Defining accuracy

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James Kavanagh explains what accuracy means in the context of Level 2 BIM

A cross-industry collaborative group has been working hard to reach consensus on the 5 geospatial issues that threaten the adoption of Level 2 building information modelling (BIM) (see the related feature: BIM: challenges of geo-enabling), and deciding on how to communicate this to the wider professional community. These critical 5 issues are accuracy; interoperability; metadata; level of detail; and generalisation.

Survey4BIM, a collective of geospatial professionals, has formed a number of smaller groups that have focused on each of these issues, and recently presented at the GeoBusiness 2017 event. The first issue to be tackled is an old geospatial chestnut ? namely, accuracy ? and was agreed by all involved as the most important to get right.

Misunderstandings

There is a general misunderstanding of what accuracy means even among expert geospatial surveyors, never mind civil engineers, architects, cost estimators and any of the other related professions involved in BIM ? and this is not even to touch on the confusion between relative and absolute accuracy.

These definitions can also be applied to other aspects of surveying, such as International Property Measurement Standards , topographic surveys, boundary definition and many more. Understanding the differences between the terms is therefore essential for surveyors making any kind of spatial or physical measurements.

The Survey4BIM accuracy group has produced a comprehensive wording for what accuracy, tolerance and precision mean in the context of surveying and its application to BIM. This common understanding is an essential building block in both Level 2 BIM adoption and effective collaboration. The group was led and managed effectively by geospatial expert Bernhard Becker, CEO at GeoLearn .

Accuracy

The term 'accuracy' is often used to describe the way work conforms to a predefined standard or specification. This interpretation includes completeness of information as well as how true or accurate that information is.

The completeness of information can, however, be treated separately from accuracy. In a BIM context, the level of detail or definition and generalisation of information can be used to deal with completeness. Therefore, the accuracy in a geospatial sense can be defined as: 'The degree to which a survey measurement and/or calculation conforms to its true value.'

There is a considerable body of study and reference material devoted to defining accuracy. For definition in BIM systems, 3 principal difficulties arise.

1. We can never know with absolute certainty what the true value of an observed quantity actually is. We can only derive a most probable value using multiple observations and statistical calculations such as standard deviation.
2. Measurement and location has to be related to a co-ordinate system. For BIM, the same system should be used from project feasibility to operation. The co-ordinate system is realised using co-ordinated survey control stations, such as benchmarks and control markers. Inaccuracies in the survey control will find their way into survey detail, for instance, in the form of scanned points. It must be possible to describe geospatial accuracy in digital BIM systems to enable effective co-ordination.
3. There are many situations where the accuracy of measurements ? distances, bearings and height differences ? between specific points or objects is more important than the absolute accuracy of each point in a co-ordinate system. For example, when considering a dimension between 2 corners of a room or the front and rear elevation of a building, such as overall floor span, the accuracy of that derived distance may be more important than the accuracy in its co-ordinate system. This is known as relative accuracy, and also needs to be understood in a BIM system.

So in geospatial terms, 'absolute accuracy' is the extent to which an object or point conforms to its true location in a chosen co-ordinate system, while 'relative accuracy' is the comparison of a measurement derived from specific surveyed points or objects and their true measure.

Absolute accuracy can be expressed as the 3-dimensional co-ordinate or individual co-ordinate component difference between its reported most probable value in a defined survey co-ordinate system ? that is, x, y or z ? and its true position in that co-ordinate system.

In lay terms, this could be how a survey relates to a national grid or a global co-ordinate system. Many BIM specifications, including the 2014 RICS Measured surveys of land, building and utilities guidance note, 3rd edition, stipulate that a BIM survey contains a co-ordinate link to a national or regional geospatial system to help tether it in the real world.

Relative accuracy

Relative accuracy is a more complex concept because it depends on selecting specific features from which to derive a measurement and the way those measurement observations are related, in range and recording methodology; that is, how far apart they are, how many measurements are taken and how they are related to each other.

For example, if 2 features are recorded within the same point cloud, from a single instrument set-up, at the same time and under the same conditions, the derived measurement between those features is likely be more accurate than a derived measurement between 2 points separated by several rooms and different instrument set-ups that have been joined together by a co-ordinated traverse.

Tolerance

Tolerance is determined by the designers, and represents the maximum permitted difference between the design and reality. So in geospatial terms as well as in a BIM system, we can see tolerance ? design intent ? as complementary to accuracy ? as-built measurements. We can therefore use a similar description as we do for accuracy, but emphasise that it is for use in the construction phase of the project.

In geospatial terms, 'absolute tolerance' is the maximum extent to which an object or point conforms to its intended design location in a defined co-ordinate system; and 'relative tolerance' is the maximum extent to which the specific points or object in a design can vary from their actual measure when built or manufactured.

Relative tolerance can be used to specify the alignment of particular objects, and characteristics such as straightness, height difference and distance, as well as many other aspects of their geospatial relationships.

