Are Your Surveys Accurate?

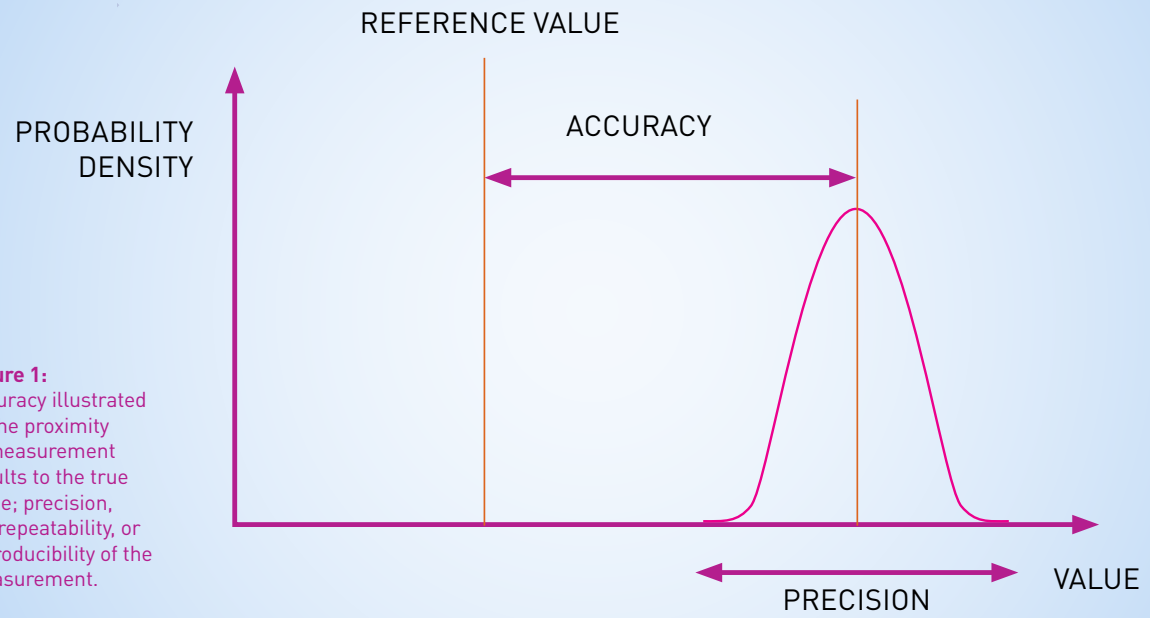

Figure 1: Accuracy illustrated as the proximity of measurement results to the true value; precision, the repeatability, or reproducibility of the measurement.

This may not be an easy question to answer, off the cuff. For starters, what does it mean for something to be accurate? Experience shows several different meanings are attached to this word. Which one(s) should apply to surveys?

AC·CU·RATE ***adjective*** \ˈA-KYƏ-RƏT, ˈA-K(Ə-)RƏT\[1]

1. free from error, especially as the result of care
2. conforming exactly to truth or to a standard: exact

Hmm, something very interesting in the definition—"free from error." Is that possible? If so, how? I remember hearing an engineering definition that speaks of accuracy in degrees. How can that jive with the absolute definition, "conforming exactly to truth?" The engineering/mathematical definition usually calls accuracy "closeness to truth" and precision as "degree of care" or "fineness of repeatability."

Anyone being prepared for legal deposition has been advised not to say more than he knows; do not expand; answer only the question put to him. Why? Of course, it is so a slight misstatement or contradiction will not have to be defended or explained under cross-examination. Those who practice examination and cross-examination know a witness who is sworn to tell the truth loses credibility if ANY of his testimony is not accurate; that is, not truthful! Perhaps, to be sure, a look at the competing word, precise, is in order.

PRE·CISE ***adjective*** \PRI-ˈSĪS\[2]

1. exactly or sharply defined or stated
2. minutely exact
3. strictly conforming to a pattern, standard, or convention

Figure 1 illustrates the engineer's/mathematician's textbook understanding of accuracy and precision.

