Chapter 3

Economic Change and Structures of Classification

The 20th century encompassed enormous change in the structure of the U.S. economy. Two World Wars and the Korean and Viet Nam conflicts, combined with the Great Depression, OPEC oil embargoes, major structural changes in the global economy, and revolutionary computer technologies, all illustrate the importance of understanding how such shocks have affected our economy and will continue to affect it in the coming decades.

At the same time, the 20th century witnessed the evolution of the Federal statistical system. Methodological innovations, such as sampling theory, national income accounting, and the incorporation of computer technology, all improved the quality and timeliness of specific statistics.[1] In addition, the development of standardized classification systems provided more consistency across data systems. Classification systems create an order that demonstrates relationships and facilitates analysis.

In the statistical world, the availability of a universal classification system facilitates comparisons of findings across data collection efforts. At an even more basic level, classification systems are necessary to translate micro-data into tables and charts that can be understood by data users.

Clearly, statisticians and economists need to work from a common base of classification, both for industries and for occupations. In a dynamic economy, any classification system must, of necessity, be a work in progress, continually balancing the need for a current and accurate description of the economy with the need for consistent time series data.

The purpose of this chapter is to present the evolution of classification systems in use in this country over the past 100 years for both industry and occupational data collection efforts. It would make for a better story if we could point to specific technological developments, such as the invention of the telephone or the semiconductor as the impetuses for change.[2] The fact is, however, that our economy has evolved as much in response to social, political, and economic factors, such as wars and depressions, as it has to specific technological innovations. That evolution has been taking place steadily over all of the past 100 years, and would require a lengthy volume indeed to spell out all the factors of change that have been involved. Our hope here is to give an outline of the factors leading to several key developments in U.S. economic taxonomy and, finally, to look to the future with some ideas of how our current classification systems will serve us in the coming decades.

Industry Classification

Industry-based data collection began in 1810 with the institution of the Census of Manufac-

tures.[3] Agriculture, mining, and fisheries censuses followed in 1840, and the Census of Governments began in 1850. Data were collected by a number of agencies, among them the U.S. Treasury Department and the U.S. Department of State.

The censuses carried out in 1810, 1820, and 1840 provided little more than the gross outlines of manufacturing development. The reasons are many, and include the fact that the Federal marshals who supervised the field operations also had other duties, and often were unable to devote the necessary time and attention to the censuses given into their charge. The marshals' assistants, the actual census enumerators, often were given only very sketchy direction or none at all, and may have had difficulty eliciting answers to the more complex economic questions embodied in the business censuses.

The marshals had the responsibility for compiling and classifying the data gathered in their jurisdiction. This decentralization introduced some irregularities in the reported information because the marshals were not trained statisticians, and they often used divergent procedures in carrying out their census duties. To add to the difficulties, many of the entrepreneurs of the day believed that the government should play a minimal role in economic affairs, and were suspicious and uncooperative when asked to provide information about their business to Federal agents. In many other cases, the enumerators were faced with businesses that maintained little or no ongoing record of their operations, and whose owners or managers were thus unable to answer the detailed queries with any more than the sketchiest estimates.

Industry classifications were very rough and ready during the first three manufacturing census efforts. The classification, such as it was, reflected a primarily demand- or market-oriented approach, which lumped more or less substitutable products into loose industry groupings. As a result of the inaccuracies of these first censuses, Congress established the Census Board, precursor to today's Census Bureau, on March 3, 1849. The Census Board oversaw the collection of data from establishments (once again by Federal marshals' deputies) and carried out the compilation in Washington with a cadre of trained clerks supervised by statisticians. Data items were classified by industry based on the product that the respondent said was produced at the establishment in largest quantity, essentially leaving the question of classification up to the respondents themselves.

Early critics of the Census Board's industry-based data collection programs noted that, because of the lack of focus on industry classification, not enough information was collected to adequately estimate total production of specific commodities across the economy. In 1925, analyst Laurence F. Schmeckebier described problems in classifying information on the flavoring extract industry.[4] Results of the 1921 Census of Manufactures showed the output of this industry to be $33,060,000, but this figure included output of other, secondary products by the industry that were not identified by commodity. Moreover, another $14,372,692 worth of flavoring extracts were produced as secondary products of other industries, although those industries were not themselves identified. It thus was impossible to determine the value of production of the commodity flavoring extracts from published reports on the 1921 Census of Manufactures. Indeed, problems surrounding how data were collected and what data were collected were so pressing that the issue of how industries were defined was not examined critically during the first 100 years or more of data collection.

Mobilization for World War I forced a number of Federal statistical agencies to the realization that they needed to collect data on an industry basis. Quite a few disjointed and inconsistent methods of defining industries sprang up, and the business establishments that were asked to respond to these data requests became alarmed at the lack of coordination and what they saw as poorly designed data collection efforts. The response burden quickly grew to the point that, in 1918, the War Industries Board established the Central Bureau of Planning and Statistics.[5] The Bureau undertook to:

(1) improve statistical operations by developing uniform standards and definitions,
(2) catalog government statistics, and
(3) advise agencies on statistical methods.

In 1919, the functions of this agency were transferred to the fledgling Bureau of Efficiency, which concerned itself with the coordination of statistical programs. It issued a report in 1922, recommending the centralization of nonadministrative statistical work in a Federal Bureau of Statistics, at which point the Bureau was disbanded, presumably to make room for this newly recommended central sta-

tistical office. The Bureau of Statistics was, however, never approved, and the issues of statistical and classification oversight were effectively shelved for the remainder of the 1920s.

As a result of the Great Depression and also because of political developments in Europe, interest once again grew in the mid-1930s for greater coordination of Federal statistical programs. On July 27, 1933, President Franklin D. Roosevelt signed an Executive Order, prepared by a committee of the American Statistical Association and the Social Science Research Council, authorizing the formation of the Central Statistical Board (CSB). CSB had as its primary responsibility "to formulate standards for and to effect coordination of the statistical services of the Federal Government incident to the purpose of the National Industrial Recovery Act." While four earlier attempts to coordinate Federal statistics programs had failed, CSB (through its successor agencies) was destined to survive right up to the present day. Most germane to the present discussion was the formation by the CSB in 1937 of an Interdepartmental Committee on Industrial Classification "to develop a plan of classification of various types of statistical data by industries and to promote the general adoption of such classification as the standard classification of the Federal Government."

Standardization of the industry classification plan was an important objective because various agencies were once again collecting industrial data, each using its own classification scheme. Such a situation made the comparison of industrial data prepared by different agencies difficult and often misleading. Work began on this standardized industrial classification in June 1938, and was guided by the following general principles:

1) The classification should conform to the existing structure of American industry.

2) The reporting units to be classified are establishments rather than legal entities or companies.

3) Each establishment is to be classified according to its major activity.

4) To be recognized as an industry, each group of establishments must have significance from the standpoint of the number of establishments, number of wage earners, volume of business, employment and payroll fluctuations, and other important economic features.

The Standard Industrial Classification system

The result of all this work was compiled as the *Standard Industrial Classification Manual* (SIC) and was issued in duplicated form as two volumes: *Volume 1, Manufacturing Industries* (released primarily in 1939) and *Volume 2, Nonmanufacturing Industries* (released primarily in 1940).[6] The results were reviewed in light of the experiences of the agencies making use of the new classification system, and the first printed edition of the SIC was published for manufacturing industries in 1941 and for nonmanufacturing industries in 1942. Major revisions to the SIC were published in 1957, 1967, 1972, and 1987. These revisions were a result of cooperation among statistical agencies and the business sector, with overall coordination provided by the CSB, then by the Bureau of the Budget, and, finally, by the U.S. Office of Management and Budget.

Unfortunately, the SIC shared a major problem with all earlier industrial classification systems in that it lacked a theoretical foundation based on economic concepts.[7] While there was an underlying idea that an establishment should be classified by type of economic activity, this idea was not defined with sufficient rigor. With no single guiding economic principle of classification or aggregation laid down at the outset, the SIC evolved into a number of different classification schemes. In most cases, the product or activity dominated the classification decision but, in some cases, end use, raw materials, or market structure was the deciding factor. None of these schemes was incorrect, but they were not consistent. Moreover, as old industry definitions were modified or new industries were added, the logic seemed to make perfect sense for each change. Unfortunately, the result was that, over time, the SIC became a less and less homogeneous grouping of industries. Some examples may help clarify the inconsistencies that had crept in over the years.

