

The Scientific Method and the Valuation Process

Each year, billions of dollars of properties are bought, sold and financed based upon the judgments and opinions of real estate appraisers, says Randall Bell in this month's Commentary and Analysis article. Furthermore, court decisions such as Daubert v. Merrell Dow Pharmaceuticals (509 U.S. 579 (1993)) have reemphasized that the property valuation process must be scientifically sound. If a court finds an expert witness does not meet this standard, their testimony can be partially or entirely excluded from the evidence presented to the jury. Accordingly, evaluating the valuation process in the context of the scientific method is useful in ensuring it meets these essential standards. This article posits that, to comply with the scientific method, the valuation process must (1) identify the problem, (2) collect relevant data, (3) propose a hypothesis, (4) test the hypothesis and (5) assess the validity of the hypothesis.

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The fields of economics and valuation must employ methods that are scientifically valid. The scientific method is a process that involves observation, development of a theory, establishment of a hypothesis and testing. The valuation process applies principles of the scientific method as a model, based upon economic principles (primarily substitution) as the hypothesis. The model is widely used by appraisers and the marketplace. It is noteworthy that the founders of the appraisal practice in the U.S. referred to the science of appraising in the same sense that they referred to the science of economics.¹ This is particularly important in the context of expert testimony.

In this regard, the appraisal literature recognizes the purpose of the “gatekeeper” requirement laid out in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*² “is to make certain that an expert, whether basing testimony upon professional studies or personal experience, employs in the courtroom the same level of intellectual rigor that characterizes the practice of an expert in the relevant field.”³ The “court must determine whether the expert testimony reflects scientific knowledge, whether the findings are derived by scientific method, and whether the work product amounts to good science.”⁴

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¹ John D. Dorchester, Jr., MAI, CRE, *The Federal Rules of Evidence and Daubert: Evaluating Real Property Valuation Witnesses*, The Appraisal Journal, July 2000, at 291, n.8..

² 509 U.S. 579 (1993).

³ *Kumho Tire Co. v. Carmichael*, 526 U.S. 137, 152 (1999).

⁴ Richard Hoyt, PhD, Robert Aalberts, JD and Percy Poon, PhD, *Daubert and Qualification of the Appraisal Expert Witness*, The Appraisal Journal, Summer 2010, at 285.

The valuation process is set forth by the Appraisal Institute within its texts, courses and seminars. This process is observed in various forms worldwide and is built upon the scientific method.⁵ To embrace predictive analysis, practicing appraisers need to understand and utilize basics, including the following: (1) statistical assumptions, in addition to appraisal assumptions; (2) how imperfect assumptions and imperfect data each affect analyses; (3) the crucial role of methodology; (4) modeling decisions; (5) the aspect of art; (6) the scientific method; (7) critical thinking; and (8) statistical thinking. These constitute what needs to be the emphasis of statistical education for appraisers.⁶

The scientific method is an established outline of procedures for conducting credible research. Kerlinger defines scientific research as “the systematic, controlled, empirical, and critical investigation of natural phenomena guided by theory and hypotheses about the presumed relations among such phenomena.”⁷ When an analyst uses the scientific method, the credibility of that analyst’s work product increases.⁸ To be considered “scientific,” the methodologies must be observable, measureable and repeatable by one’s peers. Reliability can be evaluated based on two characteristics: (1) the ability to obtain a consistent, predictable result repeatedly using either the same or different measurement techniques; and (2) the ability to obtain an accurate result with the measurement techniques or instruments used.⁹

The Appraiser Qualifications Board has stated that appraisers should be trained in scientific methods. This is becoming increasingly relevant as all federal courts and half the state courts have started requir-

⁵ Dorchester, *supra* note 1, at 300.

⁶ George Dell, MAI, SRA, *Common Statistical Errors and Mistakes: Valuation and Reliability*, The Appraisal Journal, Fall 2013, at 340.

⁷ Fred N. Kerlinger, *Foundations of Behavioral Research* (Holt, Rinehart, and Winston eds., 3rd ed. 1986), at 10.

⁸ Bill Mundy, *The Scientific Method and the Appraisal Process*, The Appraisal Journal, July 1992, at 494.

