A Sociology of Quantification

Wendy Nelson Espeland and Mitchell L. Stevens

European Journal of Sociology / Volume 49 / Issue 03 / December 2008, pp 401 - 436
DOI: 10.1017/S0003975609000150, Published online: 06 March 2009

WENDY NELSON ESPELAND
AND MITCHELL L. STEVENS

*A Sociology of Quantification**

Abstract

One of the most notable political developments of the last thirty years has been increasing public and governmental demand for the quantification of social phenomena, yet sociologists generally have paid little attention to the spread of quantification or the significance of new regimes of measurement. Our article addresses this oversight by analyzing quantification – the production and communication of numbers – as a general sociological phenomenon. Drawing on scholarship across the social sciences in Europe and North America as well as humanistic inquiry, we articulate five sociological dimensions of quantification and call for an ethics of numbers.

THE MAY 2008 issue of *Global Change Biology* includes an article documenting recent ecological changes in Siberia's Lake Baikal, the world's largest freshwater lake. The authors, a team of Russian and American scientists, report that Baikal's average seasonal temperatures have increased significantly over the past sixty years, a change which correlates with shifts in the lake's unique biotic environment and growing evidence about global warming in high-latitude regions (Hampton *et al*. 2008).

The article may have gone unnoticed by non-specialists were it not for its remarkable origin story. Since 1945, three generations of Russian scientists – Mikhail M. Korhov, his daughter Olga, and her daughter, Lyubov Izmesteva – had ventured almost weekly to a site 2.5 km offshore from the village of Bol'shoie Koty, where they recorded temperatures and took water samples. The culmination of

* We are grateful to Steven Lukes for his encouragement and patience; to Arik Lifchtitz, Stacy Lom, Simone Polillo, and Michael Sauder for helpful comments on an earlier draft; to Stephanie Hampton for permission to reproduce her exemplary graphics; and to Karly Sarita Ford and Cassandra Malik for careful research assistance. The work was additionally improved through presentation at the annual meetings of the Social Science History Association and at the University of Michigan.

Wendy Nelson ESPELAND, Department of Sociology, Northwestern University [wne741@northwestern.edu] and Mitchell L. STEVENS, Stanford University [stanford4@stanford.edu].
Arch.europ.sociol., XLIX, 3 (2008), pp. 401–436—0003-9756/08/0000-901$07.50per art + $0.10 per page

their efforts was ''physical and biological data. . .of inestimable scientific value, spanning 60 years of ecological change at high temporal and taxonomic resolution'' according a 6 May 2008 feature in the *New York Times* (Dean 2008). The story highlighted the extraordinary production of the raw materials that made possible new insights into global climate change: thousands of observations, collected despite harsh climate, thick ice, little financial support, and political revolution; dutifully and precisely recorded. At the end of this humble human effort was a series numbers about a single site in a remote region, assembled to tell a story of global significance.

This essay is about quantification – the production and communication of numbers – and its consequences for the organization and character of modern life. Quantification is a constitutive feature of modern science and social organization, yet sociologists have generally been reluctant to investigate it as a sociological phenomenon in its own right.[1] This reluctance is troubling in light of growing public, academic, and government demands for the quantification of most social phenomena. Whether as an effort to incorporate scientific evidence into policy decisions, extend market discipline to government or non-profit organizations, integrate governments and economies, or coordinate activity across geographical and cultural distances, pressures to devise and revise measures have expanded greatly in the past few decades (Porter 1995; Power 1997; Power 2003; Strathern 1996; Strathern 2000). Compared with their colleagues in accounting, anthropology, history, and statistics, sociologists have paid relatively little attention to the spread of quantification or the significance of new regimes of measurement, perhaps because, like many scientists, we have been more concerned with the accuracy of measures than with their social implications.

We address this oversight by analyzing quantification as a general sociological phenomenon. Building on earlier work (Espeland and Stevens 1998), our ambition is to help integrate analyses of quantification in fields such as politics (Alonso and Starr 1986; Herbst 1993), administration (Espeland 1998), education (Stevens 2007; Stevens 2008), law (Sunstein 2000) and everyday life (Igo 2007; Lave 1986) into a synthetic line of critical inquiry. We develop a conceptual toolkit for empirical investigations of quantification, identifying and illustrating some primary dimensions that such inquiries might pursue. While we cannot exhaustively catalogue the proliferating interdisciplinary

[1] Important exceptions include Alonso and Starr 1986 and Duncan 1984.

scholarship on quantification, by specifying some of the most salient aspects of quantification we encourage cross-fertilization in order to stimulate interest, breadth and nuance in sociological approaches to numbers.

We first offer some working premises for the analysis of quantification, borrowing loosely from J. L. Austin, the British philosopher of language. We then define quantification, distinguishing between forms of quantification that name phenomena and those that commensurate. Subsequent sections are primarily restricted to commensuration, the more socially transformative form of quantification. We include sections on five key dimensions of quantification: the work it requires; its reactivity; its tendency to discipline human behavior; its polyvalent authority, and its aesthetics. We conclude by suggesting how a sociology of quantification might serve an ethics of numbers.

Doing Things with Numbers

J. L. Austin's approach to language in *How to Do Things with Words* ([1962] 1975) provides a helpful analogy for thinking about quantification. In those posthumously published lectures and in other work, Austin challenged the terms through which many philosophers of language understood their project. He argued that not all sentences are vehicles for stating facts or offering descriptions that should be evaluated for their accuracy. Instead Austin understood words as deeds, which can go wrong – his term was *infelicitous* – and which can be evaluated for how well or poorly they conform to conventions or contexts. Like words, numbers also can be evaluated in terms other than their accuracy as representations, although accuracy is a common criterion for evaluating numbers. Numbers that defy conventions or expectations can be infelicitous as well as wrong, as our discussion of the aesthetics of quantification will suggest.

In Austin's analysis ([1962] 1975), to say something is always to do something. He used the term *speech act* to convey this, identifying three dimensions that characterize all speech acts. *Locutionary* acts are the act *of* ''saying something,'' which involves using vocabulary and grammar in ways that make sense to interlocutors. Sentences that are statements of fact, or which describe or assert, are locutionary acts. Understood as locutionary acts, numbers involve conventions of

production, expression, and interpretation that make them sensible or not. Numeracy, statistics, mathematics, and broadly shared methodological standards are part of the 'grammar' and 'vocabulary' that make this use of numbers meaningful in particular contexts.

Illocutionary acts are those we do *in* speaking, which have a pragmatic force by virtue of conventions for interpreting them. For Constable (2008), illocutionary speech is when ''. . .the saying of words *constitutes* the doing of the act (e.g. promising, betting, or apologizing)''. Numbers often help constitute the things they measure by directing attention, persuading, and creating new categories for apprehending the world.

Perlocutionary acts are the effects of speech acts, the changes that we bring about *by* saying something.[2] Only by analyzing speech acts in context, not as isolated words or sentences, can this dimension of speech acts be revealed.[3] Efforts to establish what words mean by stabilizing or containing meanings are misguided because ''there is *no* simple and handy appendage of a word called 'the meaning. . .''' (Austin 1961, p. 62). Investigating the variable effects of quantification can be understood as appreciating its perlocutionary dimensions, which are sensitive to context and communities of interpretation.

Our extension of Austin's analyses of speech acts to quantification is intended to highlight important parallels between his approach for investigating utterances and strategies for advancing sociological analyses of numbers. Our use may require some defense. Austin focuses his attention on ''utterances,'' the saying or doing of speech. It is fairly unconventional to apply Austin's thinking to other forms of speech in other media, including print and video.[4] In his emphasis on utterances, Austin was explicitly not concerned with the development of the language being spoken, or in explaining its grammar. Rather, he attends to what words do in speech. While we will be saying

[2] For example, if someone said to me ''Shoot her!'' the meaning of that sentence, that a particular person said to me that I should shoot a specific person, is the locution; (note that its content extends beyond the literal words); the illocution is that the person urged (or ordered, advised) me to shoot a person; the perlocution is whether I was persuaded to shoot that person (Austin 1975, pp. 101-102).

[3] The literature on Austin and speech acts is enormous. Helpful discussions include Warnock 1989, Bach 1998 and Constable 2008.

[4] If many speech act theorists emphasize utterances, others extend the meaning of speech act to any use of language, spoken or written. For Bach (1998), ''the phrase 'speech act' should be taken as a generic term for any sort of language use, oral or otherwise.''

something about the work of producing numbers, like Austin we also will emphasize the doing of numbers, highlighting the different dimensions of what gets done by them in different contexts. We conceptualize quantification as social action that, akin to speech, can have multiple purposes and meanings. Only by analyzing particular instances of quantification in context can these purposes and meanings be revealed. As with language, purposes and meanings of quantification are established through use.

Consider the counting of lives and deaths. In contemporary societies, national governments regularly carry out censuses. The official purpose of these counts is to provide accurate representations of national populations. Numeracy, statistics, mathematics, or standardized social-science methods constitute the 'grammar' or 'vocabulary' that make such projects possible and comprehensible. Demographers analyze census figures for how accurately they count the citizens of a particular region. In the United States, debates about the accuracy of the constitutionally mandated decennial census often address whether sampling would produce more accurate results than more exhaustive counting, such as contacting a reference person in each household for information about all of its members (Anderson and Feinberg 1999).

But the pursuit of empirical accuracy is only one thing that can be done with censuses. They also create new kinds and categories of things. Censuses not only count but constitute nations and colonies and the categories of persons presumed to comprise them (Cohn 1996; Loveman 2005). Counting citizens entails making distinctions between who is part of the polity and who is not. Queries about attributes of census respondents, such as their race, gender, ethnicity, age, education level and religious identification formalize and institutionalize them into ''official'' statistics (Desrosières 1998; Ventresca 1995). This is why the categories and questions included in government surveys are so often objects of political controversy (Bardet 2008).