Supply-based vs. demand-based. Two possible approaches to defining industries were from the supply side and from the demand side. In the supply-side approach, establishments were grouped into industries based on similarities in the production process. That is, establishments with similar or identical production functions were grouped together as an industry concept. In this approach "the production function should be understood as an abstract description of the engineering prin-

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ciples for a production process, or as a description of the production technology, not just as a list of inputs. In principle, it is engineering information about the production process that determines if establishments are sufficiently similar to justify grouping them by a supply-side concept." An example of this type of industry classification is provided by the two different chain-producing industries: SIC 3496, chain made from purchased wire, and SIC 3462, chain made from forged steel. Even though the end products of these two industries were good substitutes for each other, the production processes differed significantly; thus, the decision was taken to follow a supply-side approach to industry definition in this case.

A demand-side, or commodity-oriented, classification concept groups together commodities or services that have similarities in use, that belong together, that are used together for some purpose, or that define market groupings. Consider the apparel industries. Apparel industries are split between men's and boys' apparel and women's and girls' apparel. Clearly, the production technology is virtually indistinguishable between the two groupings, yet the markets are different in terms of marketing approach and pricing.

Embodiment of the true economic structure. A frequently encountered statement in the early economic classification literature is that the classification system should "reflect the structure of the economy." If a well-defined economic concept of "structure of the economy" does not exist, however, the potential for difficulties arises over time. In one view, the structure of the economy encompasses what industries exist, where they are located, what inputs they use, what outputs they produce, and what markets they serve. Yet, one must question whether the SIC really did accomplish this purpose. In the 1987 SIC, 57 percent of the four-digit SIC codes are goods-producing industries, while 43 percent relate to the entire nongoods-producing sector. In 1987, however, only 45 percent of real gross domestic product was accounted for by the goods-producing sector, while 55 percent arose in service-producing industries. Nonagricultural employment in 1987 was split 24 percent to 76 percent between goods-producing industries on the one hand, and service-producing and government industries on the other. On the basis of these estimates, many economists and statisticians were increasingly concerned that the SIC did not reflect the true structure of the economy.

Another definition of "structure of the economy" refers to the organization of production units for marketing goods or services, including the degree of vertical integration. For example, two separate meat processing industries are recognized in the 1987 SIC, meat packing plants (SIC 2011) and sausages and other prepared meat products (SIC 2013). The two produce the same output—meat products—but meat packing plants slaughter the animals they use in their production process while the other industry produces meat products from purchased carcasses and other meats. Here, the degree of vertical integration was the deciding factor in splitting these two sets of establishments. At the same time, however, poultry slaughtering and processing (SIC 2015) includes both types of processing establishments, regardless of whether they actually slaughter the poultry themselves.

Another "structure of the economy" issue concerns the extent to which some industries combine activities. The hotels and motels industry (SIC 7011), for example, encompasses many distinct economic activities, including restaurants, bars, room rental, and gift shops, many of which also are enumerated in other four-digit SIC categories. By including the value of production of all these distinct activities in one industry, the statistics relating to the other four-digit SIC codes are distorted to a degree that may not be immediately apparent.

Finally, many economists and statisticians noted that the SIC was unable to recognize new or emerging industries in a timely manner. The point of all of these examples is not to judge which of them were "right" or "wrong" but to point out the growing number of inconsistent treatments that had crept into the SIC scheme of classification, inconsistencies that were due almost entirely to a lack of a unified economic concept of the industry and of the proper way to categorize establishments by industry.

The enactment of the North American Free Trade Agreement (NAFTA) formalized a free-trade area among the United States, Canada, and Mexico. In 1993, when the agreement was signed by all three countries, the U. S. industry classification system was governed by the 1987 SIC. Canada's classification system dated from 1980, and Mexico had no industry classification system in place (its first was published in 1994). To meet the monitoring requirements

built into NAFTA, a coordinated industry classification needed to be developed to suit all three economies. This turned out to be the ultimate argument for replacing the Standard Industrial Classification.

The North American Industry Classification System

An International Conference on the Classification of Economic Activities was held in Williamsburg, VA, in 1991. As a result of that conference, the U.S. Office of Management and Budget established the Economic Classification Policy Committee (ECPC) in 1992, chaired by the Bureau of Economic Analysis and with representatives from BLS and the Census Bureau. The charter of the ECPC was to undertake a "fresh slate" study of alternate economic concepts by which to categorize industries and to recommend changes to or replacement of the SIC system of industry classification.

Working papers of the ECPC during those first years provided a detailed analysis of conceptual problems with the existing SIC system, along with a set of alternative strategies regarding the development of a system that would replace the SIC. These "straw man" proposals formed the basis for extensive comment and debate, not only among government statisticians and economists, but also among the users of SIC-based statistics from academia and the business community. As a result, the ECPC developed a set of final proposals for a system that would replace the SIC, and that they hoped would adequately address the problems and inconsistencies that had been developing over the 50-year lifespan of the SIC.

The result of ECPC's work was published in 1997—the North American Industry Classification System (NAICS), constructed within a single conceptual framework.[8] Economic units that have similar production processes are classified in the same industry, and the lines drawn between industries demarcate, to the extent practicable, differences in production processes. Special attention was given to developing these production-oriented classifications for:

(1) new and emerging industries,
(2) service industries in general, and
(3) industries engaged in the production of advanced technologies.

NAICS went on to provide enhanced industry comparability among the economies of the United States, Canada, and Mexico, and it provided increased compatibility with the two-digit level of the International Standard Industrial Classification of the United Nations.

NAICS divides the economy into 20 sectors. (See box entitled "A comparison of the NAICS and the SIC structures.") Industries within these sectors are grouped according to the production criterion. Although the goods/services distinction is no longer explicitly reflected in the structure of the new classification system, 5 sectors are largely goods-producing, and the remaining 15 are entirely service-producing industries.

What exactly has NAICS accomplished? ECPC has summarized what makes NAICS a better economic classification system in terms of relevancy, consistency, comparability, and flexibility.[9]

Relevancy. NAICS provides 1,170 detailed industry classifications for the U.S. economy, a 15-percent increase in total classifications, compared with those available under the SIC. The new system replaces or revises approximately 60 percent of the previously available SIC industries, and provides 358 new industries not identified at all under the SIC. The resulting expanded and revised industry classifications better mirror businesses and methods of business operation in our modern economy. (Some of the new industries identified under NAICS are shown in the box entitled "New NAICS industries.")

Consistency. NAICS changes key classification concepts and definitions, a development that may have substantial impacts on how businesses are classified and the number and kind of businesses in particular classification groupings. Each business is now classified into a detailed industry based on the production processes it uses.

Use of this production-based classification principle has an impact on the boundary between retail and wholesale trade sectors. Retailers typically sell merchandise in small quantities using public-oriented methods such as mass media advertising, placement of stores in high-traffic locations, and design of attractive displays. Wholesalers sell goods in large quantities using business-oriented methods such as developing specialized catalogs, nurturing customer contacts, and locating warehouses or offices judiciously. This definitional approach

improves the classification and statistics for each sector but also changes them. For example, more than half of the petroleum bulk stations previously classified as wholesalers under SIC will be classified as retailers under NAICS.

Comparability. NAICS was developed, is being implemented, and will be maintained by statistical agencies of Canada, Mexico, and the United States. When the system has been fully implemented, comparison of industrial statistics for all three countries will be possible, and completely new information about cross-border trade flows and business markets will be available. For Canada, the *NAICS Canada Manual* has been published and implementation of the new classification system took place over the 1997-2000 period. For Mexico, NAICS implementation is in progress. That country's 1998 Economic Census was carried out using NAICS.

A comparison of the NAICS and the SIC structures	
NAICS	SIC

Sector (two-digit)
    Subsector (three-digit)
Industry group (four-digit)
    NAICS international industry (five-digit)
    National industry (six-digit)
	Division (one-digit)
	    Major group (two-digit)
	    Industry group (three-digit)
	    Industry (four-digit)

Total (713 five-digit industries) Agriculture, forestry, fishing, and hunting (42 five-digit industries) Mining (10 five-digit industries) Utilities (4 five-digit industries) Construction (28 five-digit industries) Manufacturing (179 five-digit industries) Wholesale trade (69 five-digit industries) Retail trade (62 five-digit industries) Transportation and warehousing (42 five-digit industries) Information (28 five-digit industries) Finance and insurance (32 five-digit industries) Real estate and rental and leasing (19 five-digit industries) Professional, scientific, and technical services (35 five-digit industries) Management of companies and enterprises (1 five-digit industry) Administrative and support, waste management and remediation services (28 five-digit industries) Educational services (12 five-digit industries) Health care and social assistance (29 five-digit industries) Arts, entertainment, and recreation (23 five-digit industries) Accommodation and food services (11 five-digit industries) Other services (30 five-digit industries) Public administration (29 five-digit industries)	Total (904 four-digit industries) Agriculture, forestry, and fishing (58 four-digit industries) Mining (31 four-digit industries) Construction (26 four-digit industries) Manufacturing (459 four-digit industries) Transportation and public utilities (67 four-digit industries) Wholesale trade (69 four-digit industries) Retail trade (64 four-digit industries) Finance, insurance, and real estate (53 four-digit industries) Services (50 four-digit industries) Public administration (27 four-digit industries)

Flexibility. The intention is that NAICS classifications will be updated on a regular basis to keep pace with changes in the U.S. economy. All three North American countries will review NAICS every 5 years and make necessary revisions.

