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THE EQUALITY STATE SURVEYOR PROFESSIONAL LAND SURVEYORS OF WYOMING



Low 10.1. 20.A. SHOSHONE IN	DIAN RESERVATION October 2015
President • Sonja "Suzie" Sparks, PLS	A PICTURE OF THE U.S. LAND OFFICE IN LANDER WYOMING THAT WAS FOUND IN THE FREMONT COUNTY PIONEER MUSEUM IN LANDER.
President Elect Randall Stelzner, PLS Secretary/Treasurer Marlowe Scherbel, PLS Image: Secretary Stress Cotton Jones, PLS Image: Secretary Stress Cotton Jones, PLS Image: Secretary Stress Mark Corbridge, PLS Image: Secretary Stress Mark Corbridge, PLS	Museum IN Lander. CONTENTS Page 3 PRESIDENT'S MESSAGE Page 4 ANNOUNCEMENTS Page 5 PREXY PASTURE PARTY CHIEF By: Mark Rehwaldt, PLS Page 10 TRIGISTAR KENNY IS A CONCRETE DREAMER By: Ben Ramsey Page 11 GEODETIC SURVEYING: PART VIII THE ACTIVITIES OF THE ORDNANCE SURVEY
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PLSW (Professional Land Surveyors of Wyoming: PO Box 725, Afton, WY 83110) 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). Lines and Points is published by the Professional Land Surveyors of Wyoming. Lines and Points is not copyrighted and permission is hereby granted to reprint articles with appropriate credit. The Professional Land Surveyors of Wyoming assume no responsibility for statements made or opinions expressed in this publication. The articles and opinions as put forth in this journal are not necessarily those of PLSW or the Editorial staff of this journal.	Advertising InformationDigital-ready, full-color advertising with payment should be mailed to Lines & Points, P.O. Box 8, Cheyenne, WY 82003. Advertising rates are as follows: Year Issue Full Page \$810 \$210 Half Page \$540 \$140 Quarter Page \$310 \$80 Business Card \$40 \$10 Employment Free FreeSpecial Rates apply for PLSW Chapters and cover placements. For more information please contact Jack Studley.



Greetings PLSW members:

As summer gives way to fall, our BLM surveyors, like many of you, are reviewing their current work to decide what can be done during the winter months and what must be completed before the snow starts to pile up. I hope you are squeezing in some recreation - end of season camping and riding (in my case, motorcycles), and gearing up for your favorite fall and winter sports, which hopefully includes supporting your local teams and our Wyoming Cowboys.

We should be looking at training opportunities for ourselves and our employees. Speaking of which, it is time again for the November Fall Technical Session. Bill Fehringer and the education committee have once again come up with what should be a very interesting couple of days. Thanks Bill! Look for the announcement in your mail, on the website, and in this issue. I hope that we see many of you at the Parkway Plaza for this event. It's a great time to catch up with colleagues, have a few laughs, and get some continuing education as well. Don't forget the S.O.S. (Save Our Surveyor) competition. Look through your corner records for some different and interesting examples. It would be great to see several competitors this year.

Kudos to the scholarship committee. The board approved four scholarship applications for the fall semester, and two for the spring. We were able to commit \$4000 to deserving students. This is a great investment for PLSW and the surveying profession.

The results for the Wyoming and National Trig Star competitions have recently been announced and the Wyoming winner placed second in the national competition. Go Wyoming! I know that the Trig Star committee can always use help getting students and instructors to participate. If you have a contact at your local high school, want to help, or have ideas about getting students interested in the competition and in surveying as a profession, talk to Mark Corbridge.

The By-Laws committee has been working on revisions and corrections to this document. It has been an arduous task. When you get the opportunity, please take time to review and comment. Our goal is to have final proposed changes ready for membership vote in January.

I had the awesome opportunity to assist on a survey around the boundary of Devils Tower National Monument a few weeks ago. This was another reminder of why I became a surveyor, and why I choose to survey in Wyoming.

Remember: Do the right things, for the right reasons, every day.

Cheers!

Suzie Sparks, PLS

President, Professional Land Surveyors of Wyoming

ANNOUNCEMENTS

CONGRATULATIONS! To the following student that have been awarded PLSW Scholarships for the Fall 2015 Semester: Lisa Johnson, Thermopolis, WY new Wyoming registrants: Thad Jones, Casper, WY Michael Walker, Rock Springs, WY Seth Todd, Cody, WY And special thanks to all that have supported and continue to support our Scholarship Fund! Professional Land Surveyors of Wyoming are looking for member volunteers for the position of State Secretary and/or Treasurer. Interested parties please contact Cevin Imus (307) 682-1661 • THE 2009 MANUAL OF SURVEY INSTRUCTION

is now available online through the BLM website at http://www.blm.gov/pgdata/content/wo/en/ prog/more/cadastralsurvey/2009_edition.html. It can also be accessed directly at plsw.org on the "References" page.

CONGRATULATIONS!

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

Fritz Nelson Worland, WY	LS 15031
Chad Anderson Evanston, WY	LS 15091
Steven Granger Evansville, WY	LS 15092
Christopher Robinson Dickinson, ND	LS 15122
Kristopher Wroolie Fort Ripley, MN	LS 15249
Christopher Kaschmitter Casper, WY	LS 15262
Robert Reiling Lead, SD	LS 15263

POSITION DESCRIPTION -SURVEYOR **CROUCH ENGINEERING, P.C**

REQUIREMENTS

Education:

□ Required: 4 Yr Degree in Surveying or related field

Licensing/Registration/Certification:

□ Required: Driver's License;

Experience:

Required: Knowledge and training about topographic surveying from experience and or education background

□ Preferred: Experience with topographic surveys; AutoCAD and/or Microstation

Skills, Knowledge and Abilities

Demonstrate the proven ability to organize, work with and contribute to a work team.

- □ Must have the ability to respond to inquiries and/ or complaints from customers, regulatory agencies or members of the community.
- Must be willing to travel and stay overnight as needed to complete surveys;

□ Must have the ability to work in a variety of outdoor conditions.

□ Must become familiar with the equipment used by Crouch Engineering, P.C.

□ Must stay up to date with changes in the equipment and industry.

DUTIES AND RESPONSIBILITIES,

□ Assist with / Perform surveys including topographic, boundary and leveling surveys. □ The Surveyor shall be able to use the basic equipment (such as EDM's, levels, data collectors, laser levels, GPS equipment, and various computer programs to download and reduce survey data from the various data collectors. etc.) to complete these and other surveys. (Note: The majority of surveying work performed will be on and adjacent to Railroad right-of-ways. Surveyors will be annually safety trained and must be familiar with Railroad roadway worker protection rules.)

□ Properly document and turn in/export time and expenses according to CEPC standards.

ADDITIONAL INFORMATION

- □ Full time position, with some overtime required.
- □ Pay will be based on experience.
- □ Crouch Engineering performs surveys

throughout the US, with the majority of the work occurring in the Southeast.

