



## What Makes a Good Indicator?

*Science and Engineering Indicators (Indicators)* provides information on the state of the S&E enterprise in the United States and globally through high-quality quantitative data from domestic and international sources. The data are “indicators,” that is, quantitative summary information on the scope, quality, and vitality of the science and engineering (S&E) enterprise or its change over time. The Methodology Appendix of the report provides detailed information on the methodological, statistical, and data-quality criteria used for the report. This sidebar provides a brief and high-level summary of the data sources used in this report and data-quality issues that influence the interpretation and accuracy of the information presented in *Indicators*.

First and foremost, a good indicator for use in the report explains something meaningful about the state of U.S. S&E in its global setting. The report provides multiple indicators to inform different aspects of a topic. These indicators are used by a wide variety of people and organizations with differing views about which indicators are the most significant for their specific purposes. Additionally, because each indicator provides a partial measure of overall activity, multiple indicators facilitate a more accurate and comprehensive understanding of the issue at hand.

A good indicator for the report is policy relevant, in that it contributes to an understanding of the current environment and to informing the development of future policies. *Indicators* data are used by policymakers at the federal-, state-, and local-government levels. A good indicator is also policy neutral, in that it provides an objective, balanced, and accurate description of the issue at hand. *Indicators* generally emphasizes neutral and factual description using simple statistical tools and then invites the exploration of more sophisticated causal models and relationships by the research community.

In addition, a good indicator provides an unbiased representation of its intended concept, with small enough measurement error to allow data users to make meaningful distinctions between the categories and time periods (Hall and Jaffe, 2012). When possible, the indicator is a direct measure of the intended concept, for example, the representation of different demographic groups in S&E jobs. In other cases, the intended concept is hard to measure directly and so related or proxy indicators are the best available. An example of this kind of indicator is S&E degree production (Chapter 2). The concept most data users are interested in is the capacity of the workforce to be productive in S&E fields, but the measure presented is S&E degrees earned.

Many of the indicators in the report are collected in surveys that are conducted by federal statistical agencies in the United States and other countries. Well-constructed surveys align the questions asked of respondents to the concepts that the indicator is intended to measure and provide the detailed category breakdowns that are most relevant to data users. How well the survey-based indicator represents the intended population depends on how well the survey has been able to obtain responses from the targeted population. The indicator’s precision, or inherent variability, depends on number of respondents; more is better.

Some indicators used in the report come not from surveys but from data collected by companies, governments, and organizations as part of their ongoing internal activities; these data are administrative data. Patent and bibliometric data (Chapter 5, Chapter 6, and Chapter 8) are two examples. Because the data collection was not originally intended as an indicator, these data may not fully correspond to the intended use for *Indicators* and may not fully represent the desired population. Good features of these kinds of data are that the respondent burden is low because the data already exist, data sets are often very large, and the data source often has structured the data carefully, though generally for uses other than as an indicator. Additionally, these data are often available with a shorter delay than is possible with survey data



production cycles. In these cases, transparency about the difference between the concept intended and the actual data provided allows a partial indicator to be a good one as well.

*Indicators* is prepared for the National Science Board by the National Center for Science and Engineering Statistics (NCSES), a federal statistical agency within the National Science Foundation. Many of the individual indicators presented are from NCSES's own surveys as well as from U.S. and other nations' statistical agencies. To ensure the quality of the indicators, wherever possible international data comparisons are presented using data that have been harmonized by international organizations, such as the Organisation for Economic Co-operation and Development and the United Nations, or has been prepared for NCSES across countries using consistent standards.