The NAICS implementation schedule within the U.S. statistical community is spread out over a 7-year period. (See exhibit 1.) The first major program affected by NAICS was the 1997 Economic Census. For a sample of the data that have been made available in the Economic Census, see Annex A.

Despite its great advances in industry classification, the existing NAICS is still a work in progress. Due to severe time constraints, the ECPC decided to leave the wholesale and retail trade sectors and the construction sectors essentially unchanged from the 1987 SIC. A second edition of NAICS, scheduled for release in 2002, will address the revisions in these three sectors, as well as revisions of the other 1997 industries as required.

Finally, for all those researchers who depend on the availability of consistent time series data, it may well be a decade before an adequate set of data has been generated under NAICS. For the 422 industries that are substantially unchanged between the SIC and NAICS classification schemes, there is no problem—analysts will simply continue to gather data as they are released. For the 748 industries that are either new or substantially revised from the SIC, the problem becomes a bit stickier. For a time, it will be necessary to bridge backward to a consistent SIC basis (insofar as that can be carried out) but, ultimately, the analyst will find it necessary to bridge earlier SIC-based data forward to the NAICS. Both bridge processes will require some carefully thought-out approaches and well-documented assumptions, especially in light of the fact that only one period of data overlap is planned for most industry-based data collection efforts.

Occupational Classifications

"Occupations" are jobs or positions that employ the knowledge and skills of people. Positions and jobs are the structures of work that employers offer to workers. When a position or job is filled by a person, it becomes that person's occupation. When a person is performing in a position or job, the person is referred to as a worker. An occupation is defined by the interaction of the work organized in a position or job, the work content, and the education and skills that a person brings to performing that work content. Occupational information looks beyond titles to the work content, education, and skills that are required by the structure of work in our economy. The products of occupational analysis are the structure of positions and jobs in the economy, the skill base of the employed workforce, and the economic contribution of the employed workforce as measured by wage data. The development of these products in the form of data series creates a dynamic picture of the change occurring in the character of work in the economy. Occupational data may be analyzed either within industry classification structures or solely within their own occupational classification structure. These concepts create a framework for a "job economy."

Purpose and value

An occupational classification is the logical structure used by statisticians, economists, and persons in other disciplines to describe and quantify the variety of ways in which a workforce is remuneratively employed. The actual variables that define and influence the occupational structure of the American workforce are even more complex and dynamic. The availability of a classification structure, even with inherent limitations, permits the collection of statistics that measure these variables and represent others by inference. The level of wages earned by the employed workforce is one of the most evident of such measures. In turn, these wages represent the economic contributions and productivity of various workforce segments defined in the classification structure. The products and services of the employed workforce and the market context in which they are delivered are indications of the more complex variables that shape the workforce. For example, energy production is one of society's continuing needs. Throughout a complex chain of consumer demands and production requirements, the number of persons employed in this pursuit and their corresponding wages are determined.

In its dynamic aspects, the actual workforce structure is derived from the final demand for a commercial and consumer "market basket" of products and services. The demand for products and services reflects a variety of competing requirements for the Nation's standard of living and the means to produce and maintain it. How individual occupations are structured

New NAICS industries
Semiconductor machinery manufacturing Fiber optic cable manufacturing Software reproducing Convenience stores Gasoline stations with convenience stores
Warehouse clubs and superstores Food (health) supplement stores Pet and pet supply stores Pet care services Cable networks
Satellite telecommunications Paging Cellular and other wireless telecommunications Telecommunications resellers Credit card issuing
Temporary help services Telemarketing bureaus Hazardous waste collection HMO medical centers Continuing care retirement communities
Casinos Casino hotels Bed-and-breakfast inns Limited-service restaurants Automotive oil change and lubrication shops Diet and weight reducing centers

is largely a matter of technology, a combination of human and machine technologies. Products and services themselves reflect advances in science, engineering acumen, and consumer knowledge. For example, in retail distribution, workers selling the same goods may be employed by a traditional retail outlet, a discount or warehouse store, or an Internet marketer.

Some may be inclined to view an occupational classification system as a window into the activities of the employed workforce. However, there is another, more important perspective that this discussion presents. As treated here, an occupational classification structure is more like a prism or a crystal. Depending upon our perspective—which may be political, social, economic, technological, or cultural—the same occupational classification structure can suggest a variety of different parameters that have shaped it and defined its contributions to our current standard of living and way of life. Although it is difficult to know all these parameters directly, they

may be known by inference. For example, the form and functions of products such as automobiles change as a result of science and technology. How and where these automobiles are produced is determined by technology and economic choice. The form and quality of these products often are the result of cultural preferences and education. The workforce changes subtly in response to all of these forces.

Why classify occupations?

An occupation is a group of jobs in which workers perform similar tasks, duties, or activities at similar skill levels. A job is a group of similar positions and a position is a slot in an organization occupied by a single individual.[10] Occupations may be clustered into groups based on some common element, such as similarity of work, workplace, or worker characteristics. An occupational classification system helps define the occupational structure in the workplace and provides a framework for descriptive occupational statistics, such as employment levels, job openings, earnings, and education.

There are four primary groups of users of this information:

(1) workers and potential workers needing information about likely jobs,

(2) employers needing labor market information for personnel, marketing, or planning purposes,

(3) counselors in the academic and vocational sectors, and

(4) researchers, including economists and sociologists, and related policymakers, for analyzing labor market trends, social policies, and other issues.[11]

The users of occupational information also may be grouped as micro-users and macro-users. Micro-users require information to assist in structuring jobs, defining job requirements, recruiting workers, developing career plans, seeking training opportunities, and aiding others in finding jobs and related training. Macro-users require occupational information to evaluate the structure and performance of the economy, develop models for studying labor market dynamics, identify current and potential areas of worker dislocations, promote targeted economic development efforts, and plan and implement education and training programs.

Occupations may be viewed from a survey perspective. The Census of Population and the Bureau's Current Population Survey ask open-ended questions about household members' occupations, with responses referred to as occupational titles. Census analysts group related titles, and these groups constitute census occupations. Closed-end surveys, typically of employers, provide occupational definitions that specify the range of job activities included, and data collected represent all workers whose position descriptions match these definitions.

While positions have independent existence, jobs and occupations are, in some essential way, arbitrary and artificial.[12] Most occupations do not have natural boundaries. Positions and jobs can be viewed as existing on a continuum, along which classifiers set boundaries.[13] The breadth of occupations depends, to a great extent, on the level of detail desired and the total number of occupations in a system. For example, mechanics, automotive mechanics, automobile body repairers, or automotive glass installers each could be an individual occupation. In a system with more detailed occupations, higher levels of aggregation might become minor or major occupation groups, rather than occupations. There is

tremendous potential for occupational detail. The 2000 census, for example, lists about 31,000 individual job titles, and the 1991 Dictionary of Occupational titles lists more than 12,000 jobs.

Education or skill level also may be considered in determining boundaries—for example, to ensure that there are distinctions among "professional," technician, and aide occupations in the same field or among craftworkers, (semiskilled) operatives, and helpers.[14] Use of this criterion, in particular, encourages homogenous groupings, so that meaningful inferences can be made about characteristics of individual cases. Obviously, the greater the level of occupational detail, the more homogeneity possible. However, limited sample size or inadequate responses to open-ended questions may limit the amount of occupational detail. For example, distinctions among short order, institutional and cafeteria, and restaurant cooks, or between light or delivery services and heavy and tractor-trailer truck drivers have been perennial problems in household surveys. Employer-based surveys are better at collecting this information and permit the gathering of more detail. The appropriate level of detail also may be determined by the range of job tasks. Many health technologist, technician, and therapist jobs are very specialized, with workers performing a limited range of tasks, generally specified by licensing boards. In contrast, sales jobs tend to be general, with most having common tasks.[15] This suggests that sales occupations be specified in relatively less detail than health occupations.