⁹ *Id.*

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ing expert witnesses to couch their expertise in the scientific method to conform to the ruling in the *Daubert* decision.¹⁰ Most appraisers would agree that the valuation profession would be advanced and its stature enhanced if appraisers were to strive for a higher degree of reliance on the scientific method, thus increasing the precision of value estimates.¹¹

The steps for the scientific method are outlined as follows¹²:

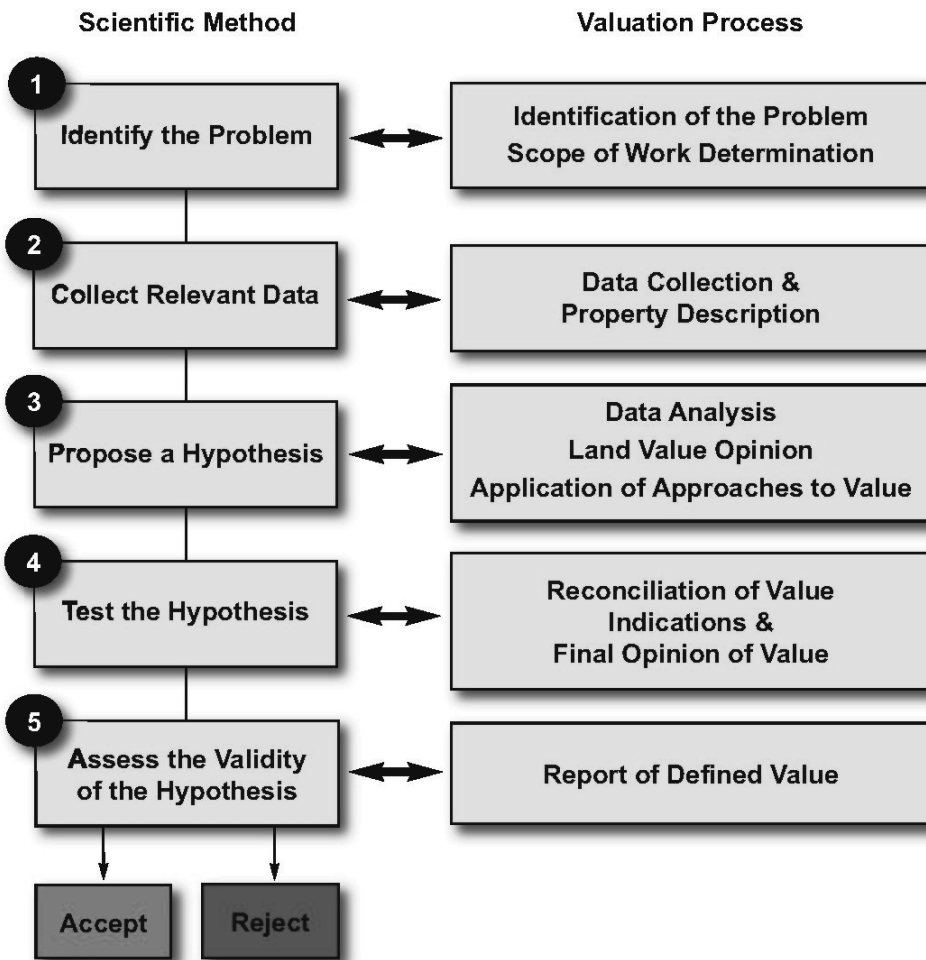
- Step 1: Identify the Problem
- Step 2: Collect Relevant Data
- Step 3: Propose a Hypothesis
- Step 4: Test the Hypothesis
- Step 5: Assess the Validity of the Hypothesis

¹⁰ Bruce R. Weber, MAI, *Environmental Uses of GIS, the Scientific Method and Daubert*, Valuation Insights and Perspectives, Third Quarter 2002, at 38.

¹¹ Mundy, *supra* note 8, at 493.

¹² David E. O'Connor & Christopher Faille, *Basic Economic Principles: A Guide for Students* (Westport: Greenwood Press 2000), at 7.

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Source: "Basic Economic Principles" by David E. O'Connor and Christopher Faille

Source: "The Appraisal of Real Estate - 14th Edition" by the Appraisal Institute

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(a) Step 1: Identify the Problem

The first step of the scientific method is to properly identify the problem. In the context of the valuation process, this entails identifying the problem and establishing the scope of work. In the scientific method, the objective is to look for explanations for defined problems, whether they be an initial conditions or some of the universal laws, or both.¹³

In this first step of the valuation process, an appraiser identifies all the assignment elements that are relevant in the appraisal: the client; intended users; intended use of the appraisal; purpose of the assignment (which includes the definition of value, with source); effective date of the opinion of value; relevant characteristics of the property; and any assignment conditions, such as extraordinary assumptions or hypothetical conditions. The combination of the elements creates a unique assignment. If an element changes, another assignment is created.¹⁴