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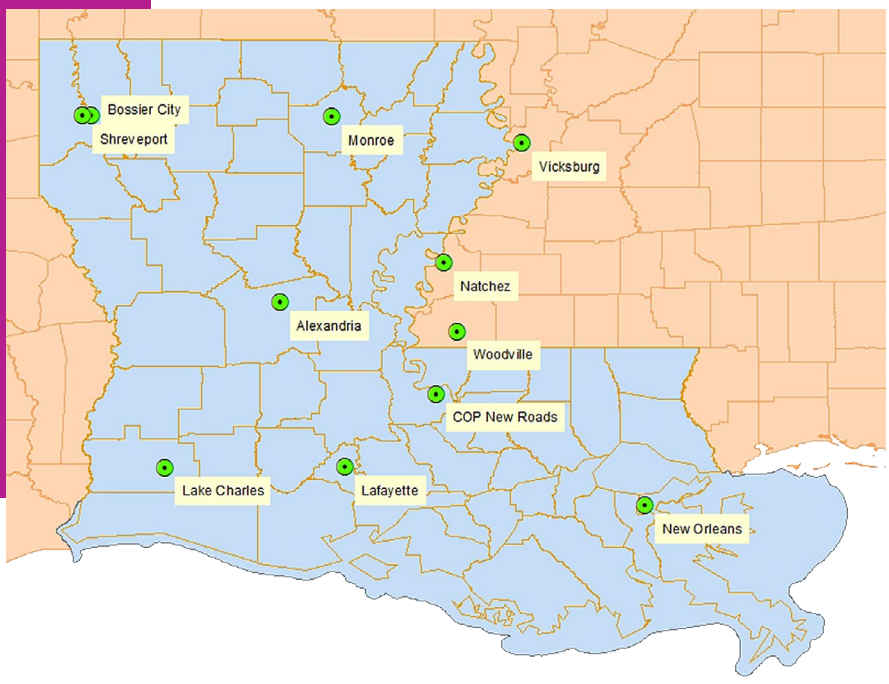

Figure 2: COP marks the center of population for Louisiana at New Roads

Accuracy, the noun, is commonly defined by proximity or by degrees instead of by truth or lack of error. It would seem a surveyor must decide whether he functions as a designer (engineer/technician) or a surveyor ("weigher" of evidence). Perhaps even more importantly, he must know to which definition his client audience subscribes. Those who subscribe to the latter definition tend to consider the work of surveying as essentially little more than using a ruler or similar tool to measure a value or apply a technology.

Here's another example. Observe **Figure 2**. Notice the Center of Population for Louisiana is near New Roads. Assume there is an sample of people who when asked where they live answered "Louisiana" and one was from Lake Charles, one from New Orleans, one from Shreveport and one from Woodville, Mississippi lied. The statistical center of Louisiana is marked by the COP at New Roads. Of the three respondents the one from Woodville (the liar) gave the most accurate textbook answer. His home is closest to truth. Shreveport, Lake Charles and New Orleans (all truthful answers) would be considered less accurate by the engineering text book definition.

As a land surveyor, conveying useful, correct information is of the utmost importance. After all, actions taken or avoided due to a lack of understanding can be extremely costly and painstaking to correct. The professional owes accuracy (the truth), above all, to his client and, to the degree the client needs and can understand, precision. Sometimes accuracy demands a lessening of precision because even a little bit of wrong contaminates the whole and changes it from true to false. "I am from Louisiana" would be true if from Monroe or Lafayette but "I am from Shreveport" would be false if from Bossier City despite that they share a common boundary. Likewise stating the area of a parcel to fewer significant figures might change a false report to a true one.

> "Throughout history surveyors have been aware of the importance of consistency and discipline in measurement techniques."

How do you know your survey reports and maps are accurate? Do you always check measurements? Do you always verify records? What about field evidence? Do you simply trust them as is?

How do you know the precision of your surveys and maps? Do you always check measurements? Do you always verify field notes? What about instrument calibration and employee procedures? Do you simply trust them as is?

History of Precision

Precision can be an important part of surveys. It has always been important for the surveyor to be aware of the limits of precision inherent in measurements. Throughout history surveyors have been aware of the importance of consistency and discipline in measurement techniques. Geometry and trigonometry were used as a means of checking consistency in linear measures. Likewise linear measures could be used to check angular measures. By today's common experience, the uniformity of standards, especially standards of linear measure look inconsistent. The inhabitants of the period were well aware of that and what was primarily sought was consistency within a local area or a single project.

A good example might be found in the bible. Genesis 6:15 in the Bible describes the Ark's dimensions were 300 cubits long, 50 cubits wide, and 30 cubits high. Many think that's about 450 feet long, 75 feet wide and 45 feet high! It could have been different, because cubits were used and the length of the cubit depended most likely on the stature of the construction supervisor, in this case Noah.

A cubit was the length of a man's arm from fingertips to elbow. A quick look with Google gives one a perfectly clear example of how those who can count, but don't understand mensuration almost always find ways to make measures definite and WRONG. It proudly displays on the top of the search: "1 cubit = 45.72 centimeters." They somehow KNOW this ancient and variable measure to a tenth of a millimeter! That's more precision than I can muster and I wonder about how many men it would prove accurate? Very, very few I am sure.