The collection of data describing occupations, the process of organizing it, and the analysis of occupational data require a conceptual toolkit. Definitions of terms are a logical starting point. While the 31,000 job titles in the 2000 census index have importance in general socioeconomic terms, their usefulness in economic analysis is limited by the fact that household data are reported by title, without definition and verification of job content. Even if every title were supported by a unique definition of job content that was verified, the large number of jobs makes organization and analysis of this information impossible. In order to arrive at a structure for organizing and analyzing occupations, a taxonomy built upon similarities is needed. The structure of the taxonomy should be flexible enough to admit new occupations as they develop. Similarities within and between groups

in the taxonomy are required. Work content and skill requirements are basic similarities among jobs. Formal education, licensing, and certifications are other similarities that may be considered.

For purposes of illustrating the conceptual tools used in occupational analysis, consider how the job "bus driver" presents complexities that are not evident at first glance. Bus drivers differ and share similarities based upon the points they connect and the distances they drive. Likewise, they may operate commercial vehicles of various sizes. Bus drivers convey different groups of passengers with varying needs for assistance, such as those related to infirmities and disabilities, luggage, special fare rates, and safety requirements. There may be different legal and licensing requirements for operation of certain classes of vehicles or groups of passengers. A taxonomy for "bus drivers" must take these similarities and differences into account. In the Standard Occupational Classification (SOC) system (p. 106), bus drivers who drive large commercial buses on a scheduled basis over regular routes, on charters, or as private carriage are classified as "bus drivers, transit and intercity." Those who transport students or special clients such as the elderly or disabled are classified as "bus drivers, school." Consider now the complexity of following this same process in developing a taxonomy for 31,000 jobs that can be reduced to a manageable and meaningful number of detailed occupations about which survey data can be collected and analyzed.

There have been two basic systems used to classify occupations. One, classifying occupations by the industry in which they are concentrated, was used by the Decennial Census of Population through 1930. The other, classifying by some combination of several factors—nature of the work performed, skill level, education requirements, and socioeconomic class, with only minor regard for industry in which occupations are concentrated—has been used in all later systems.

No single classification system can create occupational groupings to suit all purposes. For example, systems based solely on work performed do a poor job of grouping occupations by required level of education.[16] The greater the level of occupational detail, the easier it is to rearrange occupations to meet alternative analytical purposes.

The distinction made between the characteristics of workers and those of occupations is useful for purposes of discussing supply and demand dynamics that may determine the content of occupations. These two sets of characteristics overlap and interact in the definition of particular occupations and in the determination of the wages that the incumbents are able to earn. When worker characteristics are defined in job terms, the result is a definition of employer demand requirements. Conversely, when worker characteristics are defined in terms of education, training, and skills; the resulting definition represents the supply of workers. These distinctions come into practical play when surveyed work content is classified. For example, work performed is defined by employers, while education and skill represent assets that workers bring to bear in performing the defined work. Sometimes, problems may arise when classifying occupations because worker characteristics such as education, licenses, and certifications may be assigned undue importance in defining the skill requirements for the performance of certain work. Given jobs may be performed within a wide range of educational accomplishments and skills. Any imposing of a particular educational or performance level in defining an occupational category might artificially disassociate occupational categories that have the same performance requirements. Accepting a wider range of educational and skill qualifications in job definitions will result in a wider range of associated wage rates. These wage rates might be the best reflection of the interaction between the characteristics of occupations and the characteristics of workers.

New occupations can be added or rapidly growing ones split, while declining occupations can be combined or deleted to reflect the changing distribution of employment or the effect of new technologies and business practices. Some "new" occupations are, in fact, simply spin-offs of long-existing occupations. New job tasks generally are first assumed by workers experienced in related tasks in existing occupations. These tasks may remain comfortably classified within existing occupations or may eventually be spun off.

To determine which jobs are appropriate for spin-offs, occupational classification specialists look for groups of jobs 1) with tasks and activities that are sufficiently distinct from those of other jobs, and 2) that show potential for growth. They rely on anecdotal evidence; labor market research, such as that conducted by Occupational Analysis Field Centers;[17] large

numbers of responses on census questionnaires; or employer responses to questions about occupations not listed on survey forms. Early identification of new jobs that require formal training is important so that data for career guidance and education planning can be collected. Yet, this can be difficult. Many groups of jobs identified as "new and emerging" in the past never grew much or received further attention.[18] In contrast, computer jobs, which might have been identified as occupations during the 1950's, were not, but it was not then obvious that computers had enough applications to support much employment growth.[19]

The current occupational employment information obtained from employers has no immediate, direct use in the study of labor market mobility dynamics. Data needed for mobility studies are collected through surveys that follow individuals over time, such as the Current Population Survey. While it is theoretically possible to discuss the elasticities of worker job choices within and among industries, the data needed to test related hypotheses currently are unavailable or imprecise. Similarly, the elasticities of employer demand for workers existing between a given occupational category and closely related categories cannot be gleaned from available data at this time, and no known plans exist for collecting suitable data in the near future.

Some economists have identified what they consider economic criteria for the structuring of occupational classification based on elasticity criteria. These are standardization of occupational classifications, adaptability to change over time, ability to reflect technological change, responsiveness to changing educational policy, and the range of substitution possibilities available to employers. If all these criteria were met, the available occupational information would provide a consistent framework within which to study employer selection decisions and worker job choices. The current SOC system is a move in the direction of providing a needed standardized framework within which worker mobility may be studied.

The early census approach
The 1900 census specified 475 occupations (but published data on 303), developed from about 17,000 titles; the 2000 census allowed for 503 occupations, developed from about 31,000 titles. From 1870 to 1930, census occupations were organized within an industrial framework. Occupations were placed in the industry of greatest employment, even if much of their employment was in other industries. (Several of the industries, however, may be more accurately described as service groups.) The 1900 census specified five major categories:

(1) Agricultural pursuits

(2) Professional service

(3) Domestic and personal service (including health, food service, and protective service)

(4) Trade (including banking, insurance, and real estate) and transportation (including communication)

(5) Manufacturing and mechanical pursuits (including construction, fishing, and mining)

The 1910 census was expanded to allow for nine major occupational categories.[20] There also were numerous subgroups, consisting mostly of managers, foremen, operatives, or laborers specified by detailed industry, but few occupational subgroups. This system generally grouped occupations producing similar goods and services and located on the same promotion ladders—for example, helpers and apprentices, journey-level workers, supervisors, and managers.

The revised census approach
In 1938, the American Statistical Association and the Central Statistical Board appointed a joint committee on Occupational Classification to devise a standard classification. (The Board also formed a committee on Industrial Classification, as discussed in the previous section.). This classification was based on some combination of similarity of work, education requirements, skill level, and socioeconomic class, with only minor regard for industry in which occupations were concentrated. It was first used in the 1939 Dictionary of Occupational Titles (DOT), published by the U.S. Employment Service (USES) to present job descriptions and other nonstatistical information about occupations. It also was used, with some modification, to organize data on occupations collected in the 1940 census. The revised census scheme consisted of 11 major groups:

(1) Professional and semiprofessional

(2) Farmers and farm managers

(3) Proprietors, mangers, and officials, except farm

(4) Clerical, sales, and kindred workers

(5) Craftsmen, foremen, and kindred

(6) Operatives and kindred workers
(7) Domestic service workers
(8) Protective service workers
(9) Service workers, except domestic and protective
(10) Farm laborers and foremen
(11) Laborers, except farm

Occupations with similar work functions were placed in the same group and groups were arranged in a hierarchical system that corresponded, more or less, with skill and training level and socioeconomic status.[21] The new system grouped all managers together, and did the same for craftworkers, operatives, and laborers. Sales workers, who had been grouped with wholesale and retail dealers and managers and other workers in the trade group, were now combined with clerical workers.[22] The domestic and personal service group was split, and the professional service group became professional and semiprofessional workers.[23] These major groups were more homogeneous than the industry groups.

The 1940 census system had another advantage. It permitted tabulation of wage and salary employment data by industry *and* occupation,[24] and calculation of occupational staffing patterns—each occupation as a percent of total employment in every industry. This made possible construction of the BLS Industry-Occupation matrix, a key tool in developing occupational employment projections.[25] However, the system, like its predecessor, lacked occupational subgroups; within groups, occupations were simply listed alphabetically.[26]

A period of transition

Since the 1960s, policymakers, academicians, government administrators, and researchers have independently recognized the changing character of the American economy. Some might term it a mature economy; others might characterize it as "post-industrial"; many see it as part of a global network; and others see it as a high-technology economy, characterized by knowledge industries. All of these observers are reporting on or projecting the changing character of the "work structure" of the economy. The results of this recognition have contributed to major paradigm shifts in the way in which America's industries will be viewed. The change from the Standard Industrial Classification system entailed a change in fundamental concepts, defining industries in terms of processes rather than products. The change from the census system of classifying occupations to the SOC system involved a movement from a mixed system of classification to a system based entirely on work performed and related skills. The SOC system further incorporates structural features that free occupational classification from its previously industry-rooted structure.

