72. For discussions of statistics during the Revolutionary and Napoleonic periods, see: Marie-Noëlle Bourguet, *Déchiffrer la France: La statistique départementale à l'époque napoléonienne* (Paris: Editions des Archives Contemporaines, 1988); id., "Décrire, Compter, Calculer: The Debate over Statistics during the Napoleonic Period," in *The Probabilistic Revolution*, ed. Lorenz Krüger, Lorraine J. Daston, and Michael Heidelberger, vol. 1 (Cambridge, Mass.: MIT Press, 1987), 305–16; and Stuart J. Woolf, "Towards the History of the Origins of Statistics: France 1789–1815," in *State and Statistics in France 1789–1815* (New York: Harwood Academic Publishers, 1989), 79–194.

TWO

A REVOLUTION TO MEASURE:

THE POLITICAL ECONOMY OF THE METRIC SYSTEM IN FRANCE

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Why is a Meter a Meter?

ACCORDING to the most recent textbooks, a meter equals the distance traveled by light in a vacuum in 1/299,792,458 of a second. One might well ask, why so bizarre a number? A possible answer goes as follows: the meter acquired that present value so as to equal a platinum bar built in the 1870s and housed in the Parisian *Conservatoire des arts et métiers*. This bar was built to match an earlier platinum bar manufactured at the time of the promulgation of the metric system; that is, during the French Revolution. And that first bar was based on a geodetic survey, conducted during the 1790s, which measured a portion of the length of a quarter of the earth's meridian (the distance from pole to equator) and divided that distance by ten million. The ostensible purpose of this geodetic survey—which took six years and cost half-a-million *livres*—was to create a standard measure based on invariant nature that just so happened to be on the human scale and roughly equal to the *aune* of the Old Regime.

The very elaborateness of this charade, however, suggests a different sort of answer. To uncover it, I will need to show that at the core of "universal standards" commonly taken to be the products of objective science lies the historically contingent, and further, that these seemingly "natural" standards express the specific, if paradoxical, agendas of specific social and economic interests.[1] In particular, I will show how a technocratic elite during the period of the French Revolution used a new system of measures to mediate a fundamental tension between state authority and the construction of a market economy. This then is the story of how a rational language—the metric system—was deliberately crafted to break the hold of the Old Regime's political economy and serve as the universal idiom of the modern mechanism of exchange.

The Paradoxes of Standardization

The hobgoblin of uniformity haunted the philosophical mind of the Enlightenment. Already in his *Esprit des lois*, Montesquieu had warned against the seductive aesthetic of a leveling rationalism.

> There are certain ideas of uniformity which sometimes seize great minds (as they did Charlemagne's), but which invariably strike the petty. They find in them a kind of perfection which they recognize because it is impossible not to discover it; the same weights and measures in commerce, the same laws in the state, the same religion in all parts. But is uniformity always appropriate without exception . . . ? So long as people obey the law, what does it matter if they obey the same one?[2]

Montesquieu became known in the late eighteenth century for his sly willingness to accommodate the existing order, a pragmatic and moderating spirit which feared the consequences of its own rational criticism. Not all eighteenth-century thinkers were so deferential; for them, rational criticism sounded an unequivocal call to action. The above passage in Montesquieu greatly offended Condorcet. "Here we have one of the most curious chapters of the book. It has earned Montesquieu the indulgence of the prejudiced, of those who hate enlightenment, of those who defend abuses, etc. . . . Ideas of uniformity, of regularity, please all minds, and especially just minds. . . . A good law ought to be good for all men, as a true proposition [in geometry] is true for all men."[3]

That nature's laws were everywhere the same meant, for Condorcet, that the hodgepodge of human laws must be realigned with universal principles. By reducing the legal code to its essential form, he expected to render it comprehensible to all literate men and women, and to diminish the unfair advantage that those in authority held over the powerless. This program of social justice depended, in Condorcet's view, on a scientific study of society to be conducted by means of new rational languages for the facts of the social realm, including symbolic languages that would be universally valid and "bring to all objects embraced by human intelligence a rigor and precision that would render knowledge of the truth easy and error almost impossible."[4] One such language was to be the metric system.

Keith Baker has analyzed the virulent debate between Necker's monarchical pragmatists and Turgot's free-market Physiocrats.[5] The two camps also differed on the related question of metrical reform. Whereas Necker confessed that the reform of weights and measures lay beyond the crown's power, one of the unfinished projects of Turgot's ill-fated ministry was to ascertain the precise length of a one-second pendulum with an

eye toward constructing a uniform system of measures based on invariant nature.[6] As Baker has pointed out, Turgot thereby sought to enlist the authority of science to resolve a contentious political debate.[7] And in the event, the system of rational measures elaborated by his disciple, Condorcet, proved highly prophetic of the metric system adopted twenty years later by the French Republic. This was, of course, no accident; as we will see, Condorcet assisted Talleyrand with his 1790 proposal for revolutionary measures, and guided the Academy of Sciences toward its final formulation of the metric system. His goal in both instances was twofold and paradoxical: on one hand, to facilitate free exchanges between French citizens by introducing a uniform language for the objects of daily economic life; and on the other, to enable the government to collect accurate information for the purposes of rational policy-making. Condorcet expected decimal division to enable ordinary citizens to calculate their own best interests "without which they cannot be really equal in rights . . . nor really free."[8]

This sort of liberatory rhetoric has dominated discussion of the metric system, both then and now.[9] And certainly many of the advocates of metrical reform upheld a democratic vision of equal access to knowledge. In the year II of the Revolution, the Jacobin mathematician Gaspard Monge would tout the decimal system as being "within the reach of everyone; all children will know it, and it will be a means of reducing the inequality among men."[10] This essay is intended to point out the paradoxical context in which such liberatory "rationalization" operated. As the Physiocrats themselves recognized, replacing the Old Regime's society of particularist interests with a scientific and natural social order meant in some sense erecting reason as "sole despot of the universe." In practical terms this also meant making the citizen knowable to the state. Nor was this the only irony. So long as Condorcet believed he spoke in the name of the common good (since what is true is necessarily good), he felt justified in castigating his opponents as purveyors of falsity who sought only to protect their private interests. "The uniformity of weights and measures cannot displease anyone but those lawyers who fear a diminution in the number of trials, and those merchants who fear anything that renders the operations of commerce easy and simple."[11]

To ensure the triumph of free trade, Condorcet and his followers came to adopt an authoritarian rhetoric which excluded defenders of the "Gothic" measures from the realm of virtuous and legitimate discourse. This dual irony of intent and word was to reverberate through the wider polity when the Revolutionary state later deployed the metric system as part of its effort to impose a free-market economy on France.

Recent historiography of the French Revolution has focused on the supremacy of the word.[12] This essay is, among other things, an attempt to

broaden this fashionable analysis of political discourse to include the political work done by *non-verbal* languages explicitly concerned with material objects and property relations. I intend to examine both the rhetoric *about* the metric system and the metric system *as* a politicized language about the material world. My goal is to help reconnect an increasing rarefied academic analysis of political signs and symbols with the daily economic lives of French men and women in the 1790s. The revolutionaries themselves saw the metric system in just this light. Bureaux de Pusy, military engineer and representative to the National Assembly, assured the legislature that in a nation cut off from its past, the metric system would provide a unifying language that tied citizens to the economic life of the country. "What means are more capable of bringing together the *esprits* and diverse interests into that precious unity which is the strength of government than a common idiom, common symbols, and identical rules for all the objects necessary or useful for the daily needs of individuals; and how much the uniformity of measures will fulfill this goal!"[13]

For Bureaux de Pusy the advantages of such a uniform and rational language were also material: the system would increase exchanges between distant parts of the nation, and hence specialization in more valuable types of production; it would end the wasteful and fraudulent practices of merchants who purchased a commodity at a large measure, and then sold it at a smaller one; and finally, it would enhance the productivity of agriculture—the basis of national prosperity—by enabling the comparison of yields on different plots of land, and hence specialization in suitable crops. For all these good Physiocratic reasons, he assumed such a system was sure to be embraced by a grateful nation—according to the President of the Assembly, in no more than six months.[14] In fact, each of these advantages involved a fundamental misconception of the meaning of measurement in the Old Regime and resulted in a woeful misreading of the source and strength of the resistance to the new measures. And again, historians have reproduced that misreading to the point where most major accounts of the Revolution have assumed that the metric system was one of the few unrescinded successes of the period.[15] But the Revolutionary governments failed to impose the metric system on France. In 1812, Napoleon, the "great systematizer," effectively returned France to the old standards, and only under Louis-Philippe was the metric system reinstated in the 1840s.

