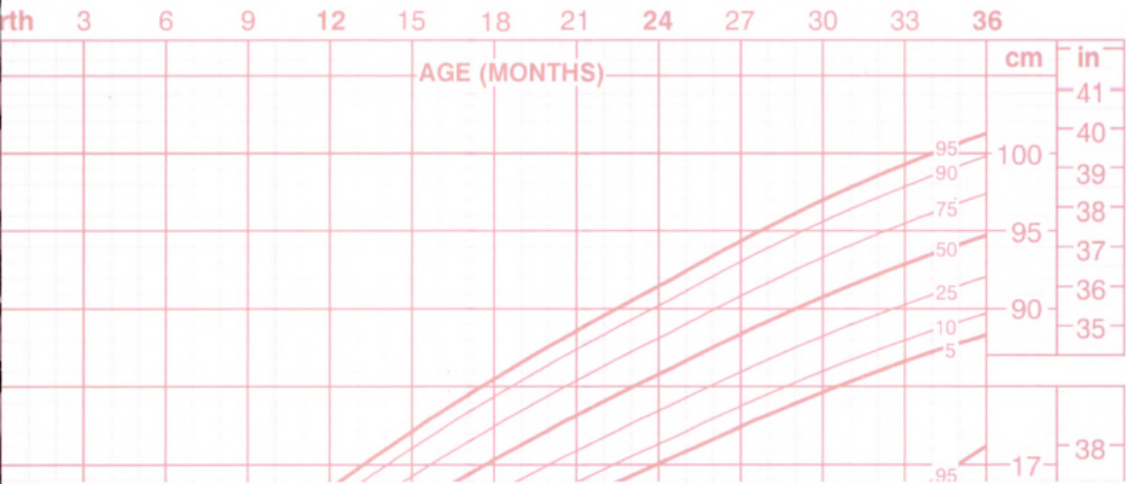


0 to 36 months: Girls

NAME _____

Length-for-age and Weight-for-age percentiles

RECORD # _____



STANDARDS AND THEIR STORIES

HOW QUANTIFYING, CLASSIFYING, AND
FORMALIZING PRACTICES SHAPE EVERYDAY LIFE

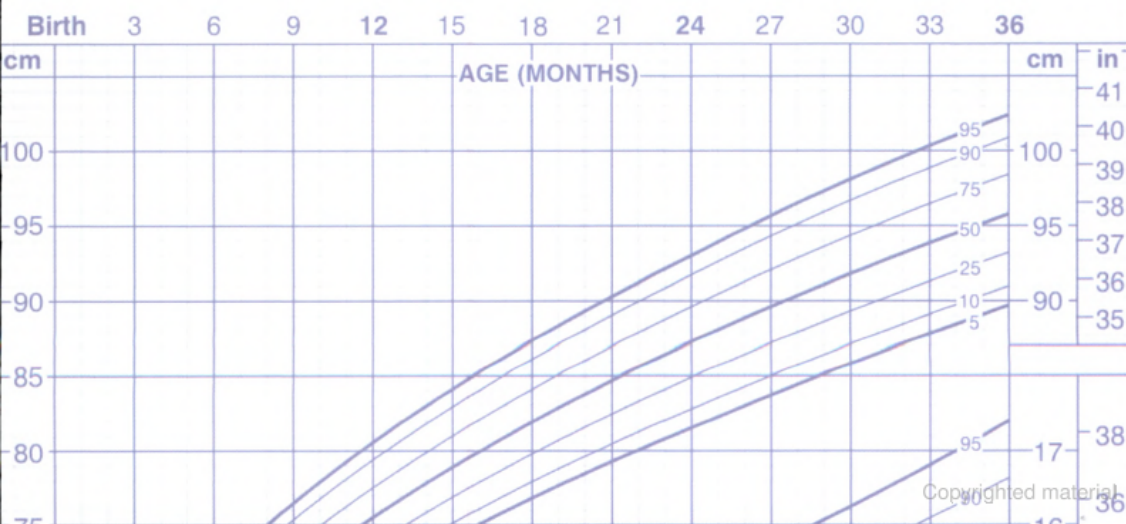
Edited by **Martha Lampland** and **Susan Leigh Star**

0 to 36 months: Boys

NAME _____

Length-for-age and Weight-for-age percentiles

RECORD # _____



STANDARDS AND THEIR STORIES

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Edited by **Martha Lampland**
and **Susan Leigh Star**

Cornell University Press
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**STANDARDS
AND
THEIR
STORIES**

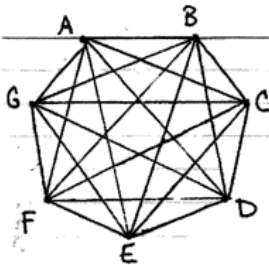
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The seven deadly sins led by the devil. Animal symbols constituted a visual classificatory scheme depicting the seven deadly sins, visible on the flags, for example, a pig for lust, the head of a bear for gluttony, a hedgehog for greed, an ass for sloth, a wolf for wrath, and a lion for pride.

Anonymous artists, woodcut, published September 25, 1490.

■ Two Representations of the Seven Deadly Sins

Then and Now



A = Lust
 B = Gluttony
 C = Greed
 D = Sloth
 E = Wrath
 F = Envy
 G = Pride

\overline{AB} = Edible Undies \overline{CF} = Advertising
 \overline{AC} = Prostitution \overline{CG} = Status Symbols
 \overline{AD} = Quickie \overline{DE} = Passive Aggression
 \overline{AE} = Domestic Abuse \overline{DF} = Welfare
 \overline{AF} = Adultery \overline{DG} = Slackers
 \overline{AG} = Trophy Wife \overline{EF} = Cattiness
 \overline{BC} = Last Donut \overline{EG} = Boxing
 \overline{BD} = Saturday \overline{GF} = 2nd Place
 \overline{BE} = Bulimia
 \overline{BF} = High Metabolism
 \overline{BG} = Fat men in Speedos
 \overline{CD} = Get Rich Quick Scams
 \overline{CE} = Muggings

"We're all going to Hell."

