30 Cannon Street, London EC4M 6XH, United Kingdom
Tel: +44 (0)20 7246 6410 Fax: +44 (0)20 7246 6411
Email: iasb@iasb.org Website: www.iasb.org

International Accounting Standards Board

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These notes are based on the staff papers prepared for the IASB. Paragraph numbers correspond to paragraph numbers used in the IASB papers. However, because these notes are less detailed, some paragraph numbers are not used.

INFORMATION FOR OBSERVERS

Board Meeting: **19 July 2007, London**

Project: **Conceptual Framework**

Subject: **Phase C: Measurement Concepts and Principles (Agenda Paper 2B)**

INTRODUCTION

1. In March, the Boards approved several changes to the plan for the measurement phase of the conceptual framework (CF) project. One of those changes was to add a discussion of measurement concepts and principles at the beginning of Milestone II. The Boards also agreed that measurement concepts and principles should be the first set of criteria used to evaluate the measurement basis candidates brought forward from Milestone I.

2. This paper discusses measurement concepts and principles. The concepts discussed are generalized ideas about measurement taken from various theories of measurement. The principles are fundamental propositions associated with the theory of measurement that the staff thinks is most appropriate for accounting measurement. The evaluation of measurement basis candidates in light of those concepts and principles is the subject of *Measurement 5A* (FASB Memorandum XX, IASB Agenda Paper XX). The scope of both papers is confined to financial

statement measurement of assets and liabilities, and changes in them. Although much of the discussion may pertain equally to measurement within the broader scope of financial reporting, these papers do not consider any implications of their content for differences between the two scopes.

PURPOSE

3. In Milestone I, the Boards agreed to a set of *measurement basis candidates* and definitions of those candidates. The purpose of standardizing measurement basis terminology was to improve communication and understanding among Board members, staff, and constituents throughout the measurement phase of the CF project.

4. The staff thinks that a similar effort with respect to *measurement concepts* is as important, if not more so. Both within and outside the discipline of accounting, terms such as *measurement, estimation, calculation, allocation,* and *forecast* have been used interchangeably. The result has been imprecision in communication and confusion of the concepts behind the terms.

5. Whereas beginning the measurement phase of the CF project with a discussion of what the term *measurement* means was not essential, doing so now is essential. Otherwise, miscommunication and confusion may inhibit progress throughout this phase.

6. The staff acknowledges that the concepts, principles, and terms discussed here can be interpreted differently. The interpretations that the staff recommends in this paper are intended to help the Boards and staff both to identify and to understand differences in measurement basis candidates for financial statements.

7. To a considerable extent, this paper looks beyond familiar ideas, standards and literature about financial statement measurements for a conceptual basis to anchor subsequent deliberations in the measurement phase. Such a broader view is necessary to instill discipline into our thinking about measurement.

ORGANIZATION

8. This paper is organized in three parts. The first part, which constitutes the bulk of the paper, discusses the concept of measurement and proposes a definition of measurement for the conceptual framework. The second part contains principles[1] that relate to the concept of measurement that may be useful in later analysis. The final part discusses the terms mentioned in paragraph 4 that are sometimes confused with measurement, as well as the terms *direct measurement* and *indirect measurement.* An appendix contains a measurement lexicon that includes the proposed definition of measurement and the terms discussed in the third part of the paper.

9. Part I is lengthy, with many subparts and a complex line of thinking. Parts II and III, while brief, also contain subparts. Therefore, the staff offers the following outline as both an overview and a reference:

PART I: DEFINING MEASUREMENT

- Basic Definition
- Standard Setters' Definitions
- Theories of Measurement
  1. Classical theory
  2. Representational theory
  3. Operational theory
- Levels of Measurement
  1. Ratio measurement
  2. Interval measurement
  3. Ordinal measurement
  4. Nominal measurement
- Stevens' Scheme and the Definition of Measurement
- Measurement in Academic Accounting Literature
  1. Classical theory
  2. Representational theory
  3. Operational theory
- Proposed Definition of Measurement

PART II: MEASUREMENT PRINCIPLES

[1] To illustrate what is meant by *principle* in this case, one of the measurement principles discussed later is that it is not possible to measure an object in its entirety, but only an aspect of the object.

Single Attribute
Present Timeframe
Observability
Inexactness
Variability
Invariance

PART III: TERMS RELATED TO MEASUREMENT

Estimation
Calculation
Allocation
Forecasting
Direct Measurement
Indirect Measurement

10. Definitions of *measurement* and *financial statement measurement* are proposed at the end of the Part I (paragraphs 68 and 69, respectively). No formal definitions of the measurement-related terms are included in Part III, but they are included in the measurement lexicon. The staff envisions that lexicon as a tool that Board members, staff, and constituents alike can use throughout the CF project to facilitate communication and expects to add to it throughout the measurement phase as needed.

PART I: DEFINING MEASUREMENT

Basic Definition

11. Measurement is the most fundamental and difficult of the concepts and terms that need to be clarified. A basic dictionary definition of *measure* (verb form) is "To determine the dimensions, quantity, or capacity of," which results in a basic definition of measurement as either "The act of measuring or process of being measured," or "The dimension, capacity, or quantity determined by measuring."[2]

12. Such a basic definition provides one sense of the meaning of measurement, but hardly begins to reveal the extent and complexity of the concept. Further illumination of the meaning of *measurement* is provided by accounting standard setters, theories of measurement, accounting academia, and elsewhere.