In 1965, the then Bureau of the Budget asked 28 agencies about the desirability of establishing a standard classification system for occupations, corresponding to the SIC for industries. It was prompted by a desire to provide more comparability among occupational statistics prepared by Federal agencies and other organizations. Based on responses to this letter, the Bureau appointed an Interagency Occupational Classification Committee to provide recommendations on a new classification system. The committee first met in 1966, and preliminary work was incorporated into the 1970 census. For example, professional, technical, and kindred workers (professional and semiprofessional in the 1940 census was renamed in 1950) were organized into a number of minor groups, replacing the 1960 census alphabetical listing. These minor groups included computer specialists (three computer occupations were created in 1970); teachers, except college; writers, artists, and entertainers; and three health occupation groups. A *Standard Occupational Classification Manual* was published in 1977, and was revised in1980 (in time for the 1980 census) and again in 2000 (for the 2000 census).

The SOC system classifies occupations on the basis of work performed and on required skills, education, training, and credentials, as did the 1940 census system.[27] The 2000 SOC has 23 major groups, which generally correspond to or are disaggregations of 1940-70 census major groups.[28] It provides much more hierarchical structure, with 96 minor occupation groups and more occupations—821. The census professional and technical group was split into eight major groups, corresponding to minor groups in the 1970 census, with some combining and reconfiguration, reflecting the growing number of professional and technical occupations. Service workers were allocated among five major groups, and craftworkers (including construction), extraction workers, mechanics and repairers, and precision production workers, operatives, and laborers were allocated among four major groups.

The 2000 SOC structure is shown in exhibit 2. The SOC also provides an aggregation (intermediate level) of these 23 groups into 11 groups. A comparison of the 23-group and the 11-group categories makes clear how the SOC evolved from the census structure. The intermediate grouping is shown in exhibit 3.

Response of the classification system to new products, technologies, and other changes

This section discusses classification system responses to three 20th century products or technologies—motor vehicles, airplanes, and computers—and three changes in the methods and organization of production—the growth of science and engineering, the advent of mass production, and the rise of bureaucratic organizations. The character of work has changed at an accelerating rate during the past 100 years. The organization of work in terms of jobs or positions reflects ongoing changes in the structure and nature of capital stocks, progress in the development of technologies, changes in the structure of product and factor markets, and rising levels of education and training. The increasing rate of change in the structure of work in the American economy requires a corresponding increase in the ability of employers to create jobs and positions that utilize the full economic talents of workers and in opportunities for workers to obtain the education and training needed for these jobs and positions.

The development of motor vehicles radically changed transportation. It also gave rise to many new occupations and caused the decline of others. In 1900, there were only 8,000 registered motor vehicles. The first mass-produced car was introduced in 1901, and the first practical vehicles were produced by 1903. Automobile industries developed rapidly thereafter and, by 1910, there were nearly half a million automobile and 10,000 truck registrations. By 1920, there were 8 million automobile and 1.1 million truck registrations. As a result, six motor vehicle-related occupations were added in the 1910 census: two repair-related—garage owners and managers and garage laborers; two automobile factory-related—semiskilled operatives and laborers; retail automobile dealers; and motor vehicle drivers, called chauffeurs. However, attempts to distinguish chauffeurs and other motor vehicle drivers from drivers of vehicles using draft animals—draymen, teamsters, and express-

men; and carriage drivers and hacks—in data collection were not very successful.[29] A seventh occupation—automobile mechanics—appeared in the 1910 *Index to Occupations*, but no data were published for it until 1930.[30] Retail dealers, gasoline stations; and laborers and helpers, auto stores and filling stations also appeared in the classification system in 1930, and attendants, filling station and parking lot, were included in 1940.

As the use of motor vehicles spread, employment related to horse-drawn vehicles declined sharply. In the 1930 census, livery stable managers and foremen of livery companies were downgraded to titles within the category of transportation managers and transportation foremen. Draymen and teamsters were combined with carriage drivers in 1930, but the combined occupation (name shortened to Teamsters in 1940) remained an occupation until 1980, when it was downgraded to a single title within the category of miscellaneous material moving equipment operators. Also in 1940, hostlers and stable hands were downgraded to titles in laborers (not elsewhere classified) and operatives in wagon and carriage factories and, in harness and saddle factories, to titles within operatives (not elsewhere classified). In the 1950 census, bus, taxi, and truck drivers were separately enumerated and so, in the 1970 census, were automobile body repairers. The 2000 SOC specified two types of bus drivers and truck drivers, and separated a new specialty—automobile glass installers and repairers—from other body repairers, reflecting the shift of much auto glass work to specialized glass shops.

Aviation industries, although highly visible, developed much more slowly than did automobile industries, and this was reflected in much slower change within the classification system. While the first heavier-than-air flight took place in 1903, scheduled air transportation did not begin until 1926. Aircraft technology and production and air transportation developed during the 1930's and World War II, but air passenger and freight traffic were not significant economic activities until the 1950's.

The occupation of aviators appeared in the 1910 census (as "aeronauts"), classified under showmen, which also included titles such as athletes, balloonists, and performers; in 1920, aviators became a separate occupation. Aircraft mechanics appeared as a title under other mechanics in 1920 and as an occupation in its own right in 1930. Three air transporta-

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tion industry occupations—proprietors, managers, and officials; foremen and overseers; and laborers—also were added to the job classification in 1930, even though the industry was small. Aircraft manufacturing operatives appeared as a title in 1920 and as an occupation in 1940. Aeronautical engineers, which also appeared as a title in the 1920 census under mechanical engineers, became an occupation in 1950.[31] Airline stewardesses appeared as a title in 1940 under registered nurses, reflecting the requirement that they be nurses, presumably to deal with passengers' discomforts from unpressur-ized cabins and air-sickness. The nursing requirement was soon removed and, in 1950, the title was shifted to the housekeepers and stewards category; in 1970, airline stewardesses became an occupation. Air traffic controllers also appeared in 1940—as airport control operators, a title within radio and wireless operators—and became an occupation in 1970.

Electronic computers, an outgrowth of mechanical and punchcard-based calculators and computers, have given rise to a number of occupations. The first commercial electronic computer was delivered to the Bureau of the Census in 1951.[32] Programming languages soon were introduced, and increased capacities and speed led to the widespread adoption of computers, with continued expansion, including the development of networks, during the 1990's.

Calculating machine operators and tabulating machine operators first appear as titles in the 1920 census within other clerks and, in 1940, within office machine operators. Systems engineers (in SIC 357, office machine manufacturing), first appeared as a title in the 1950 census—not within engineers, but in the category, all other professional and technical workers—and, according to the 1949 Dictionary of Occupational Titles, devised procedures for use of punchcard-based systems. Computer programmers, computer systems analysts, and computer specialists (not elsewhere classified) first appeared as titles in the 1960 census (under professional, technical, and kindred workers, not elsewhere classified) and by 1970, all three were designated as occupations. Computer operators and data processing machine repairmen also were added in 1970. The 2000 SOC lists 12 computer specialists, including computer engineers, computer support specialists, database administrators, network and computer systems administrators,

and network systems and data communications analysts, placed in a computer and mathematical science occupations major group.[33]

All engineers appeared in the 1870 census as one occupation. The 1900 census classified a number of engineering branches into three categories: civil; chemical, metallurgical, and mining; and mechanical, electrical, and all other. As employment grew, branches specified in 1900 were separated; in 1940, industrial engineers were added and, in 1950, aeronautical engineers. The 1970 census separated petroleum engineers from mining and, in 1980, nuclear engineers were separated from electrical engineers. The 2000 SOC lists 19 types of engineers, including biomedical and environmental, and classifies engineers in a major occupation group, along with architects and surveyors.[34]

The 1900 census had only one scientific occupation, chemists, assayers, and metallurgists. However, it listed astronomer, bacteriologist, botanist, entomologist, geologist, mathematician, and paleontologist titles under other professional pursuits.[35] Titles were added in following censuses, and these were combined in 1950 into six occupations—agricultural scientists, biological scientists, geologists and geophysicists, mathematicians, physicists, and miscellaneous natural scientists. (Data were not published for these groups until 1960.) The 1970 census added atmospheric and space scientists and marine scientists. The 2000 SOC listed 21 natural scientist occupations, including biochemists and microbiologists, classified into both life scientist and physical scientist minor groups. As science and engineering became more institutionalized, the role of inventors declined. Inventor, a separate occupation since 1900, was downgraded to a title within professional workers (not elsewhere classified) in 1940.