Twentieth-century Americans are inevitably sensitive to the problems associated with converting to a new set of units. And unlike the French historians noted above, John Heilbron, in his recent study of the metric system, sees through the self-serving "grantsmanship" of the Revolutionary savants, and with mordant wit exposes their naive faith in the common people's willingness to join this orgy of rationalization.[16] But Heilbron too implies that the slow spread of the new measures can serve as a

yardstick (meter stick?) for the spread of reason among an innumerate public—a people whose resistance he attributes to four causes: 1) consumers' fears that shopkeepers would raise the price of goods when they rounded up to the new units; 2) the fact that the decimal system does not lend itself easily to the familiar division of commodities by twos and threes; 3) the unexpected difficulties, particularly among an innumerate people, of mastering calculations even in the decimal system; and 4) most people's attachment to particular numbers as qualitative judgments about, say, what constitutes a "tall" person. Clearly, these are the sort of translation problems that afflict citizens asked to adjust from one set of "imperial" units to the metric system—and they certainly operated in Revolutionary France. But French citizens of the Revolutionary period were also being asked to confront the additional and very different problems associated with converting to the metric system from a world of premodern measures that was deeply embedded in the practices of the Old Regime, a world with its own autonomous moral economy and its own consistent "reasonableness." What *was* the meaning of measurement in Old Regime France? What was the savants' "grantsmanship" meant to cover up? And what can explain this strange equivocation in the history of French modernization?

The "Infinite Perplexity" of the Old Regime

The diversity of measures in pre-Revolutionary France astounded visitors. In his travels of 1789, Arthur Young was continually infuriated by a country "where the infinite perplexity of the measures exceeds all comprehension. They differ not only in every province, but in every district, and almost in every town. . . ."[17] In the eighteenth century there existed as many as 700–800 different metrical names which expressed a mind-boggling total of some 250,000 local variants![18] The diversity of measures within the province of Forez (now the department of the Loire) bears out this numbing complexity.[19] Why should this have been so?

Measurement is indispensable to exchange. As performed within a modern system, it is an operation where objects are described in abstracted, commensurable units that relate to a conventional standard. As performed in early modern France, measurement was an operation almost inseparable from the object measured and a specific measuring device.

In the Old Regime, different commodities were measured with different units, whose values differed from parish to parish. In the Saint-Etienne district of the Forez there existed separate units for grain, wine, oil, salt, hay, wood, coal, and other products. Likewise, different trades employed different units, a reflection of the particularism of Old Regime

corporate practices.[20] But the fundamental reason for this variation was that most measures had meaning only in reference to a specific receptacle or ruler. The famous iron *toise* of Paris was set in the wall of the Grand Châtelet. And the *bichet* (bushel) of Saint-Etienne referred not to an abstract capacity of grain, but to a specific cylindrical receptacle housed in the municipal offices.[21] The dimensions of this vessel influenced its capacity because, depending on local custom, the grain was measured either "heaped" or after being "struck and combed" in a prescribed manner. Thus measurement in pre-Revolutionary France did not just represent an abstract quantity, it embodied a whole mesh of physical objects, ritualized custom, and the practices of artisanal producers.

But far from being irrational, the hodgepodge measures of the Old Regime made real sense to the artisans, peasants, and shopkeepers who used them. Almost all premodern weights and measures had at their origin an anthropomorphic meaning; that is, they referred to the human scale and human needs. By this I do not mean those units which had simply taken their name from human anatomy (*pied*, *pouce*, etc.); these units had long since become fixed by reference to specific rulers—at least in the major market towns. Instead, I mean the many other units associated with human labor and production. For instance, the *aune*, a measure of cloth, was defined as the width of the local looms.[22] And coal in the Saint-Etienne region was measured in *charges* equal to one-twelfth of a miner's daily output, while the unit that measured the length of his progress varied with the difficulty of the face being worked.[23] The measurement of land area in particular was closely tied to human labor. In many regions of France, the Forez among them, arable land was still measured in *bicherées*, a value based on the number of *bichets* (bushels) of grain required to sow that field; while in the vineyards, land was measured in the *homme* or *journalier*, the area of grape-growing land that a peasant could pick in a day. The Saint-Etienne district also possessed a separate measure for pasture land, itself divided into five *dégrées* based on the quality of the land.[24]

As Witold Kula, the great Polish economic historian, has pointed out, these anthropomorphic measures expressed both a quantity of human labor and a qualitative evaluation of the land (rich land was more densely sown than poor land; plentiful vines took longer to pick), features of primary concern to those who worked the soil.[25] (And for those who think there's no difference between this and modern measures, there's five hectares in Florida I'd like to sell you. . . .) These "natural" measures are analogous to the "natural" time that E. P. Thompson says workers reluctantly surrendered in emerging European manufactures of the early modern period. There, enterprising owners replaced the task-oriented time of their proto-industrial work force with the new mechanical clock-

time, recasting labor in terms of an abstract quantity (time) so as to enforce greater shop floor discipline and appropriate any increase in the productivity of their operatives.[26] As we will see, the same process seems to have taken place when the natural measures of land-labor were converted into abstract units of surface area.[27] This task-oriented sense of the word "natural" has the exact opposite meaning of that advanced by Enlightenment scientists for their "natural" units, which were the antithesis of anthropomorphism.[28]

But despite their anthropomorphic origin, most units of measure had stabilized during the early modern period, as lawsuits and the protracted dealings of artisans, peasants, commercial traders, and seigniors established local convention.[29] Particularly important were the struggles between peasants who paid rent in kind and their seigniors, who sought to increase the dimensions of their measures as a way of extracting greater rent.[30] Consumers also had an interest in stable measures as a way of controlling price. This applied especially to the paramount issue of bread. As the cost of foodstuffs soared on the eve of the Revolution, angry townspeople in Saint-Etienne complained—justifiably as it turned out—that bakers had decreased their weights so as to sell smaller loaves.[31] So the crowd of irate citizens forced their aldermen to tour the town bakeries armed with the local standards and required the bakers to conform to the local standards.

This incident reveals one of the most important functions of metrical diversity. In a "fair price" economy, traders used differences in standards of weight to compensate themselves for their services. In 1754, the government's agent in Tours admitted that variations in local measures allowed dealers to make a profit by buying grain at one measure and selling it (for the same price) at a lesser measure.[32] But rather than condemn this practice, he noted that it encouraged commerce in the region, since attempts to raise prices risked the wrath of the local populace. Obviously, these differences opened the door to considerable fraud and chicanery, but as the Assembly of Sens noted in 1788, "the establishment of a uniform measure would ruin this genre of commerce, destroying at the same time an infinity of little markets which subsist only on these differences and, though of no great importance, supply the needs of the nearby consumers. . . ."[33] The ability to manipulate measures in this way depended on an intimate familiarity with the local metrical "dialect" and enabled local traders to protect their market niche.

The flexibility of measures in the Old Regime also enabled workers to skim off some of the materials that passed through their hands and thereby extract a "customary appropriation" to supplement their meager wages. As Peter Linebaugh has shown in the case of the eighteenth-century transatlantic tobacco trade, English merchants used hogshead con-

tainers of standard volume to try to end this sort of "depredation."[34] In France, too, ports and other transfer points were notorious for incurring such carrying charges; and dock workers often bitterly resisted the standardization of measures. While the metric system did not put an end to such practices—and may even have simply invited government officials to take a "cut" instead—regular standards made it easier for traders to criminalize these popularly sanctioned customs.[35]

Standards of measurement are inevitably arbitrary; but enforcement can be pursued through various mechanisms. In modern societies, standards are set by scientists and enforced by government bureaucracy. In premodern societies, local communities have the primary role in safeguarding measures, and by this means they attempt to protect their livelihood and insulate local economies from outside disruption and competition.