Posted by Jessica Hagy, January 29, 2007. Available at: <http://indexed.blogspot.com/2007/01/were-all-going-to-hell.html>.

RECKONING WITH STANDARDS



Susan Leigh Star and Martha Lampland

■ A friend, who has recently moved to the Netherlands, makes an appointment to see a U.S. tax preparer. She has no phone. She walks in to the tax office and schedules a time for the next day.

“What is your phone number, please?” asks the polite young man managing the office calendar.

“I don’t have one.”

“I’m sorry, I can’t put your appointment in to the calendar without a phone number.”

“Yes, but I don’t have one.”

Silence.

“Would you like me to make one up?” asks our friend.

“Oh, yes,” sighs the calendar-filler, “that would be great.”

“1-2-3-4-5-6-7,” says my friend.

“Perfect!” the young man says. “The computer accepted that just fine. See you tomorrow!”

This short anecdote introduces one of the main themes of this book: how contemporary people interact with standardized forms, technologies, and conventions built into infrastructure. This compilation is one of a few papers and books beginning to analyze the contemporary view of this question, one that includes the growing place of all sorts of standards, formal and informal, in our everyday lives (Bingen and Busch 2006; Brunsson and Jacobsson and Associates 2000; Busch, 2000). This growth is apparent at the most minute level and at the most macro level.

In the grocery store, labels referring to standards blossom. At times even each *piece* of fruit is labeled with a number, referring to a particular farm or crop; often there is other information pointing to rules, standardized practices, or other

techno-socio-agricultural constraints. Standards for the labeling of food are constantly changing, most recently including properties of its manufacture such as whether the food has been through a mill where nuts, wheat, or other allergens have also been processed. Sometimes in the United States, warnings of genetically modified organism (GMO) foodstuffs is to be found there; this is now standard in Europe. Standards for naming a product *organic* have recently been established in California; terms such as *natural* or *free range* are not standardized and, essentially, mean nothing. Outside of the market, the number and location of disabled parking spots are standardized and regulated by the Department of Motor Vehicles. This is a quick, light observation. A detailed study of even one market would reveal thousands of interlocking standards (and even more if it is one of a franchise of markets). How can we even approach this thicket?

This book considers a specific question: How have people dealt, in ordinary ways, with these millions of interlocking standards? Although the anecdote at the beginning of this chapter is meant to be amusing, it is, at the same time, deadly serious. These sorts of workarounds and stalling off computerized consequences are ubiquitous—work must get done, even though one size never fits all. The data that are missing when this happens are part of a vast domain of shadow work (Ilich 1981) that can never be recovered. At the same time, these practices can be crucial to our understanding of how things really occur in the workplace. We hope to contribute here, in a modest way, to the dulling of the impulse to standardize everything that seems to grip modern organizations. We are not, in any sense, against standardizing—only against society’s romance with it.

Our purpose here is hardly to compile a comprehensive history of standardization. Our goal is to show how standards are phenomena worthy of study in their own right, from multiple social scientific points of view. We hope to invite other studies of both the mundane and the arcane, the unconscious use of standards and numbers, and their very conscious use in intellectual development and research itself. Investing in forms is a cultural historical project, as is the increasing marginalization or deletion of content and residual categories (Thévenot 1984). The chapters included in this book (and the eclectic collage of examples interspersed) constitute our attempts to grapple with the phenomena of standardization and quantification in several domains: biology, public news media, food preparation, work and labor units, insurance, education, and everyday activities such as shopping.

Analytic Commonalities

To understand this romance better and to think about the human use, creation, and disuse of standards, we have built on the chapters here to analyze their commonalities. One of the results found across these chapters is that standards, as with all similar forms of compression and representations of actions:

- Are nested inside one another.
- Are distributed unevenly across the sociocultural landscape.
- Are relative to communities of practice; that is, one person's well-fitting standard may be another's impossible nightmare.
- Are increasingly linked to and integrated with one another across many organizations, nations, and technical systems.
- Codify, embody, or prescribe ethics and values, often with great consequences for individuals (consider standardized testing in schools, for example).

Let us consider each of these dimensions in turn.

Nested

When we refer to standards as being nested, we are speaking of the ways that they fit inside one another, somewhat like a set of Russian dolls (*maitruska*). Returning to the seemingly simple example at the beginning of this chapter, we can pull on a thread anywhere in the example and see that its implications are recursive through many systems. There are apparently tiny standards, such as the form for filling in the telephone number in the tax preparer's electronic calendar. Most people who visit a tax-preparation company in the United States have a telephone and know its number; however, for a variety of reasons, not all do. Americans who live abroad but still pay taxes to the United States may temporarily not have a phone; a homeless person may not have a phone, but may pay taxes and even require assistance in doing so; newcomers to an area may not have a standard arrangement for receiving telephone calls; and so on. The standard of *having a phone* is linked with *making an appointment*, which is linked with an inflexible, standardized *computerized calendar*. Not to belabor the point, but there are also medium-sized standards lurking in the background in a much larger, encompassing "nest"; for example, the U.S. tax code is so complexly standardized that most middle-class people pay US\$300–1,000 to have someone else navigate it for them every April 15. Quite large standards and practices—what percentage of a person's income goes toward state and federal taxes, and how little a person can get away with paying—nest the small interaction with the calendar. Many very rich people pay no taxes; they have enough money to purchase tax shelters and other workarounds to the standard percentages.