Counting lives and deaths also can be a means for making sense of events, imbuing them with significance, as in the enumerations that were standard features of medieval chronicles about the aftermath of tragedy. Louis Heylign of Beeringen's 1347 depiction of the Plague's effect on the papal court in Avignon includes the ''7,000 empty houses'' and the ''11,000 bodies'' (Horrox 1994) left by the disease. Not meant to be taken literally, such numbers were read iconically, for didactic purposes, resonant with cultural, often scriptural, meanings. For contemporary audiences, 7,000 and 11,000 would have

communicated an almost unimaginable number, a multitude, rather than a precise measure.[5]

If precision was not the point of medieval enumerations, it was the sacred duty of those committed to counting the fallen in the aftermath of the U.S. Civil War. According to historian Drew Gilpin Faust (2008), the devastation of that conflict gave rise to a national obsession with commemoration, an important form of which entailed the meticulous counting of the dead. Like the deaths at Avignon, counting was a means of conveying the scale of suffering, but it was also a form of inclusion and ethical discussion. For nineteenth century Civil War commemorators, it mattered that every single life lost be part of the tally, and the numbers of the fallen shaped the conversations through which Americans made sense of the loss. As Faust concludes,

> The rhetoric of Civil War mortality statistics provided the language for a meditation on the deeper human meaning of the conflict and its unprecedented destructiveness, as well as for the exploration of the individual in a world of mass – and increasingly mechanized – slaughter. It was about what counted in a world transformed. (Faust 2008, p. 266)

As with words, the purpose and meaning of numbers often change as they travel across time and social space. Subsequent uses and interpretations may bear little resemblance to what produced numbers in the first place. In the United States, founding fathers added a constitutional provision in 1787 to establish the census as a means for allocating government representatives and taxes. Today census data are used for countless purposes: to inform social policy, assess business opportunities, report news, measure progress and write dissertations. The census now is part of the infrastructure of governing and knowing the population. Much contemporary social policy and social science would be impossible, indeed unimaginable, without it.

In light of this variety, and following Austin, we suggest that the work and conventions used to make numbers, and their meaning and consequences, should never be presumed.

[5] Thanks to Elspeth Carruthers for this example. For an intriguing description of how numbers were used as mnemonic heuristics during the Middle Ages, see Mary Carruthers (1990, pp. 80-107). Porter (1986, pp. 18-39) provides a helpful account of the changing use of social numbers from the political arithmetic of the fifteenth century to statistics in its current sense.

Marking and Commensuration

We here offer some orienting definitions and distinctions. We define quantification broadly, as the production and communication of numbers. One important distinction among forms of quantification is between those that mark and those that commensurate.

Numbers that mark

Numbers often are used to identify particular persons, locations, or objects. Some numerical marks are simple and even arbitrary. Numbers printed on football jerseys are clear instances of numbers that mark, distinguishing particular players from all others on team rosters and television screens. Such numbers can take on the character of names, as when announcers referred to Michael Jordon as ''Number 23,'' or when luminary numbers are ''retired'' to honor former recipients. Numbers can also be used *as* names, like the popular American whiskey called ''Old Number 7''. Used as marks, numbers distinguish one object or person without quantifying.

Other numerical marks are the products of complex systems that are significant human accomplishments in their own right. The Dewey Decimal System, for example, is a technology for cataloguing knowledge. Dewey generates a unique classification number for each text, organizing knowledge into ten main classes of subjects with numbers ranging from 000-999. These classes are further elaborated into 100 divisions and 1000 sections that specify sub-topics, geographical locations, or time periods. The number 300, for instance, indicates that a book is about social science; 314 designates European statistics as its topic. The numbers to the right of the decimal point can go on indefinitely (sometimes including a letter): the more digits, the finer the distinctions. 314.09033 P722c identifies William Playfair's treatises, *The Commercial and Political Atlas* (1786) and *Statistical Breviary* (1801), landmarks in the history of graphical display. Used this way, sequences of numbers distinguish books from one another in a qualitative and categorical, not quantitative way. Books about technology (600) are not twice as good or as numerous as books about social science (300). Quantification here precisely represents and orders knowledge in meaningful, useful ways but it does not measure books or their knowledge.

Industrialization was accompanied and facilitated by a great profusion of numerical marking systems. Towns and cities developed them to specify addresses, facilitating the movement of people and parcels through urban space. Chicago residents are proud of the clarity of their city's grid system, in which numbers of buildings and blocks increase from the intersection of State and Madison Streets downtown; Parisians have comparable affection for the unpredictable house numbers in their city's pre-industrial core. Telephone numbers, postal and registration codes, account numbers, digital passwords – numbers that mark but do not commensurate – are ubiquitous facts of life in literally all formally organized societies.

Numbers that commensurate

Many of the most consequential uses of numbers entail commensuration – the valuation or measuring of different objects with a common metric (Espeland and Stevens 1998). Common forms of commensuration include the prices that assess the value of goods and services, votes that indicate political preferences, scores that evaluate the quality of wine or water, and standardized tests that assess ability or capacity.

Commensuration creates a specific type of relationship among objects. It transforms all difference into quantity. In doing so it unites objects by encompassing them under a shared cognitive system. At the same time, it also distinguishes objects by assigning to each one a precise amount of something that is measurably different from, or equal to, all others. Difference or similarity is expressed as magnitude, as an interval on a metric, a precise matter of more or less.

Commensuration always is a process, often one that requires considerable social and intellectual investment. Before objects can be made commensurate they must be classified in ways that make them comparable. If the categories of classification are broadly agreed upon, commensuration may appear to be a simple matter of specifying incremental differences between otherwise similar things. If, however, commensuration creates a relationship between objects that are not conventionally regarded as comparable, we are more aware that we are doing something by commensurating. Securities and derivatives markets provide good examples of both phenomena. We take for granted that traders in New York and London make good livings by exchanging precisely calibrated units of credit and debt. Yet financiers have a special term, ''commoditization,'' for the process through which new things are integrated into markets. This process is hardly

simple. The creation of futures markets in air pollution and the carbon offset system, in which manufacturers, energy companies, government agencies, commercial brokerage firms, and concerned citizens can buy and sell units of environmental exhaust, were huge organizational undertakings that required and facilitated reimagining pollution (Levin and Espeland 2002; Stern 2006).

From marking to commensuration

Marking and commensuration may be understood as representing the two ends of a dimension of quantification. At one end, objects have only a categorical relationship. This is marking. At the other end, objects have primarily a metrical relation to one another. This is commensuration. Stanley Smith Stevens' famous designation of ''levels of measurement'' may be read as a formalization of these dimensions (Stevens 1946). Different mathematical or statistical operations are appropriate depending on the ordering of objects. The most common distinctions are between nominal, ordinal, interval, and ratio levels. Nominal measures classify objects through a coding system that may or may not be numerical. In social surveys, gender often is coded with a nominal measure: male or female. This code may be numerical (0 = female; 1 = male), in which case the numbers function as marks, indicating only that respondents are like or unlike with no provision for variation within or across categories, rank or magnitude.

Ordinal levels of measurement classify by rank. They vary hierarchically, but there is no presumption about quantities of difference. Like nominal measures, ordinal ones need not be coded using numbers. Clothing sizes provide good examples. ''Medium'' codes items larger than Small and smaller than Large, but differences in sizes are not metrical.

With interval and ratio measures the differences between objects become metrical, and measurement entails commensuration. Interval and ratio measures are always quantitative. Interval measures assess objects on scale in which distances among intervals are equal, but there is no absolute zero. The Celsius and Fahrenheit temperature scales are interval measures. On both, the difference between 10 and 20 degrees is the same as the difference between 40 and 50 degrees but the zero point is an arbitrary designation; 20 degrees is not twice as warm as 10. Ratio measures also have standard intervals but also possess an absolute zero. The stock and trade of modern quantitative social science, ratio measures are amenable to elaborate statistical

manipulation. Examples include income, wealth, educational attainment, and scores on standardized tests.

It is scientific doxa that these different kinds of measurement have a hierarchical relationship. That interval and ratio measures are judged ''higher'' than nominal and ordinal ones, suggests a stratification of measurement such that quantitative precision enhances prestige. The information produced by nominal and ordinal measures often is regarded as raw material for ratio and interval ones – necessary precursors to more rigorous modes of inquiry. As one prominent statistician put it, ''Classification is fundamental to any science. All other levels of measurement, no matter how precise, basically involve classification as a minimal operation'' (Blalock [1960] 1972).

Work

Quantification requires considerable work, even when it seems straightforward. When grading essays, for example, teachers might use a 100-point scale to evaluate each one, relying on prior experience and comparison to quantify individual accomplishment. The scale may correspond to rubrics contained in course syllabi that identify particular attributes and assign weights to them (e.g., 50 points for quality of argument, 25 for writing clarity, 25 for correct format and citations). The application of even such simple schemes can be laborious, as every teacher knows.

Integrating scores on individual assignments into cumulative measures of school performance requires huge investments in infrastructure and coordination. Teachers must create or follow methods for aggregating scores into course grades, which must be further aggregated so that grades can be linked to persons over time. Creating such linkages usually involves making and deploying a numerical coding system, which often includes assigning individual identification numbers, another intensive bureaucratic exercise. Aggregated evaluations of students' performance entail meticulous rules for reporting, processing and challenging grades, as well as registrars who protect the accuracy of records. This work becomes even more consequential when graduate schools, prize committees, employers, and government funding agencies use grade averages to distribute scarce resources.

Counting may seem like a simple act, but doing it on a large scale requires well-funded bureaucracies with highly trained administrators,

especially if the counts are politically contested or ''official'' – and the two usually go together (Porter 1995). As many scholars have shown, producing a national census is an arduous undertaking (Anderson 1988; Desrosières 1998; Loveman 2005). Bourguet's investigation of the failed census conducted by the French Bureau de Statistique in 1800 shows the consequences of not having a large, trained labor force. Overwhelmed prefects were forced to enlist local elite volunteers to compile the information they wanted about their regions. Instead of recording only quantitative information about local economies, populations, and occupations using the designated categories, volunteers submitted detailed descriptive monographs that reflected their local knowledge but were difficult for the Bureau to assimilate. Revolutionary France, it turned out, was still too divided by status and locale to fit into the categories prescribed by the statisticians. The standardization required by the census could only be accomplished with a more centralized state and a more uniform populace. Rendering France statistical required a transformed nation as well as statistical innovation (Porter 1995).

