided with the polar axis, and the resulting surface was generated by rotating the ellipse about the semiminor axis. This is known as the prolate ellipsoid (historically incorrectly called spheroid).

Newton's contemporaries (residing on the European continent) did not endorse his proposal, but believed the major axis coincided with the polar axis and the minor axis lay in the equatorial plane. In order to support their proposal, the French Academy of Science, supported by the French monarch, sent expeditions to Peru (today Ecuador and northern Peru) and Lapland (now Finland) to linearly measure portions of meridional arcs and compare the difference in latitude determined by astronomic latitude at the termini. The quotient of the linear measure divided by the difference in latitude (in arc measure) would be the radius of that arc. If the northern radius is longer, Newton would be vindicated, and if the northern radius is shorter, the French proposal was the vindicated. The equatorial radius was shorter, and the discipline of geodesy was formally stated.

The survey methods to measure the linear portion of the survey lines was by traverse or triangulation. By measuring one side of a triangle interconnected with the a series of triangles

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Hints to Authors

Dear Readers:

The editors of Lines & Points wish to convey our gratitude to the numerous authors who have contributed photographs, technical and professional articles, and other information to be incorporated into the quarterly journal. In recent years, the assembly and redaction of the submitted materials has taken on considerable technical application of the various English language compilers, office suites, and "publishing suites". This means that the communication and transfer of information and materials arrive at the editors' desktops in a multitude of formats and styles, which sometimes are not compatible with the PLSW personal computers.

We, the editors, are setting forth some simple rules for submitting materials which, hopefully will simplify your efforts and make the transition to the published version simpler and less time consuming.

1. If you have any questions or comments, please contact S. Dennis Dawson, Publications Comm. Chm., (dennieandbarb@gmail.com) or Michael A. Flaim, Editor-in-Chief (mike.flaim@bresnan.net).

2. If an article contains any illustrations, photographs, graphs, or other graphics, please transmit them as separate individual files. You may also include the illustrations within your manuscript, but the image integrity/quality is degraded seriously when attempting to extract them from the manuscript to create a published digital image. The Editor-in-Chief states that a much better digital resolution is obtained from the separate, individual illustrations submitted.

3. All submissions (electronic and snail mail) should be sent to S. Dennis Dawson (4005 Snyder Avenue; Cheyenne 82001). It is recommended a second copy be sent to Mike Flaim (1212 Southwest Drive; Cheyenne 82007).

4. It is strongly recommended that all submissions be transmitted six weeks prior to the publication deadline. The publication deadlines are: 1 January; 1 April; 1 July; and 1 October, annually.

5. Lines & Points is the official publication for the Professional Land Surveyors of Wyoming. Therefore, hence forth there will be incorporated in the publication all formal announcements pertaining to official business of the organization and other announcements. This includes announcements for the Annual Meeting; state-wide membership meetings; seminars; and the Fall Technical Session. These announcements are to be submitted to the PLSW Secretary/Treasurer John J. Studley (PLSW; Attn.: Mr. Jack Studley; P.O. Box No. 8; Cheyenne 82003) (jklz0318@gmail.com), at least four weeks prior to the publication deadline in which the announcement will appear. The PLSW Secretary/Treasurer will circulate the announcements to the Publication Comm. Chm.; the Editor-in-Chief; and the PLSW Board of Directors.

6. Advertisers and prospective advertisers should communicate directly with PLSW Secretary/ Treasurer Studley about any advertisements and modifications.

Lines and Points Article Rotation Submission Schedule By Chapter

Responsible Chapter	First Call Date	Last Call Date	Publication Date
Northeast Chapter	March 1	March 15	April 1, 2022
Northwest Chapter	June 1	June 15	July 1, 2022
West Chapter	September 1	September 15	October 1, 2022
Central Chapter	December 1	December 15, 2022	January 1, 2023
South Central Chapter	March 1	March 15	April 1, 2023
Southeast Chapter	June 1	June 15	July 1, 2023
Upper Platte Chapter	September 1	September 15	October 1, 2023
Southwest Chapter	December 1	December 15, 2023	January 1, 2024

As the Board of Directors discussed, any four page article (with pictures) may be from within the particular chapter membership (survey stories, or technical experiences) or after acquiring permission to use an article from another professional society publication or which provides information of interest to the PLSW members. The Board also approved assigning the responsibility for the article development and submission to each chapter's vice president. If a Chapter does not provide an article that same Chapter shall be obligated to provide an article for the next publish date.

Thoughts on Professional Practice and Education

Article 1: Faculty Licensure

by Knud E. Hermansen P.L.S., P.E., Ph.D., Esq.

This will be the first of several articles giving thought to the topic of professional practice and education.