[2] Webster's Dictionary

Standard Setters' Definitions

13. Although accounting standards frequently use the terms *measure* and *measurement*, the staff is not aware of any standard that defines measurement. However, some accounting standard setters have provided definitions in their conceptual frameworks.

14. The IASB's *Framework for the Preparation and Presentation of Financial Statements* states that:

> "Measurement is the process of determining the monetary amounts at which the elements of the financial statements are to be recognized and carried in the balance sheet and income statement." (paragraph 99)

Identical or very similar definitions have been adopted by accounting standard setters in Australia, New Zealand, the UK, and Canada. A slightly different definition is offered by the ASB of Japan which, in its December 2006 draft conceptual framework, states that:

> "Measurement in financial statements represents assigning amounts in monetary units to items that are recorded in financial statements." (page 32, paragraph 2)

15. FASB Concepts Statement No. 5, *Recognition and Measurement in Financial Statements of Business Enterprises,* does not explicitly define measurement. However, its discussion of measurability and measurement attributes (paragraphs 65-70) implies that accounting measurement is the quantification of a measurement attribute in terms of monetary units.

16. The standard setters' definitions of measurement are not discriminating enough for our purposes. Those definitions are equivalent to saying that all methods of deriving financial statement amounts are equally good and constitute measurement. Because the existing methods for determining financial statement amounts include calculation, estimation, allocation, and forecasting, those definitions do not provide a means for distinguishing between measurement and those other activities. Furthermore, those definitions do not provide a means for evaluating the

measurement basis candidates because they do not discriminate among the candidates or their variations in any way.

Theories of Measurement

17. The definitions and concepts of measurement of accounting academics and theorists are more diverse and at times more discriminating than those of standard setters. In each case, they reflect more developed theories of measurement derived from science and used in the world at large. As such, it is useful to examine those theories directly before discussing the views of accounting academia.

18. There are three basic theories of measurement, all of which are products of either the physical or social sciences. The names of these theories vary somewhat among authors on the subject. This paper refers to the three theories as the classical theory, the representational theory, and the operational theory.

Classical theory of measurement

19. The classical theory describes what measurement means and how it is performed in the physical sciences, as well as in the applied sciences that derive from the physical sciences. The adjective *classical* is used because measurements in the physical sciences date back to ancient history, particularly to the Greeks.

20. Classical measurement theory assumes that an objective reality exists that can be observed. According to classical theory, measurement is the process of mapping an observable attribute[3] of a physical object onto the imaginary world of mathematics using a rule. Stated another way, measurement is the process of representing quantitative attributes of physical things in terms of numbers.

21. The measurable attributes of objects in classical theory are of two kinds:

a. Those that are part of the physical objects themselves (such as an object's length)

[3] The terms *property* and *dimension* also are used in classical theory. The term *basis,* as used in the CF project, is intended to have the same meaning as these other terms.

b. Those that are relations between a physical object and other physical objects (such as the distance between two such objects).

22. Not any rule will do when it comes to numerically representing an attribute of something physical. The rule used must produce a mathematical representation that preserves the relationship of the object measured with respect to that attribute to other objects with the same attribute. For example, a rule for measuring weight that represents a lighter object with a greater number than a heavier object is not a good rule. Furthermore, any mathematical transformations of the representation allowed by the rule must result in secondary representations that are not only mathematically accurate but also meaningful in terms of the physical reality that is supposedly represented. For instance, it is mathematically accurate to say that 90 divided by 10 equals 9. However, if 90 represents an individual's weight according to some measurement rule and 10 represents the number of the individual's toes, then the result of 9 is not meaningful because total body weight per toe has no empirical or pragmatic meaning.

23. The process of measurement is basically one of comparison, either comparing the physical property of one object to that same property in another object, or by comparing two objects by quantifying a physical relation between them. To facilitate comparison and communication of comparison results, measurement scales are developed and accompanying units of measure are defined and standardized. Sometimes the measuring scale and unit of measure are unique (the Ohm scale and the ohm unit of electrical resistance, for example), while at other times competing scales and units of measure exist (the centigrade, Fahrenheit, and Kelvin scales of temperature with degrees centigrade, Fahrenheit, and Kelvin, for instance). When a physical object used for comparison is calibrated according to a selected scale and unit of measure, that object becomes a measurement instrument or device (a thermometer or weighing scale, for example). Procedures are described for carrying out a measurement process or using a measurement instrument.

24. The concept and terminology of measurement in the physical sciences may be summarized using an example of measuring the length of a log felled by a forester. The length is the physical property to be quantified. The unit of length may be a

meter. The measurement instrument (that is, the comparison object) may be a measuring tape. The process of measuring may proceed with the forester securing the beginning of the measuring tape to one end of the log and walking to the other end as the measuring tape unwinds. After pulling the tape taut, the forester follows a procedure of noting the tape marking closest to the end of the log without surpassing the end. If that reading is 15.25 meters, the forester attributes 15.25 meters of the measuring tape length to the log and concludes that the length of the log is 15.25 meters.

Representational theory of measurement

25. Measurement in the social sciences is more challenging in some respects than in the physical sciences, because the social sciences frequently deal with characteristics of and relations between people. Some of those characteristics, like age, height, and weight, are physical or quantitative properties that are used by both physical and social scientists and, therefore, may be measured in the context of social science in the same way they are measured in the physical sciences. However, many attributes that social scientists attempt to measure are not quantitative physical properties or relations but rather are qualitative mental characteristics or traits, such as intelligence or comprehension, or mental or emotional attitudes and states, such as love or happiness.