In a world saturated with numbers, it is easy to take the work of quantification for granted. Rigorous, defensible and enduring systems of quantification require expertise, discipline, coordination and many kinds of resources, including time, money, and political muscle. This is why quantification is often the work of large bureaucracies. It also is why, when wealthy nation-states and international organizations try to impose quantitative regimes globally, some nations find it difficult to comply. We often forget how much infrastructure lies behind the numbers that are the end product of counting regimes. This is especially true when numbers circulate to places that are removed from the bureaucracies that manufactured them.

Quantification usually is embedded in larger social projects. It is work that makes other work possible. Numbers foster cooperation and control in complex systems and signal one's legitimacy. For example, Laura Hein (2004) shows how conducting a national census and creating a statistical bureau was understood by Japanese intellectuals as a way to rehabilitate their country's reputation after WWII (Hein 2004). Modern societies depend on insurance instruments that calculate the distribution of risk (Heimer 1985); navigation systems that facilitate nautical, rail, and air travel across far-flung geographies (Cronon 1991); ''vital statistics'' and profit-and-loss statements that enable state authorities and businesspeople to rule their empires from great distances and despite formidable linguistic and cultural divides

(Cohen 1982; Scott 1998). Anthropologist Edwin Hutchins (1995) calls the general phenomenon ''distributed cognition,'' in which a number of parties coordinate their work to maintain some larger order or enterprise. Many such enterprises are unimaginable without legions of quantitative laborers: actuaries, cartographers, navigators, statisticians, economists, and all manner of specialized metricians.

Reactivity

Measurement intervenes in the social worlds it depicts.[6] Measures are reactive; they cause people to think and act differently. We already have suggested that turning qualities into quantities creates new things and new relations among things. As the statistician Alain Desrosières (1998) puts it, ''The aim of statistical work is to make a priori separate things hold together, thus lending reality and consistency to larger, more complex objects.'' Our understanding of crime (Katz 1988), health (Rusnock 2002), public opinion (Herbst 1993), poverty (Katz 1983; Katz 1986) and intelligence (Carson 2007) are just a few examples of how measures help transform individual experiences and events into general categories or characteristics. The laborious task of constructing comparable statistics and accounting standards is an important aspect of modern nation-building, of making an otherwise amorphous composite of people and attributes into a thing that holds together in the imaginations of politicians, government officials, and the general public (Desrosières 1998; Bruno *et al*. 2006; Igo 2007). Measures also alter relations of power by affecting how resources, status, knowledge and opportunities are distributed. As Cusso and D'Amico (2005) explain, changes in international education statistics reflect and shape global reform in education and affect how aid and loans are distributed to nations. Individual test scores can determine educational trajectories that have important consequences for career options and potential earnings. This is why the chronic racial disparity in standardized test scores among students in the United States is so controversial (Jencks and Phillips 1998).

Another way that measures are reactive is when they create or reinforce the categories used to conceive of human beings, a process Ian Hacking (1999) calls ''making up people.'' For example,

[6] This section relies on Espeland and Sauder 2007.

Desrosières (1998) describes how *cadres*, a term designating salaried executives that is fundamental to the status and occupational system of France (but translates only awkwardly into English), devolved loosely from a social solidarity movement among engineers and managers during the late 1930s. It was only after *cadres* as a category was incorporated into official French statistics and became an important variable in many kinds of analyses that the meaning of the term was diffused and elaborated, taking on great cultural weight.

Alfred Kinsey's pioneering surveys of sexual behavior in the United States are another case of measures making up people. The 1948 publication of Kinsey's book, *Sexual Behavior in the Human Male*, generated a maelstrom of controversy with its shocking depiction of sexual practices at odds with prevailing views about sexual convention. Among the more startling statistics were those pertaining to homosexual behavior. While Kinsey published a range of relevant statistics, two of his more famous numbers were 37 %, the proportion of (white) males who had had at least one overt homosexual experience to the point of orgasm since adolescence; and 10 %, the proportion of men who had had more or less exclusively homosexual relations for at least three years between ages 16 and 55 (Kinsey 1948).

These figures significantly influenced the development of the modern gay rights movement. For people who had been stigmatized as criminal or sick, Kinsey's numbers were deeply reassuring, offering an important, if abstract, form of visibility that historian Sarah Igo (2007) calls a ''statistical community.'' Kinsey's statistics also prompted some people to understand themselves as a political group. For community activist Harry Hay, the statistical prevalence of homosexuality indicated by Kinsey's research served as the impetus for the definition of a minority group that could be organized politically based on a shared culture and identity. In pursuit of that goal, Hay founded the Mattachine Society, the first sustained gay rights organization in the U.S. and the catalyst for a form of political organizing emphasizing homosexual identity (Armstrong 2002; D'Emilio and Freedman 1988; Michaels and Espeland 2006; Timmons 1990). Kinsey's 10 % statistic was generalized and incorporated into founding documents, speeches, placards, and soon circulated broadly among gay supporters and eventually in mainstream media. Before long the idea that 10 % of any population is gay, an idea at odds with how Kinsey conceptualized homosexuality, became a taken for granted feature of how gay and lesbian people understood themselves and how they and their opponents conducted politics. That is, until new, lower estimates of

homosexuality emerging from social science surveys during the 1990s challenged this understanding (Laumann *et al*. 1994).

Measures create and reproduce social boundaries, replacing murky variation with clear distinctions between categories of people and things. This is why measures so often are implicated in projects of social differentiation and distinction (Lamont and Molnar 2002), often with unintended effects. The recent history of homosexuality is exemplary here again. Alfred Kinsey was adamant that homosexuality was a means of classifying behavior, not persons. He refused to relegate people into binary categories, arguing that ''heterosexual'' and ''homosexual'' were not ''substantives which stand for persons,'' but adjectives that described behavior (Kinsey 1948). A great irony of Kinsey's legacy is that although he rejected the idea of homosexual persons and tried valiantly to measure people's behavior in ways that excluded their interpretations of it, his statistics encouraged a political movement that defined homosexuality as a thing that held together as a legitimate category of human and political identity.

Discipline

The capacity of measures to discipline is a distinctive form of reactivity. We already have suggested the discipline required to make credible numbers. But numbers also can exert discipline on those they depict. Measures that initially may have been designed to describe behavior can easily be used to judge and control it. In his famous analysis, Michel Foucault (1977) investigated discipline as a mode of modern power that is continuous, diffuse and embedded in everyday routines. Disciplinary practices define what is appropriate, normal, and to what we should aspire; they also define which kinds of persons should be subjected to which forms of knowledge, applied by which groups of experts.[7] Quantitative measures are a key mechanism for the simplifying, classifying, comparing, and evaluating that is at the heart of disciplinary power.[8]

The spatial surveillance that was the hallmark of Foucault's panopticon and that epitomized surveillance under industrial capitalism has been augmented by new technologies: digital cameras, satellites,

[7] While Foucault focused on the production of 'docile bodies' his ideas can be extended to institutions and groups.

[8] See SAUDER and ESPELAND 2009 for a detailed analysis of rankings as discipline.

programs for tracing Internet transactions, computerized tracking devices, and increasingly, techniques of conceptual or analytical surveillance that rely on many numbers (Miller and O'Leary 1987; Simon 1988). ''Accountability'' and ''transparency'' are becoming ever more closely associated with making and monitoring metrics (Espeland and Vannebo 2008). Quantification makes visible people, objects or characteristics that may formerly have been invisible. It permits scrutiny of complex or disparate phenomena in ways that enable judgment. The Gross Domestic Product, among the broadest and most famous indicators of economic health, includes the annual value of a nation's goods and labor. The production of the GDP is a monumental bureaucratic task, shaped by elaborate guidelines issued by the United Nations and national governments, and requires the collection, standardization and integration of vast amounts of information. This indicator makes it possible to ''see'' economies and make comparisons, to judge which ones are growing or shrinking, performing well or poorly. The GDP informs countless numbers of decisions regarding national monetary policy, investment strategy, national security, and even climate change. Similarly, the DOW, Nikkei 225, and DAX are indexes comprised of baskets of stocks that allow investors to ''see'' and track stock markets in the U.S., Japan and Germany. Seeing something is the first step to controlling it.

By simplifying, excluding and integrating information, quantification expands the comprehensibility and comparability of social phenomena in ways that permit strict and dispersed surveillance. One virtue of numbers is that they easily circulate and seem straightforward to interpret, making it possible to monitor or govern ''at a distance'' (Miller and Rose 1990; Cohen 1982; Scott 1998). Quantification permits remote parties to check on people and things they wish to control. Principals vulnerable to the discretion of agents often argue that the discipline imposed by quantification makes visible the consequences of decisions and provides checks on the biases, politics and self-interest of agents. Medici family bankers with agents all over Europe, for example, relied on standardized double-entry bookkeeping and regular audits to ensure that they were not being cheated (Carruthers and Espeland 1991). Sean Redding (2006) shows how the census was a form of surveillance that made it possible to tax Africans and became a vehicle for creating and sustaining the South African apartheid state. Colonizers have long relied on surveys of various sorts to discipline those they rule, simultaneously overcoming and maintaining distance from their subjects (Cohn 1996; Loveman 2005).