I have reached the age where I have a great many opinions and have no fear of sharing them. I have no employers that would take umbrage of my opinion. Perhaps some current or past clients might object but they are free to seek others to perform their services should they wish.

If this is the first of several articles I plan to write, I can introduce myself thoroughly in this article and be reticent about an introduction in later articles.

I am retired after 30 years of teaching though I still do contract teaching for surveying and engineering programs. I have also retired from the military where I was a surveyor and engineer for over twenty years. I have been licensed in several states as a surveyor, engineer, and attorney. I still have an active license for each profession in at least one state. I have consulted in a wide variety of roles offering surveying, engineering, and legal services. I have surveyed many miles of boundaries. I was a member of a licensing board at one time. On numerous occasions I have served as an expert witness, trial attorney, appeals attorney, arbitrator, mediator, boundary commissioner, and, of course, a professor and instructor. Old age, experience, and my varied and unique practice I hope gives me a perspective that will generate some thought, no doubt some controversy, and perhaps some changes.

In this missive I will focus on surveying faculty qualifications. I will not and never claim to be among the best faculty. I am sure there are some former students that will claim I am not even a satisfactory faculty for I had hard standards and high expectations that left some students disgruntled and unhappy that I chose to apply these standards to them. As I said, I am too old to change or even give much care to what a young student, lacking experience, may believe. To put it simply, their opinion is seldom my reality. After the graduate has practiced in the surveying profession for fifty years and still wishes to maintain a low opinion of my instruction, I will welcome their thoughts and give them worthy consideration.

The point I wish to make in this missive is to give my opinion on faculty licensing. I do not believe a quality surveying program must require every faculty to be licensed to practice the profession of surveying. However, I do believe a majority of faculty should be licensed to practice the profession. I will offer three reasons for my opinion.

First and most importantly, I am of the firm opinion that no amount of education and research in surveying or 'geomatics' (as some programs prefer to use), allows a faculty to provide the impactful presentation experience allows. Of course, any person wishing to become faculty and claim they have experience outside of academics should have enough experience to be able to qualify and sit for professional exams in at least one state.

I am mindful that some faculty may have experience in areas of surveying practice that their state of residency will not accept toward licensure. Yet, that person will not be prevented from applying and being licensed in some other state that does accept their experience for licensure. (There is no state, by law, that can demand residency in the state before being licensed.) By way of example, I would refer the reader to some states that require a license for and therefore must accept experience in areas of remote sensing and GIS when applying for professional licensing.

Second, I believe it important that faculty set an example that will encourage students to seek professional licensing in the surveying field. This is done most effectively by the faculty themselves being licensed to practice the profession of surveying. I have seen numerous articles in professional magazines that lament the aging of the licensed surveyor population and how few young persons are entering the profession. Many employers lament the difficulty of finding young persons interested in filling employment openings. Young adults are not given a good example by allowing surveying instructors to be unlicensed.

Third, I believe faculty are much more inclined to have been or become active in their state and national professional societies when licensed. I am of the very firm belief that a successful college surveying program must enjoy the support of state surveying societies. To enjoy that support, there must be continuous interaction and familiarity between the academic program and the professional society. The interaction and familiarity are often absent or tenuous at best when faculty are not licensed. Lacking a license, the faculty can't be a full member of the professional society.

I have such a firm opinion on the importance of requiring licensed faculty, that I would demand licensing as a prerequisite for a faculty member even at the sake of academic qualifications. If the only choice to fill a faculty position was between a licensed individual and one with a Ph.D. of similar temperament, I would opt to always take the licensed individual.

Many universities that host surveying programs require a Ph.D. These same surveying programs do not require professional licensing of faculty. For some reason which I cannot comprehend, even after 30 years in college teaching, university administrators think it much more important to hire a Ph.D., without practical experience, often without experience as a resident, to teach surveying topics. The administrator will not accept someone without the Ph.D. that would have many years of relevant experience, relevant license, and familiarity with the residency where a graduate is likely to seek employment.

Having given my opinion, I now offer advice by suggesting ABET and professional societies make strenuous and consistent requests of administrators of surveying programs to demand current faculty become licensed and new faculty to be licensed prior to employment. The line is very clear. If a person wishes to teach in a surveying or geomatics program, they should have a professional license.

† Other books and articles by Knud can be found at https://umaine.edu/svt/faculty/hermansen-articles/

(Continued from Page 8)

forming a chain or complex network, and measuring a sufficient number of the angles in the remaining triangles, it is possible to calculate the remaining lengths and omitted angles.

Employing spherical trigonometry, it was then possible to compute the latitude and longitude of each triangle's vertices.