□ Interested parties can send resumes to Jay Harris at jharris@crouchengineering.com

or call 615-791-0630 for additional information.

428 Wilson Pike Circle, Brentwood, TN 37027 www.crouchengineering.com

University of Wyoming & Sheridan College News

Hello from the Prexy Pasture Party Chief. You haven't heard from me in a while. I was working on things. I don't like to formally mention things that are being worked on until they are a "Done Deal'. In my life, until it is a "Done Deal", it is just a possibility, a hope, a dream, or a gleam in a young man's eyes, but nothing more, nothing to take to the bank. Now the Land Surveying Program has some things that you can take to the bank.

Starting this fall, the Land Surveying courses have their own prefix. Instead of being a CE prefix, they will have a LS prefix. This will distinguish the Land Surveying courses from the Civil Engineering courses, and the courses have been renumbered.

Also starting this fall, the University of Wyoming is offering a Minor in Land Surveying. The minor pairs well with a Civil Engineering degree, a Geography degree with a concentration in GIS, or a Bachelor of Applied Science degree with a concentration in Land Surveying. The Bachelor of Applied Science degree and the Land Surveying course work are available via distance learning. The minor meets the Wyoming Board of Registration for Professional Engineers and Professional Land Surveyors' surveying specific education requirements for licensure.

The Northern Wyoming Community College District's (Sheridan College) Associates of Applied Science in Surveying Technology Degree has been upgraded. Students enroll in Sheridan College and take their core classes and the prerequisite classes for the UW Land Surveying Program. After the prerequisites are met, they enroll in the UW Land Surveying Program and take the surveying specific classes which they transfer back to Sheridan College to complete their degree requirements. The Associates of Applied Science Degree in Surveying Technology is also available via distance learning. Then if a student wishes or needs a Bachelor's Degree, they may come back to UW and earn the Bachelor of Applied Science in Organizational Leadership.

A listing of the new and the old course numbers follow, along with the course name and when it is typically offered.

If you have questions or need additional information, please contact me, (307) 766-1700 mrehwald@uwyo.edu

Take care and happy surveying.

Sincerely,

Mark Rehwaldt, PLS

Cours	se		
New	Old	Hrs	Name
* LS 2010	CE 2072	2	Engineering Surveying Lecture (Fall)
LS 2015	CE 2073	1	Engineering Surveying Lab
* LS 2020	CE 2090	4	GPS for Land Surveyors (Spring)
LS 2100	CE 2076	3	Records Research for Surveyors (Spring)
* LS 2110	CE 2050	3	Real Property Law (Spring)
* LS 2400	CE 2089	2	Basic Geodesy for Today's Land Surveyor (Fall)
LS 2410	CE 2083	3	GIS in Surveying (Spring)
* LS 3100	CE 2088	2	Real Property Descriptions (Fall)
* LS 3110	CE 3750	2	Boundary Evidence (Spring)
* LS 3120	CE 3740	2	Boundary Principles (Summer)
* LS 3130	CE 2085	3	Public Land Surveys (Spring & Summer)
* LS 3200	CE 3710	3	Route Surveying (Spring & Fall - Even, Summer - Odd)
* LS 3210	CE 3720	4	Advanced Surveying (Summer - Even, Spring & Fall - Odd)
LS 3230	CE 3760	4	Applied Least Squared Adjustments (Spring - Even)
LS 3300	CE 2074	1	Ethics for the Professional Surveyor (Spring)
LS 3400	CE 4750	3	Remote Sensing and Photogrammetry (Spring - Even)
LS 4120	CE 4730	3	Inland Water Boundaries (Spring - Even)
LS 4130	CE 4740	4	Advanced Public Lands (Fall)
ES 1061	ES 1061	1	Spreadsheets (Spring)
*		3	CAD see note below

Notes:

* -courses required for the Minor in Land Surveying

"Even" refers to even numbered years,

"*Odd*" refers to odd numbered years

(semester the course is offered)

CAD - Students may take ENTK 1500 – Engineering Graphics or ENTK 1510 – Civil Drafting or ENTK 2500 – Computer Aided Drafting I from Sheridan College to fulfill this requirement.



Edward Curtis Fry, WY PE&LS No. 662, was a Charter Member of the Professional Land Surveyors of Wyoming. Reprinted from the August 10, 2015 edition of the Wyoming Tribune-Eagle with permission of Cheyenne Newspapers, Inc., Copyright 2015. All rights reserved.



Edward Curtis Fry of Highland Haven, Texas, died Aug. 1 after an extended illness. He was 84 years old.

He was a long time resident of Cheyenne, working for the Wyoming Highway Department from 1961 to 1976 and again from 1989 to his retirement from state service in 1993. While there, he worked his way up from draftsman to a senior engineer. Between his two stints at the WHD, he established Civil Engineering Services, a civil engineering and land surveying business in Cheyenne. Mr. Fry was born Jan. 6, 1931, in Fredericksburg, Texas, to Edward Alfred Fry and Edith Ellen Fry, nee Lewis. He graduated from Fredericksburg High School in 1949. He served in the U.S. Navy for two years, followed by one year of junior college at Shriner Institute in Kerrville, Texas.

He married Virginia Victoria Heep of Fredericksburg on April 6, 1953.

From 1953 to 1961, he worked for Plymouth Oil Company as a land surveyor and later as a draftsman.

Following his retirement, he and his wife moved to Highland Haven and remained there until 2011. They lived at Buckner Green Ridge retirement community in Austin, Texas, until his wife's death in 2013. He returned to Highland Haven until his death.

He is survived by his son, Jeffrey; grandson, Alexander; granddaughter, Stephanie; and his great-granddaughter, Haley.

2015 SAG Award Recipient Cheyenne/Laramie County GIS Cooperative



Special Achievement in GIS 2015 Award Winner

Redlands, California – July 29, 2015 – The Cheyenne and Laramie County Geographic Information Systems Cooperative Program was honored with a Special Achievement in GIS (SAG) Award at the 2015 Esri International User Conference in San Diego, Calif. This award acknowledges vision, leadership, hard work, and innovative use of Esri's geographic information system (GIS) technology.

The GIS Cooperative Program is a collaboration of local government agencies fully committed to the coordination of GIS efforts within the City, County, BOPU and MPO departments. Hardware and software coordination is integral to the success of the Program with the Laramie County GIS department being one of the team leaders in providing this coordinated network and data management environment.