Statisticians became a title (under other professional pursuits) in the 1900 census,[36] as did psychologists in 1920 and economists in 1930; these three, along with miscellaneous social scientists, became occupations in 1950. (Data were not published until 1960.) The 1970 census added political scientists, sociologists, and urban and regional planners, and the 2000 SOC included market research analysts and survey researchers.

By 1900, mass production, using power machinery and characterized by minute division of labor, was replacing handcraft, and semiskilled operatives were replacing craftworkers.

In response, the 1910 census greatly expanded the number of manufacturing industries for which it showed semiskilled operatives (not elsewhere classified). In addition, it downgraded a number of craft occupations, such as broom and brush makers, glovemakers, leather tanners, and tool and cutlery makers, to titles within semiskilled operatives (not elsewhere classified). Later censuses downgraded other occupations, including blacksmiths, coopers, glass blowers, and potters. Some new manufacturing occupations, such as computer-controlled machine-tool operators, fiberglass laminators and fabricators, and team assemblers were added. However, reflecting the relative decline of manufacturing employment, the share of of production occupations among all occupations decreased from more than 2 out of 5 in the 1900 census to about 1 in 6 in the 2000 SOC.

The growth of bureaucratic organizations and specialized administrative activities gave rise to new business and financial operations occupations and their classification as a major occupation group in the 2000 SOC. Accountants and auditors is the only occupation in this group that existed in the 1900 census classification, although there were insurance examiners and adjusters, purchasing agents and buyers, loan agents, and various government inspector titles at that time. Purchasing agents and buyers and inspectors, government were added in 1940 and personnel and labor-relations workers and insurance adjusters, examiners, and investigators, in 1950. In the 1980 census, a management-related occupations minor group, which eventually became the business and financial operations major group in the 2000 SOC, was created. It also included management analysts, underwriters, and other financial officers. The 2000 SOC lists 30 occupations in this group, including 4 personnel and labor relations occupations, cost estimators, financial analysts, and meeting and convention planners.[37]

The Occupational Employment Survey
Occupational information has always been a component of population data. However, its current economic importance can be traced back to the regional loss of jobs in the 1950s in both the automobile and textile industries. Competition in the auto industry led to the closing, consolidation, or relocation of several Detroit-area automobile manufacturers and to periods of extended unemployment for the

workers affected. Similarly, the textile industry in the New England States experienced relocations of major mills to the south. During this period and in response to these situations, the Manpower Development and Training Act of 1962 was enacted, and responsibility for its implementation and administration initially was given to the U.S. Department of Labor's Bureau of Apprenticeship and Training. This act was the progenitor of a series of workforce training acts that have culminated in the current Workforce Investment Act of 1998, administered by the Labor Department's Employment and Training Administration. All of these acts have in common the fact that labor market information at the detailed occupational level is necessary for their proper administration. This information serves to identify areas of demand for workers and requirements for their training. These developments explain the early and continuing efforts of the Bureau of Labor Statistics (BLS) to provide occupational information and statistics to an increasing range and number of users.

Starting in 1959, BLS began collecting information through employer surveys of 18 scientific, engineering, and technical occupations.[38] This experience helped guide a series of pilot studies during the 1960s to test the feasibility of collecting occupational information for a larger number of occupations. In 1968, a comprehensive survey of the metalworking industries was conducted to collect data on 54 clerical and blue-collar occupations. The printing and publishing industry was surveyed in 1970 using a list of 97 occupations. Various tests of mailed structured and unstructured data collection techniques were made during this period, and it was determined that mailed structured techniques including lists of defined occupations were necessary to develop useful and comparable data.

In 1971, the first Occupational Employment Statistics (OES) survey was completed through the cooperation of BLS and 15 participating States, with support from the U.S. Department of Labor's Manpower Administration (the predecessor of the current Employment and Training Administration). During the 1973-76 period, an expanded survey, with data collected by 29 States, was completed. For purposes of completing the national data framework, information for the remaining States was collected by the BLS Washington office. The first national estimates for occupational employment were

completed in 1977. The number of occupations included in the survey was 2000 in 1970 and 800 in 1980, reflecting the experience gained by program personnel in collecting useable occupational information.

Throughout the historical development period of the OES survey, the Standard Occupational Classification (SOC) system originated, evolved, and matured into its current form as a skills-based occupational classification system. During the 1970s, the U.S. Office of Management and Budget attempted to have an SOC system incorporated into the1980 census. The 1980 SOC had 664 detailed occupations, compared with the 750 then found in the extant OES classification system. The two systems both were in use (along with several others) until 2001, when the SOC became the governmentwide standard.

Beginning with the 1999 survey, the OES survey questionnaire was converted to reflect the SOC coding system. About 400 of the SOC-based occupations matched to old OES occupations on a one-to-one or many-to-one basis, at least conceptually. The goal of matching the SOC occupations to the old OES occupations was to maximize the number of publishable estimates.

The 1998 OES survey occupational titles and definitions were based on the old OES coding structure and definitions. For the 1999 survey, however, the SOC was the source of the OES occupational titles and definitions. Even for the approximately 400 occupations whose definitions basically matched on a one-to-one or many-to-one basis between the two surveys, there were slight and subtle differences in the occupational titles and definitions that may have affected reporting by the respondents.

Patterns of change in the OES and SOC occupational classification systems

An ever-present issue in the process of developing and using an occupational classification system to collect employment data is the inherent conflict between collection of data to form a valid and reliable data series and use of a structure that permits and identifies changes in the occupational composition of the employed workforce. A related issue involves validity and reliability of data obtained from supply-side respondents in household surveys versus that obtained from demand-side respondents who are employers. Three problems

associated with this issue are the volume, variety, and comparability of responses that identify occupations by as many as 31,000 titles, and possibly even more variations on these.

The range of methodologies for addressing these issues starts, on one hand, with the use of unstructured responses, such as those that the census elicits and that are subsequently placed within a classification structure. At the other extreme are closed classification structures that place choices into a limited number of fixed categories. All structured classification systems include a category of "residuals." The use of a classification that includes "all others" is a way of providing flexibility and realizing economies in collecting data that would otherwise be ignored or forced into an inappropriate classification. The occupational classification systems of the OES are structured systems that include categories of residuals at various levels of detail.

The patterns of change in census occupational categories are known to reflect changing socioeconomic conditions in which the Nation's policymakers and administrators might be interested. The earliest choices of occupations to be surveyed in the OES program were those identified on an industry basis—for example, occupations found in metalworking, printing, and electrometallurgical industries. The early OES surveys were considered to be pretests for the evaluation of survey tools that included structured and unstructured alternatives.

In the first attempts to implement a comprehensive occupational survey, BLS staff used the *Dictionary of Occupational Titles* and other sources to develop lists and definitions of occupations for each industry. These were reviewed by State agencies, the U.S. Manpower Administration (precursor of the U.S. Employment and Training Administration), trade unions, employer associations, and a cross-section of 535 manufacturing firms. Comments and suggestions from these various reviewing sources were incorporated in the job list and definitions. To make the survey tools manageable and to avoid placing unnecessary burdens on employers, occupational lists were tailored to the identified staffing patterns of particular industries. This practice continues today.

The major changes in occupational classifications from the OES system to the SOC system were intended to achieve the following:

(1) Increased emphasis on the business and financial operations that constitute the support for management occupations,

(2) A greater delineation and explication of the professions, including:
- Computer and mathematical occupations
- Architecture and engineering occupations
- Life, physical, and social science occupations
- Community and social services occupations
- Legal occupations
- Education, training, and library occupations,

(3) A more detailed specification of service occupations, including:
- Arts, design, entertainment, sports, and media occupations
- Healthcare support occupations
- Protective service occupations
- Food preparation and serving related occupations
- Building and grounds cleaning and maintenance occupations
- Personal care and service occupations, and

(4) Increased coverage of installation, maintenance, and repair occupations.

The former OES classification system was at its most extensive in 1970, including as many as 2,000 occupations. In 1980, the OES classification system was based on approximately 800 occupations. While a direct cross-walk from the former OES occupations to the SOC detailed occupations is not possible because of the many splits and consolidations of old occupations into new occupations, it is noteworthy that a core of approximately 800 occupations make up the skill-based foundation of the current SOC classification system.