Laurent Thévenot, in "Rules and Implements: Investment in Forms" (1984), argues that we are increasingly forced to make and use these sorts of standards and their attendant forms (now usually computerized, but with a sizable amount of paper still remaining). The very stuff of bureaucratic action is just such an investment in form. Content, such as a telephone number, may vary from instance to instance, but in fact the shape of the form becomes the primary human-capital investment. The flexibility of such linkages, as well as of each form, is variable. Options such as "Other" or a box labeled "Other forms of contact" would actually free up the way the form is driving the interaction. At the same time, however, the

nested structure of the forms remains and is essentially not disturbed by a small number of such workarounds or residual spaces. Martin Lengwiler's inspection of the substandard human (chap. 4 in this volume) works inside the conception of a standard human, an object and set of events that is constantly being molded. Martha Lampland's work science standards (chap. 5 in this volume) are nested within a hierarchy of social inequities and a commitment to certain moral principles—principles that keep being renegotiated as work itself changes. Likewise, the privileging of chronological age is nested within structures of administration forms and rights, such as the ability to vote, drink, fight in the military, and drive (Judith Treas, chap. 3 in this volume). The formal techniques described by Florence Millerand and Geoffrey Bowker (chap. 6 in this volume), such as quantification, are nested within other standards in order to summarize information; metadata are nested within a whole system of standards.

Distributed Unevenly

With respect both to impact and obligation, sociotechnical standards are distributed unevenly. So, for example, most students in most Western countries must take standardized examinations at various stages of their schooling. This is a thorny, politically charged question. The very rich and the very poor, however, often escape the obligatory taking of the tests, or they have different relationships to it. Very rich youth may be educated in a way that is exempt from standardized testing (elite boarding schools outside the tests' jurisdiction, private tutors replacing classroom teaching standardized to the test, and so forth). Very poor young people may run away from school altogether; be educated in an environment that is not equipped to educate them about testing, rendering the test results moot; start work as children; or never achieve standard literacy through schooling. As Martha Lampland points out, the meaning of a standard, such as a work-hour, varies according to political regime and class position. When and where an individual is born matters greatly, as we see when we reach into the past to look for an uneven distribution of standards. The very definition of age is culturally variable, both unevenly distributed across historical periods and relative to the needs of states, labor pools, and who really counts.

Being able to speak English during the past years of computerization conveys a great privilege with respect to standardization. The implementation of most programs has until recently (and even now, although things are better) relied on a system of encoding, ASCII, that disproportionately disadvantaged people whose alphabet used non-ASCII characters. The examples from Swedish given by Daniel Pargman and Jacob Palme (chap. 7 in this volume) make clear the subtle but real advantages conveyed in qualities such as searchability on the Web and how the use of non-ASCII characters affects that.

Finally, for those of us who stood shocked as the CNN narratives about September 11, 2001, unfolded, we saw a disproportionate use of a standard set of

images and the hardening of a story, reaching into the ways that news is made and acceptable narratives are constructed.¹

Relative to the User and Communities of Practice (Social Worlds)

Following on the last point about uneven distribution, standard forms are also relative in their impact, meaning, and reach into individual and organizational lives. Standards, and the actions surrounding them, do not occur acontextually. There is always a kind of economy and ecology of standards surrounding any individual instance. Thus, what is benignly standard for one person at one time may be a barrier, or even a life-threatening occurrence, for another. For example, the act of presenting a passport in a standard gesture, in a standard format, works for millions of people much of the time. But, of course, some people are stateless, some states' legitimacy is questioned by other states, and some people (e.g., infants and prisoners) may be necessarily linked to others in order to enact standard citizenship. Steven Epstein (chap. 2 in this volume) speaks of different standards for different bodies, and Lengwiler (chap. 4 in this volume) talks about standard versus substandard lives (according to an insurance company). Throughout the book, this relative sense of standards is very clear. Millerand and Bowker (chap. 6 in this volume) note that standards are always relative to the infrastructure within/upon/sometimes against which they are implemented. The need for and the politics of metastandards thus arise—although the problem does not stop here; it is recursive.

Integrated

As we sit down, perhaps in the morning with a cup of tea or coffee, and answer our e-mail, we may read a greeting from a friend, a new deadline from a boss, or an argument from a student about a recent grade. Regardless of the particular words or emotional tones of the e-mails, in reading any of them, we use (invoke might be a better word) thousands of standards. For e-mail to function properly, these standards must be integrated one with the other, beginning with the source of access to the Internet (the service provider), software for presenting messages from many sources and in many formats, and telephonic and other carrier standards, and continuing right down to the machine code in the terminal or computer on the desktop and out to the Internet with its complex, evolving sets of handshakes and protocols (see Abbate 1999). The nature of this integration is profound, global (not, however, universal), increasing, and evolving. Social science theorists face new challenges in understanding exactly how this integration forms and drives action. For instance, when parents use cell phones to locate their teenage daughters and sons, is this a new form of surveil-

1. The first official meeting of the standards research group was held on Tuesday, September 11, 2001.

lance? How do families then configure themselves around the contact provided here? The older forms of checking up on and managing teen behavior on the part of parents included having them “telephone in” and meet curfews or having them remain within eyesight or in a chaperoned place. Do the caller identification numbers now enabled through a cell phone change how offspring manage information about their whereabouts? When some form of tracking becomes integrated with cell phones (such as a global positioning system, GPS) and family cars, does the resulting emotional ecology change the meaning of trust? We are beginning to study and weave answers to these sorts of questions (for example, Millerand and Bowker, chap. 6 in this volume); at the same time, the situation is moving very quickly.