The GIS Cooperative Program uses Esri ArcGIS technology to more fully embrace Web GIS and mobile technologies to drive more efficient workflows, improve data collection and asset management, collaboration, and dissemination of information internally and to the public. Notable activities include their establishment of a gallery of public Web (ArcGIS Online) applications designed for a variety of purposes such as helping constituents locate parks, greenway paths, trash pick-up schedules, zoning districts, bus routes and stop locations, public buildings, flood plains, and street monuments and control points. The City's Public Information Officer also published a Cone Zone Map

to show the location and progress of construction projects throughout the City of Cheyenne. Additionally, cooperative member Chevenne Board of Public Utilities (BOPU) expanded mobile workflows and applications to enable better field data collection and data management systems providing capabilities such as the ability to turn valves on/off from remote locations. Their collective efforts have led to modernization of business practices supporting better decision making and support for regional residents. Public Web maps can be viewed at http://clcgisc.maps.arcgis.com/home/index.html. In addition to this regional GIS Program, Esri honored more than 170 organizations from around the world and across a variety of industries including agriculture, cartography, climate change, defense and intelligence, economic development, education, government, health and human services, telecommunications, and utilities.

"The SAG Awards identify the organizations and people who are using the power of geography to make our world a better place," says Esri president Jack Dangermond. "At Esri, we are always deeply inspired by the passion and innovation of our users. They deserve recognition for their invaluable contributions to their communities and the continued evolution of geographic science."

For more information about the 2015 Special Achievement in GIS Award winners, including project information and photos, please visit esri.com/sag.



Speaker Biography

Ron Scherler is currently the Certified Federal Surveyors Program (CFedS) Chairperson responsible for the day to day administration of the Program and the Program's Training Coordinator. After graduating from Oregon Technical Institute in 1973 he began his career with BLM's Western Field Office moving to the Oregon State Office in 1983, the Alaska State Office in 2003, BLM's National Training Center in 2005 and completing his career back in the Oregon State Office where he retired in 2011. He served as the original CFedS Program Manager, working with Dennis Mouland on the development and design of the CFedS training material, and with the CFedS Certification Panel developing the administrative guidelines for the program. Ron has instructed several subjects in BLM's Advanced Cadastral Survey and Foundation for Land Tenure courses, and is a frequent speaker at local, state and national survey conferences.

PRE-REGISTRATION FEE:

\$100 PLSW Members \$50 PLSW Affiliate Members \$175 Non-Members

A \$20 late registration fee will be added to all registrations received after October 30, 2015.

LOCATION AND LODGING

A block of rooms has been reserved at the Parkway Plaza, 123 West E Street, Casper, Wyoming until October 15th. Rate: \$72.99 per night. Telephone: 307-235-1777.

FOR MORE INFORMATION, CONTACT: Paul Svenson 307-266-2524 Bill Fehringer 307-995-2620

DISCREPANCIES IN THE OFFICIAL RECORD

This session will examine how the courts have resolved discrepancies in the official survey record. Four of the leading cases will be examined and several BLM surveys involving various record discrepancies will be discussed. Principles will be presented for resolving the most common discrepancies including: Adjacent townships show different information for the same line, Areas are not based on the distances shown on the plat, Plat bearing and distance does not agree with the field notes, Field notes are ambiguous, Omitted lands, Substantial accretion prior to patent and Hiatus and overlap situations.

TUSSIO, 37 IBLA 135

An in depth review of a recent Interior Board of Land Appeals (IBLA) decision. There will be breakout sessions, a careful examination of BLM's actions & final opinion, and finally a discussion of IBLA's decision. The position of the ¼ section corner of section 5 and 8 and the ¼ section corner of section 8 and 17 as determined in the 1972 BLM dependent resurvey was challenged by Mr. and Mrs. Tussio, owners of the east half of section 8. The challenge was based on calls to a road and lava bed contained in the original field notes. BLM could not reconcile the topographic calls with the location of the recovered original corners at the NE and SE corners of section 8.

PROFESSIONAL DEVELOPMENT HOURS

12 Professional Development Hours will be awarded for the entire seminar.

Certified Federal Surveyor Registrants will also receive 3 credit hours.



NATIONAL TRIG-STAR COMMITTEE SELECTS WINNERS OF THE RICHARD E. LOMAX NATIONAL TRIG-STAR AND TEACHING EXCELLENCE AWARDS

The National Society of Professional Surveyors (NSPS) is pleased to announce the recipients of the 2015 Richard E. Lomax National Trig-Star Awards. The Trig-Star committee met on July 31 and August 1, 2015 to determine the three top high school students from the national examinations submitted by state winners. This year there were thirty-nine state winners submitted. A past president of NSPS, Richard Lomax was the driving force behind the elevation of the local Trig-Star program to the national level. In October 1994, Board action named this high school trigonometry skill award in his honor.

The Richard E. Lomax National Trig-Star Awards are as follows:

First Place: William Mitchell, West Valley High School, Fairbanks, Alaska

Second Place: Russell Kenney, Big Piney High School, Big Piney, Wyoming

Third Place: William Zhang, Vestavia Hills High School, Vestavia Hills, Alabama

The Richard E. Lomax National Teaching Excellence Awards are as follows:

First Place: Sandra Ryan, West Valley High School, Fairbanks, Alaska

Second Place: Jennifer Banks, Big Piney High School, Big Piney, Wyoming

Third Place: Todd Taylor, Vestavia Hills High School, Vestavia Hills, Alabama

The first place student receives \$2,000, second place student receives \$1,000, and third place student receives \$500. The first place teacher receives \$1,000, second place teacher receives \$500, and third place teacher receives \$250. The Trig-Star Policy states that "the National Student and Teacher Awards be given to the winning students at or before the next state professional land surveying organization conference of the student's home state."



TRIG-STAR KENNEY IS A CONCRETE DREAMER

By Ben Ramsey, reporter@subletteexaminer.com



COURTESY PHOTO Russell Kenney, of Big Piney, won second place in the national surveyors' Trig-Star contest.

BIG PINEY - Russell Kenney, a 2015 graduate of Big Piney High School, earned a second-place award in the National Society of Professional Surveyors Trig-Star competition this year.

High school math teacher Jenna Banks said Kenney was an extremely gifted and motivated student during his time at BPHS. He and his twin brother Dwaine graduated as Co-valedictorians in May.

"I'm really tickled for him," Banks said. "He's worked really, really hard, and from his eighth-grade year, we have tried to find ways to push (him and his brother), since they are really bright boys."

To get to this level, Kenney practiced relentlessly, keeping trigonometry fresh in his mind even after he moved on to other types of math in school. He competed at the local, state and national level, leading to a second-place finish last month, which earned him \$1,000.

"I didn't expect it at all," Kenney said. "Last year felt really easy and this year seemed much harder. I didn't expect to get all the questions right, let alone get a fast time ."

The tests are comprised of four questions that are strictly trigonometry, but the fifth is a surveying problem, which makes sense since surveyors sponsor the competition as a way to keep students sharp at the necessary skills for surveying.

Kenney said the competition isn't so much about being good at trigonometry as it is about being creative.

"It's not necessarily being good at trig," Kenney said. "It's looking at the shapes and knowing how you 're going to solve the problem. You kind of have to look at it from outside the box to solve it."