Not all surveillance that has disciplinary consequences is motivated by intent to discipline. Sometimes discipline is a by-product of surveillance. For example, mass-media rankings of colleges and graduate programs in the United States began as efforts to inform prospective students and their families about the relative quality of schools, as well as a plan for selling magazines and creating a distinctive identity for one magazine (Sauder and Espeland 2009). Perhaps naively, rankers did not intend to change schools or shape policy but simply wanted to measure them. Yet schools soon realized that important groups of constituents – students, faculty, trustees, employers, other media – were using rankings to make decisions that had large consequences for schools: where to apply, how to evaluate administrators' performance, which graduates to employ. As attention to rankings spread, schools felt pressured to take them seriously, even when sociometricians and administrators considered them bad measures. Before long schools were working diligently to improve their rank, which entailed expensive and sometimes ingenious efforts to boost the factors that journalists included in ranking schemes. What began as a strategy for publicly evaluating schools soon became a means of identifying and punishing schools that did poorly according to metrics schools themselves did not control. Rankings quickly were internalized and institutionalized by schools, as their officials absorbed the terms of status the rankings had created. The discipline that rankings elicited increasingly became self-imposed as schools included them in their planning and self-understandings (see also Covaleski *et al*. 1998).

By simultaneously unifying and distinguishing objects, a process Foucault called ''normalization'' (1977), measures like rankings classify, reward and punish, and organize interventions. As Hacking (1990) suggests, it is easy to conflate normal in a statistical sense with normal in a moral sense. The ''outliers,'' ''under-achievers,'' and ''under-performers'' produced by performance measures become targets of manipulation, disapproval and anxious self-scrutiny. Measures easily become aspirations.

Authority

As deeds, one thing numbers do is persuade. One way to think about how numbers persuade is to investigate the authority people

grant to them: to consider why and when people find numbers credible ways of knowing and communicating. The authority of numbers may be vested in (1) our sense of their accuracy or validity as representations of some part of the world (Anderson and Feinberg 1999; Desrosières 1998); (2) in their usefulness in solving problems (Carson 2007; Didier 2002; Porter 1995); (3) in how they accumulate and link users who have investments in the numbers (Feldman and March 1981; Kalthoff 2005; Latour 1987; Callon 1986; March and Simon 1958); or (4) in their long and evolving association with rationality and objectivity (Daston 1992; Nussbaum 1986; Weber 1978). It often is some combination of these phenomena that makes particular numbers compelling. Here we focus mainly on the first three kinds of quantitative authority.

Concern over the relationship between numbers and the ''real'' world may be explicit for those who make and use statistics for a living (Duncan 1984). But, as Desrosières notes (2001), even if ''reality'' often is invoked by the producers and users of statistics, it is usually taken to be ''self-evident.'' A sociology of quantification must, of course, interrogate this self-evidence, examining how it is established and varies across contexts. Desrosières identifies four ''attitudes'' concerning the relationship of statistics to reality and its proof: metrological realism, accounting realisms, proof-in-use realism, and constructionism. The first three attitudes are versions of realism in which measures capture more or less accurately some feature of an external world, while the fourth rejects this stance. These attitudes are not the only possible responses and are sometimes mixed together unselfconsciously in practice. However their differences help disentangle an important feature of quantitative authority: how we evaluate numbers as depictions of the world. Each attitude has its own history, enlists a distinctive language, style of argument, and assumptions, and each of the realist attitudes has its own ''test of proof'' that verifies its reality by confirming its independence from measurement.

Metrological realism, the heartland of which is public statistical agencies, devolves from 18th century measurement theory in mathematics and the natural sciences. Introduced into social science via sampling methods, it spawned the age of ''statistical observation.'' Here the reality of the objects measured, even if invisible and variable, is presumed to be as permanent and real as any physical object. The vocabulary, requirements and argumentation associated with metrological realism emphasize reliability that is conveyed in terms of accuracy, precision, measurement error, distributions, and so on.

Pragmatism in accounting or *accounting realism* emerged from accounting practices dating back to the development of double-entry bookkeeping, first codified in Pacioli's famous Venetian text of 1494 (Carruthers and Espeland 1991). The reality of the objects measured in accounting realism is based on the trustworthiness of numbers established through standardized practices that are consistent, reproducible and ''fair'' evaluations of past, present, and projected financial positions. If in metrological realism commensuration is established mostly through physical quantities such as time and space, accounting realism relies on money as its generalized medium – which, as Georg Simmel (1978) famously explained, objectifies value at the same time it symbolizes the relativity of value. Money, the ''perfect tool,'' permits the broad circulation of claims about credit, debt, or value that compose the continuous streams of accounts generated by business. The core reality test in accounting realism is whether accounts are balanced.

The *proof in use* attitude is the province of researchers and those who argue policy or make decisions in political and economic institutions. For those who typify this approach, reality is defined by databases and the analyses they support, and which are mobilized to make arguments and defend positions. Social and cognitive distance usually separates those who create the datasets and those who make use of them. Users often take data as given, displaying little interest in how the numbers were collected, coded, and cleaned. For proof-in-use users, data are ''self-sufficient,'' which permits these users to argue positions supported by statistical manipulations with little or no interrogation of the origins of the underlying numbers. The realism that characterizes this attitude is evident in contexts of argumentation and the role that statistical data play in convincing or not. Proof-in-use realism construes the language of plausible results and procedures for checking internal consistency as more vital than correspondence to features outside the database.

Each of these three attitudes highlights a version of realism that depends on documenting the consistency of a form of perception and establishing the independence of what is measured from the act of measuring. In contrast, the fourth attitude, *constructionism*, perhaps most familiar to sociologists, anthropologists and science-studies scholars, understands the objects targeted by measurement as products of measurement and measurement conventions that are negotiated and variable. Desrosières sees this attitude as a response to crisis, the breakdown of forms of trust that sustain the other three forms of

statistical realism. This attitude is the bread and butter of social-constructionist approaches in sociology. The challenge for this type of sociology is to show how quantitative authority is accomplished and mobilized, how it gets built into institutions, circulates, and creates enduring structures that shape and constrain cognition and behavior. How constructed an object or relation appears is a function of how successful groups have been in securing its durability and legitimacy, in making it seem inevitable.[9] The constructionist approach undermines the reality of objects as independent entities by highlighting interactions between people and measures, showing the reflexive adaptations of those observing and the people and things being observed. Statistics help to create the reality that they measure by providing a language for accessing it and techniques for its manipulation. The crucial test for this approach is not to establish the independence of measures but to explain their starring roles in the interactions that produce reality.[10]

While the different meanings given to numbers are key distinctions among Desrosières' four attitudes, others have emphasized the development and marketing of uses for numbers as features of their authority. These approaches are especially attentive to the spread of particular kinds and uses of numbers, and are less centrally focused on what makes numbers seem more or less real. Theodore Porter's (1995) work exemplifies this approach. He argues that numbers are a technology whose authority derives from their value in helping resolve the fundamental problem of people wishing to communicate across sometimes vast distances that may be social, geographical and political. Quantification offers a shared language and discipline that transcends other forms of differences that threaten collective or competing social projects. Especially in collaborations characterized by conflict, divided expert opinion, dispersed parties, distrust, or when parties' actions are politicized or subject to close scrutiny from powerful others, numbers offer a valuable form of authority which Porter (1995) characterizes as "mechanical objectivity."[11] In contrast with objectivity grounded in expert opinion, elite discretion, or divine

[9] Constructionism's place in sociology is vast. Classic works depict the constructed nature of commodities (Marx [1867] 1977), subjectivities (Foucault 2003), gender (Smith 1991), and common sense (Berger and Luckmann 1966), to name a few. See Hacking 1999 for an overview.

[10] Desrosières' investigation of statistical realisms includes an altar call to sociologists, urging a commitment to analyzing more systematically and rigorously the various kinds and uses of statistical argument, especially as they pertain to issues of "quality."

[11] On the evolving meanings of objectivity for scientists see Daston 1992.

will, mechanical objectivity is grounded in quantification that conforms to standardized rules about how to derive, manipulate and use numbers. Its particular value for distrusting parties is that it is impersonal and constraining. It limits discretion when credibility or disinterestedness is suspect or when there are no broadly shared means for evaluating discretion. It replaces trust in persons with trust in numbers.

Quantitative techniques like cost-benefit analyses, audits, rankings, and the push for performance, measures, which has reinvented whole agencies and spawned an expanding consulting industry, provide examples of how numbers can constrain discretion and hold people accountable. The federal sentencing guideline movement in the United States offers a good example of mechanical objectivity at work (Espeland and Vannebo 2008). Seeking to eliminate large disparities in the sentences judges issue convicted defendants, even those committing similar crimes, legal scholars and politicians pressed for more uniform sentencing. Legislation passed in 1984 and implemented by the newly created Sentencing Guidelines Commission produced rules designed to standardize sentencing practices. An explicit goal of this legislation was to limit judicial discretion.

The primary tool for standardizing sentences was the Commission's creation of the Sentencing Table. This deceptively simple one-page grid consists of a vertical axis that measures severity of a crime and a horizontal axis that measures an offenders criminal history, with intersecting cells indicating a narrow range of appropriate sentencing defined by months in prison. The grid is the culmination of elaborate, often revised instructions known as the Guidelines Manual that includes nearly 2000 pages of rules and, in paperback form, tips the scales at 5 U.S. pounds.

After twenty years of experience, the consensus of the U.S. legal community is that mandatory sentencing guidelines as implemented were a resounding failure. It turned out that mechanized sentencing was extraordinarily cumbersome in practice, and that excluding particular circumstances often produced sentences that seemed irrational and unfair. A famous example is in sentencing for cocaine possession. Under the guidelines, the severity of a sentence is linked to the weight of the narcotic someone possesses. Because crack cocaine uses a heavier water-based medium than powder cocaine, possession of crack generates longer sentences than possession of powder, even if the actual amount of the narcotic is the same. Just as important, experience also made clear that instead of eliminating discretion the

guidelines merely shifted it to new and less visible arenas: from courtrooms to prosecutors' offices, from judges to parole officers. In time the results became so contested that the legitimacy of judicial sentencing was not enhanced but undermined by the reform, and the U.S. Supreme Court ruled that the federal guidelines would no longer be mandatory but "advisory."[12]

Caron and Gely's (2004) investigation of intelligence testing reveals patterns similar to Porter's. Wartime pressures to sort soldiers quickly, along with the emergence of psychology as a new discipline with insecure borders, prompted a powerful alliance that helped institutionalize intelligence testing in a remarkably short time. Along with this shift came significant changes in the definition of leadership, merit, and ability. As this and other work shows, efforts to enlist quantification, whether as a way to improve decisions or constrain discretion, can destabilize authority based on other kinds of claims (Espeland 1998).