26. Social scientists developed the representational theory of measurement in order to extend classical ideas of measurement to qualitative attributes insofar as possible. To the extent that classical ideas do not readily transfer to the measurement of qualitative attributes, representational theory has expanded the concept of measurement. Representational measurement theory still assumes an objective reality, but that reality may be qualitative rather than physical and thus may not be directly observable. In representational measurement, social scientists look for observable attributes, often behaviors, which are assumed to be related to the unobservable attribute of interest. A model is then developed that mathematically relates the observable attribute(s) to the unobservable attribute. Even though the attribute of interest cannot be observed, it is assumed to exist because relationships

between the observable attribute(s) can be explained in terms of the unobservable attribute.

27. Consider, for example, the task of measuring human intelligence. Intelligence is a qualitative mental concept that is not nearly so well-defined and understood as a quantitative physical concept like length is. There is general agreement that it exists and there is a general notion of what it is, but no one can observe it or strictly define it. Nevertheless, a number of social scientists have attempted to measure it. They have done so by assuming that observable attributes, such as performance on carefully constructed exams, are related to intelligence. That is, the more questions (and the more difficult questions) that a person answers correctly on an intelligence exam, the more intelligent that person is thought to be.

28. Even though the result of representational measurement is numerical, and a measurement scale may be developed for something like intelligence, generally there is not a unit of measurement in such a scale as there is with physical measurement. Units of measurement are discrete and conceptually precise, requiring a precisely preconceived measurement attribute. Quantitative attributes fit that description, whereas qualitative attributes usually do not. Therefore, the numerical result of representational measurement is more likely to represent a person's relative position with respect to others (his or her percentile ranking on an intelligence test, for example) rather than an absolute position on a scale with a unit of measurement.

Operational theory of measurement

29. The operational theory of measurement is not as easily categorized as the other two theories. Many scientists regard it as an extreme form of the representational measurement theory, whereas others view it as a theory in its own right.

30. The basic difference between the operational theory and the classical and representational theories is that the operational theory does not assume any objective reality, observable or unobservable. In the operational theory, the operation that is called measurement is more important than what is being

measured. If the result of the operation is considered useful (if it can be used to make predictions, for instance), then it does not matter whether what is being measured can be observed, or whether it even exists.

31. Using the example of human intelligence, a representational theory proponent might say that intelligence is the ability to think and reason. In contrast, an operational measurement proponent would say that intelligence is what is measured by an intelligence test. For the operationalist, if an intelligence test can successfully predict academic success at the university level, then it does not matter whether intelligence can be understood or observed, and arguments about the niceties of measurement that are made by representational theorists, and more particularly classical theorists, need not be taken quite so seriously. Having a practical tool that works is more important to an operationalist than understanding how or why that tool works. That pragmatic attitude accounts in part for the popularity of the operational theory among its supporters.

32. The increasing use of statistics in the last century has been an impetus for the development of the operational approach to measurement, too. Statistics are used to make inferences about measurements made by researchers from all three schools of measurement thought. However, classical and representational theories place some constraints on the use of statistics; particular statistical methods are thought to be appropriate for only certain kinds of data. Operational theory, on the other hand, relaxes some of the assumptions about the appropriate use of statistics, thus offering its proponents a greater array of tools for analyzing qualitative or vague characteristics.

Levels of Measurement

33. A better understanding of the consequences of adopting one of the above theories of measurement as opposed to the others is possible if those theories are related to what are commonly called the levels of measurement. Generally speaking, most of what classical theorists consider to be measurements are found at higher levels of measurement, operational measurements are found at the lowest level, and representational measurements fall in between.

34. More than one scheme exists for classifying measurements. The classification into levels discussed in this paper is that of Stanley Smith Stevens. Stevens was a psychologist and proponent of the representational theory of measurement who sought to improve and legitimize measurement in the social sciences. He proposed four levels of measurement, or measurement scales, that vary according to the mathematical operations that may be meaningfully performed on the measurements within each level, as well as the kinds of statistics that are appropriate for measurements in each level.[4] Stevens' scheme is the most widely used and is instructive in further understanding the concept of measurement and differences between many measurements in the physical and social sciences. Stevens' four levels are:

a. Ratio measurement
b. Interval measurement
c. Ordinal measurement
d. Nominal measurement

Each of those levels is discussed in turn below.

Ratio measurement

35. This is the highest level of measurement in Stevens' scheme. The feature that distinguishes ratio measurements from those at lower levels is found in the term *ratio.* Numbers that result from ratio measurements can be used to create meaningful ratios. Stated differently, it is meaningful to apply the mathematical operations of multiplication and division to such numbers. For a measurement scale to be a ratio scale, it must have an absolute zero value (in contrast to a relative zero value such as that found in Celsius and Fahrenheit temperature scales). Otherwise, multiplication and division of measurement results cannot faithfully represent the physical reality.

[4] Stevens, S.S. (1946). On the theory of scales of measurement. *Science*, 103, 677-680.

36. Many, but not all, measurements in the physical and applied sciences are classified as ratio measurements, including measurements of length, mass, volume, and energy. An example of a ratio measurement is a temperature measurement using the Kelvin scale. Because that scale has an absolute zero value, it is meaningful to say that $400^{o}K$ is twice as hot as $200^{o}K$.