During this era, numerous European countries initiated national mapping programs. In order to improve the geometrical integrity of the final maps, it was decided that the procedure should start with the preselected points whose geometrical position on the ground were accurately known with respect to neighboring points. The mappers/topographers then mapped the countryside surrounding each point, and, hopefully overlapped into neighboring submaps, preparing a series of sub maps. If the latitude and longitude of the points have been accurately determined and plotted on the master map, the sub maps could then be traced/transferred onto the master sheet to produce the desired product.

The geodesy program to determine the size and shape of the earth was not a primary objective. However, the need to provide accurate survey points for national mapping utilized triangulation and traverses became a suitable objective. The same equipment and the personnel could produce information requiring geo-positional data for mapping for both activities. Simultaneously, as the geodesists produced survey positional information, they searched for improvements. Early endeavors were in applying gravimetry, geometrical mathematics, and quality control. One of these early efforts in quality control was multiple observations of individual quantities and observing additional quantities which provided multiple solutions having slightly different values. The geodesists recognized early that multiple solutions of a single problem included data which might contain errors caused by imperfections in the instrumentation, theory of observing, and human frailties. Through these endeavors, new and improved instruments were designed, the associated discipline of metrology was formalized, and several sub programs of the infant geodesy became full fledge geodetic disciplines. These include, but are not limited to gravimetry/

physical geodesy, field positional astronomy, and geodetic elevations.

From the closing decades of the eighteenth century through the 1970's, the efforts of the geodesists have been to optimize accurate data collection, to publish resulting geodetic solutions in a variety of formats needed by the end user, to identify micro-magnitude errors and anomalies, which were not previously perceived, and to remove observer physiology in the observed data. In general, the horizontal control estimated "accuracy" was approximately 1:20,000 prior to the middle of the nineteenth century. After World War II, the accepted "accuracy" of triangulation for general civilian applications was 1:50,000. However, because of the high accuracy between widely spaced points, horizontal control surveys (both triangulation and traverses), other disciplines became interested in applying geodetic positions within their programs. One of the earliest applications was the location of navigation aids (light houses, navigation hazards, navigation channel buoys, etc.). A second program was the location of the cross-country air beacons used in the 1920's, and later the positioning of the FAA navigation beacons.

Probably the most remarkable application resulted in the analysis of the regional geometric ground disturbance after an earthquake. The San Francisco earthquake (April 1906) was the largest seismic event in the contemporaneous United States after the New Madrid earthquakes (1811-1812), which had radically modified the Mississippi River channel. Therefore, U.S.&.G.S. personnel were directed to reobserve the triangulation network in the San Francisco area. The original networks were established to support hydrographic charting of the California coast. The survey personnel were directed to extend their survey work north and south from San Francisco until the reobservations (of angles) showed no change from the original work. The final report's investigation was authored by John Fillmore Hayford and Lillian Pike. Not only was the magnitude and direction of the movements from the 1906 event, but ascertained movements elsewhere is the network which were the result of another significant earthquake in the 1860-70 era. This investigation initiated a new, and important, application for geodesy. The results demonstrated that accurate/precise geodetic surveys (both horizontal and vertical) could support the study of seismology and tectonics. Also, other disciplines in the geological and geophysical sciences became interested in geodetic information in order to coordinate widely separated projects and programs. One of the novel projects was developed in the 1930's was the geological/geophysical analysis of the earth's crust under and surrounding the newly constructed Hoover Dam and Lake Mead. In this project, geodesists specifically designed the survey networks for the investigation.

During the eighteenth and nineteenth centuries, land surveying and engineering surveying disciplines were expanding and addressing more assignments. Until 1855, land surveying literature was published in volumes of geometry and trigonometry. In England, William Leybourne (1579), Leonard Digges, John Fitzherbert, Aaron Rathborne, and John Love authored popular works on surveying. However, John Love's Geodaesia was the first English language surveying book to address surveying in the American colonies, and was published in the United States even after independence. In the early 1800's Albel Flint authored a very popular mathematics/surveying textbook, which went through several editions. In one of the sets of general instructions issued to survey the Public Lands (east of the Mississippi River), the Surveyor General stated that the deputy surveyor should possess a copy of "Flint's Surveying".

Besides the Military Academy at West Point, several engineering schools and colleges were established in the U.S. Many of the programs had several courses on surveying incorporated within the civil engineering curriculum. One of the leading institutions was Union College where Professor William Gillespie authored the first modern textbook on surveying. The book's format was radically different from previously published works, and became the standard format for surveying books published in the United States to this day.