Another means for analyzing the authority of numbers is to investigate their practical uses, describing how they become embedded in networks of people who make and use them, and the techniques and routines that facilitate this embedding. Drawing on insights from actor-network theory first developed in science studies by scholars such as Bruno Latour (1987; 1988) and Michel Callon (1986), we posit that the authority of numbers, like that of scientific facts more generally, depends on establishing networks among objects and humans that become so sturdy they are no longer disputed or subject to disassembly. As for example in the relationships between databases and those who rely on them for arguments, numbers can accumulate constituents who invest them with particular meanings and uses. Ultimately calculations can become epistemic practices, embodying and routinizing norms of skepticism and certainty about the world (Kalthoff 2005; Knorr-Cetina 1999).

Organizational scholars take a different stance in considering how numbers accumulate authority as they circulate. Ever since classic work by March and Simon (March and Simon 1958), such scholars have examined patterns in the flow of information within (or among) organizations. 'Raw' information typically is collected and compiled by workers near the bottom of organizational hierarchies; but as it is manipulated, parsed and moved upward, it is transformed so as to make it accessible and amenable for those near the top, who make the big decisions. This "editing" removes assumptions, discretion and

[12] *United States v. Booker* 543 U.S. 220 (2005).

ambiguity, a process that results in ''uncertainty absorption'': information appears more robust than it actually is. As March and Simon put it: ''Uncertainty absorption takes place when inferences are drawn from a body of evidence, and the inferences instead of the evidence itself, are then communicated'' (p. 165).

The premises behind the numbers disappear, with the consequence that decisions seem more obvious than they might otherwise have been. An often unintended effect of this phenomenon is numbers that appear more authoritative as they move up a chain of command. The authority of the information parallels the authority of its handlers in the hierarchy.

Aesthetics

The *Oxford English Dictionary* defines the adjective *aesthetic* as ''Of or pertaining to the appreciation of the beautiful or of art.'' Like any expressive action, quantification has an important aesthetic aspect. We speak here of individual numbers (for exemple a startling pH value or a provocative coefficient), mathematical models of causal processes, and tabular and graphical depictions of numerical data of all kinds. Call them pictures with numbers, or numerical pictures: the point is that many of our most consequential representations of the world are made quantitatively. Those who produce and consume such pictures for a living want them to be not only errorless but also compelling, elegant, and even beautiful. It is more than a matter of esoteric connoisseurship. The appearance of numerical pictures matters greatly to the gatekeepers who determine their publication in books and scholarly journals, and to the policymakers who make consequential decisions on the basis of the information contained within them.

The criteria used to assess the aesthetic merits of numerical pictures vary over time and across realms of expertise. Statistical models that impress reviewers as state-of-the-art at one point can appear retrograde only a few years later. Styles of statistical modeling go in and out of fashion, obliging those who wish to remain at the cutting edge of their fields to keep up with changing expectations. Additionally, those who work within different research communities prefer different kinds of numerical pictures. Even the most sophisticated quantitative methodologists in one discipline, when reading work outside of their own fields, sometimes find that they ''can't tell if

its good'' and seek the judgment of colleagues in other disciplines. Techniques of numerical and graphical representation also vary. The historical development of the use of stars and asterisks to mark statistical associations conventionally regarded as ''findings'' in U.S. sociology journals is one well-documented example (Leahey 2005). Those who remember assembling numerical tables without computers, or who attend international conferences at which data graphics are produced by a global array of software platforms, appreciate how widely representational conventions can vary across time and space.

Yet despite such variation, two aesthetic ideals for numerical pictures are virtually universal: clarity and parsimony. Regardless of temporal and disciplinary context, people who make pictures with numbers typically prize representations whose primary information is easily legible (clarity), and which contain only those elements necessary and sufficient for the communication of this primary information (parsimony). These aesthetic ideals are visual manifestations of the allure of numbers outlined above: their peculiar capacity to make complex phenomena comprehensible. But capacity and accomplishment are not the same thing. Making pictures with numbers is a craft. Doing it well requires skill.

The craft is a modern one, according to Edward Tufte (2001), one of its most famous analysts. A European invention, statistical graphics did not emerge until the late eighteenth century, likely because of the complex mix of mathematical, analytical, and artistic capacities required to produce them. Their emergence in world culture is ''surprisingly recent,'' coming much later than ''such triumphs of mathematical ingenuity as logarithms, Cartesian coordinates, the calculus, and basic probability theory'' (p. 9).

Tellingly, techniques of numerical picture-making grew out of cartography (Friendly 2008). Like maps, numerical pictures are schematic renderings of large amounts of information. Scholars point to the British Enlightenment as an important locus of innovation in numerical representation – hardly a historical coincidence, given the ongoing imperatives of overseeing a global empire. The work of William Playfair (1759-1823), a Scottish engineer, businessman and polymath, was particularly influential. Credited with inventing the bar chart and pie graph, Playfair's monographs on the political economies of Britain, Europe, and the United States are landmarks in the history of statistical graphics (Friendly 2008; Tufte 2001). The penchant for numerical representation expanded and diffused widely in the latter half of the nineteenth century. Numerical information was prized by

theorists and practitioners of democratic government, who viewed statistics as politically neutral means of knowing a population. The rapid development of census and survey techniques by government officials, social reformers, and social scientists was fueled by this faith in the impartiality of numbers and facilitated by the expansion of state bureaucracies (Anderson 1983; Cohen 1982; Desrosières 1998; Hein 2004). By the early twentieth century, government officials' views of their societies commonly came in the form of numerical pictures. The accumulation of census, survey, and polling data of all kinds, and the increasing speed and sophistication of computational technology created societies ever more defined by statistics and graphical representations of them – and ever more ways to manipulate and misread numerical information (Alonso and Starr 1982; Duncan 1984; Igo 2007; Prewitt 1986).

Just as making quantitative pictures requires special skills, so too does their interpretation. These interpretive skills are acquired through mimesis, apprenticeship, and formal instruction. Primers include Tufte's *The Visual Display of Quantitative Information* (2001) and William S. Cleveland's *The Elements of Graphing Data* (1994). Widely consulted and cited, these books teach technical and normative lessons. The first page of the first chapter of Tufte's *Visual Display* (p. 13) summarizes good statistical graphics as ''complex ideas communicated with clarity, precision, and efficiency'' and lists what graphical representations of numbers ''should'' do:

– show the data
– induce the viewer to think about the substance rather than about methodology, graphic design, the technology of graphic production, or something else
– avoid distorting what the data have to say
– present many numbers in a small space
– make large data sets coherent
– encourage the eye to compare different pieces of data
– reveal data at several levels of detail, from broad overview to the fine structure
– serve a reasonably clear purpose: description, exploration, tabulation, or decoration
– be closely integrated with the statistical and verbal descriptions of the data set.

Tufte also offers maxims for what graphical displays should not contain: ''The interior decoration of graphics generates a lot of ink

that does not tell the viewer anything new'' (p. 107). He coins two phrases to describe such decoration: *non-data-ink* and *chartjunk*. ''Like weeds, many varieties of chartjunk flourish,'' he explains, making clear the normative character of his admonitions. Such nuisances take characteristic forms: excessive use of color and pattern; gridlines which unnecessarily clog up the data frame; and a surplus of decorative ornament that overwhelms the information a picture is intended to convey.

Subsequent pages offer a dazzling array of numerical pictures: data maps of the distribution of cancer diagnoses; time-series displays of weather, import/export rates, and mail traffic; narrative graphics of the demise of Napoleon's military advance toward Moscow; and dozens of bar graphs and scatterplot diagrams. The glue holding all of this material together is aesthetic: representational ideals that Tufte calls ''graphical excellence'' and ''graphical integrity,'' and advice for approximating them. The very existence of this text, with its stern wisdom and vivid examples of numerical pictures good and bad, undermines a conceit common among those who privilege quantitative forms of information: their presumed transparency. *Visual Display* suggests otherwise. Numerical pictures are not clear glass windows. They color and refract what comes through. Tufte can make normative claims about numerical displays because they can be manipulated with varying degrees of craftsmanship and responsibility.

Like Tufte's work, William S. Cleveland's *Elements of Graphing Data* (1994) offers broad wisdom about the craft of making numerical pictures and a range of examples demonstrating its being done well and poorly. Cleveland also provides a treatise on how numerical pictures mediate information. Numerical pictures are refracting media through which authors send information. The accomplishment of graphical communication depends on authors' own representational skills, but also on the skills of audiences. He calls these skills *encoding* and *decoding*. Graphs encode quantitative and categorical information via ''position, size and color.'' In studying graphs, we decode visual information.

> A graphical method is successful only if the decoding process is effective. Informed decisions about how to encode data can be achieved only through an understanding of the visual decoding process, which is called *graphical perception*. (Cleveland 1994, p. 20; author's emphases)

Looking through a clear pane of glass requires little in the way of skill, but decoding visual displays of quantitative information demands fairly sophisticated interpretive capacities. Cleveland devotes

an entire chapter to specifying them. ''Table look-up,'' for example, entails ascertaining what kind of information a graph purports to convey; ''pattern perception'' is the ability to find coherence in the information presented in a graph. Making sense of numerical pictures is something people must learn how to do well if communication with numerical pictures is to be accomplished. As Cleveland puts it,

> The decoding is the vital link, the *raison d'etre*, of the graph. No matter how intelligent the choice of information, no matter how ingenious the coding of the information, and no matter how technologically impressive the production, a graph is a failure if the visual decoding fails. (Cleveland 1994, p. 221)

The complexity of making and reading numerical pictures makes decoding challenging, ''Even the most simple matters an easily go wrong'' (p. 9).