37. Ratio measurements include all the primary features of measurements at lower levels. They are also amenable to analysis using the widest range of statistics.

Interval measurement

38. Measurements in this level are so named because the intervals between units on interval measurement scales are equal. This is also true of ratio scales; however, interval scales do not have an absolute zero value. Therefore, addition and subtraction of interval measurements may be meaningful, but multiplication and division cannot be. Temperature measurements using the Centigrade and Fahrenheit scales are common examples of interval measurements. For measurements using those scales, it is meaningful to say that a measurement of 10^{o} is five degrees warmer than a measurement of 5^{o}, but it is not true that 10^{o} is twice as warm as 5^{o}.

39. Some measurements in the social sciences fall into the category of interval measurements, but most do not.

Ordinal measurement

40. The distinguishing feature of ordinal measurements is that they can be used to indicate the rank order (1^{st}, 2^{nd}, 3^{rd}, and so forth) of things with respect to the property of those things that is measured. Thus, comparisons can be made between two objects to the effect that one object is greater than or less than another object in terms of that property. However, higher order mathematical operations on ordinal measurements, such as addition and subtraction, have no meaning.

41. Because no mathematical operations other than greater than or less than are possible with ordinal measurements, the measurement scales associated with them can use words instead of numbers. Examples of numerical ordinal measurement scales include the Mohs scale of mineral hardness, and a movie rating system where 5 is the highest rating and 1 is the lowest rating. Examples of non-numerical ordinal scales are U.S. beef grades of good, choice, and prime, and turkey grades of A, B, and C. With all ordinal scales, whether numerical or not, it is possible to say that something measured at a high level of the scale is greater with respect to what is measured than something measured at a low level of the scale, but it is not possible to say how much greater.

42. A few measurements in the physical sciences (for example, those using the Mohs scale mentioned above) and most measurements in the social sciences fall into the category of ordinal measurements.

Nominal measurement

43. This is the lowest level in Stevens' measurement scheme. As with ordinal measurements, nominal measurements may be given in terms of either numbers or words. The numbers or words of nominal measurements are, in effect, names or labels for the objects being measured. There are no measurement scales in nominal measurement. The names or labels given to the objects simply result in sorting those objects into various categories. The only comparisons that can be made using nominal measurements are those of equality and inequality, but those comparisons do not have any quantitative meaning. In the context of nominal measurement, equality and inequality mean only "of the same category" or "not of the same category."

44. An example of numerical categories in nominal measurement is the use of numbers to label routes on city buses. All buses with the same route number follow the same route. A non-numerical example is the use of colors to identify group members in temporary settings. Thus, attendees at a large meeting may be divided into red, yellow, green, and blue groups for smaller breakout sessions. All attendees with the same color next to their name go to the same breakout session room.

Stevens' Scheme and the Definition of Measurement

45. In conjunction with his four levels of measurement, Stevens provided a definition of measurement as being "the assignment of numerals to objects or events according to some rule." That definition is commonly used in various disciplines. A comparison of Stevens' definition with each of his levels of measurement shows that each level satisfies that definition. However, it is also apparent that measurement means something quite different at each level. A significant difference exists between the quantitative relationships among objects that can be expressed mathematically and analyzed statistically using ratio measurement and the quantitative meaning of nominal measurements, which is nil.

46. When ratio measurement is used, the arithmetic operations of addition, subtraction, multiplication, and division can be performed on the numerical representations resulting from that measurement and produce new representations that still correspond to relationships among the objects that were measured. Furthermore, the entire range of statistical tools can meaningfully be used to analyze ratio measurements. On the other hand, when nominal measurement is used, all that can be said of two objects that have two different measurement results is that they are not in the same category, and no meaningful statistical analysis of the measurements is possible.

47. While Stevens' scheme and definition have been widely used and adapted, the range in meaning of measurement among his levels has generated considerable disagreement. Many physical scientists did not then and do not now consider rank ordering (the result of ordinal measurement) or categorization (nominal measurement) to be "true" measurements. Some social scientists would agree with that position in the case of categorization, but not in the case of rank ordering. That difference in view is understandable, given that many measurements used in the social sciences are ordinal. On the other hand, while there is no universal agreement on what is or is not measurement, it is generally conceded that only units in scales used for ratio and interval measurements are legitimately called measurement units.

Measurement in the Academic Accounting Literature

48. That background in measurement theory and the levels of measurement makes it possible to meaningfully summarize the understanding of measurement among accounting academics. As it happens, there is support for each of the three theories of measurement (classical, representational, and operational) in the academic accounting literature.

Classical theory

49. The use of the classical theory of measurement by accounting academics is perhaps best represented in the works of several accounting theorists from the "golden age" of accounting theory, the 1960s and 1970s. Raymond J. Chambers in Australia, Edgar O. Edwards and Philip W. Bell in the U.S., and Robert R. Sterling in the U.S. all developed rather detailed accounting theories that depended on the classical theory for their concepts of measurement.[5] All of those theorists advocated some kind of current price as the appropriate measurement basis for assets and liabilities. Each of their theories is compatible with a view that the relation between an asset and a current price is as real and measurable as many of the properties and relations measured in the physical sciences.