As was the practice in census classifications and in the OES classification, the SOC system retains the use of residual categories at all levels below the major level. This feature permits the coding of new and emerging occupations to be done during the initial data collection. Over time, it also permits the collection of sufficient data on these emerging occupations to justify their explicit, detailed identification at the detailed occupation level of the SOC system.

Future Directions

One may rightly ask what has been accomplished and where are we going. The answer is that a new framework has been laid for continued development of information, policy, and programs that will ensure continued industrial development and full utilization of the Nation's workforce. It may be difficult to see at this time how such a process-based system for industry information will contribute. But, consider that we are in the midst of an economy with an increasingly important service sector that needs to be nurtured and further developed. Look at the unexplored impacts of recent technology changes and consider our gaining an increased ability to define new production and employment opportunities. Take into account the fact that a dynamically changing economy must be able to offer its citizens education or programs to develop skills needed to enjoy new jobs. Existing workers should have mobility opportunities based on recognition that skills are not tied to a particular industry or job title. These new strengths depend upon developing and using the kinds of information and analyses that can put workers, educators, employers, and various workforce program administrators abreast or ahead of changing conditions. This will not happen overnight. These new systems are now being put into use. They are the right answer for guiding the Nation's economy into Millennium 2000.

While it is too early to point to realized benefits, some gains from the new framework for occupational analysis can be anticipated. First and foremost, more informed policy attention will be directed to changing job conditions, availability, and impacts, in our economy. Intra- and interindustry skill requirements will be better defined; and future education and training programs will contribute to enhanced worker mobility and increased employer willingness to hire outside of traditional industry patterns of requirements. Changes at the industry level will be better accommodated by the increased mobility opportunities of workers. Over the long-term, the role of work in defining socioeconomic status will be diminished in favor of increasing the economic importance of an individual's education and planned acquisition of skills.

Exhibit 1. **NAICS implementation schedule for major statistical programs**

Program	Data reference year	Publication date
CENSUS BUREAU PROGRAMS		
1997 Economic Census		
Advance employment, receipts, and payroll	1997	1999
Comparative Statistics Report	1997	January 2000
Bridge Between NAICS and SIC	1997	March 2000
Manufacturing surveys		
Annual Survey of Manufactures	1998	June 2000
Current Industrial Reports	1998	2000
Manufactures Shipments, Inventories, and Unfilled Orders	2001	2001
Services surveys		
Annual Trade Survey (wholesale)	1998–99	March 2001
Wholesale Trade Monthly	2001	2001
Annual Retail Trade Survey	1998—99	April 2001
Retail Trade Monthly	2001	2001
Transportation Annual Survey	1998—99	February 2001
Service Annual Survey	1998—99	February 2001
Other programs		
County Business Patterns	1998	March 2000
Quarterly Financial Report	Fourth-quarter 2000	March 2001
Annual Capital Expenditures Survey	1999	February 2001
Manufacturing and Trade Inventory and Sales	2001	2001
Research and Development Survey	1997—98	April 2001
BUREAU OF ECONOMIC ANALYSIS PROGRAMS		
Foreign Direct Investment Benchmark Survey	1997	1999
U.S. Direct Investment Abroad Benchmark Survey	1999	2001
Annual Foreign Direct Investment Survey	1998	2000
Annual U.S. Direct Investment Abroad Survey	2000	2002
Quarterly Foreign Direct Investment Survey	2001	2001
Quarterly U.S. Direct Investment Abroad Survey	2002	2002
Benchmark Input-Output Accounts	1997	2002
Corporate Profits	1998	2001
State Personal Income	2000	2001
Gross Product Originating by Industry	2001	2002
Real Inventories, Sales, and Inventory-Sales Ratios, Manufacturing and Trade	2001	2002
Gross State Product by Industry	2001	2003
BUREAU OF LABOR STATISTICS PROGRAMS		
Employment and Wages Report (annual)	2000	2001
Current Employment Statistics survey (monthly)	2002	2003
Occupational Employment Statistics (annual)	2002	2003
Producer Price Index/1997 Net Output Indexes (monthly)	1997	2004

Exhibit 2. **Structure of Standard Occupational Classification (SOC) 2000**

SOC code	Major group
11-0000	Management occupations
13-0000	Business and financial operations occupations
15-0000	Computer and mathematical occupations
17-0000	Architecture and engineering occupations
19-0000	Life, physical, and social science occupations
21-0000	Community and social services occupations
23-0000	Legal occupations
25-0000	Education, training, and library occupations
27-0000	Arts, design, entertainment, sports, and media occupations
29-0000	Healthcare practitioner and technical occupations
31-0000	Healthcare support occupations
33-0000	Protective service occupations
35-0000	Food preparation and service related occupations
37-0000	Building and grounds cleaning and maintenance occupations
39-0000	Personal care and service occupations
41-0000	Sales and related occupations
43-0000	Office and administrative support occupations
45-0000	Farming, fishing, and forestry occupations
47-0000	Construction and extraction occupations
49-0000	Installation, maintenance, and repair occupations
51-0000	Production occupations
53-0000	Transportation and material moving occupations
55-0000	Military-specific occupations

Exhibit 3. **Intermediate-level Standard Occupational Classification (SOC) grouping**

SOC code	Intermediate grouping
11-13-000	Management, business, and financial
15-29-000	Professional and related
31-39-000	Service
41-0000	Sales and related
43-0000	Office and administrative support
45-0000	Farming, fishing, and forestry
47-0000	Construction and extraction
49-0000	nstallation, maintenance, and repair
51-0000	Production
53-0000	Transportation and material moving
55-0000	Military

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[1] Joseph W. Duncan and William C. Shelton, *Revolution in United States Government Statistics 1926-1976* (Washington, U.S. Department of Commerce, October 1978).

[2] For a fascinating discussion of the most critical technological developments of the past century, see Robert J. Gordon, "Does the 'New Economy' Measure Up To the Great Inventions of the Past?" Working Paper 7833 (Cambridge, MA, National Bureau of Economic Research, August 2000).

[3] An interesting history of the economic census program from its inception in 1810 is included in *History of the 1997 Economic Census* (U.S. Census Bureau, July, 2000).

[4] Lawrence F. Schmeckebier, *The Statistical Work of the National Government* (Baltimore, Institute for Government Research, Johns Hopkins Press, 1925).

[5] For good surveys of the history of the Federal statistical system, see Duncan and Shelton, *Revolution in United States Government Statistics 1926-1976*; Joseph P. Goldberg, and William T. Moye, *The First Hundred Years of the Bureau of Labor Statistics* (Washington, U.S. Department of Labor, September 1985); and Richard B. Morris, ed., *U.S. Department of Labor Bicentennial Histroy of the American Worker* (Washington, U.S. Department of Labor, May 1976).

[6] Esther Pearce, "History of the Standard Industrial Classification," unpublished memorandum (Washington, Office of Statistical Standards, Bureau of the Budget, Executive Office of the President, July 10 1957).

[7] For a full background discussion of many of the drawbacks of the SIC, refer to the series of *Issues Papers* published by the Economic Classification Policy Committee: "No. 1: Conceptual Issues," February 1993; "No. 2: Aggregation Structures and Hierarchies," February 1993; "No. 3: Collectibility Issues," May 1993; "No. 4: Criteria for Determining Industries," October 1993; "No. 5: The Impact of Classification Revisions on Time Series," July 1993; and "No. 6: Services Classifications," February 1993.

[8] *North American Industry Classification System* (Washington, U.S. Office of Management and Budget, 1997).

[9] *New Data for a New Economy* (Washington, Economic Classification Policy Committee, 1997).

[10] See *Standard Occupational Classification Manual, 2000* (Washington, U.S. Office of Management and Budget, 2000); and J.W. Cunningham, Donald W. Drewes, and Thomas Powell, "Framework For A Revised Standard Occupational Classification," Paper presented before the Standard Occupational Classification Revision Policy Committee, Seminar on Research Findings, Apr. 11, 1995, pp. 69 and 91. Tasks generally are specified in employer position descriptions and as part of job titles in the Dictionary of Occupational Titles and the O*NET.

[11] Peter Capelli, "Conceptual Issues in Developing a System for Classifying Occupations," Paper presented before the Standard Occupational Classification Revision Policy Committee, Seminar of Research Findings, Apr. 11, 1995, pp.13-14

[12] Capelli, "Conceptual Issues," p. 8.

[13] Capelli, "Conceptual Issues," p. 10.