In an appraisal assignment, for example, identification of the problem to be solved requires the appraiser to identify the following assignment elements: the client and any intended users, intended use of the appraiser's opinions and conclusions, type and definition of value, effective date of the appraiser's opinions and conclusions, subject of the assignment and its relevant characteristics, and any assignment conditions.¹⁵

Regarding competency, the Uniform Standards of Professional Appraisal Practice (USPAP) states, "The appraiser must determine, prior to accepting an assignment, that he or she can perform the assignment competently. Competency requires: 1. the ability to properly identify the problem to be addressed; 2. the knowledge and experience to complete the assignment competently; and 3. recognition of, and compliance with, laws and regulations that apply to the appraiser or to the assignment."¹⁶

In the valuation process, the identification of the assignment elements leads directly into the scope of work of an assignment (i.e., the type and extent of research needed to solve an appraisal problem). Professional standards place the responsibility for determining the appropriate scope of work in the appraisal

assignment squarely on the shoulders of the appraiser. The scope of work for an assignment is acceptable if it leads to credible assignment results, is consistent with the expectations of parties who are regularly intended users for similar assignments, and is consistent with what the actions of the appraiser's peers would be in the same or similar assignment.¹⁷

To solve any problem, the problem first must be identified; only then can the appropriate solution to the problem be determined. In appraisal practice, problem identification logically precedes scope of work determination.¹⁸ The first step to solving a problem is to identify the problem. An appraiser can't derive a solution, let alone a valuation, until they know exactly what the problem is.¹⁹

(b) Step 2: Collect Relevant Data

Once the valuation problem has been established, the second step of the scientific method is to collect relevant data or, as set forth by the Appraisal Institute, data collection and property description. The market data must be applicable to the problem that has been identified.

Setting forth clear objectives acts as a guide to where to look for theories, what concepts are relevant, what kind of models are needed and ultimately how the data is to be collected.²⁰ In real estate appraisal, the quality and quantity of information available for analysis is as important as the methods and techniques used to process the data and complete the assignment. Therefore, the ability to determine the amount and type of data needed to answer the client's question, distinguish between different types of data, research reliable data sources and manage information is essential to effective appraisal practice.²¹

USPAP Standards Rule 1-4 states, "In developing a real property appraisal, an appraiser must collect, verify, and analyze all information necessary for credible assignment results."²² The first step asks the question, "Why is this data collection project being conducted?" The data verifier should review the purpose of the data collection, data in the sample collection, data generation and documentation.²³

¹³ Jeremy Bray, *The Logic of Scientific Method in Economics*, *Journal of Economic Studies* 4, no. 1 (1977), at 8.

¹⁴ The Appraisal Institute, *The Appraisal of Real Estate* (Chicago: Appraisal Institute, 14th ed. 2013), at 49.

¹⁵ The Appraisal Foundation, *Uniform Standards of Professional Appraisal Practice* (The Appraisal Foundation, 2014-2015 Edition), at U-13.

¹⁶ *Id.*, at U-13.

¹⁷ The Appraisal Institute, *supra* note 14, at 87.

¹⁸ *Id.*, at 38.

¹⁹ Stephanie Coleman, MAI, SRA, *Scope of Work and Problem Identification: The Significant Seven*, *The Appraisal Journal*, Summer 2006, at 232.

²⁰ Bray, *supra* note 13, at 18.

²¹ The Appraisal Institute, *supra* note 14, at 95.

²² The Appraisal Foundation, *supra* note 15, at U-19.

²³ Donald R. Epley, PhD, MAI, SRA, *Data Management and*

The U.S. Department of Health and Human Services (HHS) guidelines note there are two important considerations that apply to all data collections: attention to detail and data recovery.²⁴ For even greater accuracy, one could use greater care in data collection. Possibilities include collecting more and bigger samples of algae to analyze, collecting more frequently or otherwise improving the raw data.²⁵

Ultimately, collecting accurate, reliable data remains an essential task because the conclusions of the analyses of appraisers are only as good as the data that support those conclusions.²⁶

(c) Step 3: Propose a Hypothesis

In this step, the appraiser analyzes the market data in an effort to reach a credible hypothesis of the price most properties probably would sell for if placed on the market. In the valuation process, this is the analysis of data, land value and the application of the relevant approaches to value. In essence, the valuation process uses multiple approaches to value, which can result in multiple hypotheses that later are reconciled.

While the scientific steps 1 and 2 are easily identified with valuation nomenclature, the term “hypothesis” may be less intuitive. It is, however, squarely in the scope of the valuation process as well.