50. The theories of Chambers and Sterling are even more closely aligned to classical measurement theory in that they viewed assets as having not only a real relation with prices but also a property or attribute that could be measured by comparison to their preferred current price. For Chambers, that attribute was called a current cash equivalent; Sterling thought of his attribute as cash potential, and referred to it as exit value. In both cases, the attribute may be viewed as a surrogate for wealth, and changes in the attribute may be viewed as surrogates for enhancements or diminutions of wealth. In the works of both Chambers and Sterling, the preferred current price for measuring their attribute is current exit price.

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[5] See Chambers, Raymond J.,*Accounting, Evaluation and Economic Behavior,* Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1966; Edwards, Edgar O. and Philip W. Bell, *The Theory and Measurement of Business Income,* Berkley, California: University of California Press, 1961; Sterling, Robert R., *Theory of the Measurement of Enterprise Income,* Lawrence, Kansas: University of Kansas Press, 1970; Sterling, Robert R., *Toward a Science of Accounting,* Houston, Texas: Scholars Book Co., 1979.

51. The difference between the approaches of Chambers and Sterling, on the one hand, and that of Edwards and Bell, on the other, may be explained by a slight difference in focus. Chambers and Sterling focused on asset measurement and viewed income as a derivative of proper asset measurement. Edwards and Bell focused on income measurement and viewed proper asset measurement as a step in income measurement. The preferred current price in their work is current entry price.

Representational theory

52. Representational measurement theory in the academic accounting literature appears in two different contexts, accounting theory construction like that just discussed, and contemporary academic accounting research.

53. Examples of accounting theory that use representational measurement theory are Mock's study of the relationship between measurement and accounting information systems[6] and Ijiri's defense of historical cost accounting.[7] Both of these academics went beyond the classical concept of measurement to include ideas from representational measurement theory in their accounting theories.

54. Mock's work focused on accounting information systems rather than assets or income and did not reach conclusions as to what measurement basis was preferable. However, he did try to demonstrate that scientific measurement concepts could be applied to accounting, using income determination under a Hicksian change in wealth concept as an example.

55. Although Mock's work relied in part on representational concepts of measurement, the staff thinks that Ijiri's work more closely exemplifies representational theory. While Ijiri advocated historical cost (and all its derivatives that the staff has labeled as modified past amounts) as the appropriate measurement basis for assets, his focus was not asset measurement but performance measurement. He viewed net income, determined using historical cost accounting, as a surrogate for a business

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[6] Mock, Theodore J., *Measurement and Accounting Information Criteria*, Studies in Accounting Research #13, Sarasota, Florida: American Accounting Association, 1976.
[7] Ijiri, Yuji, *Theory of Accounting Measurement,* Studies in Accounting Research #10, Sarasota, Florida: American Accounting Association, 1975.

enterprise's economic performance, a concept which he considered vague at best. Just like the surrogates used by social scientists to measure unobservable psychological qualities, Ijiri considered the various historical cost components of net income to be observable and objective surrogates for economic performance.

56. In addition to the theories of Mock, Ijiri, and others like them, representational measurement theory in the academic accounting literature is found in contemporary academic accounting research as well. In fact, most current accounting research is based on that theory. There is a significant difference in the use of representational theory in accounting research from that in theory construction, however. Whereas the accounting theories summarized above use measurement theory to develop a theory of asset or income measurement, most accounting research focuses on different, albeit peripherally related, subject domains.

57. Among the subjects of contemporary accounting research that have been explored widely are:

a. The relationship between reported financial statement numbers and stock market prices

b. The relationship between accounting choices in standards and management behavior

c. The agency relationship between a business' management and its owners or creditors

d. Judgments and choices made by auditors.

Many research studies on these and like subjects use a traditional social science approach that depends on the representational theory of measurement. In most cases, a qualitative concept that is somewhat imprecise and not directly observable, such as information content, risk aversion, or quality of earnings, is selected as the focus of the study. Then one or more observable and quantifiable surrogates are selected and used in a mathematical model to try to measure the unobservable thing of interest. Many of those models are based on regression analysis, with which most professional accountants are familiar from their academic studies. The results of applying the model are then analyzed using statistics.

Operational theory

58. The operational theory of measurement is exemplified in academic accounting literature primarily through the use of Stevens' broad definition of measurement as the assignment of numbers to objects or events using some rule. Generally, such uses predate the FASB's original conceptual framework. An example is found in the following quote from a committee of the American Accounting Association made over 35 years ago:

> "…accounting measurement is an assignment of numerals to an entity's past, present or future economic phenomena, on the basis of observation and according to rules. Under this definition, it should be pointed out, the rules employed need not be good ones and observations made need not be correct to qualify as accounting measurement."[8]

59. The staff suspects that many accounting academics whose interests lie outside accounting theory, as well as most accounting practitioners, think of measurement in a way that is consistent with the operational theory and Stevens' definition. Because the term *measurement* is widely used by accountants of all backgrounds, and because there are so many ways to obtain accounting numbers for financial statements, it is not surprising that any operation that accountants use is thought of as measurement.

Proposed Definition of Measurement

60. Given the simplicity and fairly wide use of Stevens' measurement definition, it is tempting to adopt that in the CF project. However, there are risks in doing so.

61. Some of the risk lies in the great variability of meaning attributable to measurements that satisfy that definition, depending on the level of measurement, as discussed above. In that context, the risk is one of making measurements at a lower level in Stevens' scheme and attributing meaning to them that legitimately pertains only to measurements at a higher level of the scheme. Because everything

[8] American Accounting Association, "Report of the Committee on Accounting Measurement," *Accounting Review Supplement*, 1971, p. 3.

encompassed by the four levels is given the same label, *measurement*, that risk is not difficult to conceive.