He said this year, he and the top competitor from each state had to resize the curve of a highway as their final question.

When asked if trigonometry is his favorite kind of math, Kenney said that title belonged to calculus.

"I think it's fun," Kenney said. "It's a little more complicated, and I'm finding interesting applications for it in my engineering studies as well."

Kenney's engineering studies have, until now, consisted mainly of his involvement in the robotics club at Big Piney High.

Kenney said he sees himself continuing in this vein of study and eventually working for SpaceX or Boeing. When asked what he thought of Tesla founder and SpaceX CEO Elon Musk and his wish to die on Mars, Kenney said he liked his ambition, even though he didn't share his vision.

"I know I wouldn't want to do that ," Kenney said. "But it's pretty cool that he's that adventurous. I wouldn't want to die on another planet."

Kenney doesn't think that a return trip will be possible for 'Martians any time soon, but then again, he doesn't think Mars is the best option in the first place.

"I read a paper by NASA physicist Phillip Metzger, about sending autonomous robots to the moon and asteroids where they can harvest resources for human beings without them being there," Kenney said. "Then, 40 years down the line we can send humans to an already constructed space station. It would be a lot cheaper to send them to pre-construct an environment. So, my idea would be to send people to the moon, but don't even send them until 50 years from now."

Kenney said he doesn't have any big plans for his winnings, which were \$100 for local, \$300 for state, and \$1,000 for nationals.

Right now, he's too preoccupied with starting his first year at the University of Oklahoma.

This semester he is taking calculus 3, a chemistry class, a class entitled "What is science," and introduction to engineering, among others.

For Banks, Kenney's runner-up national prize felt a bit like justification.

"I think (Big Piney students) are the top kids in the'nation," Banks said. "But to see someone else recognize them as the top kid in the nation is amazing."

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Geodetic Surveying: Part VIII The Activities of the Ordnance Survey of England from 1845 Until 1870

Herbert W. Stoughton, PhD, PELS, CP

Changing of the Guard: Colby - Lewis A. Hall - Henry James

In 1838, William Yolland was posted to the Ordnance Survey under Colonel Colby. Yolland was born in Plympton St. Mary, Devon, on 17 March 1810. He was commissioned into the Royal Engineers in 1828, and completed his technical education at the Royal School of Military Engineering in Chatham, Kent (1831). After graduation, he received assignments in Britain, Ireland, and Canada, before being posted to the Ordnance Survey. In 1842, Yolland wrote an Account of the Astronomical Observations Made With Ramsden's Zenith Instrument. This instrument was subsequently destroyed in the fire at the Tower of London. Yolland's study of Ramsden's Zenith Sector addressed ten stations observed between 1802 and 1818, and subsequent observations at Greenwich in 1836. Yolland also authored Measurement of the Lough Foyle Base and Astronomical Observations made with Airy's Zenith Sector (27 stations between 1842 and 1850). These three works were the standard authorities upon observations with which they dealt. They also served as the model of analysis reporting. With these papers, Yolland was recognized as a premier geodesist.

Colby worked closely with Captain Yolland from the time of his arrival in 1838. Four years later, Colby was restarting and addressing the six-inch survey of Scotland, and Yolland was placed in charge of the operations at the new headquarters relocated to Southampton after the fire in the Tower of London. When Colby decided to retire (1846), Yolland was only 37 years old and there were two captains serving under Colby who were senior.

Colby strongly endorsed Captain Yolland, but Master-General John Burgoyne appointed Lieut.-Colonel Lewis A. Hall, R.E. superintendent. Col. Hall had no previous acquaintance or experience with surveying and mapping matters or the Ordnance Survey. For nearly six years Yolland maintained geodetic operations for Hall, who was only an administrator. Hall eventually posted Yolland to Ireland to avoid watching day-today Yolland's superior abilities, knowledge, and expertise in geodetic matters. Yolland updated the Irish mapping program while the English program languished.

In 1854, Colonel Hall retired, and many thought that Yolland had the inside track to be appointed director. However, Hall, who resented Yolland's succeeded in blocking Yolland's abilities, appointment. Major Yolland immediately departed the Ordnance Survey, and never returned. Yolland was highly respected by the geodetic communities in the British Isles and the United States. He secured an appointment to the Railroad Inspectorate of the Board of Trade. He also was appointed to evaluate the best methods of scientific and technical education for military engineers. His findings and the report still influence programs for military engineers in the United States and Great Britain at the end off the twentieth century. In 1877, he was appointed Her Majesty's Chief Railway Inspectors. He died at Atherstone, Warwickshire, at the age of 75 years.

Col. Hall's replacement as director was probably the most controversial. Henry James was the fifth son of John James and Jane Hoskers James. He was born in 1803 at Rose Vale, Cornwall. He attended grammar school in Exeter, and completed his academic studies at the Royal Military Academy at Woolwich. He was commissioned a second lieutenant in the Royal Engineers on 22 September 1826. He was promoted to captain in 1846, and colonel in 1857. In 1827, Lieut. James was posted to the Ordnance Survey, and spent much of his career working in Ireland. Before beginning his appointment as director, James spent a short time posted at the Admiralty. In 1850, he was in charge of the Edinburgh office of the Ordnance Survey.

After his appointment as director, Col. James created a photography department in the Survey. James led the campaign to change the published map scale to 1 : 2,500. The process did not require recompilation of maps but photographing existing maps and creating printing plates at a different scale. The process was called photozincography. One of the early projects was to publish a facsimile of the Doomsday Book. Col. James retired in 1875, and died in 1877.

Alexander Ross Clarke

Although Roy, Mudge, Colby, Larcom, Yolland, and James were outstanding figures at the Ordnance Survey, Alexander Ross Clarke would be the intellectual giant and brightest star during the organization's first century. Alexander Ross Clarke was born at Reading, Berkshire, on the 16 December 1828. He was the son of David Ross Clarke and Eliza Hall Clarke (married in 1827). Clarke's father had gone to Jamaica, and young Clarke spent several years there. Eventually, the family returned to settle in London, and finally settled in 35 Devonshire Place.

At age 17 years, Clarke decided to join the Army. After about three weeks preparation for the entrance examinations, Alexander was admitted to the Royal Military Academy at Woolwich, last on the list of cadets. He was commissioned a second lieutenant in the Royal Engineers on 1 October 1847, at the head of his class. He attended the Young Officers Course at the School of Military Engineering at Chatham, Kent. Upon completion of his studies, he was promoted to the rank of first lieutenant, 11 July 1849.

Sir William Reid, who was a major under Col. Colby at Mountjoy, Dublin, Ireland, would perform the Ordnance Survey a great service. When Colby was called to London on business, Reid directed the Irish survey operations. He and Colby had differences of opinion abut survey operations, and after the Parliamentary inquiry in 1828, Reid departed the survey. Reid went on to be Governor of Bermuda and Barbados; chairman of the executive

committee of the Great Exhibition of 1851, and Governor of Malta. Although he never returned to the Ordnance Survey, he strongly recommended appointment of Alexander Ross Clarke, who was posted to Southampton in April 1850.