From the mid eighteenth century through the first one-half of the twentieth century numerical cartography evolved. Lambert, Gauss, Krüger, and Clarke designed rigorous mathematical map projections. Deetz, Adams, and Thomas (at the U.S.C.&G.S.) contributed by authoring manuals detailing the accurate/precise applications of these map projections.

Although several surveying and mapping disciplines had maturated through the centuries, World War II would have significant ramifications. The world wide nature of the conflict required surveys and maps spanning nations, continents, and oceans. Geodesy and cartography assumed expanded roles to produce surveys and map/chart information required for the numerous war theaters. After the war, these hastily expanded organizations assumed the tasks to assimilate volumes of collected data from diverse sources. In the process, the geometrical 'connection' between various local geodetic datums could not be resolved employing classical mathematical techniques. Various definitions of length standards, the numerous epochs of the surveys, and numerous other factors seriously impeded the efforts. Also, the launch of the space age generated new survey requirements. The analysis of existing networks strongly indicated that newer surveys executed to higher standards needed to be conducted and interconnected with the existing networks. During this era, the International Union of Geodesy and Geophysics was completing a detailed campaign with other international scientific/engineering organizations/societies to standardize the fundamental definitions of primary and secondary constants being used (i.e. velocity of light, length of the meter, length of the time second, unit of mass, etc., to name a few).

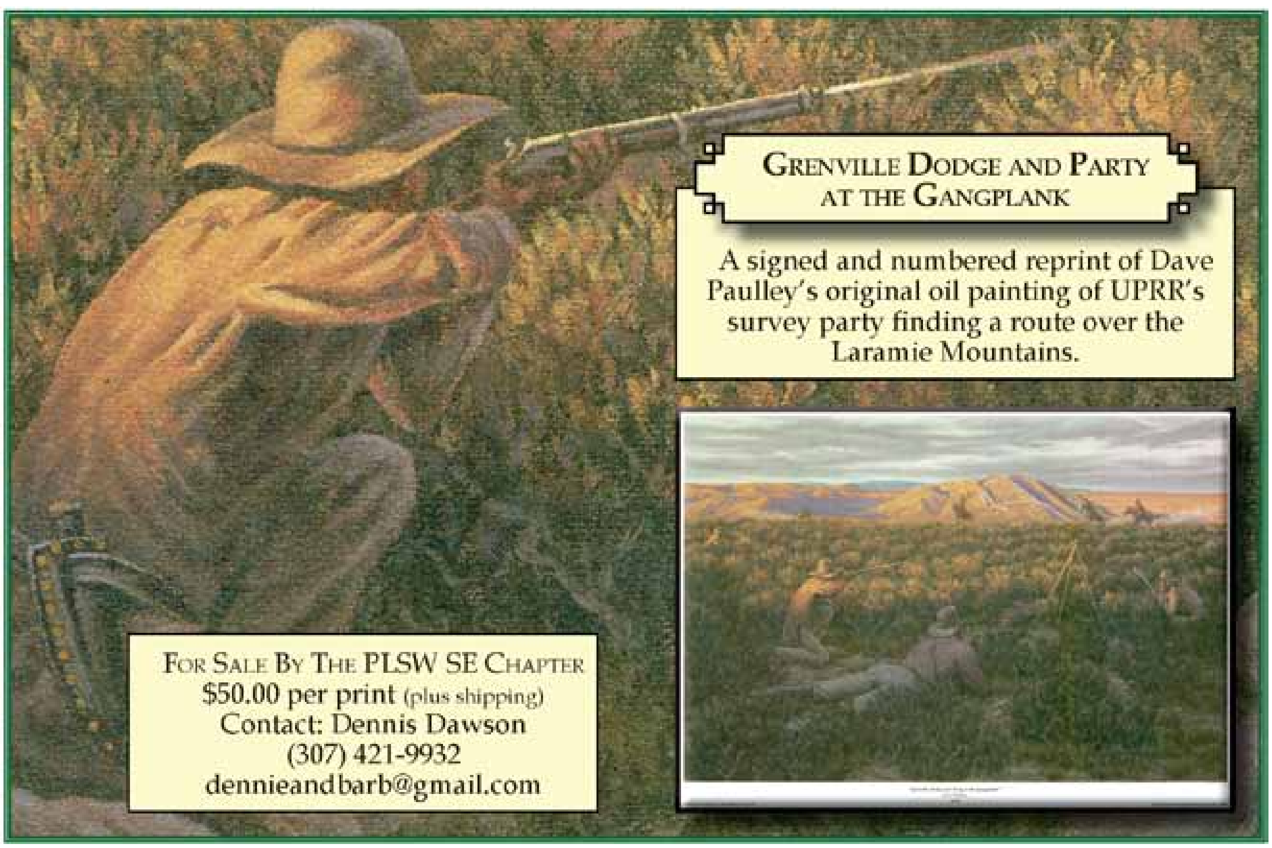
The NAD83 datum/adjustment for North America resulted. During its computation/adjustment in the early 1980's, a newer surveying technology appeared. Although satellite positional surveying employing the NNSS and the Doppler technique, produced final point positions (which respect to the earth's mass center) were within a few meters. A new DoD constellation specifically designed for navigation, time, frequency, and positioning was implemented, and was known as the Global Positioning System (GPS). Several other nations launched similar programs, and today the entire system is known as GNSS.