62. A greater risk relates to the fact that Stevens' definition most easily fits the lowest level of his scheme, in the sense that little or no elaboration beyond the definition is needed to produce what is considered a measurement at that level. That is, perhaps, one reason that many scientists reject nominal measurement as measurement and simply refer to it as categorization. In that context, the risk of using Steven's definition is that his lowest level of measurement may too easily be interpreted as saying that any rule whatsoever that assigns numbers to objects or relations between objects is a measurement.

63. If Stevens' definition of measurement is not suitable, then what would be a suitable definition? The staff thinks the answer lies in selecting the theory of measurement that is most closely aligned with the nature of assets and liabilities, then constructing a definition of measurement that is consistent with that theory.

64. In that regard, the staff thinks that the classical theory is the appropriate one to use for two reasons. The first reason is that assets and liabilities have economic attributes of interest to accounting that are measurable in the sense that term is used in the classical theory. The second reason is that the level of measurement that is most appropriate for measuring assets and liabilities is ratio measurement, which is most closely associated with the classical theory.

65. The staff acknowledges that associating the classical theory of measurement with accounting may seem awkward or inappropriate to those who have not been exposed to measurement theory previously. After all, the roots of classical measurement theory are in the physical sciences. Many people do not regard accounting as a science at all, let alone a physical or applied science. At best, some would classify accounting as a social science because of its association with economics, which is so classified. However, the staff observes that human behavior in the face of scarce resources (substitute *assets*, if you will) is the central theme of economics, not assets and liabilities themselves. The nature of human behavior, and thus of the discipline of economics in general, is consistent with the

representational theory of measurement, but that need not and does not determine the nature of assets and liabilities.

66. Assets (including cash) and liabilities, and changes in assets and liabilities (including both price changes and cash flows) are fundamental economic phenomena; they are economic resources, claims to economic resources, and changes in economic resources. The nature of assets and liabilities corresponds much more closely to the physical phenomena of classical measurement theory than the human behaviors with respect to economic resources, claims, and changes that are the focus of economics.

67. The staff also thinks that it is important to remember that whatever one's view of the relationship between science and accounting, or economics and accounting, there are certain expectations about accounting numbers that are almost universally held. Specifically, almost everyone expects to be able to add, subtract, multiply, or divide accounting numbers and yield meaningful results. As previously discussed, that expectation is only justified with respect to addition and subtraction if either interval or ratio measurement is used and with respect to all four arithmetic operations only if ratio measurement is used.

68. In reviewing the accounting literature on measurement, the staff did not find a definition of measurement that considers the nature of assets and liabilities and the expectations for their measurement discussed in the previous paragraph. However, the staff did find a discussion of measurement principles[9] from which it constructed the following general definition:

> Measurement is the numerical ordering or comparison of an object or event to other objects or events with respect to a preconceived and defined attribute in terms of a unit of measure that possesses that same attribute, with the result that the object or event is properly placed in a given scale.

69. The staff thinks that the above definition is suitable as a general definition of measurement and that its inclusion in the measurement lexicon would be useful.

[9] Adapted from Sterling's five measurement propositions in Robert R. Sterling, *Theory of the Measurement of Enterprise Income,* Lawrence, Kansas: University of Kansas Press, 1979, pp. 72-80.

That definition uses terminology from measurement theory and may help the Boards and staff relate more easily to the preceding discussion. However, the staff thinks that a definition that is restricted to ratio measurement and that uses accounting terminology where possible would be more useful in achieving the objectives of the measurement phase. Therefore, the staff proposes the following definition of financial statement measurement to supplement the general definition:

> Financial statement measurement is the numerical ordering or comparison of an asset or liability (or a change in an asset or liability) to other assets or liabilities (or changes in other assets and liabilities) with respect to a preconceived and defined basis in terms of a monetary unit that relates to that same basis, with the result that the asset or liability is properly placed in a monetary ratio scale.

70. *Question: Do the Boards approve the general definition of measurement and the accounting definition of measurement for use in the CF project?*

PART II: MEASUREMENT PRINCIPLES

71. There are several principles derived from measurement theory that may be useful in understanding the nature of measurement and in evaluating the measurement basis candidates in this project. By principle, the staff means a basic assumption or premise. The principles are in no particular order, nor are they intended to form a complete list. Others may be added in future discussions if the need arises. These principles have been selected to clarify the nature of measurement in the sense the staff has recommended above, namely classical measurement.

Single Attribute

72. **It is not possible to measure an object or event itself**. Only an attribute, relation, dimension, aspect, etc., of an object or event can be measured. It follows from this principle that it is not possible to faithfully represent an object or event in its entirety, numerically or otherwise. Only attributes, dimensions, relations, etc., can be faithfully represented. Thus, a person cannot be measured, but his or her height, weight, age, etc., can be measured. Similarly, in terms of the economic phenomena

of assets and liabilities, an asset or liability cannot be measured, but an economic attribute of an asset or liability can be measured.

Present Timeframe

73. **Measurement takes place only in the present**. Thus, future dimensions or relations of things cannot be measured, only forecast. However, past dimensions or relations can be measured in the present if the necessary observations have been made in the past and all that remains to be done in the present is to compare observations to each other, compare an observation to a scale, or use the observation in a calculation. The application of this principle in an accounting context means that an economic attribute of an asset or liability can be measured only in the present.