A hypothesis is a theoretical system that is drawn by means of logical deduction.²⁷ “Hypothesis” has meanings ranging from a mere educated guess or assumption to a position that is highly probable in light of established research or facts. A hypothesis is defined as “an explanation accounting for a set of facts that can be tested by further investigation.”²⁸ This definition reconciles in the context of valuation, as an appraiser’s final opinion of value often is actually a value based upon a hypothetical sale, or hypothesis. This position reconciles with USPAP, which states, “The effective date of the appraisal is the date on which the hypothetical sale of the subject property is assumed to occur.”²⁹

Continual Verification for Accurate Appraisal Reports, The Appraisal Journal, Winter 2002, at 69.

²⁴ *Id.*, at 73.

²⁵ Max Kummerow, PhD, *Protocols for Valuations*, The Appraisal Journal, Fall 2006, at 359.

²⁶ The Appraisal Institute, *supra* note 14, at 95.

²⁷ Karl R. Popper, *The Logic of Scientific Discovery* (London: Seventh Impression, 1974), at 32.

²⁸ Houghton Mifflin Company, *Webster's II New College Dictionary* (2001), at 545.

²⁹ Richard Marchitelli and Peter Korpacz, MAI, *Market Value: The Elusive Standard*, The Appraisal Journal, Winter 1992, at

As appraisers can use multiple approaches to value property, each with divergent viewpoints, an appraiser can actually develop multiple hypotheses in an single assignment, which later can be reconciled. An appraiser’s hypothesis or opinion of value is derived from a variety of analyses (market analysis; highest and best use analysis) and the application of different approaches to value (sales comparison; cost; income).

Each of those forms of analysis deals directly with different sets of data about the subject property, competitive properties, and the larger market. However, all of those traditional appraisal analyses increasingly are influenced by the discipline of statistics.³⁰ The valuation process specifically includes a component for land value, as land provides potential utility as the site for a structure, recreational facility, agricultural tract or right of way for transportation routes, water storage and other uses.³¹

In assignments to develop an opinion of market value, the ultimate goal of the valuation process is a well-supported value conclusion that reflects all of the potential factors that influence the market value of the property being appraised. To achieve this goal, an appraiser studies a property from three different viewpoints, which are referred to as the approaches to value.³²

Value is measured from the closing date of each sale property to the hypothetical closing date of the subject property (i.e., the effective date of appraisal). Just as the time and effort required to market the sale properties were historical to their respective closing dates, any efforts to market the subject property are assumed to be historical to the effective date of the appraisal. This assumption clearly is the basis on which the valuation process operates in every situation that requires a current value estimate.³³

The hypothesis framework of the scientific approach also is found incorporated into USPAP. For example, USPAP states that exposure time is the “estimated length of time that the property interest being appraised would have been offered on the market prior to the hypothetical consummation of a sale at market value on the effective date of the appraisal.”³⁴

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³⁰ The Appraisal Institute, *supra* note 14, at 275.

³¹ *Id.*, at 359.

³² *Id.*, at 36.

³³ Marchitelli and Korpacz, *supra* note 29, at 321.

³⁴ The Appraisal Foundation, *supra* note 14, at U-2.

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It has been observed that the criterion is a hypothetical sale; hence, the buyers therein referred to are hypothetical buyers, not actual and existing purchasers.³⁵ Market value is the prediction of an economic event. Since the appraiser is to judge what the property would bring if exposed to the market, he must predict the outcome of an event which hasn't yet occurred (i.e., the hypothetical sale of the property and the subsequent transaction price).³⁶

Ultimately, in the context of the scientific method and valuation process an appraiser, using multiple approaches to value, may develop multiple hypotheses.

(d) Step 4: Test the Hypothesis

In this step of the scientific method, the analyst attempts to test and reconcile the data. In the valuation process, this is the reconciliation of the various indications of value and final opinion. The scientific approach requires testing of the hypotheses developed in the valuation process.

Resolving the differences among various value indications is called reconciliation.³⁷ In the final reconciliation, the appraiser reconsiders the entire appraisal, making sure the data available and analytical techniques and logic applied have led to consistent judgments.³⁸ The appraiser resolves multiple value indications derived within a single approach as part of the application of that approach. Furthermore, after resolving multiple value indications within a single approach, the appraiser applies the same process to the value indications of multiple approaches, providing the client with clear analyses of why the results of one (or more) of the approaches to value is given more weight than the results of the other.