From 1851 to 1854, Clarke served in Canada. In 1853, he married Francis Dixon, the daughter of Major General M. Dixon, R.E. In 1854, the newly weds moved to Southampton, Hampshire, and resided at 21 Carlton Crescent. On 8 September 1855, he was promoted to second captain, and in 1856 he was appointed head of the Trigonometrical and Levelling Departments.

On 2 February 1858, was published Account of the Observations and Calculations of the Principal Triangulation: and of the Figure, Dimensions, and Mean Density of the Earth As Derived Therefrom. The authorship and direction for the computations and adjustments were solely Clarke's efforts. With respect to information contained in the volume, it is self contained in 782 pages. As a side light, what is a most remarkable matter is that the list of published errata is only one page! Truly a remarkable job of writing and editing/proof reading.

Clarke referenced G.B. Airy's "The Figure of the Earth", several papers by Bessel, and the (CONTINUED ON PAGE 19)



Digital Aerial Photography LIDAR

Topographic Mapping Orthorectified Imagery



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Years ago a friend who knew of my interest in "all things technical" sent me a video showing a German made drone dubbed "HexaKopter". Watching the video I was amazed at the speed, agility and power of this little ship and thought of how much fun one of these would be to own. Researching further, I found that they also have a multitude of practical uses and how a few companies were beginning to dabble with the prospect of drones as a photogrammetry tool. I suppose this was my "eureka moment" and justification for owning a HexaKopter, or as my wife believes, the beginning of the "money pit".

I quickly discovered HexaKopter's were very pricy but found I could buy a kit for considerably less, or so I thought. And besides, building a Hexa would be fun and give me a much better understanding on how they work...

The kit arrived with several packages of electronic parts and instructions in German and after months of research and retraining myself on how to solder, I had my first HexaKopter. Once the Hexa was finished, I couldn't wait to see it work. I had no flying experience but thought by placing it in the middle of an open football field and flying up only a short distance, nothing could possibly go wrong. In the middle of the football field, I gave what I thought only a small amount of thrust and in an instance the Hexa had climbed 40+ feet. In a worry, I let off the throttle and the copter fell sharply, so before hitting the ground I again give it throttle. Okay – now the copter is 150 feet in the air and while pondering on how to get it down safely, the copter begins slowly flying away. Trying to manipulate it back, things kept getting worse and before long I could barely see it as it was still moving further away. As the best of

all the bad options, I decided to turn off the remote and possibly keep the copter from flying further. Lucky for me, as bad as this idea seemed at the time, the copter actually did stop flying away and landed directly at the position where radio signal was lost.

Running towards the location where the Hexa went down, I could see it landed in the middle of a busy street with cars slowing down and driving around. Before I reached the copter, a young lady who happened to see what was going on, calmly parked her baby stroller on the sidewalk and pulled the HexaKopter back to safety. Looking back, I suppose it was quite a site for the gathered spectators to see me leaping fences, and screaming like a school girl as I ran to retrieve my copter.

After the first disastrous flight I decided it might be best to consult a friend with model aircraft piloting skills. He suggested I first train using a flight simulator and then find an area far-far away from civilization and obstructions before actually flying. Now who could possibly argue with that logic...?

Spending months on a flight simulator, (all the while thinking of the many lectures to my son how he should stop playing video games) I finally had the skills for flying... or so I thought.

After multiple expensive wrecks, I came up with a grand idea for saving money. With my own design, not only would I save money, but I could build a lighter, stronger Hexa that is much easier to repair. And besides, designing a Hexa would be fun and give me a much better understanding on how they work...

Learning AutoCAD (I have good AutoCAD skills, but 3D modeling was a whole new ball game) and sending multiple design iterations to

manufacturers, I finally found the true meaning of expensive. So, to save even more money, I decided by owning a 3D printer I could also save time... Back to the part where my wife thinks this project is a money pit, I admit, it's been expensive, but no doubt one day she will see the light.

I was very excited after seeing an advertisement for photogrammetry software designed mainly for drones. Pix4D was the software of choice for Trimble in their UX5 Unmanned Aircraft System, and from what I saw, did an incredible job. However, my excitement soon cooled after finding the software cost \$16,000+ per copy (the cost has since dropped below \$10,000), and with said aforementioned "money pit", \$16,000 was out of the question for now.

A year later... Seeing an advertisement for a fixed-wing UAVs with included Pix4D software, I thought owning a fixed-wing would be a good addition to my mapping arsenal and also give me a chance to learn Pix4D software. Besides, the term "money pit" had not been mentioned for a

while and this could be my chance to get moving with the project again...

Financial Infidelity:

Once I received the fixed-wing, I took it to an area far-far away from civilization and obstructions (per previous advice) before flying. Instructions were simple, and the plane was designed to fly completely autonomous after uploading a flight plan. So what could possibly go wrong...

Everything seemed fine until about 15 minutes into the flight when the UAV went completely bonkers, displaying a show of aerobatics before flying away at some high rate of speed. Nervous before launching the plane, I was in full panic mode once I realized it had gone off the radar. Spending hours searching, I finally found the scattered remains strewn through the brush.

Back at home:

Amazing how quickly the nearly forgotten socalled "money-pit" could rear its ugly head.

Returning pieces and parts, I was relieved when the company who sold me the plane replaced it with a new one. If I had not found parts of the wrecked plane, would they have honored their warranty?

UAVs Fail: With issues I have had and with other horror stories of fly always and crashes I hear, one item on every pre-flight check list is a tracking device; never fly without one.

Are UAVs Legal for Commercial Use?

According to the Federal Aviation Administration's (FAA), no rules have been developed for UAVs, so their use is generally illegal unless it falls under the recreational use exemption. However, all FAA attempts to fine commercial UAV operators have failed with judges declaring that the FAA has not followed procedures for rulemaking and therefore they have no regulations prohibiting their use.

Nonetheless, in 2014, the FAA began allowing the use of UAVs for hire through a petition for exemption know as a Section 333 Exemption. These exemptions include many limitations and will most likely serve as a prelude for permits once regulations are approved. Below lists some of the proposed rules:

•Operators are required to obtain an unmanned aircraft operator certificate, be at least 17 years old, and be vetted by the Transportation Security Administration

•No operations beyond visual line of sight (VLOS)

•No operations over any person not directly involved in flight operation

•Operations are limited to daytime hours only (sunrise to sunset)

• Operations are limited to 500 feet above ground level (AGL)

The requirement having to operate within a visual line of sight will hinder many proposed uses, but so far three companies have been given permits for "extended" line of sight allowing for inspection of railroads and pipelines. As a surveyor, I am often in areas where it would be difficult or impossible to keep visual contact of a UAV.