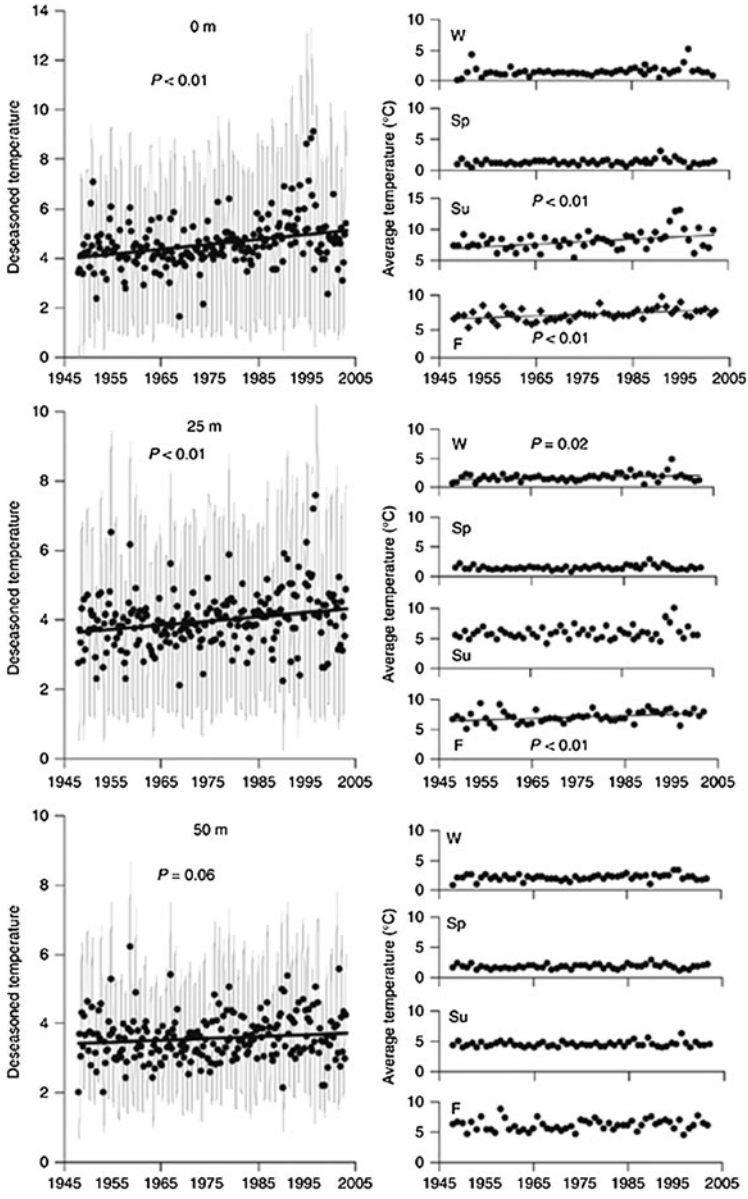
When things go right, however, when data, skillful representation, and capable interpretation converge, the results can be profound. Numerical pictures are ubiquitous partly because they can be made to tell large stories with great brevity and lucidity. Consider the story that began this essay, the decades-long investigation of temperature change in Lake Baikal. The journal article on which that newspaper story is based is built around a series of numerical pictures representing change in Baikal's water temperature and biotic life over time (fig. 1).

These pictures are stunningly parsimonious, which was the gist of the article in the *New York Times*: all those thousands of individual observations, duly and responsibly recorded for decades, assembled and compressed into a few journal pages, depicting a phenomenon of global proportions. The graphical images are essential components of the scientific project. It may not be too much to say that they are the foundation for the entire argument. Like photographs of faraway lands that transport armchair tourists to places they cannot visit, the graphical images enable readers to ''see'' thousands of temperature readings they cannot witness in the space of a few column inches.

The most successful numerical pictures influence the ontology of what they represent. The picture becomes its own subject, replacing, in the comprehension of observers, what it originally was intended merely to depict. One famous example in North American sociology is found in Peter Blau and Otis Dudley Duncan's *The American Occupational Structure* (1967). The book is a milestone in empirical sociology for its rigorous demonstration that fathers' socioeconomic status has both direct and indirect effects on the occupational outcomes of sons. Today this fact is a sociological commonplace, but in the 1960s the infrastructure required to demonstrate it statistically

FIG. 1

Graphical Displays from Hampton et al. 2008



was only just emerging. The analysis required a large and carefully derived sample of survey respondents, each providing uniform information that could be expressed numerically. It required state-of-the-art computational equipment – something available only at the most prominent universities in the 1960s.

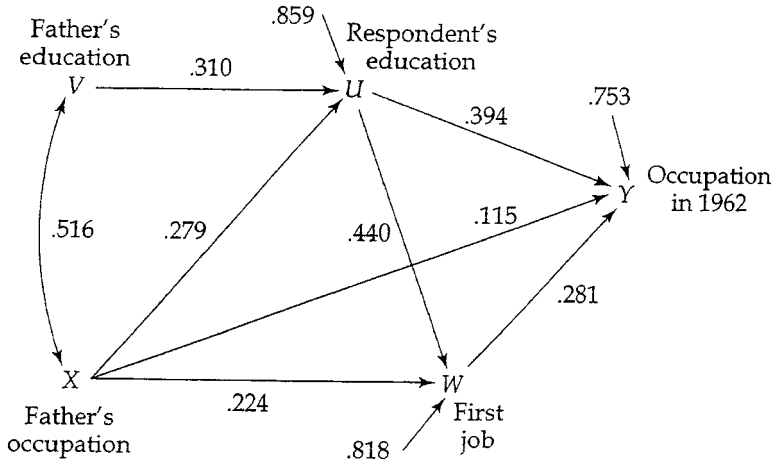
The American Occupational Structure is over 500 pages in length, but much of its argument is summarized in a single numerical picture that appears midway through the text (fig. 2). It is a path diagram representing statistical relationships between father occupation, father education, respondent education, respondent first job, and respondent occupational status in 1962. One of the most famous pictures in social science, it is instantly recognizable to stratification scholars worldwide. Like the graphical images depicting temperature changes in Lake Baikal, this picture is impressively parsimonious. It represents relationships of hundreds of thousands of data points in the space of a few square inches. It simultaneously makes an argument about intergenerational stratification and provides evidence for that argument. Testament to its clarity, the diagram is still taught to novice sociology students. A colleague recently confessed that she had its coefficients were committed to memory years after graduate school.

This picture has been more than enduring, however. It also has shaped the American sociological imagination, helping to define how scholars conceive of the social world. For example, Blau and Duncan's conception of education as an individual metrical quantity has cast a long shadow over subsequent generations of sociological research on schooling (Stevens 2008). Education, a pervasive and diffuse social practice, became an objective thing, a possession that people acquired, in varying amounts, as individuals. In the problem space of American sociology, amount of schooling also became primarily a mechanism of stratification. Blau and Duncan's path diagram is by no means exclusively responsible for this profound instance of social-scientific objectification. But as an early, clear, and parsimonious picture of education as a metrical phenomenon and individual possession, it facilitated this objectification, literally providing a way of seeing social reality that has endured.

Numerical pictures are important mechanisms through which quantification holds things together in Desrosières' sense. They give form to things that otherwise would be hard to comprehend. Good graphical representations make complex phenomena (like global warming) and statistical associations (like those between parental

FIG. 2

Blau and Duncan's (1967) Model of Status Attainment



education and children's occupation) thinkable. The most successful ones endure in scientific and social history.

The influence and ubiquity of numerical pictures in modern life have not gone unnoticed by social critics, satirists, and artists, who often call attention to the artifice inherent in numerical representation. No less a master of the craft than Otis Dudley Duncan created the pithy term "statisticism" to decry the common tendency to make statistical representation and manipulation ends in themselves. In characteristically witty and elegant prose, Duncan defined statisticism as

> . . .the notion that computing is synonymous with doing research, the naïve faith that statistics is a complete or sufficient basis for scientific methodology, the superstition that statistical formulas exist for evaluating such things as the relative merits of different substantive theories or the 'importance' of the causes of a 'dependent variable'; and the delusion that decomposing the covariations of some arbitrary and haphazardly assembled collection of variables can somehow justify not only a 'causal model' but also, praise the mark, a 'measurement model.' There would be no point in deploring such caricatures of the scientific enterprise if there were a clearly identifiable sector of social science research wherein such fallacies were clearly recognized and emphatically out of bounds. (Duncan 1984, p. 226)

Statisticism may not be a surprising phenomenon in societies where numerical expressions of knowledge enjoy such high prestige.

The aesthetic seductions of numerical pictures contribute to the temptation for misuse.

One canny critique of statisticism is a project by the Russian expatriate artists Vitaly Komar and Alexander Melamid known variably as *The People's Choice*, *Painting by Numbers,* and *America's Most Wanted* (Wypijewski 1997). Komar and Melamid came to prominence in the global art world in the 1980s, through send-ups of Socialist Realist painting that poked fun at the Soviet state's official painting style. In 1993, with funding from the Nation Institute, the artists began an elaborate effort to specify and illustrate national popular preferences in painting styles. They commissioned Marttila & Kiley, a respected private research firm, to administer a national survey questioning a statistically representative sample of Americans what they most and least wanted in their paintings. As the project's official chronicle explains:

> For eleven days the survey continued, as people throughout the forty-eight contiguous states pondered: soft curves or sharp angles? brush strokes or smooth surfaces? 'realistic-looking' or 'different-looking'? serious or festive? outdoor scenes or indoor? wild animals or domestic? famous people or ordinary? at work or at leisure? On and on, for an average of twenty-four minutes, until all 102 questions had been asked. When it was over, 1,001 Americans had been interviewed. (Wypijewski 1997, p. 2)

Komar and Melamid then created paintings reflecting the tastes measured by the poll.

''America's Most Wanted'' is a landscape (favored by 88 % of respondents), presented in autumn (favored by 33 %), rendered with soft curves (favored by 66 %) and containing large fields of blue sky and blue water (the color favored by 44 % of respondents). In recognition of respondents' preferences for pictures containing wild animals (51 %) in their natural setting (89 %), two dear frolic on the banks of the scene's water feature (49 % of respondents favor lakes, rivers, oceans, and seas), alongside renderings of several human beings whose identity is unclear (fully clothed – favored by 68 %). Perhaps because 50 % of respondents were ambivalent about whether they favored ''ordinary or famous'' people, the painting's fourth human subject resembles George Washington.