Embody Ethics and Values

To standardize an action, process, or thing means, at some level, to screen out unlimited diversity. At times, it may mean to screen out even limited diversity. For example, despite the fact that transsexual and intersexual individuals have been a highly publicized, well-known aspect of modern culture for at least twenty years, almost all forms seeking demographic data have one binary choice, “M/F” (or male/female). And despite the fact that forms of partnership range from a single male and single female conjoined in one marriage for life to polyamorous arrangements with multiple genders and numbers of partners, most demographic forms ask “Married” (answer: “yes/no”) or the functional equivalent. The silencing of “Other” choices here is a moral choice as well as a technical and data-collecting one. Where on a form do the transsexuals “go”? In traditional population census data (although this is changing dramatically in many places), where do people of racially mixed heritage (that is, all of us, if we carry this further) “go”? Often, individuals are forced to choose to self-silence some aspect of their lineage (see Bowker and Star 1999, chap. 5). Epstein (chap. 2 in this volume) speaks movingly of the ironies of resistance and the politics of representation in medical testing. When a person chooses one side of his or her heritage, it is often to redress inequalities conferred by the lesser status; other aspects of him or her self remain invisible. This invisibility is only one form of moral inscribing that derives from standardizing forms and processes. Others involve making things visible in a positive manner—such as including environmental data with economic assessments and including emotional stressors or physical danger with wages, where the more stressful or dangerous the job, the higher the wages, and this becomes formulaically part of pay. Sometimes, as Treas (chap. 3 in this volume) discusses, age conveys age-related benefits or honor—but just as often, it conveys discrimination. The wide range of values in design, use, and propagation of standard systems is another opportunity for social science/technology analysis. In the following section, we consider some of the ways the shadow work continues to be propagated.

Standards: Some Considerations of Invisibility

This book grows out of a research group devoted to thinking through three related phenomena: standardization, quantification, and formal representation.² These are phenomena, like the investment in form, that pervade modern life. For us as social scientists, one of the interesting aspects is that they have largely escaped consistent attention as sociocultural projects in themselves. The work of creating them is often invisible or deleted in descriptions of their development. Standardizing clothing sizes, developing indices of economic growth, creating computer databases, identifying the appropriate population for clinical trials in medicine, mandating testing in schools—all these procedures entail processes of standardization and quantification (and usually formal representation) (see Lynch 1991). Yet the standards, numbers, and models tend to be black boxes in their own right. They may be presented as secondary or epiphenomenal to the procedures of which they are a part: marketing for mass consumption, economic development policies, transmitting information, testing medical innovations, and supporting children's educational progress.

Talking with a production engineer, research scientist, classroom teacher, medical professional, or factory manager, we discover that their lives are filled with tasks designed to create standards or comply with existing standards. Associations such as the American Standards Institute or the International Standards Organisation (ISO) are familiar creatures in the current technological and production landscapes. Increasingly, humanities and the fine arts are filled with standards as well. Why, then, have they so often escaped social analysis?³ Perhaps because many social scientists (ourselves included) fall into the taken-for-granted ease of seeing numbers and models, or specifications, as somehow “outside social order.” Perhaps some of the neglect is due to the Byzantine politics of qualitative versus quantitative approaches in the social sciences.

Clearly, standards are also complexly related to quantification, formal modeling, and data mining, reuse, and classification. Another book or more would be needed adequately to describe the role of each of these. Quantification is the most developed historically and sociologically (see, e.g., Porter 1995; MacKenzie 2001). Some attention has been paid to formal modeling and its consequences, notably in the work of geographers and in the work of philosophers of biology (Wimsatt 1998; Griesemer 1990; see also Morgan and Morrison 1999). As a shorthand, and

2. *Quantification* is the representation of some action, being, or model through numbers. *Formal representations* are those not tied to a particular situation or set of empirical data but, rather, are a synthesis of data and a presentation of rules for combining and acting. These are often conveyed in visual form, as graphs, tables, or formulae. They may also be conveyed in narrative form, such as conventional sayings or standard characterizations of phenomena.

3. The exception here is the economic analysis of networked standards; see, for example, Paul David (1985).

to better focus, we use the term *standardizing* throughout the book. At many junctures, however, numbers and other formal tools play a critical role alongside standards, and we have tried to be aware of these moments.

Standardizing has become a central feature of social and cultural life in modernity.⁴ The purpose of standardizing—to streamline procedures or regulate behaviors, to demand specific results, or to prevent harm—is rarely queried because it has come to be understood as a valuable and necessary, even if cumbersome, process. Certainly debates do take place over the extent or degree of standardization and especially about how and whether to measure the outcome of standardization (e.g., the nature and cultural bias of the IQ test and the Scholastic Aptitude Tests, SATs). But the question of whether to standardize (or quantify) *at all* is often suppressed. At times, it seems that standardizing overwhelms the primary activity—that is, the investment in form outweighs the performative content of the forms. Teachers, nurses, and psychotherapists, among others, criticize the increasing amount of time devoted to standards of care, teaching, and testing and the time lost from actually doing “the real work.” These professionals frequently complain about the demands of paperwork—recording evidence for insurance companies and government agencies—that attempts to standardize their practice and its evaluation. So, too, factory managers, design engineers, architects, builders, and social workers can easily and quickly compile a lengthy list of codes and regulations that must be accommodated in their work on a daily basis. But the measuring-standardizing activity is often the only thing that people consider “real evidence of results.” It is a failure of imagination to believe this.

Modern industrial and urban worlds were built with standards embedded in them. Think of any modern institution: education, the city, policing, the military, the stock exchange. Each is predicated, to some degree, on the tools of measurements, the purchase of standardized commodities (or investments in the futures of commodities) (Cronon 1991), and the measurement and formal presentation of results. And, as thoroughly at the center as these processes are, their mandate often remains unquestioned.