74. The principle of measurement in the present may be extended to the processes of estimation and calculation, as well. Strictly speaking, one cannot estimate or calculate something about the future; one can only forecast.

Observability

75. **Only that which can be observed can be measured**. This principle, of course, only applies to measurement in the classical sense. Adherents of representational and operational measurement would not follow this principle. Since something that cannot be observed cannot be measured, it can only be estimated, calculated, or predicted. Restated for an accounting context, this principle means that only economic attributes of assets and liabilities that can be observed are measurable.

Inexactness

76. **Measurement is by nature generally inexact**. Absolute precision and exactness exist only in the discipline of mathematics. The assignment of numbers to quantitative dimensions or relations in a measurement process is useful, and may give the appearance of exactness. However, except for counting the number of objects in a set or group, it is not possible to measure anything with absolute precision. Only calculation can be exact. Even atomic clocks, which exemplify the

greatest measurement precision achieved to date, are not absolutely precise, and physicists continue to look for ways to increase their precision.

Variability

77. **Measurement is variable with respect to the conditions in which it is made**. There are relatively few constants in this world. Most quantitative dimensions and relations change with respect to time and/or place because of changes in conditions that vary temporally or spatially (that is, vary with time or space). Thus, for example, the temperature at which a particular liquid will boil will vary at different altitudes because of variations in atmospheric pressure. In this, as in most other respects, measurement in accounting is no different than measurement in other disciplines.

Invariance

78. **A property required of good measurements is that the resulting comparison between objects should be the same, or invariant, irrespective of other factors**. This principle means that, except for acceptable measurement error, two measurements of the same dimension or relation of the same object or event at the same time, in the same location, under the same conditions, and using the same measurement scale should yield the same result.

PART III: TERMS RELATED TO MEASUREMENT

79. Although there are many terms relating to measurement, the staff thinks that we should focus initially on those that are the most basic and that commonly are confused with measurement. Those terms are *estimation, calculation, allocation, forecasting,* and the distinction between *direct measurement* and *indirect measurement*. *Unit of account* and *monetary unit* will be discussed separately in a later paper, as may other terms.

80. Each term below is discussed in terms of a process. However, in the case of *estimation*, *calculation*, *allocation*, and *measurement*, the same term is used for both the process and the outcome of the process. Thus, the result of the process of estimation may be called an estimation (as well as an estimate), and the result of the process of calculation is a calculation.

Estimation

81. *Estimation* is used as a synonym for at least three processes that are relevant to this discussion. Those processes are:

    a. Approximation

    b. Measurement

    c. Modeling

    Each of those usages is discussed below.

As approximation

82. *Estimation* is often used in conjunction with both measurement and calculation. In both instances, estimation has the same meaning, namely the process of making a rough approximation. An implication of this meaning in either case is that something more precise could be done, but is not done for some practical reason.

83. An example of estimation in this sense is pacing off the distance between holes for fence posts instead of using a measuring tape. An example with respect to calculation is rounding up to the next whole dollar the cost of each item in a shopping basket instead of using a pocket calculator. In the measurement example, a more precise measurement is possible by using the measuring tape; in the calculation example, an exact calculation is possible. In both examples, estimation is used because it is easier (or perhaps the measuring tape or calculator is not readily available) but still gives a satisfactory result.

As measurement

84. *Estimation* is used also as a substitute for *measurement*. Because there is always some degree of error in measurement, some scientists think it is inappropriate to refer to the result of any measurement process as a measurement. Instead, they prefer to call the result an estimate. The staff thinks that distinction is unnecessary and obscures the meaning of measurement that this paper has tried to clarify.

As modeling

85. In a third sense, estimation is used in situations where measurement is either not possible or not feasible. Such situations may occur when the measurement attribute is not observable, when no measurement method has been developed, or when measurement is prohibitively costly. A theoretical model then may be used to quantify what cannot be measured. The difference between estimation in this sense and estimation as a process of rough approximation is that approximation is still a direct comparison between a measuring instrument and the object of measurement. In other words, it is still a measurement, albeit a purposely imprecise one. On the other hand, estimation in the modeling sense quantifies the object of interest through the object's association with other objects or events. Some or all of the other objects or events in the model may be measured in the classical sense of measurement, but the object of interest itself is not. The use of the Black-Scholes model to estimate the value of stock options is an example in economics and accounting.

86. A social scientist subscribing to the representational theory of measurement might call the result of modeling a measurement, but a physical scientist would more likely call the result an estimate. Given that assets and liabilities are economic phenomena more akin to the physical phenomena measured in the physical sciences, the staff thinks that the result of a quantification using a model should be called an estimate for purposes of this project.

Calculation

87. Calculation is the process of applying mathematical operations to numbers. In and of itself, calculation is not equivalent to measurement, although it is closely related. One of the principal purposes of quantifying the magnitude of an attribute of an object is to be able to mathematically manipulate the result. If the selected attribute can be faithfully represented using a ratio or interval measurement scale, then it is possible to learn things from the mathematical transformation of measurements of that attribute that cannot be learned from the measurements themselves. It is possible to manipulate the numbers derived from the measurement process using mathematical operations and obtain a result that is not only true in the imaginary world of mathematics, but also meaningful in the real world of what was measured. Therefore, manipulation of measurements is an important facet of calculation.