Surveyors knew the difficulty of manufacturing and sharing perfect copies of any standard length, so common items with tolerably small variations were employed. Often, if one drops the least significant figure in any measure, they would agree on the unit length. Some of the earliest known land surveys were completed by the Ancient Egyptians in 3000 BC. They used relatively rudimentary tools and simple

geometry, resulting in incredible maps. Over time, technology has been refined and with it, precision. Has accuracy? It depends (the standard survey answer).

While many of the advancements in tools available today seem almost miraculous, the fundamental basics of land surveying remain the same. The wisdom of the ancients still serves us well when we honor accuracy over precision. The ancients knew the supervisor's arm was a good standard for a single project. They knew, on the ground, permanent monuments would survive and correct following surveyors whose standard length was different AND serve as obvious, notorious markers for all to witness.

> "...the disconnect happens between those who have learned arithmetic and counting, and those who have learned to measure."

We are now able to take measurements down to tiny fractions of an inch and use highly technical means to reduce or point out error. But, despite all this, errors still remain. This is where the disconnect happens between those who have learned arithmetic and counting, and those who have learned to measure. Today it extends between those who put their faith in digital displays and those who know from where the displayed numbers come.

The Value of Accuracy in Maps

Accuracy is the single most important factor of maps and land surveys. Precision is often in the eye of the beholder. Since the purpose of a land survey is to locate and describe boundaries on which ownership rights may depend, assuming imprecision equals inaccuracy often leads to legal entanglements. While all surveys must be accurate, certain types require more precision than others. When things like hydrological features and roadways are involved, high levels of precision may be required.

The Imprecision of Maps

Maps are usually not all that precise. Many, if not most, think they are precise, because it is all they know, but maps are merely close approximations. As abstractions of reality, some maps may require thousands of measurements to be sufficiently precise. While modern day professionals often have access to incredible numbers of measurements, there is always a point of diminishing return. Most laymen (and too many in the geospatial fields) think it never hurts to have a little more. Frequently, less data that is precise and highly qualified will yield superior results than excessive data of poorer quality. One exception is with truly random data that one is able to "cherry-pick" for quality; more data may imply more data worth cherry-picking.

The answer lies with the relationship between the professional and his client. If the client is interested in the drainage pattern of a pasture, measurements of a density and precision that identifies clods of dirt and hoof prints is a waste of resources and a disservice because for the intended purpose it isn't any closer to the truth. **Reminder:** *accurate = true,* while *precision = how well and finely measured.*

What Is Sufficient?

There are a number of factors that go into developing an accurate map. *Depending upon the purpose,* if the map achieves the following, it should be sufficient:

- **Completeness**—Have all characteristics, features and particular requirements been mapped and labeled? Have necessary clarifying references, disclaimers and explanations been included?
- **Position**—Position refers to how close a map feature is to its actual position on the earth. This, of course, requires standard conventions on how positions are referenced on the earth and/or projected onto a plane for mapping. Make clear whether standard or unique methods were used. (NGS and others refer to this as "positional accuracy". There is usually a local and a global value expressed.)
- **Closure**—If a traverse is used to control the survey, closure error is the calculated distance and direction between the calculated position of the traverse end point to the same as the starting point. The precision of the traverse is often described as a ratio of the closure error divided by the length of the traverse.
- **Attribute**—This begs the question, are tabular attributes allocated to the right features? Features and attributes are terms made popular by geo-database/mapping software systems called GIS. Features are the items stored in the database for which there are locations and/or extents identified (points, polylines, polygons). Attributes are those pieces of information about the features of interest to the client or anticipated to be of potential interest (color, age, condition, owner, &c.). Traditional cartography supplied this information graphically and so was often limited to how much information may be included. This is still the case with any map, but the computer memory may store any number of attributes.
- **Conflicts**—This refers primarily to gaps and overlaps in claims. Conflicts may come from any direction. There may be a public administrator whose map indicates permitted uses. The neighbor may have erected a fence within the lot. One corner may have an ambiguous collection of unmarked iron rods that made it necessary to weigh the evidence to determine which is authentic. The planned swimming pool may extend into a utility servitude/easement.
- **Area**—This refers to the extent of a given feature and how it compares to its terrestrial extent. This is closely related to Position but dependent upon it in a way that makes the certainty of the area quantity less reliable than the linear, angular and coordinate quantities upon which it depends. According to the definition in the first sentence, it also depends upon how it is presented on the map; what projection is used and if it is appropriate to the purpose. ■

References

[1] "accurate." Merriam-Webster. Merriam-Webster, n.d. Web. 21 July 2014. www.merriam-webster.com/dictionary/accurate

[2] Ibid. www.merriam-webster.com/dictionary/precise

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