By 1990, the precision/accuracies achieved employing GPS indicated rethinking and expanding the Geodetic Reference System 1980. Also, because of the achievable positional accuracies for surveyed points, the static-in place-fixed position was untenable, particularly over extended time periods. Therefore, the concept of a "spatial reference system" was conceived.

If we study the transitions between each redefinition of datums, we have witnessed considerable turmoil between end users of geodetic positional data. Part of the problem was whether to migrate positional data from the older datum to the newer datum. Where data sets encompassed extensive geographical areas the geo-positional data was warped, rotated, and required linear scaling due to sequential surveys establishing the original positions.

In the past three decades (1990 - 2020) sufficient world wide geodetic positional data have been observed, and in some cases reobserved several times, to be able to mathematically model plate tectonics and crustal dynamics, so that a continuous world reference system could be established. Periodically, the point positions of the spatial reference system will be modified, but the shifts will be mathematically modeled to produce a seamless transformation between datums and epochs.

The quality of the geospatial information assigned to GIS projects will remain. The high accuracy/precision of the transformation functions developed to migrate even the highest accuracy data should not degrade the geo-positional integrity of the lower order accuracies. In other words, the designed transformation function(s) should be unbiased for any data set.



New P.L.S.W. Logo Jackets

Men's Port Authority

The Port Authority jacket is constructed from a polyester stretch woven shell, which is then bonded to polyester microfleece with an added laminate film insert to repel water. Wind-resistant, water-resistant with stretch perfect for corporate or weekend wear.

Ladies Port Authority

The Young Gun is a 100% microfiber water resistant jacket. Has a western yolk accents on front and back. Features double snaps on waist, leather Velcro *closures* on cuffs and zippered underarm vents. Concealed hood and 3 exterior pockets and 4 interior pockets.

STS Jacket Young Guns

(Men's Sizes Only)

Back of Jacket
(8-1/4 inch diameter)

Front Left Chest
(3-3/8 inch diameter)

***Mail completed form with Checks**

Payable: Frontier Marketing

PO Box 2477
Cheyenne, WY 82003
Attn: Randy Rhodes
Questions Call: 307-778-1430

Port Authority $65.00 XS-XL
Port Authority $70.00 2XL-4XL
STS Jacket $125.00 XS-XL
STS Jacket $130.00 2XL-4XL

*** Shipping $15.00 per jacket (Cheyenne orders delivered)**

PLSW contacts:
John Lee; jlee9901@aol.com; 307-760-0335
Suzie Sparks: s75spark@blm.gov; 307-775-6225
No shipping charge for Cheyenne address.
Printable order form available at www.plsw.org

Customer Name: ______________________________

Shipping Address: ______________________________

Name Left Chest: _______________________ ☐NO NAME ☐NO BACK LOGO ☐NO FRONT LOGO

Size	XS	SM	MED	LG	XL		2XL	3XL	4XL		$ TOTAL
MEN'S	N/A					$65				$70	
LADIES						$65				$70	
STS						$125				$130	
SHIPPING						$15 PER				$15 PER	

2021 Trig-Star Winner
Ms. Jennifer Banks

ARE YOU SMARTER THAN AN ELEVENTH GRADER?

By Darby Schock, PLS

The Wyoming Trig-Star competition for the 2021 – 2022 school is fast approaching! I can hear you asking, "But what is Trig-Star?"

Well, I'm the coordinator for Wyoming, so let me tell you! It is a competition developed and sponsored by National Society of Professional Surveyors, in order to recognize and reward high school students who excel in mathematics, and their teachers. The competition demonstrates the practical uses for mathematics, bringing greater awareness of the surveying profession to juniors and seniors in high school. The contest consists of a timed test of trigonometry problems, culminating in a typical "calculate the boundary" problem a surveyor might face. PLSW awards the top student and their teacher a cash prize. Top students from each state go onto the national contest where they can win an additional cash prize. Schools across Wyoming are invited to participate. The only requirements being a testing registration fee and that each school has a local sponsor.