"One Law, One King, One Weight, and One Measure"

French sovereigns and their administrators had periodically resolved to assert their authority in metrological questions—precisely to extend their ability to govern and extract revenue at the local level.[36] In practice, however, control over weights and measures lay predominantly in the hands of seigniors who kept copies of the local standards and extracted a fee for all market weighings.[37]

Nevertheless, eighteenth-century royal bureaucrats, besieged by innumerable disputes over measurement of cloth, iron, and wine, persisted in their attempts to coax France into some semblance of metrical order.[38] In 1766 Trudaine de Montigny, the Intendant of Finances, sent eighty models of the Parisian units to the major towns of the realm, and enjoined provincial administrators to draw up tables comparing local and national measures.[39] Without such a key, royal bureaucrats could not be certain of the local grain prices listed in the *mercuriales*. Control of the all-important food supply was often hindered by the diversity of weights and measures; a dangerous weakness in the administration of enlightened absolutism.[40] During the crisis of the year II, even the "all-powerful" Committee for Public Safety had great difficulty translating the *maximum* for bread prices into the thousands of local measures, and similar problems attended the sale of the *biens nationaux*.[41] The technical branches of the bureaucracy—particularly within the military—were also eager to exploit the benefits of uniform measures. Vauban, the Sun King's fortification expert, expressed an interest in standardized measures and in the decimal system of division.[42] And early in the century the artillery service introduced a single set of measures throughout its arsenals of production. Certainly the system of interchangeable parts manufacturing, conceived by artillery general Jean-Baptiste de Gribeauval in the last decades of the Old Regime, was unimaginable without some standardization of measures.[43]

This insight into the value of uniform measures was not new of course. As is well known, a number of illustrious savants had proposed various systems of measures in the seventeenth century, some based on a regularly beating pendulum and others on the size of the earth.[44] The research program of these natural philosophers had been directed toward a search for constancy in nature, and they wished to communicate their results with a hitherto unheard-of precision. Yet even these were not the first proposals for rationalized measures. Decimal division had been advocated by the Flemish engineer, Simon Stevin, a century before.[45] And Renaissance functionaries, mindful of their classics, drew up equivalencies for Roman and Greek measures, which they offered as the basis for national standards.[46]

But the primary impetus for the spread of uniform measures under the Old Regime was the transforming economy. During the early modern period Parisian measures gained appreciable ground in major urban areas.[47] By the end of the eighteenth century, townsfolk in Saint-Etienne used a single *livre*, that of Lyon, the region's major trading center—and the source of most of the town's balances.[48] Changing patterns of land tenure also spurred new "exact" assessments by surveyor-geometers.[49] In the Lorraine, for instance, peasants' methods of estimating land area gave way to the methods of "geometers" at the same time that open-field cultivation was ending and tracts were increasingly defined as the absolute property of a single owner.[50] Even in relative backwaters like the districts around Saint-Etienne, surveyors bragged that "we have put all these defective [measures] in good order, so that in each district their content is regulated in either *perches*, *pas* or *pieds*. . . ."[51] (These same surveyors cautioned, however, that for the actual partitioning of fields "it is best to stick to the report of those who sow the land. . . .") Although the rationalization of farming advanced more slowly in France than in England, redefining holdings in abstract units of surface area, rather than units of labor, improved the chances for gains in productivity—gains that presumably accrued to the landowner.[52]

In the decade before the Revolution the mood among the propertied and literate portion of the population swung decisively against the diversity of measures. Contemporaries complained of their immense variety, and pleaded for a Legislator who would give France a uniform code of measures. Alexis Paucton, the foremost metrical compiler of the Enlightenment, wrote: "They are the rule of justice which must not vary, and the guarantee of property which must be sacred."[53]

This resentment seethed in the famous *Cahiers de doléances*: 128 of the third estate's regional *Cahiers* demanded uniformity, 32 of the nobility's, and 18 of the clergy's.[54] In the Forez all three orders demanded reform of weights and measures, and the plea for "one law, one king, one weight, and one measure" figured in the complaints of 18 of its surviving parish *Cahiers*.[55] In these complaints, metrical reform was typically coupled with reducing the impediments to free trade. For instance, in La Cotte en Couzon (Forez) metrical "multiplicity" was explicitly cited as a "hindrance to commerce."[56]

But here we must confront a paradox. If the desire for uniform measures was so widespread among the elite, why did the metric system fail? One answer lies in the *type* of metrical reform the French citizens were asked to adopt.

From "Rational" Measures to "National" Measures

The metric system was the active creation of savants such as Condorcet, Prieur de la Côte-d'Or, Monge, Borda, Lagrange, Haüy, Delambre, Méchain, Lavoisier, and a score of others. Between 1790 and 1799, they sat on the planning committees, performed the scientific research, and administered the agencies that monitored the reform.[57] Their right to define and execute policy in this area stemmed to a considerable degree from the Royal Academy's traditional authority in metrical questions.[58] And like the royal academicians they had so recently been, these republican academicians were eager to provide the intellectual instruments that would assist the central bureaucracy in its attempt to fashion France into a modern state—one that would be revenue-rich, militarily potent, and easily administered. To these men, the Revolution seemed to clear the way for a full-fledged renewal of Turgot's enlightened reforms. Academicians like Jean-Baptiste Le Roy quickly noted that the fall of feudalism and seigniorial privilege in August, 1789 removed the daunting juridical barrier that had soured Necker on metrical renewal.[59] So when in 1790 Talleyrand, in consultation with Condorcet, secured passage of legislation initiating a review of French measures, the Assembly authorized the Academy to review the various proposals. But though they developed the system on behalf of their patrons in the state, as technical experts, these academicians possessed considerable latitude to give shape to the vague demands expressed in the *Cahiers*.[60]

Between 1790 and the year III they added in succession four elements to the simple demand for a uniform system of measures. Each was proposed independently, and each called for choices among alternatives. (Even the demand for uniform measures came in a variety of forms; for instance, many *Cahiers* had called for only province-by-province uniformity.) A schematic calendar showing their order of introduction is presented in table 1. First, they insisted that the single invariable standard be *taken from nature* (though the earliest legislative proposal urged the adoption of the Parisian or Roman measures, and scientists long debated whether to derive their natural standard from a pendulum or the size of the earth). Second, the various measures of length, area, capacity, and weight were to be linked into an interconnected *system of measures* (though here too scientists disagreed over how to define these relationships, especially for units such as weight). Third, the *decimal scale* would divide these units into multiple and fractional units (though a duodecimal, base 12 system was also seriously considered). And fourth, a *systematic nomenclature* would express the relation of the fractional units to the principal unit (though proposals for simple monosyllabic names were also advanced).

By deriving the system from "nature" the scientists hoped to elevate their creation above the politics of self-interest and make it seem nonarbitrary and independent of its creators.[61] Grandiloquently accepting the definitive meter on behalf of the Council of Ancients in 1799, President Baudin admitted that while any standard is ultimately chosen by convention, one taken from "inviolable" nature was surrounded by "all the authority derived from such a source."[62] In much the same way, Revolutionary politicians such as Danton and Grégoire used the familiar idea of "natural frontiers" to give France's territorial ambitions in Belgium a patina of reason and respectability.[63]

This claim of "naturalness" was principally invoked to justify the (expensive) choice of basing the standard of length upon a fraction of the earth's meridian.[64] However, this same rhetoric was used to justify all the features of the new system. Though well aware that the preference given, say, the decimal system of division was in some sense arbitrary—a convenience for arithmetic calculations—metric propagandists such as the crystallographer René-Just Haüy insisted that division by base 10 approached a "natural" base because of finger counting.[65] More to the point, Laplace argued that the universality of the decimal system made it the vastly superior choice.[66] But even Laplace acknowledged that a system founded on the duodecimal division offered real advantages for daily commercial transactions because the number 12 possessed many divisors, and hence enabled merchants and customers to partition commodities easily.[67] For the same reason, some reformers preferred base 8 because it would enable commodities to be divided in half again and again and again.[68]

These claims of "naturalness" and "universality" served practical purposes. In the early years of the Revolution the claim that the new measures had universal properties that transcended the hurly-burly of daily politicking helped build consensus around the plan as myriad proposals for new measurement systems poured into the legislature from provincial

TABLE 1
Calendar of Legislative Proposals Regarding the Metric System, Revolutionary Period, 1790–1799

1. UNIFORMITY

1788—The *Cahiers* call for the adoption of uniform weights and measures. Some urge national uniformity, others regional or local uniformity.

August 1789—Two weeks after the abolition of feudalism on August 4, Le Roy suggests to the Academy of Sciences that there are no legal impediments to national measures.

February 1790—Tillet and Abeille of the Royal Agricultural Society are the first to propose national standards of measures to the National Assembly.

2. A MEASURE "TAKEN FROM NATURE"

February 1790—Tillet and Abeille ask the Assembly to adopt the "original Roman measures," or if these cannot be determined, those of Paris.

March 1790—Talleyrand (on advice from Condorcet) suggests the national standard be based on the length of a one-second pendulum at 45° latitude north (a site conveniently near Bordeaux).

March 1791—The Academy committee (Borda, Lagrange, Laplace, Monge, and Condorcet) win approval for a standard based on a fraction of the meridian that passes through Dunkerque and Barcelona.