All theories are trials; they are tentative hypotheses, tried out to see whether they work. Likewise, all experimental corroboration simply is the result of tests undertaken in a critical spirit to find out where our theories err.³⁹ In this step of the scientific method, the approach given most weight is "tested" most obviously against other approaches to value, as well as all other indications of value. This includes, but isn't limited to, the sales price of the subject

property itself, regression residuals, escrow prices, listing prices or prior sales prices of the subject property.

To be valid, a measurement process should have discriminant and convergent validity.⁴⁰ Kerlinger notes that discriminant validity means "one can empirically differentiate a variable from other variables that may be similar, and that one can point out what is unrelated to the variable." Convergence means that evidence from different sources gathered in different ways all indicate the same or similar meaning.⁴¹ In appraisal, discriminant validity can be illustrated by the discrete nature of the three approaches to value: sales comparison, cost approach and income approach. The use of data from the income approach in the market approach, for example, would violate discriminant validity.⁴²

The multi-method/multi-trait approach is an important scientific technique for analyzing data. It is based upon the premise that independent analyses of discrete sets of data will yield results that tend to validate one another. When multiple approaches are used with discrete sets of data, the reliability of the result should improve. This technique should be relevant to the valuation profession because three separate approaches are used in valuing property.⁴³

Once these hypotheses have been formulated, a research plan must be devised that allows the analyst to credibly test the veracity of the null hypothesis.⁴⁴ Once the sales comparison, cost and/or income approaches to value have been completed, the indication of value by each must be reconciled to a final opinion of value. A thorough review of each of the approaches is made to ensure accuracy and consistency. If the results from one particular approach appear to be at a great divergence from the other(s), then each phase of this approach should be reconsidered to account for the difference.⁴⁵

The ultimate goal of the valuation process is a sound conclusion of value. This requires a reconciliation of the value indications derived from the approaches to value. Consideration should be given to the relevance of the approach and reliability of the value indication based on the quantity and quality of

³⁵ Julius L. Sackman, *Market Value Approach to Valuation*, *The Appraisal Journal*, January 1973, at 58.

³⁶ Richard U. Ratcliff, MAI, *Is There a 'New School' of Appraisal Thought?*, *The Appraisal Journal*, October 1972, at 525.

³⁷ *The Appraisal Institute*, *supra* note 14, at 641.

³⁸ *Id.*, at 642.

³⁹ Karl R. Popper, *The Poverty of Historicism* (London: Rutledge, 1974).

⁴⁰ Kerlinger, *supra* note 7, at 421.

⁴¹ *Id.*

⁴² Mundy, *supra* note 8, at 495.

⁴³ *Id.*

⁴⁴ Marvin L. Wolverson, PhD, MAI, *Research Design, Hypothesis Testing, and Sampling*, *The Appraisal Journal*, Fall 2009, at 371.

⁴⁵ Office of Real Estate Appraisers, *Appraisal and Valuation* (Office of Real Estate Appraisers, Chapter 15), at 419.

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the data available and analyzed within the approaches used.⁴⁶ When value indications are substantially different, careful analysis of the valuation data used and assumptions made is needed to determine which value indicator is the most reliable.⁴⁷ In the final reconciliation, the appraiser reconsiders the entire appraisal, making sure the data available and analytical techniques and logic applied have led to consistent judgments.⁴⁸

(e) Step 5: Assess the Validity of the Hypothesis

In this step, the scientific approach mandates the acceptance or rejection of the validity of the hypothesis. If the study's resulting theory isn't corroborated by the data from which it was derived, independent means of corroboration must be sought.⁴⁹

⁴⁶ New York State Department of Taxation and Finance, Valuation Standards, (New York State Department of Taxation and Finance), Section IV.

⁴⁷ *Id.*

⁴⁸ The Appraisal Institute, *supra* note 14, at 642.

⁴⁹ O'Connor and Faille, *supra* note 12, at 7.

If the hypothesis is accepted, the conclusions reached by the appraisers in valuation analysis are communicated to the client in the appraisal report, which may be written or oral. Facts, reasoning and conclusions must be presented clearly and succinctly.⁵⁰

(f) Conclusion

The valuation process must be constructed on a scientifically solid foundation. In reviewing the scientific method, ideally the valuation process reconciles with the scientific method whereby the appraiser: (1) identifies the problem, (2) collects relevant data, (3) proposes a hypothesis by analyzing the market data and utilizing the three approaches to value, (4) tests the hypothesis by determining if the indicated values reconcile and (5) assesses the validity of the hypothesis and renders a final opinion of value. Through this established process, the real estate market and courts are provided with valuations that are scientifically sound.

⁵⁰ The Appraisal Institute, *supra* note 14, at 649.