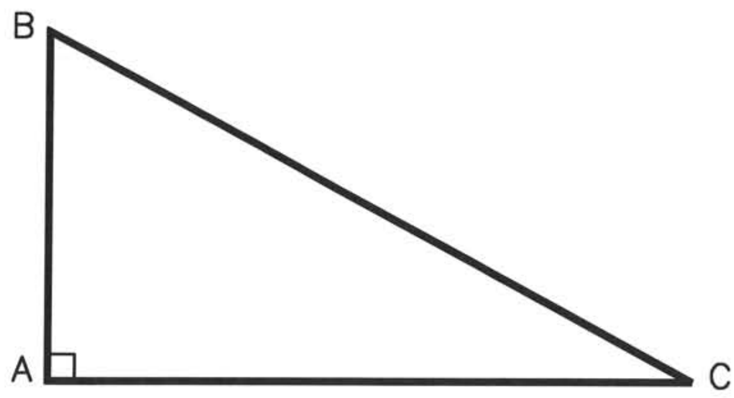
Last year's contest winner is Ms. L. Britney Jones of LaBarge, WY. She had a perfect score, taking 32 minutes and 46 seconds to complete the test. Ms. Jones is a senior this year at Big Piney High School, where her math teacher is Ms. Jennifer Banks. The Trig-Star contest at Big Piney High School was sponsored by Surveyor Scherbel, Ltd. Ms. Jones is an active volunteer in her church and school. I asked if she was interested in pursuing Land Surveying. She said that she's undecided right now, but plans on attending college to pursue a degree in accounting. While the Trig-Star competition hasn't convinced her to become a surveyor yet, it did help her realize that she does really enjoy the practical application of math. I also asked her if she had any tips to prepare for the test. She replied, "The most important tips I'd say is to not stress too much, and just do your best. If you've prepared yourself, you will be ready. Also, make a friend with your calculator. This will be your favorite (and best) tool to organize all the data in solving a question."

Now I can hear you asking, "What can I do to bring Trig-Star to my local school?" I'm glad you asked. The PLSW Board has graciously picked up the tab for testing registration this year, the fees are paid for! All schools are invited to participate, so we need sponsors for those schools! If you are interested in becoming a sponsor please contact me at darby.schock@wyo.gov and I can help connect you with a school. For more information about Trig-Star, please visit the website at trig-star.com.

Now, as promised, a chance to test your trigonometry mettle. Last year's state Trig-Star test follows. See if you can get a perfect score in less than 32 minutes and 46 seconds. Only pencils and your friendly calculator are allowed. Good Luck!

TRIG–STAR PROBLEM LOCAL CONTEST

PRINT NAME: ____________________



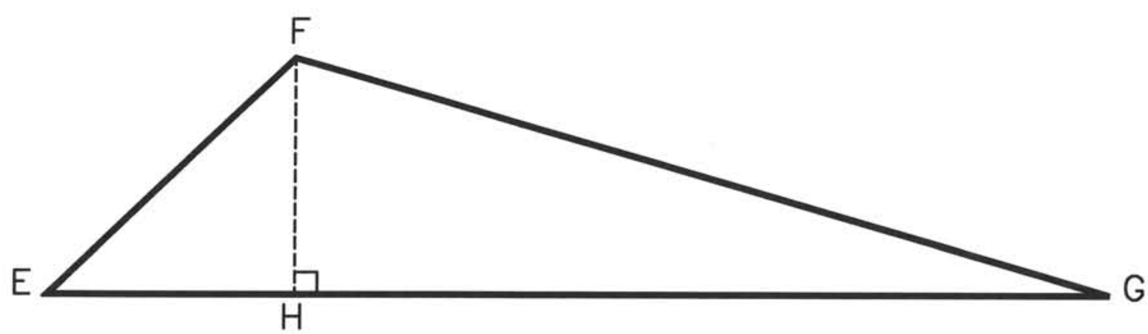
KNOWN: DISTANCE AC = 752.05 DISTANCE BC = 1044.50

FIND: ∡ ACB = ____________ (5 POINTS)

DISTANCE AB = ____________ (5 POINTS)

REQUIRED ANSWER FORMAT
DISTANCES: NEAREST HUNDREDTH
ANGLES: DEGREES–MINUTES–SECONDS TO THE NEAREST SECOND

TRIG–STAR PROBLEM LOCAL CONTEST



KNOWN: DISTANCE EF = 297.98 ∡ EFG = 112°51'15" ∡ FEG = 44°29'20"

FIND: ∡ EGF = ____________ (6 POINTS)

DISTANCE EH = ____________ (6 POINTS)

DISTANCE FH = ____________ (6 POINTS)