April 1792—Interior Minister Roland insists that the Convention adopt a temporary measure of length while the nation awaits the completion of the meridian survey.

June 1799—Calculations of the International Commission on Weights and Measures based on the six-year geodetic survey of Delambre and Méchain, result in a "definitive" platinum meter bar, which is presented to the Council of Ancients.

3. SYSTEM OF MEASURES

March 1790—Talleyrand suggests all measures (area, volume, weight, etc.) be derived from length.

1793—Lavoisier defines a gram as the weight of a given volume of distilled water at the melting temperature of ice.

1799—Lefevre-Gineau defines a gram as the weight of a given volume of distilled water at the temperature of maximum density.

4. DECIMAL DIVISION

April 1790—Le Blond proposes to the Academy of Sciences that France adopt a duodecimal system, and invents two new characters to represent "10" and "11."

TABLE 1 *(cont.)*

March 1791—Borda makes a formal proposal for a decimal system of division, which had been first reported in committee in October 1790.

5. SYSTEMATIC NOMENCLATURE

1790–93—The committees of the Academy consider various proposals for a litany of simple monosyllabic names.

August 1793—Arbogast publicly introduces the first version of the systematic nomenclature.

1794—During the Terror, Prieur advocates using low Breton prefixes.

April 1795—Prieur substitutes Greek prefixes in the near-definitive metric law of 18 germinal, year III (April 7, 1795). Minor modifications follow in the next months.

societies, professors of philosophy, and citizen-surveyors.[69] Significantly, the system offered a national standard without resorting to the adoption of the Parisian measures at a time when provincial federalists suspected the capital of harboring the same centralizing ambitions as its royal antecedents. Whereas the first men to address the Assembly on the subject begged the legislature to simply adopt the Parisian measure so as to "scrupulously distinguish our ordinary measures from our scientific measures [and] not take us beyond our desires and hopes," Talleyrand spurned the Parisian measures as not answering "the importance of the issue, nor the aspirations of enlightened and exacting [*difficile*] men."[70]

This posture of "disinterestedness" also explains the pronounced internationalism of the early proposals of Talleyrand and others. What Britain and France did together could hardly be accused of being in the interest of any single nation or group.[71] The United States and Spain were invited to participate as well. But when, in 1791, at the urging of the Academy, the National Assembly rejected a pendulum standard in favor of a survey of a meridian that traversed France alone, it signaled to even such sympathetic observers as Thomas Jefferson that the academicians' show of internationalism was of a particularly Gallo-centric stamp.[72]

In fact, the meridian project proved a real plum for French science and its main source of financial and institutional support during the Terror.[73] On August 1, 1793, in an effort to forestall the dissolution of the Academy of Sciences, Lavoisier hurriedly pushed the metric system through the legislature, even though the scientists could only offer a temporary estimate of the meter while the meridian survey was still in progress.[74] The Jacobin Convention closed the Academy anyway one week later, but permitted the unfinished metrical research to continue. Thanks in large part

to the extravagance of the meridian project, research dragged on for six more years, with a budget roughly three times the annual operating costs of the *entire* pre-Revolutionary Academy of Sciences.[75] Funds soon flowed into the coffers of the community of scientific instrument-makers who had been hit hard by the disruption of the luxury trade.[76] And when the legislature seemed to lose interest in funding the project, the department of military cartography, under General E. N. de Calon, stepped in with money.[77]

Personal and professional ambition also set the agenda for the metrical research. The astronomer Borda threw his weight behind the meridian project in the hope that it would enhance the reputation of his "repeating circles."[78] True, the oblate shape of the earth was a question about which the scientists could always use more data (though the fundamental issues had been resolved thirty years before),[79] but even at the time, observers saw the monumental geodetic survey as an unabashed exercise in grantsmanship. Louis-Sébastien Mercier, chronicler of Paris, accused the savants of having "preserved their pensions and salaries . . . under the pretext of measuring the arc of the meridian."[80] His common sense told him, "it should not have been necessary to go so far to find that which lay so near."

Ultimately, the standard "taken from nature" came to be vested in a platinum bar presented to the Council of Ancients in 1799 and housed in the legislative chamber as a symbol of the new metrical order and as a surety against all damage and decay—just as the Athenians had kept their measures in the Acropolis and the Israelites kept theirs in the Temple.[81] But this attempt to imbue the standard with the sort of sacral "solemnity" that Talleyrand had thought necessary,[82] only undermined the scientists' claims that the measure was "taken from nature." And furthermore, the International Commission that performed the final calculations was inevitably forced to gloss over numerous uncertainties. These included errors in the determination of the base lengths, the angles of the meridian, and the kilogram weight,[83] plus disputes over the value chosen to represent the oblate shape of the earth,[84] difficulties calibrating the temperature-dependence of the metal rods used to measure the triangle bases,[85] unanswered questions regarding the astronomical observations,[86] and significant last-minute changes in the latitude calculations.[87] In any case, the platinum bar itself could not be manufactured with absolute precision.[88] Recounting how he discovered an error in the angle corrections of a colleague, Delambre, the scientist chiefly responsible for the survey, said he offered up the story to "disabuse his contemporaries of the existence of some sort of chimerical perfection that mankind has never obtained and probably never will."[89] Ten years later, Delambre had revised his best guess as to the "true" length of the meter, in the process shaving off two significant figures.[90] It hardly mattered. Faced with the elaborate web of

procedures already codified in the geodetic survey, neither the French nor foreign delegates to the international committee had had much scope to suggest alternatives.[91] The measure "taken from nature" had become a human construct. None of which is meant to imply that the international commission practiced "bad" science—only that they misrepresented their undertaking in the name of political expediency.

Keith Baker argues that the Revolutionary governments, basking in their newfound claims to sovereignty, no longer needed science to legitimate their administrative reforms.[92] On the contrary, Revolutionary governments through the Directory period continued to enlist the authority of science to make palatable unpopular legislation—particularly, as we will see, those acts that ushered in a market economy. This claim for objective knowledge has since become the familiar chant of experts wandering the corridors of representative government, their way of covering political interests with the veneer of logic and number.[93] Consider, for instance, the manner in which the French scientific elite defended the metric law as an ideal system beyond the reach of political debate altogether.

In the year II, comparing the various elements of the metric reform to a chain, Haüy argued that "once the principle had been established that the unit of weight and measure was to be taken from nature, the whole plan of the system was traced in advance in prescribed order by the sequence of ideas. . . ."[94] Intended to emphasize the conceptual simplicity of the reform, such a declaration had the property of stifling dissent by condemning critics as the enemies of reason. And when the generally sympathetic editors of an agricultural journal dared to suggest that the new Greek prefixes sounded foreign to most French citizens and would be difficult to understand,[95] the scientists at the Agency of Weights and Measures effectively denied their opponents the right of criticism altogether.

> You cannot attack a part of the system without endangering the whole. Otherwise many different objections will follow: some will want a new nomenclature; others will want the meter to be based on the full circumference of the earth; still others will prefer the pendulum, etc. . . . Now that the law is promulgated (after long deliberation), it is best not to attack it, but to give it the respect it is due. . . . There must not be any doubt about the goodness of the law.[96]

Where Condorcet had expected liberated citizens to assent to the self-evident truth of the new measures, the metric system was now presented as a doctrine that demanded uncritical obedience. I doubt Montesquieu was smiling. For his part, Prieur de la Côte-d'Or—former member of the Committee for Public Safety and primary author of the metric nomenclature—vehemently denounced those vacillators who raised "petty" objections against his new names: "One cannot change the plan of a building once it is underway."[97] As we have seen, however, the metric system was

not an indivisible edifice; it had been constructed over several years out of disparate and individually controversial components. The republican scientists always claimed their work was undertaken to safeguard equality and liberty, but when confronted with dissent they spoke the language of technocratic absolutism.