[14] Or other differences. For example, psychiatrists, clinical psychologists, mental health social workers, and substance abuse and behavior disorder counselors all have some common job tasks, but each is generally classified with occupations that have similar education backgrounds and licensing. Location or population served may also be factors, for example, to distinguish between elementary, secondary, college and university, and adult education teachers.

[15] James G. Scoville, *The Job Content of the U.S. Economy 1940-70* (New York, McGraw Hill Book Company, 1969), pp. 18-19.

[16] In 1996, the BLS occupational projections program grouped occupations by 13 levels of education and training categories, ranging from professional or doctoral degree to short-term on-the-job training.

[17] Operated by the State employment services. See *Dictionary of Occupational Titles, 4th ed.* (Washington, U.S. Department of Labor, Employment and Training Administration, 1977), pp. ix and xiv.

[18] See, for example, Paulette Meleen and others, *Identifying and Planning for New and Emerging Occupations: A Suggested Guide* Belmont, MA, Contract Research Corporation, 1976.)

[19] During the early years of computers, responsibility for education and training re-

sided almost exclusively with computer manufacturers, who provided it to the staffs of their customers. Educational institutions lacked both expensive computer equipment and the people qualified to teach other to use it.

[20] Trade and transportation industries were split; extraction of minerals and public service, not elsewhere classified (including protective service occupations) became separate industry groups; and clerical occupations, except those related to transportation, were placed in a separate group.

[21] While there is little direct reference to social status in most census publications, a report by Dr. Alba M. Edwards, *Comparative Occupations Statistics for the United States, 1870 to 1940*, pp. 176-77, provides a much more socioeconomic approach. Edwards offers a modified classification to provide a closer approximation to socioeconomic class:

Professional persons

Proprietors, managers, and officials (including farmers)

Clerks and kindred (including sales) workers

Skilled workers and foremen

Semiskilled workers

Unskilled workers, including laborers and servant classes

The service worker categories are eliminated, with household workers included with unskilled workers, police and firemen with skilled workers, and most others with semiskilled workers. The goal was a classification more useful for analyzing social and economic problems.

[22] Clerical and sales were separated in 1950 and transportation equipment operatives were separated from operatives, except transportation, in 1970.

[23] This may be the most heterogeneous group in terms of work function, but the common element in this group is "performs advisory, administrative, or research work which is based upon the established principles of a profession or science… and requires …training equivalent to that represented by graduation for a college or university…or extensive prac-

tical experience." See *Classified Index of Occupations* (Bureau of the Census, 1940), p. 2. This group was renamed professional, technical, and kindred in 1950.

[24] See Population, the Labor Force (sample Statistics) Occupational Characteristics, Table 19, Occupation of Employed Persons by Industry and Sex for the United States, March 1940. It showed 116 occupations for men and 52 for women, by 132 industries.

[25] See *BLS Handbook of Methods*, Bulletin 2490 (Bureau of Labor Statistics, April 1997), pp. 125-26.

[26] The only exceptions were engineers, and mechanics and repairmen.

[27] *Standard Occupational Classification Manual 2000*, p. xii.

[28] The 1980 SOC had 22.

[29] See Edwards, *Comparative Occupations Statistics*, p. 109, fn. 130.

[30] In 1920, titles such as auto mechanic and auto repairer were placed in an other mechanic category.

[31] Automotive engineers, which also appeared as a title in 1920 under mechanical engineers, never became a separate occupation.

[32] C. Joseph Pusateri, *A History of American Business* (Arlington Heights, IL, Harlan Davidson, Inc., 1984), p. 280.

[33] One of the twelve, computer (hardware) engineers, is classified under engineers and another, computer and information systems managers, under management occupations.

[34] Engineering managers are under management occupations.

[35] No *Classified Index* is available for 1900; these titles are listed in the 1910 *Index*, which is based on the occupations returned at the 1900 census, supplemented with about 400 other occupations added in the 1910 census.

[36] Ibid.

[37] There also was a vast increase in the number of office and administrative support (clerical) occupations between 1900 and 2000.

[38] With support from the National Science Foundation.

Annex A.

The first NAICS-based data collection effort

The first look that NAICS users have had at data developed under the new industry classification system is the 1997 Economic Census.[1] Beginning in early 1999 with the *Advance Report*, the U.S. Census Bureau has maintained a demanding schedule that culminated early in 2001 with the full release of the 1997 Economic Census. For the first time, all of the data from this major periodic effort are being released on the Internet to facilitate their dissemination and use. Table A-1 presents a sample of the data, sorted by major NAICS sector.

From any of the industry sectors in table A-1, the analyst can move down to the subsector level. For example, the subsectors underlying the NAICS information sector are presented in table A-2.

Finally, the subsector data can be further subdivided into industry groups (four-digit NAICS) and into international (five-digit) and U.S. (six-digit) industries. Table A-3 shows what the data look like for information subsector 514—information services and data processing services.

Table A-1. Economic Census summary statistics, 1997

NAICS code	Description	Establish-ments	Sales, receipts, or shipments ($000s)	Annual payroll ($000s)	Paid employees
21	Mining	25,000	173,988,778	20,798,257	509,006
22	Utilities	15,513	411,713,327	36,594,684	702,703
23	Construction	656,434	858,581,046	174,184,604	5,664,840
31-33	Manufacturing	363,753	3,842,061,405	572,101,070	16,888,016
42	Wholesale trade	453,470	4,059,657,778	214,915,405	5,796,557
44-45	Retail trade	1,118,447	2,460,886,012	237,195,503	13,991,103
48-49	Transportation and warehousing	178,025	318,245,044	82,346,182	2,920,777
51	Information	114,475	623,213,854	129,481,577	3,066,167
52	Finance and insurance	395,203	2,197,771,283	264,551,401	5,835,214
53	Real estate and rental and leasing	288,273	240,917,556	41,590,766	1,702,420
54	Professional, scientific, and technical services	621,129	595,250,649	231,398,791	5,361,210
55	Management of companies and enterprises	47,319	92,473,059	154,177,673	2,617,527
56	Administrative support and waste management	276,393	295,936,350	137,336,983	7,347,366
61	Educational services	40,936	20,439,028	6,364,527	321,073
62	Health care and social assistance	645,853	885,054,001	378,205,694	13,561,579
71	Arts, entertainment, and recreation	99,099	104,715,028	32,787,273	1,587,660
72	Accommodation and food services	545,068	350,399,194	97,007,396	9,451,226
81	Other services (except public administration)	519,715	265,897,685	65,520,112	3,256,178
	Auxiliaries, excluding corporate, subsidiary, and regional managing	12,930	11,275,968	33,114,319	792,370

All of these data are accompanied by masses of documentation and definitions, SIC-based data for 1992 and 1997, and detailed bridge tables allowing the data user to go backwards and forwards from NAICS to SIC and vice versa. To fully appreciate the breadth and depth of the data associated with the 1997 Economic Census, and to begin to appreciate the many ramifications of the NAICS industry sectoring scheme, the reader should plan on spending significant amounts of time at the Census Bureau Web site pages dedicated both to NAICS (**http://www.census.gov/epcd/www/naics.html**) and to the 1997 Economic Census (**http://www.census.gov/epcd/www/econ97.html**).

[1] *The Economic Census '97—Two Moments of Truth: 1954 and 1997* (Census Bureau, 1998).

Table A-2. Economic Census, information subsector statistics, 1997

NAICS code	Description	Establish-ments	Sales, receipts, or shipments ($000s)	Annual payroll ($000s)	Paid employees
51	Information	114,475	623,213,854	129,481,577	3,066,167
511	Publishing industries	33,896	179,035,423	43,358,072	1,006,214
512	Motion picture and sound recording industries	22,204	55,925,533	9,392,048	275,981
51	Broadcasting and Telecommunications	43,480	346,315,686	63,479,623	1,434,455
514	Information services and data processing services	14,895	41,937,212	13,251,834	349,517

Table A-3. Economic Census, information services industry statistics, 1997

NAICS code	Description	Establish-ments	Sales, receipts, or shipments ($000s)	Annual payroll ($000s)	Paid employees
514	Information services and data processing services	14,895	41,937,212	13,251,834	349,517
5141	Information services	7,307	11,100,567	3,477,977	87,267
51411	News syndicates	527	1,402,374	465,466	9,483
51412	Libraries and archives	2,298	860,933	373,164	22,044
51419	Other information services	4,482	8,837,260	2,639,347	55,740
514191	Online information services	4,165	8,042,568	2,355,992	49,935
514199	All other information services	317	794,692	283,355	5,805
5142	Data processing services	7,588	30,836,645	9,773,857	262,250