With proposed rules, many UAV operators would like to see a more stepped approach. A one-pound drone is treated differently than a 10-pound or 50-pound drone. The idea being that regulation should be tougher on drones that are heavier and more dangerous.

Insurance

Speaking with my insurance agent, I asked if drones could be covered under my current business policy and the look I received was something of fear blended with "is this a joke?" Then I was bombarded by a series of questions and was certain they would soon ask "what happens when one gets loose and attacks?"

Pleasure or commercial user: The pleasure user of UAVs can easily find liability insurance by joining the Academy of Model Aeronautics. Included with an AMA membership is liability insurance but commercial use is excluded. If you are planning on flying around your house or local park for fun, your homeowners insurance will probably cover. Recently, insurers have been opening up to the commercial UAV market and it is now much easier to obtain insurance.

How can commercial operators be eligible for insurance when commercial uses have not been approved by the FAA? The answer I get: "Just as auto insurers have no exclusions in policies for violating traffic laws, aviation insurance companies do not have exclusions for violating federal aviation regulations".

Never Say Drone

After my encounter at the insurance company and from what I hear on the news each day, the difference between a drone and a UAV quickly became apparent. The word 'drone' through its militaristic reputation and bad publicity in the news has a negative connotation; drones drop bombs, spy on people and land on the White House lawn. UAVs make maps, collect survey data and take photos. Drones = bad and UAVs = good. Alternatives to the word 'UAV' are "RPA" (remotely piloted aircraft), and "UAS" (unmanned aircraft system). Some prefer the more digestible "unmanned aircraft," or just "robot". Some European Union officials opt for "RPAS," or remotely piloted aircraft systems. The Federal Aviation Administration and Congress have settled on UAS in legislation and official documents.



"Last Photo" as taken by UAV before untimely death.

15 Page

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The FAA said it now receives over 25 reports per month of drones flying too close to manned aircraft and that this number will only increase.



Fear Trumping Reality?

The news is peppered with evildoers using drones: Mexican cartels moving product across the border, drones crashing on the Whitehouse lawn, drones terrorizing, harassing and spying, and the latest news out of Montana – "Black Bears suffer ill effects from drones". No doubt drones can be used in many nefarious ways, but so far the facts do not support all of the hype.

Of all the near miss reports on the news, I find one actual UAV collision that took place in 2011. This happened when a U.S. Army UAV and a U.S. Air Force C-130 transport collided. The 200 pound UAV was completely demolished and the C-130 sustained only minimal damage. With the proliferation of UAVs, we will inevitably see midair collisions and flying should always be taken in a serious manner.

Researching injuries and mishaps by drones, I was able to find only a few cases worldwide (excepting military drones of course).

1. April 2014. Drone injures Australian triathlete causing a minor head wound.

2. September 2014. Drone crashes into Grand Prismatic Spring in Yellowstone National Park. Since this crash, Washington has banned the use of remote-controlled airplanes and helicopters at all of America's 401 national parks and memorials.

3. September 2014. Drone "attack" on German Chancellor Angela Merkel. No one was injured but the incident has raised concerns how weaponized drones could easily be used by terrorists.

4. October 2014. Drone fly's over Bank of America Stadium causing the FAA to issue stern warnings about flying model craft or drones near over large sports stadiums.

5. December 2014. The tip of photographer's nose is cut off by drone in TGI Friday's promotional event. A startled customer hit the drone causing it to careen into the face of the photographer operating the machine.

6. January 2015. A drone transporting more than 6 pounds of meth crashed while trying to cross the Mexican border.

7. January 2015. Drone crashes near the White House.

8. March 2015. 40 year old Enrique Iglesias was injured while attempting to grab a UAV during a concert performance in Tijuana, Mexico. Iglesias continued to perform for the concert although he will need to undergo reconstructive hand surgery as a result of his injuries.

Executive Summary from the Civil Aviation **Safety Authority:** *"Literature suggests that ingestion"* into one engine, and the subsequent thrust loss, is the most likely collision scenario (3 out of 4 cases); the consequences are not likely to be catastrophic, as modern jet aircraft are designed to continue safe flight with one engine loss. For collision velocities above 200 knots, UAV parts are predicted to penetrate the fuselage skin, with the potential of damaging internal systems. At landing velocities of large commercial aircraft (VFE=160-180 knots), penetration of the cockpit windscreen is not likely to occur for small UAVs below 2kg; penetration should be assumed for heavier UAVs. General aviation windscreens will be penetrated at typical cruise velocities, regardless of UAV size/weight."

Those involved with UAVs should consider insurance coverage and the implications for UAV related liability. Despite the low number of injuries and mishaps from UAVs and model craft, many attorneys are gearing up for this emerging market in what they see as the next "cash cow". http://www.droneinjurieslawyer.com/.

(CONTINUED ON PAGE 22)



A signed and numbered reprint of Dave Paulley's original oil painting of UP Rail Road's survey party finding a route over the Laramie Mountains after being forced there by an Indian war party.

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IN BRIEF

FROM WIRE REPORTS

NORTH AMERICA'S TALLEST MOUNTAIN NOW OFFICIALLY 10 FEET SHORTER

ANCHORAGE, Alaska - North America's tallest mountain doesn't just have a new name. It also has a new elevation.

Denali, the Alaska mountain formerly known as Mount NcKinley, is now officially 10 feet shorter, measuring 20,310 feet at its highest point, the U.S. Geological Survey announced Wednesday.

The previous measurement of 20,320 feet stemmed from a 1953 survey that used the technology of the time, officials said. The new elevation is the result of data collected from mountain by climbers in June using technology that didn't exist in the earlier survey, such as GPS instruments.

The change is part of an ongoing USGS program to update elevations in Alaska and elsewhere. The agency has a program that uses radar to collect more elevations over large areas in Aaska, but the Denali survey was unusual because it involved actual ground measurements, said Kari Craun, director of the USGS National Geospatial Technical Operations Center.

"It's a very visible and important point for North America" she said.



One evening my wife and I were at a restaurant, and we found this interesting Merlot on the wine list. Needless to say, the wine was good and went well with the meal.

Herb Stoughton

TRIC POINT 2012 Method Dusing Dusy Viewards - Alter Andrew Valler Sonowa Active Andrew Valler Sonowa Active Andrew Valler Sonowa Active Valler Investigation and Sonowa Comparison of Active Active Active From Trig points on the ops of hills. These locations act as Constant points of reference for all property boundaries and infrastructure. Just as Trigs are the surveyor's lasting points of reference. Cabernet Sauvignon and Mercha constraints of reference. These Bordeaux style varieties set the standard for the finest red wines throughout the world.