And the scientists' tone only grew more shrill as the population's disregard of the metric system became more evident. In the end, advocates of the metric system were driven to discover a "general will" to justify state intervention as the only way to transcend each individual's reluctance to surrender his or her own familiar measures.[98] Conscious of the contradiction between their own authoritarian rhetoric and the ascendant post-Thermidorian liberalism, the scientists at the Agency of Weights and Measures tried to reassure their co-citizens that the metric system could never be "an instrument in the hands of a [tyrant]. . . ." "[The metric system] is simply a police measure to ensure the social order. . . . Neither *our good pleasure* or *full power* are part of the lexicon of a *reasonable* people who must be enlightened and convinced."[99]

The question remained, how *were* the people to be convinced? How *was* the gap between a "self-evident" rational policy and popular discontent to be closed? Though they might stifle dissent, the scientists could not compel the public to use the new measures. The problem, as Baudin despairingly observed, was that, in the words of Jean-Jacques: "Men will always prefer a bad way of knowing to a better way of learning."[100]

The Metric of the Market

The law of 1 August 1793 had declared the metric system obligatory in eleven months. But in the face of popular indifference and hostility, the government began to lower its sights; Paris would be the proving ground.[101] Even so, police reports from Paris in the mid-1790s indicated the new measures had hardly penetrated the marketplace there.[102] And after the imposition of the metric system for the entire department of the Seine, complete metrical confusion reigned.[103] Storekeepers, trapped between the administration's insistence on the metric law and their customers' preference for the old measures, now illegally stocked two sets of weights. This invited the very abuses that the system had been intended to end.

It was a bitter irony. The ostensible purpose of the metric reform had been to facilitate free and transparent exchanges (fig. 1). Interior Minister Roland had hastened the promulgation of the earliest metric system in 1792 because he believed the diversity of measures represented the main obstacle to the national circulation of grain.[104] (And because he expected that uniform measures would help him write a new tax code.) Numerous

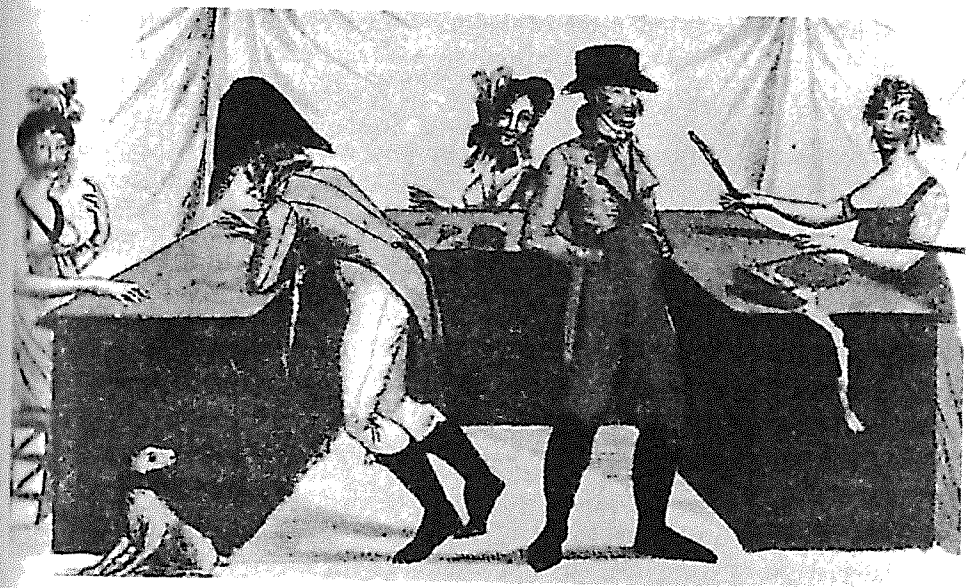

FIG. 1. In this caricature of 1800 the customer in a milliner's shop insinuates that he "prefers the meter to the *aune*." The *aune* was a linear measure of cloth in the Old Regime. *Revue Encyclopédique Larousse* 9 (1899), 847.

petitions had insisted on uniform measures as a prerequisite for open commercial transactions.[105] And the scientists who administered the metric system in the Directory had expected their system would transform France into "a vast market, each part exchanging its surplus."[106] Indeed, the metric proponents went on to argue, their system was particularly designed to facilitate long-distance exchanges, which were the most beneficial kind of trade because they connected regions with complementary resources. Their hope was that this would encourage specialization in production and an increase in yields. Henceforth, those merchants who survived on the differences in local measures, would pursue "a more useful course" and "speculate on differences in *productivity*, which is the natural basis of commerce."[107] In other words, by abstracting measurement from objects and labor, scientists sought to break the protection that particularistic measures afforded local economies, and end those practices that enabled the "fair price" market to function. In its place, they would erect price as the paramount variable.

How could this be accomplished? Initially, the central government expected to "reconquer the unity of executive power" in the realm of measurement much as the monarchy had ended feudal control of the money supply; that is, by circulating new standards that would gradually be preferred by the citizenry.[108] This liberal approach, first proposed by Condorcet in the 1770s,[109] operated in concert with an intransigent rhetoric

which denounced opponents of the new measures for their mercenary self-interest. During the Revolution, the scientists administering the reform bitterly condemned those "fraudulent" speculators who bought and sold in different measures. Distinguishing these "parasitic" cheats from honest businessmen making a legitimate profit on trade justified the use of state power to transform the economy. "Those who say that differences in measures aid commerce are just talking about their personal profits. It is not industry that profits. Just because speculators profit from diversity, do we need to keep it?"[110]

But so long as artisanal and peasant producers continued to measure their output in terms of its value (usually, the value of their labor), differences in productivity would not come to the fore. The problem was to remake the mentality of citizens. For this purpose, a uniform set of measures—such as those of Paris—did not go far enough. As the scientists in charge of administering compliance with the metric system put it: "A well-made language is essential for proper reasoning; the former [metrical] nomenclature had none of these properties."[111] Having provided a language for the rational analysis of ordinary objects, "right thinking" about exchanges would soon follow. From "right thinking" about exchanges, proper economic action would follow. That is what Condorcet meant when he said he expected the decimal division to enable ordinary citizens to calculate their own best interests "without which they cannot be really equal in rights . . . nor really free."[112] The republican scientists saw in the metric system a rational language that would remake French citizens into rational economic actors. As mathematics was the language of science, so would the metric system be the language of commerce and industry. No wonder the Minister of the Interior saw no paradox in his simultaneous assurance that "uniformity of measures has always been desired by the people," and his boast that "[it] is a splendid instrument for the molding of public opinion [*la raison publique*]."[113]

That is why the state took the lead in educating its citizens about the new system (fig. 2). Between April and December of 1795 alone, the Agency of Weights and Measures printed seventy thousand publications providing tables and graphical keys of translation.[114] Large numbers of privately printed pamphlets also explained the principles of the metric system and offered conversion tables.[115] But this did not guarantee that anyone was learning the new system. A visiting Danish astronomer observed in 1800 that "most of the people living in France do not even know the new terms, much less understand them."[116]

Nor was it enough to master this new idiom. Citizens also needed to be able to translate the old vernacular of local measurements into the new national metric vocabulary, and vice versa. Where citizens had once needed a "dictionary" to go from one town to the next,[117] they now needed one to travel into the future. The "definitive" edition of the *Tables*

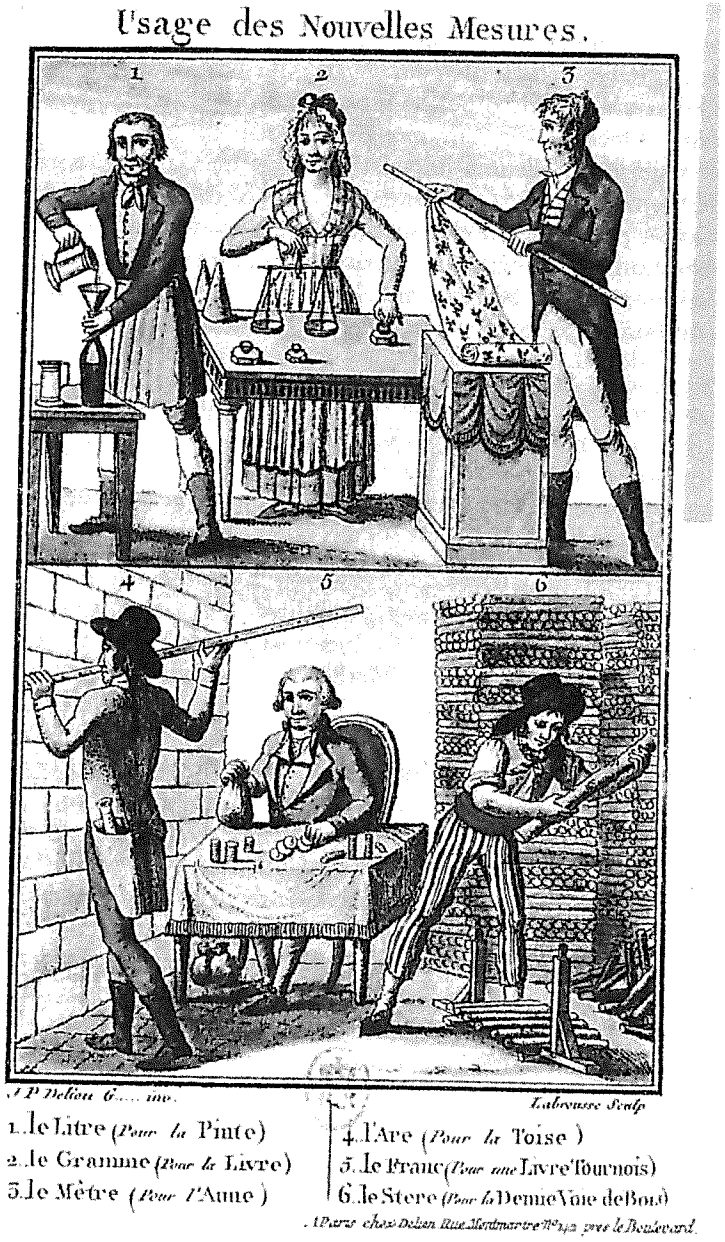

FIG. 2. This 1800 illustration of the "uses of the new measures" shows workers performing traditional tasks as a way of introducing the new names for measures of capacity, weight, length, area, currency, and volume. Hennin Collection, Bibliothéque Nationale.