One simple explanation for overlooking the question “Why standardize?” is that standardization is considered to be a necessary technique designed to facilitate other tasks. We often confront standards as fully developed forms, such as an electricity grid or a health regulation. The resulting ahistoricity is another factor that allows the quintessentially sociocultural and ethical aspects of standards to be overlooked. In this sense, the process of standardization is both a hidden and a

4. Please note that standardization is *not* exclusive to modernity per se, but it has accelerated with its electronic and global forms, as already described. The distinction between a convention and a standard, or perhaps working standard, is in some instances difficult to make (Michael Evans, personal communication). Over time, what had been social conventions become increasingly standardized in formal ways, after which the difference between a standard and a convention is no longer minor but qualitative.

central feature of modern social and cultural life (Slaton and Abbate 2001). Or, ironically, because standards are so pervasive that they have become taken for granted in our everyday environment, they may become completely embedded in everyday tools of use. (Consider the Japanese toilets that routinely check urine to see if several medical parameters are out of line.) Residual categories (e.g., “None of the above” or “Note elsewhere classified”) may help us see the boundaries of standards, for example, rare medical conditions such as being allergic to onions or having undiagnosable chronic pain.

Containing Messy Reality

Looking into the edges and detritus of infrastructure can be a messy and distasteful task. For example, in studying the history of taxidermy, Star found herself tracking down the biological supply houses that had provided items such as standard-size glass eyes for the different animals in the museum dioramas (see figure); homemade devices for shaving and softening animal skins, and other tools for preparing and preserving specimens and habitats. The glass eyes are standardized with respect to color and size, and they are designed to be “lifelike.” Because taxidermy sought to take the messy scenes of hunting and capturing specimens and create in their place a clean, almost transcendental vision of nature, more of its craft skills came to require the use of standardized parts and means of working. In this, taxidermy holds common ground with medical illustration; debugging complex computer programs; and moving from the messy, noisy birthing room to a cleaned up, peaceful space.

One final, and rather comical, reason why standards may be neglected in socio-cultural research into science and technology is that they are boring. They are often, as mentioned, deeply embedded in infrastructures of various sorts, apparent as wires, plugs, lists, labels, and other semicultural forms. Once these forms are noticed and examined, most social scientists do agree that they are important indeed⁵—but they escape notice, and so studying them can be lonely. Some ten years ago, in Palo Alto, California, several colleagues formed a new professional society. The idea for the society arose from a series of conversations we had about our somewhat unusual research topics—these very semicultural things that most people find quite dull. We called it The Society of People Interested in Boring Things. Among the boring topics that the founders brought to the first meetings were the inscription of gender in unemployment forms used by the city government in Hamburg, Germany; the difficulties of measuring urine output in a post surgical ward in the Netherlands, and how to design better cups for metrication;

5. Including, among others, Charlotte Linde and Susan Anderson anthropologists; Geoffrey Bowker, historian; David Levy, information scientist; Marc Berg, physician/philosopher; Leigh Star; Sigrid Müller; and later Martha Lampland.

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Glass eyeball chart.

From Oliver Davie. 1894. *Methods in the Art of Taxidermy*. Philadelphia: David McKay. Plate VI.

the company mascot and the slogans used by a large midwestern insurance firm in its attempts to build corporate cultures; and how nematologists⁶ use computers to keep track of their worm specimens. To put it mildly, these are not central topics in social science—yet!

How should these boring traces that bear evidence of the development of standards be studied? The authors in this book share an ecological sense of the worlds of infrastructure. Collectively, we find it necessary to deconstruct boring backstage elements. In this, we seek to restore the narratives of these standards: their historical development, their political consequences, and the smoke-filled rooms always attached to decisions made about them. This means overcoming the initial boredom of analysis and, furthermore, practicing a deeper ecology than that of input-output or systems analysis. We have to listen to infrastructure and bring imagination to understanding its components and how they work.

Listening to infrastructure does not neatly resolve into accessible questions. The relative weight of social agents and social structure has long posed an analytic dilemma. Various traditions have resolved this tension in different ways. The issue here is less one of relative weighting than of determining when and where we can identify people, objects, and emergent properties (structures) in standardizing and using standards (or not using them). Standards such as human weight charts, blood types, and electrical current now appear fixed and neutral, although this inert quality obscures the enormous amount of work needed to stabilize knowledge, freeze action, delete outliers and residuals, and facilitate use. In the course of studying standardization, the challenge has been to figure out which threads to unravel to make visible and lively the otherwise banal and interstitial character of standards and quantified or formally represented phenomena. We have interrogated stories of the inevitability of technological development and the neutrality of quantification, examined claims about standardized representations and authority, and sought to reveal the political and ethical problems at the heart of these struggles. In other words, when does a structure become a structure and when is a social actor an agent are part and parcel of the story to be told here.

Although standards become crucial (and sometimes visible) once they have been stabilized, the physical features or phenomenal manifestations vary greatly. Enormous infrastructures, such as railroad lines or urban plumbing systems (Collier n.d.), can be massive observable structures of metal and PVC (polyvinyl chloride), whereas other equally central infrastructures, such the computer language ASCII (Pargman and Palme, chap. 7 in this volume) or standards for chronological age (Bowker and Star 1999; Treas, chap. 3 in this volume) or EU environmental policy, are far less tangible. (They are argued through in hardworking committees that rarely see the light of history. At most, they may be manifested in

6. Biologists who study worms, in this case those who were sequencing the genome of the nematode *Caenorhabditis elegans*.

written documents that are rarely perused by any but their most immediate users.) But early, incomplete forms of standardization, too, set parameters within which social action takes place. In retrospect, while doing the “archaeology of things and their order,” we may come to see them as clearly the product of a long series of events and actions taken to make them so.