Komar and Melamid also produced ''America's Most Unwanted,'' an abstract painting featuring geometric patterns (favored by 30 %), sharp angles (22 %) and the colors gold, orange, peach, and teal (favored by 1 %).

Exhibited in New York City in 1994, the pictures were an artworld sensation. *The Nation* magazine carried expansive commentary on the

project that same year, and the Foundation subsequently funded the project internationally. Variations of the U.S. questionnaire were administered by polling firms in Europe, Asia, and Africa. The artists claim that their global sample now represents over two billion people, nearly one-third of the world's population (Wypijewski 1997, p. 2).

As with any work of art, *Painting by Numbers* is open to varied interpretations. One reading illustrates Duncan's statisticism: the faith that patterns discerned in quantitative data are coextensive with things in the larger world. Read this way, Komar and Melamid's project is a critique of scientific ambition and populist impulse to see the world through quantification. Numbers may help us comprehend complicated things we care about, but such comprehension comes at the price of mediation. This is true no matter how clear and parsimonious the pictures we make with numbers may be.

Conclusion

We began this essay by suggesting that numbers, like words, should be regarded as deeds: acts of communication whose meaning and functions cannot be reduced to a narrow instrumentality and which depend deeply on 'grammars' and 'vocabularies' developed through use. We offered this idea as a useful starting point for an explicit and intellectually capacious sociology of quantification. We have invoked a wide range of scholarship which might be held together by the problem of quantification, proposing five themes of recent and future inquiries: work, reactivity, discipline, authority, and aesthetics. We have argued that a sociology of quantification should recognize the effort and coordination that quantification requires; the tendency of quantification to remake what it measures; the capacity of quantification to channel social behavior; the polyvalent authority of claims made with quantitative measures; and the art and artifice of numerical expression.

Our inquiry so far has made only oblique reference to the ethical dimensions of quantification. Here we are more explicit: a sociology of quantification is best regarded as a prolegomena to an ethics of numbers. Once sociology makes clear that quantification is fundamentally social – an artifact of human action, imagination, ambition, accomplishment, and failing – the ethical implications and possibilities of quantification become more visible.

We are not philosophers, but we can suggest what an ethics of quantification might entail. First, taking a lesson of Marx, Weber, and Simmel, as well as more contemporary theorists such as Anthony Giddens, Jürgen Habermas, Hans Joas, John Meyer, and James Scott, we should recognize that quantification facilitates a peculiarly modern ontology, in which the real easily becomes coextensive with what is measurable. An ethics of quantification should view this ontology as productive but partial. There is no question that measurement has helped create the modern world (consider the census); but the character of the world where numbers triumph is not always desirable (consider ''America's Most Wanted''). Measurement can help us see complicated things in ways that make it possible to intervene in them productively (consider measures of global warming); but measurement also can narrow our appraisal of value and relevance to what can be measured easily, at the expense of other ways of knowing (consider how education became years of schooling in American sociology). An ethics of quantification should investigate how the world is made by measures, but should strongly reject any conceit, scientific or otherwise, that measurement provides privileged or exclusive access to the real.

Second, an ethics of quantification should recognize the ancient association of numbers with ideals of rationality and universalism. The enduring appeal and utility of quantification is that it facilitates the production of knowledge that transcends and integrates particularities of place, language, and custom. The dream of universalism implied by numerical expressions of value is an honorable thing – as are the myriad accomplishments of numerical deeds that have improved human understanding and well-being. At the same time, an ethics of quantification should recognize the variety, limits, and artfulness of quantitative expressions of value. We recall that Aristotle saw loss as well as virtue in Plato's dream of irrationality tamed by universal commensuration. In Aristotelean ethics, investment in singularity is a different kind of relationship than investment in things or people that vary by increments of some desired quantity. On this view, how we value matters because it helps us to know who we are, and a plurality of forms of value can make life richer and more passionate as well as more rational (Nussbaum 1986; Lukes 2008).

Third, an ethics of quantification should recognize that we live at a time in which democracy, merit, participation, accountability and even ''fairness'' are presumed to be best disclosed and adjudicated through numbers. So much opportunity and status, and so much power, is now mediated through mechanical objectivity in administration,

management, education and finance, that we cannot understand the basic terms of justice if we do not understand quantification. Numbers are implicated in the core questions of sociology: what it means to be modern, how inequality works, how communication is accomplished, values honored, domination maintained and resisted. We should not take them for granted.

BIBLIOGRAPHY

Alonso William and Paul Starr, 1982. ''The Political Economy of National Statistics'', *Social Science Research Council Items*, 36, pp. 29-35.

—, 1986. *The Politics of Numbers* (New York, Russell Sage Foundation).

Anderson Benedict, 1983. *Imagined Communities: Reflections on the Origin and Spread of Nationalism* (London, Verso).

Anderson Margo, 1988. *The American Census: A Social History* (New Haven, Yale University Press).

Anderson Margo and Stephen E. Feinberg, 1999. ''To Sample or Not to Sample? The 2000 Census Controversy'', *Journal of Interdisciplinary History*, 30, pp. 1-36.

Armstrong Elizabeth A., 2002. *Forging Gay Identities: Organizing Sexuality in San Francisco, 1950-1994* (Chicago, University of Chicago Press).

Austin J. L. 1961. ''The Meaning of a Word'', *in* Austin J. L., ed., *Philosophical Papers* (Oxford, Oxford University Press).

—, [1962] 1975. *How to Do Things with Words* (Cambridge, Mass., Harvard University Press).

Bach Kent, 1998. ''Speech Acts'', *Routledge Encyclopedia of Philosophy.*

Bardet Fabrice, 2008. ''La catégorisation ethnique entre science et politique: Le cas francais'', *Forum Mondial de l''AIS* (Barcelone).

Berger Peter L. and Thomas Luckmann, 1966. *The Social Construction of Reality* (Garden City, N.Y., Doubleday).

Blalock Hubert M. Jr, [1960] 1972. *Social Statistics* (New York, McGraw-Hill).

Blau Peter M. and Otis Dudley Duncan, 1967. *The American Occupational Structure* (New York, John Wiley & Sons).

Bruno Isabelle, Sophie Jacquot and Lou Mandin, 2006. ''Europeanization through its Instrumentation: Benchmarking, Mainstreaming and the Open Method of Coordination... Toolbox or Pandora's Box?'', *Journal of European Public Policy*, 13, pp. 519-536.

Callon Michel, 1986. ''Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St. Brieuc Bay'', *in* Law John, ed., *Power, Action, and Belief: A New Sociology of Knowledge?* (London, Routledge and Kegan Paul, pp. 196-233).

Carruthers Bruce G. and Wendy Nelson Espeland, 1991. ''Accounting for Rationality: Double-Entry Bookkeeping and the Rhetoric of Economic Rationality'', *American Journal of Sociology*, 91, pp. 31-96.

Carruthers Mary, 1990. *The Book of Memory: A Study of Memory in Medieval Culture* (New York, Cambridge University Press).

Carson John, 2007. *The Measure of Merit' Talents, Intelligence, and Inequality in the French and American Republics, 1750-1940* (Princeton, NJ, Princeton University Press).

Cleveland Wiliam S., 1994. *The Elements of Graphing Data* (Murray Hill, N.J., AT&T Bell Laboratories).

Cohen Patricia Cline, 1982. *A Calculating People: The Spread of Numeracy in Early America* (Chicago, University of Chicago Press).

Cohn Bernard, 1996. *Colonialism and Its Forms of Knowledge: The British in India* (Princeton, Princeton University Press).

Constable Marianne, 2008. ''Recalling Vico's Lament: The Role of Prudence and Rhetoric in Law and Legal Education'', *Chicago Kent Law Review*, 83, p. 3.

Covaleski Mark A., Mark W. Dirsmith, James B. Heian and Sajay Samual, 1998. ''The Calculated and the Avowed: Techniques of Discipline and Struggles Over

Identity in Big Six Public Accounting Firms'', *Administrative Science Quarterly*, 43, pp. 293-327.

Cronon William, 1991. *Nature's Metropolis: Chicago and the Great West* (New York, W.W. Norton).

Cusso Roser and Sabrina D'Amico, 2005. ''From Development Comparison to Globalization Comparativism: Towards a More-Normative International Education Statistics'', *Comparative Education*, 41, pp. 199-216.

Daston Lorraine, 1992. ''Objectivity and the Escape from Perspective'', *Social Studies of Science*, 22, pp. 597-618.

Dean Cornelia, 2008. ''Family Science Project Yields Surprising Data About a Siberian Lake'', *New York Times*, New, p. 1.

D'Emilio John and Estelle Freedman, 1988. *Intimate Matters: A History of Sexuality in America* (New York, Harper & Row).

Desrosieres Alain, 1998. *The Politics of Large Numbers: A History of Statistical Reasoning* (Cambridge, Mass., Harvard University Press).

Desrosieres Alain, 2001. ''How 'Real' Are Statistics? Four Possible Attitudes'', *Social Research*, 68, pp. 339-355.

Didier Emanuel, 2002. ''Sampling and Democracy: Representativeness in the First United States Surveys'', *Science in Context*, 15, pp. 427-445.

Duncan Otis Dudley, 1984. *Notes on Social Measurement: Historical and Critical* (New York, Russell Sage Foundation).

Espeland Wendy Nelson, 1998. *The Struggle for Water: Politics, Rationality and Identity in the American Southwest* (Chicago, University of Chicago Press).

Espeland Wendy Nelson and Michael M. Sauder, 2007. ''Rankings and Reactivity: How Public Measures Recreate Social Worlds'', *American Journal of Sociology*, 113, pp. 1-40.

Espeland Wendy Nelson and Mitchell Stevens, 1998. ''Commensuration as a Social Process'', *Annual Review of Sociology*, 24, pp. 313-343.