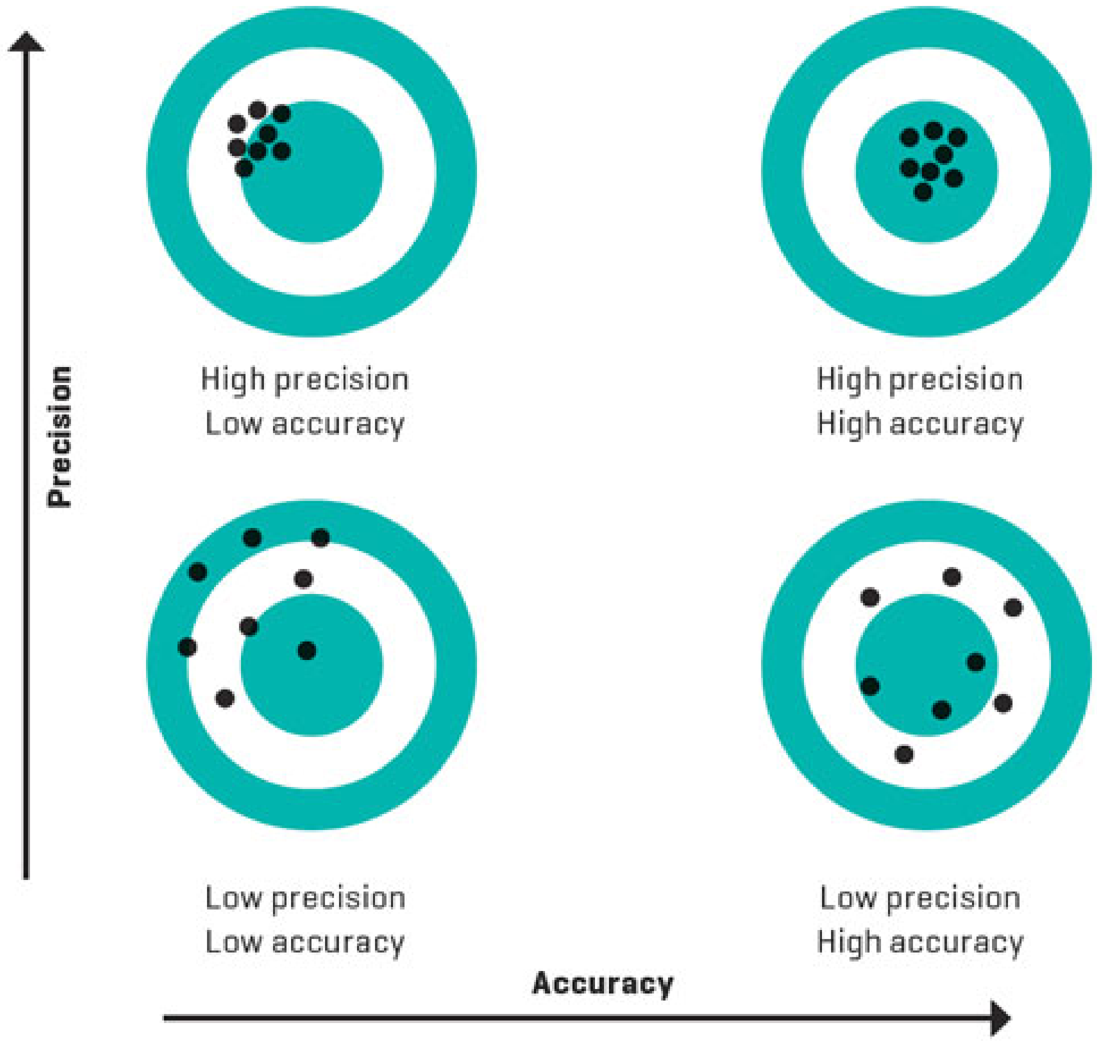

Figure 1: Comparison of precision and accuracy

Precision v accuracy

There is often confusion between the terms 'precision' and 'accuracy' as well. Precision is the degree of consistency between observations and is based on the sizes of differences between repeated measures; accuracy meanwhile is the measure of absolute nearness of an observed quantity, position or measurement to its true value. Figure 1 illustrates the difference between the 2. The Survey4BIM accuracy group has also produced an in-depth technical guide on accuracy that is due for publication in more specialist journals in the autumn. The group now moves on to the next issue, namely interoperability. This is a difficult and rapidly changing area of concern; nevertheless, the group is confident of success and is expanding its intellectual base to meet this challenge.

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Further information

- If you would like to get involved in Survey4BIM or learn more, please visit the BIM Task Group website
- Related competencies include Building information modelling (BIM) management , Engineering surveying , Measurement of land and property
- This feature is taken from the RICS Land journal (August/September 2017)
- Related categories: Building information modelling