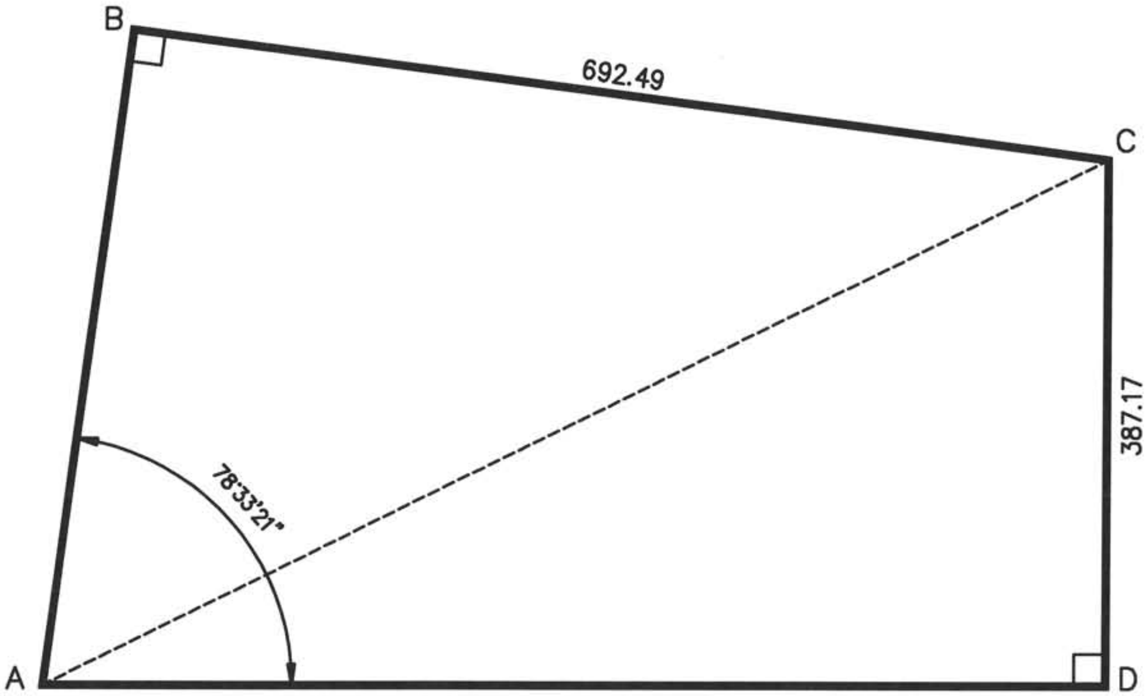
DISTANCE FG = ____________ (6 POINTS)

DISTANCE GH = ____________ (6 POINTS)

REQUIRED ANSWER FORMAT
DISTANCES: NEAREST HUNDREDTH
ANGLES: DEGREES–MINUTES–SECONDS TO THE NEAREST SECOND

PAGE TOTAL: ________ POINTS

TRIG–STAR PROBLEM LOCAL CONTEST



KNOWN: DISTANCE BC = 692.49 DISTANCE CD = 387.17
∢ BAD = 78°33'21"

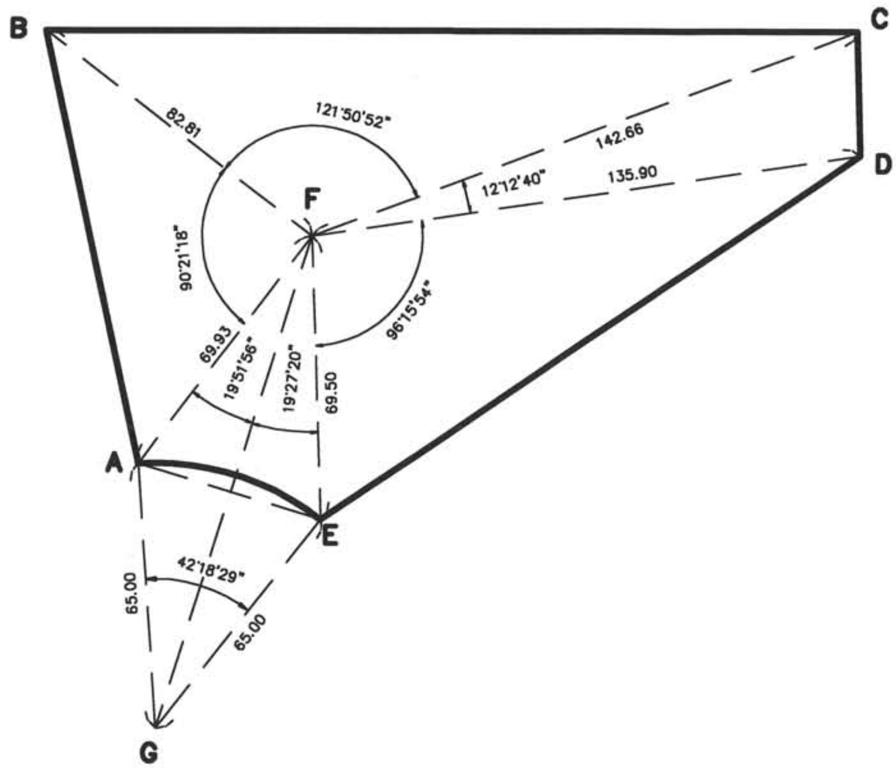
FIND:
DISTANCE AB = ____________ (10 POINTS)
DISTANCE AD = ____________ (10 POINTS)
DISTANCE AC = ____________ (10 POINTS)