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(CONTINUED FROM PAGE 12)

previous Ordnance Survey publications authored by Mudge, Dalby, Colby, Yolland, James, and Cameron. The sections "Principles of Calculation" (VI), (pp. 228 - 270); "Reduction of Triangulation" (VII), (pp. 271 -306); "Connection of Geodetical and Astronomical Observations" (X), (pp. 560 - 609); "Determination of the Amount of Local Attraction at Various Astronomical Stations in the Triangulation" (XI), (pp. 625 - 662); "Determination of the Spheroid Most Nearly Representing the Surface of Great Britain and Ireland" (XII), (pp. 665 - 716); and "Figure of the Earth" (XIV), (pp. 733 - 772), contain the classical elements of the theory of geometrical geodesy. Although there is no published bibliography (or separate list of references), there are numerous footnotes and citations in the text. Clarke had access to all the significant European literature, including the learned society journals. Also, it is noted that although the triangulation observed between 1800 and 1809 (Mudge, Colby, Woolcot, and Gardner) was adequate for the one-inch mapping, Clarke did not use it in the general adjustment. Also, Clarke did not employ the angles observed by General Roy. The only angles observed in the eighteenth century which Clarke included were observed by Mudge at St. Ann's Hill in 1792.

When this volume was published, Clarke had just passed his twenty-ninth birthday. The format and content of this volume served as the model for subsequent publications, and was the format employed by the U.S. Coast and Geodetic Survey publications pertaining to geodetic data.

In 1861, Clarke authored a second volume entitled The Account of the Levelling of England, Wales, and Scotland. On 5 June 1862, he was elected Fellow of the Royal Society, and subsequently an honorary fellow of the Royal Society of Edinburgh. In 1863, Clarke completed and had published The Extension of the Triangulation into France and Belgium.

In 1866, Captain Clarke completed his second



determination of the size and shape of the earth (Clarke 1866 reference ellipsoid). In 1879, the U.S. Coast and Geodetic Survey, who had previously employed the Bessel reference ellipsoid, adopted the Clarke 1866 reference ellipsoid for its geodetic programs, and would not replace it for more than one century. In the same year Clarke completed The Comparison of Standards of Length . . . This remarkable publication has been the basis for the old linear relationships used in geodetic operations until the construction of the International Meter in the late 1880's. It was also during this period that Clarke worked on a minimum error map projection.

During the 1860's, Clarke was elected a corresponding member of the Russian Imperial Academy of Sciences and a Companion of the Order of Bath. In 1871, he was elected an honorary member of the Cambridge Philosophical Society (undoubtedly through the efforts of G.B. Airy). He continued to advance in rank, and became a full Colonel on 27 August 1877.

In 1880, the Claredon Press (Oxford) published Geodesy. One biographer stated that the word "geodesy" was coined by Clarke. This work has been a standard reference to the geodetic community ever since. It was in this work that Clarke derived and calculated the Clarke 1880 reference ellipsoid. The organization of Geodesy closely parallels the 1858 publication Account of the Observations . . . in



LINES AND POINTS ARTICLE ROTATION SUBMISSION SCHEDULE BY CHAPTER							
Responsible Chapter	First Call Date	Last Call Date	Publication Date				
Central Chapter	THANK YOU!! (SEE "I	Learning to Fly" in this issue)					
South Central Chapter	December 1	December 15, 2015	January 1, 2016				
Southeast Chapter	March 1	March 15	April 1, 2016				
Laramie Valley Chapter	June 1	June 15	July 1, 2016				

format and content of the theoretical material. By this date, Clarke had assimilated the gravimetric effects on the figure of the earth with the geometrical effects witnessed in the trigonometric and astronomical observations. He employed Legendre polynomials to describe the gravimetric ellipsoid so that there could be a comingling with the reference ellipsoid. Although, the Legendre polynomials are no longer employed, this approach would be to marry the form of the gravimetric equipotential surfaces first proposed by Alexis Clairaut with the geometric reference ellipsoid.

In early 1881, a government bureaucrat realized that Clarke had been at a "home station" for 27 years, and deemed it appropriate for him to be shipped to a "hardship" duty station. It is said that Clarke had a somewhat short temper, and upon receiving this order submitted his retirement papers. When word spread about the incident, a storm of indignation arose from the scientific world. Letters of protest were submitted to the War Office, but to no avail. Colonel Clarke retired 1 October 1881, and moved to Redhill, Surrey.

In 1883, Clarke served as a British delegate to the Geodetic Conference in Rome, and was appointed a British member of the International Geodetic Association. At the time of G.B. Airy's retirement as Astronomer Royal, there was a movement to appoint Clarke as Airy's replacement. Clarke declined. By 1887, Clarke had earned international recognition, and received the Gold Medal of the Royal Society. Clarke authored the topic "The Figure of the Earth" in several editions of the Encyclopedia Britannica. In the famous 1912 edition of Britannia, Clarke and the German geodesist Dr. F.R. Helmert coauthored this subject.

Alexander Ross Clark was only one of a hand full of intellectual giants in geodesy. Clarke and an American who would enter on the scene shortly after Clarke's retirement revolutionize geodesy well into the closing decades of the twentieth century.

Alexander Ross Clarke, father of four sons and nine daughters, died at Strathmore, Reingate, Surrey, on 11 February 1914.

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Common Research Mistakes Surveyors Make

† Knud is a professor in the surveying engineering technology program at the University of Maine. He offers consulting services in the area of boundary litigation, title, easements, land development, and alternate dispute resolution.

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

In previous articles I have explained two of the five common mistakes made by surveyors in researching the records. In the first article I discussed mistakes made in determining senior title. In the second article I explained the deficiency existing when a forward search is omitted. The third of five common mistakes often made by surveyors when researching the records is the failure to research the road records.

Surveyors often omit searching for road records even though their property is bounded by a public road. Even if a search of road records is conducted, a surveyor will often fail to find the appropriate road records.

Road records are particularly difficult records to research for three reasons: 1) First, road records are not always found where other property records are recorded. Road records are often found in municipal offices, department of transportation offices, court records, county commissioner records, and even state archives or other historical archives. The location of road records often depend on the manner the roads were created (e.g., dedication, condemnation), the type of road (e.g., municipal, county, state) and age of the road. 2) The second difficulty arises because there is seldom an index to help locate the appropriate road record among the plethora of government documents that exist. 3) The third difficulty is the trouble in identifying a particular road from the ancient description often used when describing roads found in the records. In other words, when a road record is discovered and read, the reader often finds it difficult if not impossible to identify what road is described and where the road exists on the face of the earth using the ancient description. Consider how difficult it would be to locate the following road if knowledge of the area has been lost with the passage time.

Beginning 2 rods from Samuel Widman's pasture fence at the turnpike road, thence through Ezekiel King's land, N20°E 25 rods to a stake; thence N36°E, 120 rods to a stake; thence N48°E 90 rods to Jacob Denton's sawmill lane... To be opened at four rods. 12 June 1834.

Researching road records is not so much a matter of following a particular procedure as employing dogged determination and fortitude.