88. However, it is important to remember that mathematical manipulations are not measurements themselves. Real world meaning depends neither on calculations nor on their exactness, but on the nature of the attribute originally measured and whether mathematical manipulations of measurements of that attribute are warranted using a particular measurement scale.

Allocation

89. Allocation is the process of distributing something according to some rule. The concept of allocation derives from the distribution of real things, but also applies to the distribution of numerals that represent real things. In the latter sense, allocation is a type of calculation. It is easy to confuse allocation as calculation with allocation as physical partitioning and distribution. If the two are confused, it is also easy to confuse allocation with measurement.

Forecasting

90. *Forecasting* and *estimation* are sometimes used as synonyms, but forecasting is further removed from measurement than estimation when the latter is used in the sense of making a rough approximation. Forecasting is one class of a set of classes

called prediction. *Prediction* is the process of making a statement about an unobserved object or event. There are three classes of prediction that relate to the time frames of the past, present, and future. Making statements about the past state of objects that have not been observed, or about past events that have not been observed, is called *retrodiction*. Forming statements about the present state of objects that are not being observed, or about present events that are not being observed, is simply called *prediction,* even though that term is used to describe the set of classes as well. The term *forecasting* is reserved for statements about the future state of objects or about future events. It is not necessary to modify the description of forecasting to add that unobserved states or events are referred to because of the fact that it is not possible to see the future. Many use *forecasting* and *prediction* interchangeably, although doing so obscures the time frame reference.

Direct (Fundamental, Primary) Measurement

91. *Direct measurement* is measurement as it has been described within the classical theory of measurement. The adjective *direct* (or *fundamental* or *primary*) is used simply to differentiate that basic concept of measurement from indirect measurement.

Indirect (Derived, Secondary) Measurement

92. *Indirect measurement* is measurement of a dimension or attribute that is based on two or more direct measurements of other dimensions or attributes of the same object. The direct measurements are then associated by means of calculation (that is, using a mathematical formula). If the formula has been empirically tested and found to faithfully represent the attribute that is indirectly measured, then the result of the calculation may be expected to be the same as though the attribute of interest had been measured directly. The staff thinks that indirect measurement may represent the only situation in which it is appropriate, at least informally, to refer to a calculation as a measurement.

93. A common example of an indirect measurement is that of density. Density is defined as the mass of an object per unit volume. Thus, an indirect measurement of density involves separately making direct measurements of an object's mass and volume, then dividing the number representing mass by the number representing volume.

SUMMARY

94. This paper has discussed three main topics:

a. Concepts of measurement, including theories of measurement, levels of measurement, and definitions of measurement

b. Measurement principles, including single attribute, present timeframe, observability, inexactness, variability, and invariance

c. Terms related to measurement, including estimation, calculation, allocation, forecasting, direct measurement, and indirect measurement.

95. With respect to concepts of measurement, the staff has concluded that the classical theory of measurement provides the best foundation for understanding, defining, and applying the concept of measurement in the context of accounting for assets and liabilities and their changes. The staff thinks that conclusion is sound despite a common view that accounting is either a non-scientific discipline or a social science.

96. The measurement principles discussed in this paper are a distillation of some of the assumptions and premises that underlie the classical theory of measurement. The staff thinks that those principles may be useful in the evaluation of measurement basis candidates, both in the following paper and in future papers.

97. The discussion of terms related to measurement has made distinctions between the term *measurement* and terms that are often confused with measurement. The staff thinks that making those distinctions should improve communication during the course of the measurement phase of the CF project and facilitate evaluation of the measurement basis candidates.

APPENDIX

MEASUREMENT LEXICON

Allocation: a distribution of something according to a rule. *Allocation* derives from the distribution of real things, but also applies to the distribution of numerals that represent real things. In the latter sense, *allocation* is a type of *calculation.*

Calculation: the process of applying mathematical operations to numbers. Calculations can be used to manipulate measurements (or estimates or forecasts) to obtain useful information.

Direct (Fundamental, Primary) Measurement: *measurement* as described within the classical theory of measurement. The adjective *direct* (or *fundamental* or *primary*) is used to differentiate the basic concept of measurement from *indirect measurement*.

Estimation: (1) the process of approximating a measurement or purposely measuring imprecisely; (2) the process of quantifying by modeling when measurement is either not possible or impractical.

Financial Statement Measurement: the numerical ordering or comparison of an asset or liability (or a change in an asset or liability) to other assets or liabilities (or changes in other assets and liabilities) with respect to a preconceived an defined basis in terms of a monetary unit that relates to that same basis, with the result that the asset or liability is properly placed in a monetary ratio scale.

Forecast: a statement about the future state of objects or about future events (a *prediction* relating to the future).

Indirect (Derived, Secondary) Measurement: measurement of a dimension or attribute that is based on two or more *direct measurements* of other dimensions or attributes of the same object which are then associated by means of *calculation.*

Measurement: the numerical ordering or comparison of an object or event to other objects or events with respect to a preconceived and defined dimension in terms of a unit that possesses that same dimension, with the result that the object or relation is properly placed in a given scale.

Prediction: a statement about an unobserved object or event. Informally, *prediction* is used to describe such statements that relate to the past, the present, or the future. Strictly speaking, *prediction* is reserved for such statements that relate to the present timeframe.

Retrodiction: a statement about the past state of objects that have not been observed, or about past events that have not been observed (a *prediction* related to the past).