Perhaps the most intriguing aspect of standards is their always already incomplete and inadequate (compared to some ideal) character (for a similar argument, see Barry 2001, 62–84). The push to standardize presumes the ability to constrain a phenomenon within a particular set of dimensions, as well as the ability to dictate behavior to achieve the narrowly defined dimensions that stipulate its outcome. A great deal of work is conducted to make the standard possible, and then this must be followed up by agents committed to implementation and oversight. Again, standardization is a recursive practice, necessarily historical and embedded in a series of complex events and social structures. This is quite evident in legal proceedings adjudicating the application of standards and regulations, but it is not limited to the legal domain.

Formal compliance to standards without substantial change in practice is common. Paperwork is filled out to assure the responsible authorities that regulations have been recognized, but this can be a far cry from actually fulfilling those requirements. Obviously, there is a range of behavior here, from near compliance to outright defiance of regulations. There is also a range of means to reward and punish those who step outside the boundaries of usual (and accepted) practice. For instance, accounting standards—both technical and ethical—were strongly questioned in the period following the ENRON scandal. The unethical behavior could hardly be blamed on the standards themselves. However, large shake-ups and scandals such as this leave a legacy. Frequently, they lead to a rethinking of the shape and usability of the standards. Organizations may begin to seek ways of making standards more effective in rendering an outcome that is consistent across the entire field of use.

The attempt to purify and simplify processes of standardization—through bureaucratic maneuvers or more contested legal procedures—contributes directly to the overdetermined or layered, socially and culturally embedded quality of standards. With time, this process can lead to what Callon (1998) calls “irreversibility.” This is, in the first instance, a functional irreversibility—for instance, what would it take to change the meaning of a red light to “go” and a green light to “stop”? Obviously, we would have to invest untold billions, and some sort political platform on which to base the change, to achieve this reversal.

A related maturation and reification process that leads, over time, to complexly recursive standards is that developed by Wimsatt (1998) under the rubric “generative entrenchment.” Small changes made early in the life of any developmental system will ramify throughout the growth of the system, becoming increasingly more difficult to eradicate. Wimsatt originally used the example of teratagens,

drawing on embryology to illustrate the process. If something small goes wrong early in the development of a fetus, it will ramify systemically. If it happens late in development, it is much more likely to be trivial. So it is with standards. Small conventions adopted early on are both inherited and ramify throughout the system.

Hence, we can say that slippage (such as the made-up phone number in the introductory example) between a standard and its realization in action becomes a crucial unit of analysis for the study of standardization and quantification. Using historical analysis, this may mean analyzing irreversibilities and processes of generative entrenchment. What is being standardized, for what purpose, and with what result? When did it begin? What were its first entrenchments? What can and should be changed? Who are the actors engaged in the process of standardization, and do they change at different moments of a standard's genesis and maturation? What small decisions have ramified through the life and spread of the standards? When does a standard become sufficiently stabilized to be seen as an object or quality influencing social behavior? How do we address the objectlike quality of standards while keeping a keen eye on the necessarily historical and processual quality of its emergence, transformation, and (variably) long life? How do standards developed in one context acquire a modular character, enabling them to be moved around or to serve as templates for the development of other standards?

And as a result of this intensely social, historical process, it is necessary to acknowledge the contingent and, in some cases, arbitrary nature of the standards themselves. The confusion, anger, and frustration people express about standards are easily related to the apparent allogical or irrational character of standards. The association of standards with irrationality demonstrates, as little else can, Max Weber's powerful insight that the move toward modern rationality necessarily resulted in forms of irrationality. The iron cage of bureaucracy has perhaps become a sociotechnical cage—sticky and partly binding but also complexly structured with information architectures and human behavior. This stands in contrast to current neoinstitutionalists' arguments that change proceeds linearly and along traceable tracks.

Types of Standards

What is being standardized, and who is being standardized? What is the difference between a gold standard and a working standard? Moreover, how is the baseline for a standard determined? How does it become naturalized or standardized, so that it slips into the realm of common sense and tacit knowledge? In many cases, the causal relationships will be difficult to parse in any simple fashion. Standardized procedures are created and enforced by governmental agencies; others are created and enforced by private businesses, professions, and local regulations. Still others are created by individual labs, families, and even individuals. We bemoan

some standards and laud others; we resist some entirely while gladly imposing others on ourselves.

Another set of issues crucial to the study of standardization concerns the scale and scope of a standard. Standards vary in their scope and scale. The standards for chocolate differ in both scale and scope from standards for gasoline purity. The history of modern standards is one in which the range of standards, and their relative scale and scope, has increased dramatically. This contributes to one of the astounding features of contemporary standardization bodies—the presumption that their work is necessarily global in impact. Clearly, coordinating communication over the World Wide Web or between computers in different sites has necessitated extensive work to ensure ease of data movement and flow, akin perhaps to the grand projects of building railroads and cutting deep river channels to facilitate the movement of goods in the nineteenth century (prompting the use of the metaphor of the superhighway). We must not lose sight, however, of the simple fact that standards are intensely local, in the sense that, despite their global reach, they touch very specific communities in very specific contexts.

In their book *Sorting Things Out*, Bowker and Star (1999) explore the case of the International Classification of Diseases in some detail. It is a good example of several of the issues we have raised so far; and it is, furthermore, widespread, standardized, and old (more than one hundred years old). It thus incorporates legacy systems, multiple (and sometimes competing) architectures, and hundreds of standards. It is clear in this case, also, that Western and middle-class values and foci are inscribed in the list of mortality and morbidity labels. For instance, heroin addiction and absinthe addiction are prominently featured in the drug abuse area of medical classification; petrol sniffing (widespread in the developing world) and legal addictions to pain medicines or Ritalin in the first world are ignored. When we turn to the part of the classification scheme that encodes accidents, a person may fall from an automobile or from a commode (a common accident during the care of elders at home in the developed world) but not, say, from an elephant or a carrying chair. These labels are used, among other things, to fill out death certificates and record epidemics around the globe. They are thus critical, although often invisible, resources for allocating aid and tracking international health concerns, which in turn become standardized and quantified in many ways.