The failure to search for and locate the appropriate road record often results in the surveyor failing to properly fix the width of the road and thereby causing the client or other landowners to mistakenly build in the public right of way.

Describing typical weaknesses in the surveyor's record search will not necessarily convince surveyors to undertake the tedious and time consuming research necessary to overcome the limitations that were explained.

Knowledge of the deficiencies should allow the surveyor to inform the client that these deficiencies in the research exist at the completion of services. Should the client want to compensate the surveyor for the time to perform a thorough search, these limitations can be overcome.





"Raging Hockey Fans Destroyed An LAPD Drone Last Night", "Hunters Shoot Camera Drone", "Drone Gets Hit Out of the Air by Angry Spectator", "Kentucky man shoots down drone spying on 16-year-old daughter".

Americans value their privacy and not everyone likes drones. As UAVs become more prevalent we will see more confrontations between UAV operators and those who perceive them as invasive intruders. This will be a serious challenge for the many professionals planning on using UAVs as part of their business.

The revolution is coming

Technology in the surveying and engineering field has changed dramatically in the past few decades: the electronic distance meter, total station, GPS, laser scanners and robotic total stations and there should be no doubt UAVs will be the next "GPS" in terms of evolution in surveying. UAVs have the capability to collect massive amounts of data generating highlydetailed digital elevation models in combination with high-resolution photography. UAVs are smaller, safer and more efficient than manned craft and can now fly circles around human pilots.

Privacy Issues

Drones can be equipped with facial recognition, license plate scanners, infrared technology and they have the ability to operate at distances and heights making them impossible to detect. Private detectives are starting to use drones to track their targets. Google has deployed street-level drones to supplement images of Street View. Criminals may use drones for purposes of stalking and harassment.



The above photo shows a drone seconds before being destroyed by L.A. Kings fans.



Working on a project near Guernsey, Wyoming, I noticed an archeological crew working for days, marking grids on the ground, walking back and forth in an effort to locate an old trail for historical preservation. In an area of tall grass, the trail was mostly covered and very difficult to distinguish. Flying the same area with a UAV, and filtering the vegetation through a software application, I was astounded at how visible the trail was using a "heat-map"; what took their crews days, a UAV could do in only a few hours.

Planning the flight

Drawing a polygon over the area of interest, setting the desired resolution and locating a good area for landing/takeoff is usually all that is required with the advancements in flight planning software. Take-off and landings are the most critical especially for fixed-winged UAVs as they generally require soft landing areas of 150 feet or more. UAV planning software has become sophisticated enough to set waypoints relative to ground elevation and several companies are now adding "geo-fencing" capabilities into their applications. Besides avoiding airports, school grounds and other populated areas, UAV planning software will soon likely add geo-fenced areas around towers and other obstacles as "No-Drone" areas.



Flight path showing an area as mapped by a UAV up the face of a mountain. Waypoints were calculated using a DTM for relative elevations above the ground. This flight took about 30 minutes with a vertical climb of nearly 3000 feet. White "Balloons" shown on the map indicate photo locations.

During flight, operators have the ability to see all of the flight parameters including battery life, flight elevations, and with more sophisticated UAVs, wind speed and wind direction. If radio control is lost, UAVs may be programed to return and land at a designated area. Operators can initiate "come home" or "go land" or under extreme cases "land now" during flight. UAVs are generally programed to return home if the battery life falls below 20%, or as I prefer, 30% allowing enough power for unforeseen events.



These images show a section of the same mountain shown above as seen in a "colorized point cloud" with contour overlay (left) and an aerial image looking down (right).

Choosing the Camera

Which camera works best for UAV photogrammetry? High resolution cameras with a fixed focal-length lens works best for capturing aerial images; but, because of weight limitations, not many are well suited for use on a small UAV. Not long ago photogrammetry software worked only with fixed-lens, but now allow for a multitude of cameras including the fish-eved GoPro. For smaller UAVs, digital compact cameras such as the Sony Cyber Shot WX200 (weight 120± grams and an 18 mega-pixel sensor) or the Canon Powershot S110 (weight 180± grams and a 12 mega-pixel sensor) work great. I use both of these cameras and both generate quality 3cm resolution data from a UAV flying at around 100 meters.

Quality Data

Good placement of ground control points (GCPs) is key for obtaining quality data. Operators must ensure that the quality of the ground control matches the level of accuracy they are expecting in their results. A minimum of 5 GCPs and two check points should be placed for each subject area. GCPs should be scattered and never too close to each other or too close to the edge of the flight area. Aerial targets should be clearly visible and distinct. Targets can be anything from a large "X" spray-painted on the ground, aerial target material, painted and crossed lath or other distinguishable features such as pavement markings and manhole covers.

Other factors for obtaining quality data include sunlight and wind. While not often available, a bright sunny day with no wind works best. Pix4D software recommends photos be taken with an 85% frontal overlap and a 65% side overlap, but (the rebel I am) I find any combination above 70% works just as well.

Areas of uniform texture such as sand and grasslands can cause problems leaving gaps in the data, but flying perpendicular lines and adding targets to these areas will generally resolve the issue.



Running a "Rapid Check" generates a preview and quality report of the flight data and is always a good idea before leaving the field or before processing the full data set. Using a Core i7 4770K processor with 32GB RAM and a 500GB SSD takes about 6.5 hours to process for an area of 0.5km² with 3cm resolution, so full processing is best left for the office.

Disk space:

Anyone planning to enter into the field of UAV mapping should plan to buy many large capacity hard drives, you will need them.





Rapidly Changing Technologies

With unprecedented growth in the UAV sector, it's only natural that associated technologies should also evolve rapidly.

Real Time Kinematic (RTK): Now available for UAVs, will eliminate the need for setting ground control points.

RTK/IMU: Until a few months ago, I had no idea what RTK/IMU stood for. Turns out that RTK/IMUs (Real Time Kinematic/Inertial Measurement Units) are also available for small UAVs and that these units can operate at subcentimeter resolution for periods of time without the need for GPS corrections.

With the antiquated HexaKopter sitting on a shelf, I am now in the process of building the "Next-Gen Hexa". Not only will this unit eliminate the need for GCPs, it will be lighter, stronger and much easier to repair, it will have a longer flight time, and... Or as the wife believes, the return of the "money pit".



The End is Near... Or Maybe Not?

How long before UAVs take over a large part of my work as a surveyor? Pulling into the McDonald's drive-through I notice a conveyor filling cups of soda and I ask myself, "Will UAVs provide a better product for my clients or simply take away work?". And "How many McDonald's employees honestly thought they would get that \$15 per hour?"

Many professions will see dramatic changes to their businesses as robots continue to do their jobs quicker and more efficient. As surveyors, we must understand UAVs will replace many methods but will also add value and production. UAVs will change the way we work and like it or not, they are here and here to stay.



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The helicopter flies at low altitudes and is capable of providing elevations at two-tenths of a foot or less.







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