des rapports in 1810 confidently declared that "[a]t last the French will no longer be strangers in France."[118] The danger was that citizens would not feel at home in their own parish. In Saint-Etienne, local officials confessed that the tables did not even begin to cope with the mind-boggling diversity of local seigniorial units.[119]

Ultimately, the savants hoped the actual metric weights and rulers would themselves act as the patient teachers of this "right thinking" and serve as the physical embodiment of the new social order. In keeping with the sensationalist epistemology of the period, the scientists who administered the Agency of Weights and Measures believed that daily contact with rational measures would engender a rational citizenry.

> If we want the people to put some order in their acts and subsequently in their ideas, it is necessary that the custom of that order be traced for them by all that surrounds them. . . . We can therefore look upon the metric system as an excellent means of education to be introduced into those social institutions which conjure up the most disorder and confusion. Even the least practiced *esprits* will acquire a taste for this order once they know it. It will be retraced by the objects which all citizens have constantly before their eyes and in their hands.[120]

Unfortunately, putting meter sticks in the hands of ordinary citizens was easier said than done. In 1794, the Commission of Weights and Measures offered financial incentives for artist-citizens who undertook the production of new measures, and described a machine that would help them do so "with precision and promptitude."[121] But when private artisans failed to manufacture these standards in sufficient quantity, the Committee of Public Safety turned to the government's own *Atelier de perfectionnement,* which Prieur de la Côte-d'Or had established at the height of the Terror to mass produce interchangeable gunlocks. The *Atelier*, originally part of the mammoth Manufacture of Paris, was now assigned the task of manufacturing one thousand meter sticks.[122] These never materialized, in part because of shortages of raw materials, inflation, fraud, and mismanagement. But in a larger sense, the Revolutionary government's attempts to mass produce metrical standards foundered on obstacles stemming from the corporate work practices of artisans, obstacles in many ways analogous to the particularistic practices that made ordinary citizens unwilling to adopt the new measures.[123]

The final irony came when the state set out to justify its re-regulation of trade in the name of a language designed to foster the development of a free market. In 1799, just as the meter was being formally presented to the Counsel of Ancients, the government established the *Bureaux des poids et mesures*, offices, run as local monopolies, which charged a fee to verify commercial weighings.[124] To many, they signaled a return to the

hated feudal dues of the Old Regime and a restriction on the absolute right to trade whenever, wherever, and however one wished.[125] The Parisian monopoly granted Brillat and Co. drew particularly incensed objections.[126] In the end, the "despotic" company had to send in hundreds of troops to supplant the market weighers who thrived on the old measures, using enforcement of the metric system as their excuse for re-regulating the marketplace.[127] In this way, the new weights and measures became the wedge by which the government revived the distinction, familiar to the Old Regime, between the regulated public *marketplace* (limited in time and place, so that all might have equal access) and the chaotic *free market.*[128]

But even the sanctions of the state were not enough to force compliance. As the inspector for the Department of the Loire discovered when he went undercover, the bright new metric measures that shined in his honor on the countertops during his official visit, could vanish in a day.[129]

Standards and the State

The French elite always assumed that the resistance to the new measures was born of ignorance. This overlooked the disruption caused to long-established community norms negotiated between peasants and seigniors, customers and shopkeepers, artisans and merchants—plus the actual or feared pain of opening up local markets to outside competition. In many cases the old units could not even be adequately translated into new terms, since that would involve abstracting commodities from the labor and materials that had gone into their making. This was something that many peasant and artisanal *producers* were understandably reluctant to do—whatever gain they might expect as *consumers*. Indeed, the whole thrust of the metric reform was to replace an economic system based on value, with one in which everything—human labor, as well as its artifacts—was translated into the single, paramount variable of price.

But it would be a mistake to conclude that opposition to the metric system came exclusively from the lower orders. Ironically, the system was spurned even by the government bureaucrats, those men whose duties it was supposed to ease. In 1796, provincial notaries had not switched to the new system; in 1798, the Treasury was still not using the decimal system of money; and in 1799, Interior Minister François de Neufchâteau, complained that even the Parisian administrators continued to employ the old measures in their official correspondence.[130] No less than the common people, functionaries steeped in the traditional measures must have found the new units incommensurate with tasks formerly expressed in good round numbers. It is in this light that we must read the

absurd invoice sent in 1808 by the Parisian office of weights and measures to the Saint-Etienne office, indicating that the requested metric standards were packed inside, and that the total weight of the shipment came to 60 *livres* (*poids de marc*).[131]

This equivocation even applied to the artillery service, an agency committed since the middle of the eighteenth century to the ideals of uniformity, precision, and modern manufacturing. In the year IV, the Directory secured the assent of the Parisian arsenal to convert the artillery to the new measures.[132] And the next month, General Aboville, head of the artillery's central committee, requested that the government print a metric edition of Gribeauval's celebrated *Tables de construction* because the "precision indispensable to the operation of the artillery" required that the dimensions of cannon now be expressed in the new measures.[133] The central War Office rejected the artillery's request on the grounds of expense.[134] But by 1801, the shoe was on the other foot, and the Minister of War was pressing the artillery to adopt the metric system; a request renewed with greater insistence in 1805.[135] In the meantime, however, the cadre of officers around Gribeauval, men who had supported interchangeable parts manufacturing and the rationalization of the workplace, had been supplanted by a new generation of artillerists.[136] Under pressure from powerful military contractors, and unwilling during wartime to risk further rebellion among the armorers, these officers retreated from Gribeauval's vision of mass production. In analogous fashion, they resisted bringing the artillery into the metric age. The new units, they complained disingenuously, would ruin the mathematically precise relation between the cannonball's weight and its caliber, and would undo the uniformity and interchangeability "which we took so many pains to establish."[137] Even in 1822, the artillery, by its own admission, had hardly broached the subject of metric conversion.[138]

In the face of this widespread hostility—even among its own bureaucracy—the state was gradually forced to temporize. Intended to minimize fraud and eliminate barriers to the free exchange of goods, the metric system had in fact thrown marketplaces into confusion. Some unscrupulous bureaucrats now profited from the differences in old and new measures to extract a "fee," much as merchants had formerly bought and sold commodities in units of different size.[139] The imperial administration was under pressure to reestablish order. The rationalizers had long ago retreated from their attempts to decimalize the hours of the day, and the Revolutionary calendar was abolished 1 January 1806.[140] On 4 November 1800, the Consulate had substituted simple names for the metric units, reintroducing the *pinte*, *livre*, and *boisseau*—though these still corresponded to decimalized equivalents.[141] Laplace and the other elite scientists of the Institute were able temporarily to forestall the revocation of their vaunted system in 1804 and again in 1806 by arguing that the metric system was essential to the administration of a multinational empire and enabled the enlightened classes to address the ordinances of the state to the popular classes.[142] But on 12 February 1812, before embarking on his disastrous adventure in Russia, the Emperor signaled a final retrenchment.[143] Over the noisy protests of the scientists and departmental prefects, the Empire adopted a system of "usual" measures, discontinuing both the decimal division and the systematic nomenclature entirely. The new standards continued to be ultimately derived from the platinum meter-bar; the metric system remained the sole *legal* system for administrative work and wholesale transactions; it continued to be taught in the schools; and the metric units were still to be marked alongside the "usual" units on all rulers. In essence, however, the new law retained only the centralizing features of the metric system, instituting the simple demand of the *Cahiers* for uniform weights and measures. The Interior Minister now confessed that the decimal division had primarily "helped the bookkeeper but not the ordinary man, unaccustomed as he was to endless calculations."[144] Years later, from his exile in St. Helena, the former Emperor rebuked his fellow members of the Institute—those "geometers and algebraicists"—for having bungled a simple administrative reform with their abstractions. In the exile's bitter quip, "it was not enough for them to make 40 million people happy, they wanted to sign up the whole universe."[145]