Another crucial feature of standards, related to issues of scale and distribution, is a notion of degrees of delegation. How is the enforcement of standards (and their attendant moral orders) managed? Increasingly in developed states, delegation is managed via home-testing kits, through directives printed out from the pharmacist, or through a wobbly network of social workers and elder-care workers. The importance of degrees of delegation will perhaps help us distinguish between the character of conventions (discussed later), such as the manner in which a doctor treats a patient in a face-to-face encounter, and standards imposed at the state or national level for medical practice, such as provisions for cleanliness or the

ways people must dispose of toxic substances. This idea about degrees of delegation bears a resemblance to Bruno Latour's notion of "action at a distance" (1987, 219), but it is also, again, clearly informed by Weber's seminal work on modern bureaucracies and studies of complex organizations.

What Is Infrastructure?

Defining *infrastructure* is not as easy as it may seem. Along the way, we use the term, encounter it as used by others in connection with standardization. We had a commonsense notion of infrastructure when we began discussing the nature of "boring things"—infrastructure is something that other things "run on," things that are substrate to events and movements: railroads, highways, plumbing, electricity, and, more recently, the information superhighway. Good infrastructure is by definition invisible, part of the background for other kinds of work. It is ready-to-hand. This image holds up well enough for most purposes—when we turn on the faucet for a drink of water we use a vast infrastructure of plumbing and water regulation without usually thinking much about it.

However, in light of a deeper analysis of infrastructure, and especially to understand large-scale technical systems in the making or to examine the situations of those who are *not* served by a particular infrastructure, this image is both too shallow and too absolute. For a highway engineer, the tarmac is not infrastructure but a topic of research and development. For the blind person, the graphics programming and standards for the World Wide Web are not helpful supporters of computer use but barriers that must be worked around (Star 1991). To expand on our point about standards, one person's infrastructure is another's brick wall, or in some cases, one person's brick wall is another's object of demolition. As Star and Karen Ruhleder (1996) put it, infrastructure is a fundamentally relational concept, becoming real infrastructure in relation to organized practices (see also Jewett and Kling 1991). So, within a given cultural context, the teacher considers the blackboard as working infrastructure to be integral to giving a lesson. For the school architect, and for the janitor, it is a variable in a spatial planning process or a target for cleaning. "Analytically, infrastructure appears only as a relational property, not as a thing stripped of use" (Star and Ruhleder 1996, 113).

Infrastructure is part of human organization and as problematic as any other. The contributors to this book have done a kind of gestalt switch, what Bowker (1994a) has called an "infrastructural inversion"—foregrounding the truly backstage elements of work practice, the boring embedded things, and, of course, infrastructure. Work in the history of science (Bowker 1994b; Hughes 1983, 1989; Yates 1989; Edwards 1996; Summerton 1994) has begun to describe the history of large-scale systems in precisely this way. In science as well as in culture more generally, we see and name things differently under different infrastructural regimes. Technological developments are processes and relations braided in with thought

and work. In the study of nematologists mentioned earlier, Star and Ruhleder listed the properties of infrastructure as embeddedness; transparency; having reach or scope; being learned as part of membership; having links with conventions of practice; embodying standards; being built on an installed base (and its inertia); becoming visible on breakdown; and being fixed in modular increments, not centrally or from an overview.

The strangeness of infrastructure is not the usual sort of anthropological strangeness, in which we enter another culture with a kind of trained suspended judgment, eager to learn the categories of that culture rather than imposing our own. Infrastructural strangeness is an embedded strangeness, a second-order one, that of the forgotten, the background, the frozen in place. It always interacts with any given culture (see, e.g., Akrich 1993 on African use of electricity systems; Veran 2001 on Nigerian uses of mathematics), but it may be both local and global, or multiply standardized and adapted.

The ecology of the distributed high-tech workplace, home, or school is profoundly impacted by this relatively unstudied infrastructure that permeates all its functions. If we study a city and neglect its sewers and power supplies (as many have), we miss essential aspects of distributional justice and planning power (see Latour and Hernant 1999; Collier, n.d.). If we study an information system and neglect its standards, wires and settings, we miss equally essential aspects of aesthetics, justice, and change. Perhaps if we stopped thinking of computers as information highways and began to think of them more modestly as symbol sewers, this realm would open up a bit.

Many aspects of infrastructure are more difficult to locate, for several reasons. First, people tend to discount this aspect of infrastructure as extraneous to knowledge or to their tasks. They, therefore, do not tend to mention them in official historical narratives (except in passing; see Clarke and Fujimura 1992b for an excellent discussion of this problem). Second, details such as materials, standards, and formal modeling assumptions do not always obviously intersect the variables and processes that are familiar to us in analyzing human interactions. The known variables such as gender, race, status, career, power, and innovation trajectories are subtly represented in infrastructures, especially as they appear in processes of standardizing and quantifying (see Stern 2002). Unearthing the narratives behind the boring aspects of infrastructure does, however, reveal (often in a very direct way) how knowledge is constrained, built, and preserved. This book is a modest witness to the bricks of the infrastructure wall that are placed there in the form of codes, protocols, algorithms, and so forth.

Intellectual Background: Science Studies

In the world of science, scholars began to study how laboratories work during the 1970s, work that later linked to these concerns about infrastructure. In Europe

and the United States, notably with the publication of Bruno Latour and Steve Woolgar's *Laboratory Life* (1979), people began to explore the laboratory as a kind of anthropological field, with scientists as the tribe. *Laboratory Life* is an ethnographic examination of the production of a scientific fact. It looks at the devices (called "inscription devices" by Latour and Woolgar) used by biologists to record and preserve data. In this, Latour and Woolgar unpack the gradual deletion of uncertainty and qualifications in the statements emerging from the laboratory. They explicitly try to eschew the obvious categories that previous, more macro-scale studies of science produced: occupational stratification, the role of national cultures in science, and so forth. The idea was to approach science afresh, to look empirically at knowledge construction in a detailed, face-to-face context, much as an anthropologist would approach a new tribe (their metaphor).