Espeland Wendy Nelson and Berit Vannebo, 2008. ''Accountability, Quantification, and Law'', *Annual Review of Law and Social Science*, 3, pp. 21-43.

Faust Drew Gilpin, 2008. *Republic of Suffering: Death and the American Civil War* (New York, Alfred A. Knopf).

Feldman Martha S. and James G. March, 1981. ''Information in Organizations as Signal and Symbol'', *Administrative Science Quarterly*, 26, pp. 171-186.

Foucault Michel, 1977. *Discipline and Punish: The Birth of the Prison* (London, Allen Lane).

—, 2003. ''The Subject and Power'', *in* Rabinow Paul and Nicholas Rose, eds., *The Essential Foucault* (New York, The New Press, pp. 129-144).

Friendly Michael, 2008. ''Milestones in the history of thematic cartography, statistical graphics, and data visualization'' (Toronto, York University).

Hacking Ian, 1990. *The Taming of Chance* (Cambridge, Cambridge University Press).

—, 1999. *The Social Construction of What?* (Cambridge, Mass., Harvard University Press).

Hampton Stephanie E., Lyubov R. Izmest'eva, Marianne V. Moore, Stephen L. Katz, Brian Dennis and Eugene A. Silow, 2008. ''Sixty years of environmental change in the world's largest freshwater lake – Lake Baikal, Siberia'', *Global Change Biology*, 14, 8, pp. 1947-1958.

Heimer Carol, 1985. *Reactive Risk and Rational Action: Managing Moral Hazard in Insurance Contracts* (Berkeley, CA, University of California Press).

Hein Laura, 2004. *Reasonable Men, Powerful Words: Political Culture and Expertise in Twentieth-Century Japan* (Berkeley, University of California Press).

Herbst Susan, 1993. *Numbered Voices: How Opinion Polling Has Shaped American Politics* (Chicago, University of Chicago Press).

Horrox Rosemary, ed. and translator, 1994. *The Black Death* (Manchester, Manchester University Press).

Hutchins Edwin, 1995. *Cognition in the Wild* (Cambridge, Mass., MIT Press).

Igo Sarah E., 2007. *The Averaged American: Surveys, Citizens, and the Making of a Mass Public* (Cambridge, Mass., Harvard University Press).

Jencks Christopher and Meredith Phillips, eds., 1998. *The Black-White Test Score Gap* (Washington, D.C., Brookings Institution Press).

Kalthoff Herbert, 2005. ''Practices of Calculation: Economic Representations and Risk Management'', *Theory, Culture, and Society*, 22, pp. 69-97.

Katz Jack, 1988. *Seductions of Crime* (New York, Basic Books).

KATZ Michael B., 1983. *Poverty and Policy in American History* (New York, Academic Press).
—, 1986. *In the Shadow of the Poorhouse: A Social History of Welfare in America* (New York, Basic Books).
KINSEY Alfred C., 1948. *Sexual Behavior in the Human Male* (Philadelphia, W.B. Saunders).
KNORR-CETINA Karin, 1999. *Epistemic Cultures: How the Sciences Make Knowledge* (Cambridge, Mass., Harvard University Press).
LAMONT Michèle and Virag MOLNAR, 2002. ''The Study of Boundaries in the the Social Sciences'', *Annual Review of Sociology*, 28, pp. 167-195.
LATOUR Bruno, 1987. *Science in Action* (Cambridge, MA, Harvard University Press).
—, 1988. *The Pasteurization of France* (Cambridge, Mass., Harvard University Press).
LAUMANN Edward O., John H. GAGNON, Robert T. MICHAEL and Stuart MICHAELS, 1994. *The Social Organization of Sexuality: Sexual Practices in the United States* (Chicago, University of Chicago Press).
LAVE John, 1986. ''The Values of Quantification'', *in* LAW John, ed., *Power, Action, and Belief* (London, Routledge & Kegan Paul, pp. 88-111).
LEAHEY Erin, 2005. ''Alphas and Asterisks: The Development of Statistical Significance Testing Standards in Sociology'', *Social Force*, 84, pp. 1-24.
LEVIN Peter and Wendy Nelson ESPELAND, 2002. ''Pollution Futures: Commensuration, Commodification and the Market for Air'', *in* HOFFMAN Andrew and Marc VENTRESCA, eds., *Organizations, Policy, and the Natural Environment* (Stanford, CA, Stanford University Press).
LOVEMAN Mara, 2005. ''The Modern State and the Primitive Accumulation of Symbolic Power'', *American Journal of Sociology*, 110, pp. 1651-83.
LUKES Steven, 2008. *Moral Relativism* (New York, Picador).
MARCH James G. and Herbert A. SIMON, 1958. *Organizations* (New York, Wiley).
MARX Karl (trans. Ben Fowkes), [1867] 1977. *Capital, Volume I* (New York, Vintage).
MICHAELS Stuart and Wendy Nelson ESPELAND, 2006. ''Queer Counts: Measurement and the Emergence of Gay Identity'', *American Sociological Association* (Montreal).
MILLER Peter and Ted O'LEARY, 1987. ''Accounting and the Construction of the Governable Person'', *Accounting, Organizations and Society*, 12, pp. 235-266.
MILLER Peter and Nikolas ROSE, 1990. ''Governing Economic Life'', *Economy and Society*, 19, pp. 1-31.
NUSSBAUM Martha, 1986. *The Fragility of Goodness: Luck and Ethics in Greek Tragedy and Philosophy* (New York, Cambridge University Press).
PORTER Theodore M., 1986. *The Rise of Statistical Thinking, 1820-1900* (Princeton, Princeton University Press).
—, 1995. *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life* (Princeton, NJ, Princeton University Press).
POWER Michael, 1997. *The Audit Society: Rituals of Verification* (Oxford, Oxford University Press).
—, 2003. ''Evaluating the Audit Explosion'', *Law & Policy*, 25, pp. 185-202.
PREWITT Kenneth, 1986. ''Public Statistics and Democratic Politics'', *in* ALONSO William and Paul STARR, eds., *The Politics of Numbers* (New York, Russell Sage Foundation, pp. 261-274).
REDDING Sean, 2006. *Sorcery and Sovereignty: Taxation, Power, and Rebellion in South Africa, 1880-1963* (Athens, Ohio, Ohio University Press).
RUSNOCK Andrea, 2002. *Vital Accounts: Quantifying Health and Population in Eighteenth-Century England and France* (Cambridge, Cambridge University Press).
SAUDER Michael M. and Wendy Nelson ESPELAND, 2009. ''The Discipline of Rankings: Public Measures, Decoupling, and Organizational Change'', *American Sociological Review*, 71, forthcoming.
SCOTT James C., 1998. *Seeing Like a State* (New Haven, Yale University Press).
SIMMEL Georg, 1978. *The Philosophy of Money* (Boston, Routledge & Kegan Paul).
SIMON Jonathan, 1988. ''The Ideological Effects of Actuarial Practices'', *Law and Society Review*, 22, pp. 771-800.
SMITH Dorothy E., 1990. *The Conceptual Practices of Power: A Feminist Sociology of Knowledge* (Boston, Northeastern University Press).
STERN Nicholas, 2006. *The Economics of Climate Change* (New York, Cambridge University Press).
STEVENS Mitchell L., 2007. *Creating a Class: College Admissions and the Education of Elites* (Cambridge, MA, Harvard University Press).
—, 2008. ''Culture and Education'', *Annals of the American Academy of Political and Social Science*, 619, pp. 97-113.

STEVENS Stanley Smith, 1946. ''On the Theory of Scales of Measurement'', *Science*, 103, pp. 677-680.

STRATHERN Marilyn, 1996. ''From Improvement to Enhancement: An Anthropological Comment on the Audit Culture'', *Cambridge Anthropology*, 19, pp. 1-21.

—, 2000. *Audit Cultures: Anthropological Studies in Accountability, Ethics and the Academy* (London, Routledge).

SUNSTEIN Cass R., 2000. ''Cognition and Cost-Benefit Analysis'', *Journal of Legal Studies*, 29, pp. 1059-1103.

TIMMONS Stuart, 1990. *The Trouble with Harry Hay: Founder of the Modern Gay Rights Movement*. Boston, Alyson.

TUFTE Edward R., 2001. *The Visual Display of Quantitative Information* (Cheshire, Conn., Graphics Press).

VENTRESCA Marc, 1995. ''When States Count: Institutional and Political Dynamics in Modern Census Establishment, 1800–1993'', *Sociology* (Stanford, Stanford University).

WARNOCK G. J., 1989. *J. L. Austin* (London, Routledge).

WEBER Max, 1978. *Economy and Society* (Berkeley, University of California Press).

WYPIJEWSKI JoAnn (ed.), 1997. *Painting by Numbers: Komar and Melamid's Scientific Guide to Art* (New York, Ferrar Straus & Giroux).

Résumé

Une des plus notables nouveautés politiques des trente dernières années a été l'augmentation de la demande de quantification des phénomènes sociaux de la part tant du public que des gouvernements. Les sociologues n'y ont guère vu un phénomène social général. En s'appuyant sur les acquis des sciences sociales tant américains qu'européens et aussi sur la recherche dans les humanités, l'article dégage cinq aspects de la quantification : le travail de base requis, la réactivité, le pouvoir normatif, l'autorité multiusages qu'elle dégage et enfin la puissance dans l'ordre esthétique.

Zusammenfassung

Eine der bedeutendsten politischen Neuerungen der letzten 30 Jahre ist die steigende Nachfrage nach der Quantifizierung sozialer Bewegungen und dies sowohl von seiten der Öffentlichkeit als auch der Regierungen. Die Soziologen haben dies nicht als allgemeines soziales Phänomen betrachtet. Aufbauend auf den Erfahrungen der amerikanischen und europäischen Sozial- und Humanwissenschaften, zeigt der Aufsatz fünf Aspekte der Quantifizierung: Arbeitsaufwand, Reaktivität, normative Macht, ,,Mehrzweck''-Autorität und die Macht der Esthetik.