REQUIRED ANSWER FORMAT
DISTANCES: NEAREST HUNDREDTH

PAGE TOTAL: ________ POINTS

TRIG–STAR PROBLEM LOCAL CONTEST

ABC HOME CONSTRUCTION COMPANY HAS BEEN HIRED TO BUILD A NEW HOUSE ON LOT 22, AND HAS HIRED A SURVEYOR TO SURVEY THE LOT. THE SURVEYOR'S FIELD MEASUREMENTS ARE AS SHOWN. DETERMINE THE REQUIRED LOT DIMENSIONS BASED ON THE GIVEN FIELD MEASUREMENTS.



GIVEN: DISTANCE GA = DISTANCE GE = 65.00 ANGLE AGE = 42°18'29"
DISTANCE FA = 69.93 DISTANCE FB = 82.81 DISTANCE FC = 142.66
DISTANCE FD = 135.90 DISTANCE FE = 69.50 ANGLE AFB = 90°21'18"
ANGLE BFC = 121°50'52" ANGLE CFD = 12°12'40" ANGLE DFE = 96°15'54"
ANGLE AFG = 19°51'56" ANGLE GFE = 19°27'20"

FIND: ARC LENGTH AE = ________________ (6 POINTS)

DISTANCE AB = ________________ (6 POINTS)

DISTANCE BC = ________________ (6 POINTS)

DISTANCE DE = ________________ (6 POINTS)

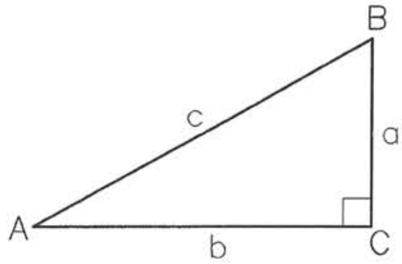
CHORD LENGTH AE = ________________ (6 POINTS)

PAGE TOTAL: ________ POINTS

REQUIRED ANSWER FORMAT
DISTANCES: NEAREST HUNDREDTH

TRIG-STAR MISCELLANEOUS DATA

RIGHT TRIANGLE FORMULAS



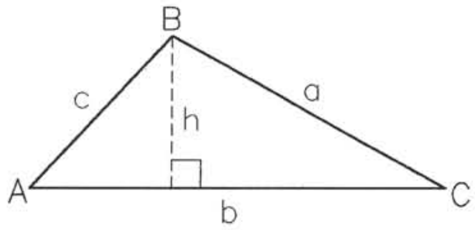
PYTHAGOREAN THEOREM: $a^2 + b^2 = c^2$

AREA: $\frac{1}{2}ab$

TRIGONOMETRIC FUNCTIONS: $\sin A = \frac{a}{c}$, $\cos A = \frac{b}{c}$,

$\tan A = \frac{a}{b}$

OBLIQUE TRIANGLE FORMULAS

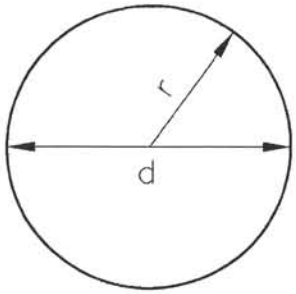


LAW OF SINES: $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

LAW OF COSINES: $a^2 = b^2 + c^2 - 2bc\cos A$

AREA: $\frac{1}{2}bh$

CIRCLE FORMULAS



DIAMETER = d RADIUS = r

CIRCUMFERENCE: $2\pi r$ or πd

AREA: πr^2

ONE DEGREE (1°) OF ARC = 60 MINUTES (60') OF ARC

ONE MINUTE (1') OF ARC = 60 SECONDS (60") OF ARC

THEREFORE ONE DEGREE OF ARC (1°) = 3600 SECONDS OF ARC.

(LOOK FOR THE ANSWER KEY IN THE NEXT ISSUE OF LINES AND POINTS)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