With the publication of *Laboratory Life*, a window was opened to a more qualitative, intensively observational set of studies of scientific work and practice. Many were produced over the next two decades, examining such interesting phenomena as talk in the laboratory, the acquisition of manual skills in performing tests, the ambiguity of scientific objects, and the intersection of heterogeneous viewpoints in making scientific theories; by the 1990s, the research community began the systematic study of the design and use of information technologies (see, e.g., Star 1995). This development toward the "technical turn" in science studies, that is, the ethnographic study of the design and use of advanced technologies such as computers, had many research ramifications. It used many of the same techniques as the earlier laboratory studies of science; however, it also directly engaged social scientists in studying communicating machines, the emergence of the personal computer (PC) and the World Wide Web, and attempts to model human behavior. In addition, by the early 1990s, several detailed studies of the materials aspects of scientific work began to appear, many of which began to pick up other aspects of boring things, such as the humble stuff used in experiments (see, e.g., Clarke 1998) and the way equipment and its layout reflects a particular scientific commitment.

Recent studies have taken this combination of the technical turn and studies of materials deep into the investigation of infrastructure (see, e.g., Star and Ruhleder 1996). The ethnographic eye that helped reveal the inner workings of science or technology research and development applies no less to the built scientific-technical environment. Arguments about standardization, selection and maintenance of tools, and the right materials for the job of knowledge production have slowly come into center stage via this synthesis (Clarke and Fujimura 1992a). Along with this has come a rediscovery of some of the research tools germane to cognate disciplines that had previously analyzed material culture and the built environment. These include, *inter alia*, fields such as architecture (in which scholars sometimes read the built environment as a kind of text), literary theory (especially those aspects of literary theory that help hidden stylistic assumptions and narrative

structure surface), and social geography (in which the values and biases inherent in such tools as maps are a lively topic of inquiry). Work on quantification and standards as structuring knowledge owes much to these fields, as well as to cognitive anthropology and linguistics, areas whose scholars have investigated the toolness and origin of various modeling systems.

An example of the study of a technical project in which infrastructure and standards are central is the sociological study of the biological effort the Worm Community Project of the early 1990s. Leigh Star and Karen Ruhleder (1996) found a world of clashing meanings between designers and users of the system. The project came just before the advent of the Web and as academe became fully saturated with e-mail users (especially in the sciences) in 1991–1994. They studied a scientific community and a custom-made system codesigned with the community. Most respondents said they liked the system, praising its ease of use and its understanding of the problem domain. On the other hand, most did not sign on. Many chose instead to use Gopher and other simpler net utilities with less technical functionality; later, of course, they turned to the World Wide Web. Obviously, this was a problem of some concern to the system developers and evaluators. Despite good user prototype feedback and participation in the system development, there were unforeseen, complex challenges to use involving standards and infrastructural and organizational relationships. The system was neither widely adopted nor did it have a sustained impact on the field as the resources and communication channels it proffered became available through other (often more accessible) means. It did provide insights for social scientists into the profound impact of the understanding of infrastructure on group interactions.

In short, the study showed that problems with local infrastructure and standardization can mean the rise or fall of expensive experiments. Each form of standardizing, quantifying, or modeling stands on top of another, supporting it but not in a smooth or seamless fashion. Some stone walls fall down; some survive for thousands of years. (The same can be said, in interesting ways, of Gothic cathedrals, many of which did fall down; see Turnbull 1993.) Thus, some forms of infrastructure are added to and maintained; some are neglected. In any event, the nesting properties of infrastructure converge with human behavior to form a complexly imbricated, messy whole.⁷

The metaphor of imbrication is important for the rest of this book, in addition to its evocative picture of uncemented things producing a larger whole. Imbrication also implies that each part may shift in character over time as the whole is edited or rearranged. Thus, a keystone at one time—a rigid standard, say—may

7. *Imbrication* means partly overlapping layers (not stacks), such as we would find in a good stone fence in New England. As a metaphor, it means the heterogeneous variety of things that partially hold one another up, including discourses, actions, architecture, work, and standards/quantifications/models.

"I sat down to read the book, read the first page, and paused while my face broke into a smile and a comfortable warm feeling came over my body. Yup, this was going to be a great book. Further reading confirmed the impression. Standards rule our lives. Yeah, standards, that dull, frustrating topic studied by 'The Society of People Interested in Boring Things.' But this book proves that far from being dull, the stories behind standards are interesting, insightful, and revealing of the workings of bureaucracy. Standards are essential for different stuff made by different companies in different countries to work well together. Whether it is bananas or chocolate, application forms for terrorist training, or the sizes of people's rear ends (critical for airline seats), standards are an essential part of life today (all these are covered in the book). This engaging book serves several purposes. It explains much of the history, rationale, and politics of standards. It shows why they have a huge social impact, far beyond what most of us realize, often far beyond what was intended. And best of all, it is fun to read."

—DON NORMAN,

Northwestern University, author of
The Design of Future Things

"*Standards and Their Stories* is an important, well-written, and extraordinarily provocative examination of a part of the world usually hidden from any sort of public view. The authors show how much of what we take for granted is the result of negotiation, compromise, and occasionally coercion. They do so by inventing a suite of new and innovative research methods. As a result, this book is likely to become not only 'the standard' for studies of this sort but also the starting point for new ways of investigating sociotechnical processes."

—LAWRENCE BUSCH,

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