During the first restoration, Louis XVIII reaffirmed the Napoleonic compromise—in metrical matters as in so much else. In 1816, the royal administration expressly forbade the metric system for ordinary transactions. Only after the revolution of 1830, did the proponents of metric reform again make themselves heard. Finally, in 1840 the metric system was definitively readopted.[146] Even so, resistance in the countryside lasted well into the late nineteenth century, and not until the twentieth century did the last traces of the premetric measures disappear.[147]

The struggle to modernize France was a protracted affair. The gradual ascendance of *le français national* over patois and "foreign" tongues is instructive in this regard. When in his great anti-Vandalism speech of 31 August 1794, Grégoire turned to the positive deeds of the Revolution, he emphasized its techno-scientific achievements, notably the measurement of the meridian and "the project to render language uniform."[148] Thereafter, the post-Thermidorian elite continued to validate their war against local idioms by reference to a "scientific, natural, and universal" system—the *grammaire scholaire* of the Ideologues.[149] In the end, however, the triumph of *le français national* depended principally on the increased circulation of citizens within national borders and on the central control of education. In the case of the *metrical* language, the rate of change likewise depended on the transformation of the economy and the government's persistence in teaching the new system. During the nineteenth cen-

tury, the national market proclaimed by the revolutionary bourgeoisie slowly become a reality. Local autarkies began breaking down. The metric system was surely a factor in this transformation and a product of it. No doubt *some* national system of French weights and measures, probably based on the Parisian standards, would have evolved in any case. Here, the British and American examples are instructive. But the specific *form* of the metric system is almost unimaginable without the circumstances of the French Revolution, a time when the repudiation of tradition gave the authority of nature a privileged position and allowed the scientific community unprecedented latitude to design a hyper-rational language of measurement.

For the generation that preceded and made the French Revolution, rationality was a license to make the world anew, a lever to pry the present from the past. Touted by its architects as one of the Revolution's "great services to mankind," the metric system was designed to "efface every trace of the [old] territorial and feudal divisions. . . ."[150] This erasure of history seemed to create startling new possibilities. Power flows from standardization. Where scales are perfectly balanced, a single thumb can move the world. Under the thumb of the new order, Benjamin Constant vividly saw this connection between symmetry and the exercise of authority.[151] Constant had a prescient understanding of the "atomizing" effect of the modern state: how it pulverizes local custom and tradition to erect itself as the central abstraction and unique embodiment of legitimacy. Among the symbols of the new tyranny of uniformity was the standardization of weights and measures.

> The conquerors of our days, peoples or princes, want their empire to possess a unified surface over which the superb eye of power can wander without encountering any inequality which hurts or limits its view. The same code of law, the same measures, the same rules, and if we could gradually get there, the same language; that is what is proclaimed as the perfection of the social organization. . . . [T]he great slogan of the day is uniformity.[152]

And that is why a meter is a meter.

Notes to Chapter Two

Abbreviations:

AP *Archives parlementaires de 1787 à 1860* (1st series; Paris: Imprimerie Nationale, 1879–).

CIP *Procès-verbaux du Comité d'Instruction Publique de la Convention Nationale*, ed. James Guillaume (Paris: Imprimerie Nationale, 1891–1907).

AN Archives Nationales.

AHG Archives Historiques de Guerre.

1. For a recent demonstration that social context shapes even the values of physical constants, see Philip Mirowski, "Looking for Those Natural Numbers: Dimensionless Constants and the Idea of Natural Measurement," *Science in Context* 5 (1992), 165–88.

2. Charles de Secondat de Montesquieu, *Esprit des lois*, in *Oeuvres complètes* (Paris: Garnier, 1875), 5:412–13.

3. Marie-Jean-Antoine-Nicolas de Caritat de Condorcet, *Observations . . . sur le 29ième livre de l'Esprit des lois*, in *Oeuvres* (Paris: Didot, 1847), 1:376–81.

4. Condorcet, *Sketch for a Historical Picture of the Progress of the Human Mind*, trans. J. Barraclough (London: Weidenfield and Nicolson, 1955), 199. On the Enlightenment view of rational language, see Michel Foucault, *The Order of Things: An Archeology of the Human Sciences* (New York: Random House, 1970), 78–124.

5. Keith Michael Baker, *Condorcet: From Natural Philosophy to Social Mathematics* (Chicago: University of Chicago Press, 1975), 62–67.

6. Jacques Necker, *Compte rendu au roi* (Paris: Imprimerie Royale, 1781), 121. Turgot to Messier, 3 October 1775, in Etienne-François Turgot, *Oeuvres* (Glashütten im Taunus: Auvermann, 1972), 5:31–33.

7. Keith Michael Baker, "Science and Politics at the End of the Old Regime," in *Inventing the French Revolution: Essays on French Political Culture in the Eighteenth Century* (Cambridge: Cambridge University Press, 1990), 153–66.

8. Condorcet, *Mémoires sur les monnoies* (Paris, 1790), 3–4, in Ruth Inez Champagne, "The Role of Five Eighteenth-Century French Mathematicians in the Development of the Metric System" (unpublished Ph.D. dissertation, Columbia University, 1979), 60.

9. Louis Marquet, "Condorcet et la création du système métrique décimal," in *Condorcet, mathématicien, économiste, philosophe, homme politique*, ed. Pierre Crépel and Christain Gilian (Paris: Minerve, 1989), 52–62.

10. Gaspard Monge, "Adresse de la Commission des poids et mesures à la Convention Nationale," in *CIP* (6 January 1794), 3:249.

11. Condorcet, *Observations*, 376–81.

12. This revisionist historiography is often said to have begun with François Furet, *Penser la Révolution française* (Paris: Gallimard, 1978).

13. Bureaux de Pusy, *AP* (8 May 1790), 15:441.

14. *AP* (8 May 1790), 15:443. The theory of political economy under which these savants operate seems to be largely within Physiocratic doctrine, hence their emphasis on agricultural yields as the source of prosperity. Georges Weulersse, *Le mouvement physiocratique en France (de 1756 à 1770)* (Paris, 1910).

15. Georges Lefebvre acknowledges that the metric reform was not complete at the end of the Revolutionary period; see *The French Revolution from 1793–99*, trans. John Hall Stewart and James Friguglietti (New York: Columbia University Press, 1964), 296. However, he never mentions, and nor do the other major French historians, that the metric system was revoked in the early nineteenth century.

16. John L. Heilbron, "The Measure of Enlightenment," in *The Quantifying Spirit in the Eighteenth Century*, ed. Tore Frängsmyr et al. (Berkeley: University of California Press, 1990), 207–42. John L. Heilbron, "The Politics of the Meter Stick," *American Journal of Physics* 57 (1989), 988–92.

17. Arthur Young, *Travels during the Years 1787, 1788, and 1789* (2d ed.; London, 1794), 1:315–16.

18. Adrien-Marie Legendre et al., *L'Agence temporaire des poids et mesures aux citoyens rédacteurs de la Feuille du Cultivateur (Paris: Imprimerie de la République, year III [1795]), 11. Roland Zupko, French Weights and Measures Before the Revolution: A Dictionary of Provincial and Local Units* (Bloomington: Indiana University Press, 1978), 113.

19. J.-B. Galley, *Le régime féodal dans le pays de Saint-Etienne* (Paris: Imprimerie de la Loire Républicaine, 1927), appendix. Jean Merley, Charles Vincent, and P. Charbonnier, "Les anciennes mesures de la Loire," in *Les anciennes mesures locales du Massif Central d'après les tables de conversion*, ed. P. Charbonnier (Clermont-Ferrard: Institut d'Etudes du Massif Central, 1990), 143–77.

20. William Sewell, *Work and Revolution in France: Language of Labor from the Old Regime to 1848* (Cambridge: Cambridge University Press, 1980), 28–29.

21. Galley, *Régime féodal*, 287.

22. Zupko, *French Weights*, 11–14.

23. A. de Saint-Léger, ed., *Les mines d'Anzin et d'Aniche pendant la Révolution* (Paris: Leroux, 1935), 2:364–65.

24. Galley, *Régime féodal*, 315–16, 326.

25. Witold Kula, *Measures and Men*, trans. R. Szreter (Princeton: Princeton University Press, 1986).

26. E. P. Thompson, "Time, Work-Discipline, and Industrial Capitalism," *Past and Present* 38 (1967), 56–97.

27. Jean Peltre, *Recherches métrologiques sur les finages lorrains* (Lille: Atelier Reproduction des Thèses, 1977).

28. In his article, " 'Nature' and Measurement in Eighteenth-Century France," *Studies on Voltaire and the Eighteenth Century* 87 (1972), 277–309, Maurice Crosland overlooks this anthropomorphic definition of "natural."

29. Kula, *Measures*, 161–264.

30. Etienne Fournial and J.-P. Gutton, *Cahiers de doléance de la province de Forez* (Saint-Etienne: Centre d'Etudes Foréziennes, 1974), 353.

31. Archives Municipales de Saint-Etienne (Loire) HH 9 Municipal minutes, 8–18 April 1789. J.-B. Galley, *Saint-Etienne et son district pendant la Révolution* (Saint-Etienne: Imprimerie de la Loire Républicaine, 1903–9), 1:51–52.

32. Robert Vivier, "Contribution à l'étude des anciennes mesures du département d'Indre-et-Loire," *Revue d'histoire économique et sociale* 14 (1926), 196.

33. Charles Porée, ed., *Département de l'Yonne, Cahiers de doléances du Bailliage de Sens* (Auxerre: Imprimerie coopérative ouvrière "l'Universelle," 1906), 177–78. Constancy in price was also a response to a chronic shortage of small coin for change.

34. Peter Linebaugh, *The London Hanged: Crime and Civil Society in the Eighteenth Century* (Cambridge: Cambridge University Press, 1992), 153–83. On customary practices among French artisans in the same period, see Michael Sonenscher, *Work and Wages: Natural Law, Politics, and the Eighteenth-Century French Trades* (Cambridge: Cambridge University Press, 1989), 208–9, 256–66.

35. AN F12 1289 Paque to Fauchat (Secretary General of Commerce) 3 February 1815. Heaped measures also invited such "fraud"; see Saint-Léger, *Mines*, 364–65.

36. E. Clémenceau, *Le service des poids et mesures en France à travers des siècles* (Saint-Marcellin-Isère: Ateliers Graphiques de Sud-est, 1909), 89–92. Georges Picot, ed., *Histoire des Etats Généraux* (Paris: Hachette, 1872), 2:256–57; 3:30, 204; 4:130.

37. Pierre Jacquart, *Traité des justices de seigneur et des droits en dépendants* (Lyon: Reguilliat, 1764), 250–51.

38. AN F12 1287 Guilloton (Inspector of Manufactures, Rennes), 1768; Montaran to Intendant of Grenoble, 19 February 1786; "Potier d'Etain" to Calonne, 22 May 1785.

39. *Histoire de l'Académie pour 1772, Mémoires*, pt. II, 501.

40. Vivier, "Contribution," 196. Kula, *Measures*, 173. Steven Kaplan, *Provisioning Paris: Merchants and Millers in the Grain and Flour Trade during the Eighteenth Century* (Ithaca: Cornell University Press, 1984).

41. D.M.G. Sutherland, *France, 1789–1815: Revolution and Counter-Revolution* (New York: Oxford University Press, 1986), 203–3. For the *maximum*, see Ch. Lorain, *Département de la Haute-Marne, les subsistances en céréales dans le district de Chaumont* (Chaumont: Cavaniol, 1911), 356–58. For the *biens nationaux*, see René Caisso, *La vente des biens nationaux de première origine dans le district de Tours* (Paris: Bibliothèque Nationale, 1967), 71.

42. Sébastien Le Prestre de Vauban, "Description géographique de l'élection de Vezalay," *Projet d'une dixme royale* (Paris: Alcan, 1933).

43. For a full treatment of this subject, see Ken Alder, "Forging the New Order: The Origins of French Mass Production and the Language of the Machine Age, 1763–1815" (unpublished Ph.D. dissertation, Harvard University, 1991), 403–7.

44. René Taton, "Jean Picard et la mesure de l'arc de méridien Paris-Amiens," *La découverte de la France au XVIIe siècle, neuvième colloque de Marseilles* (Paris: CNRS, 1980), 349–61.

45. René Taton, "La tentative de Stevin pour la décimalisation de la métrologie," in *Acta Metrologiae Historicae*, ed. Gustav Otruba (Linz: IIIe Congrès International de la Métrologie Historique, 1983), 39–56.

46. François Garrault, *Recueil des nombres, poids, mesures et monnoyes anciennes et modernes* (Paris: Mettayer et l'Huillier, 1595).

47. Armand Macheby, "Aspects de la métrologie au XVIIe siècle," *Les Conférences du Palais de la Découverte*, Series D, 33 (1955), 8. Armand Macheby, *La métrologie dans les musées de province* (Troyes: CNRS, 1962), 19.

48. Galley, *Régime féodal*, 274, 278–30.

49. Edouard Gruter and Yannick Marec, "Des anciens systèmes de mesures au système métrique," in *Actes de l'université de l'été sur l'histoire des mathématiques*, Le Mans, France, July, 1984 (Université de Maine, 1986), 111–13, 116.

50. Peltre, *Recherches*, 90–91, 200–206.

51. J.-B. Galley, *L'élection de Saint-Etienne à la fin de l'ancien régime* (Saint-Etienne: Ménard, 1903), 188. Galley, *Régime féodal*, 282, 307. On the changing class-basis of land ownership at the end of the Old Regime in Forez, see Josette Barnier, *Bourgeoisie et propriété immobilière en Forez aux XVIIe et XVIIIe siècle* (Saint-Etienne: Centre d'Etudes Foréziennes, 1982).

52. Bureaux de Pusy, *AP* (8 May 1790), 15:440.

53. Alexis Paucton, *Métrologie, ou traité des mesures, poids et monnoies des anciens peuples et des moderns* (Paris: Veuve Desaint, 1780), 7, 11.

54. Beatrice Fry Hyslop, *French Nationalism in 1789, According to the General Cahiers* (New York: Columbia University Press, 1934), 56.

55. Fournial, *Cahiers*, 57, 106, 122, 127, 141, 149, 151, 160, 170, 179, 182, 217, 263, 311, 314, 319, 334, 353. The clergy, however, only wanted uniformity of measures "in each province"; the nobility advised a "general uniformity"; and the third estate demanded universal uniformity.

56. Fournial, *Cahiers*, 149.

57. Champagne, "Role."

58. Roland Zupko, *Revolution in Measurement: Western European Weights and Measures since the Age of Science* (Philadelphia: American Philosophical Society, 1990), 114–35.

59. Archives de l'Académie des Sciences, Register of the Academy, vol. 108, J.-B. Le Roy (27 June 1789), 171; (14 August 1789), 207.

60. For a nuanced discussion of the latitude possessed by experts in their dealings with the state, see John Carson, "Army Alpha, Army Brass, and the Search for Army Intelligence," *Isis* 84 (1993), 278–309.

61. Crosland, "'Nature' and Measurement," 286–89.

62. Baudin, 4 messidor, year VII [22 June 1799], in Jean-Baptiste-Joseph Delambre and Pierre-François-André Méchain, *Base du système métrique* (Paris: Baudouin, 1806–10), 3:651.

63. Danton, *AP* (31 January 1793), 58:102–3. Grégoire invoked natural frontiers to make manageable the missionary claims of "la République universelle." *AP* (27 November 1792), 53:610–15.

64. Heilbron, "Measure," 216–24. See also Alder, "Forging," 451–55. For an opposing view, see C. C. Gillispie, "Laplace," *Dictionary of Scientific Biography* (New York: Scribners, 1978), 15:334–35.

65. [René-Just Haüy], *Instructions sur les mesures déduites de la grandeur de la terre* (1st ed.; Paris: Imprimerie Nationale, year II [1794]), xxvii–xviii.

66. Pierre-Simon Laplace, "Mathematiques," in *Séances des Ecoles Normales [de l'an III], Débats* (Paris: Reynier, [1795]) 1:10–23

67. A. G. Le Blond, *Sur la fixation d'une mesure et d'un poid—lu à l'Académie des Sciences, 12 Mai 1790* (Paris: Demonville, 1791); Rollin, *CIP* (12 frimaire, year II [2 December 1793]), 3:90–91.

68. Gueroult, *Observations sur la proposition faite par le cit. Prieur* (Paris: Guerin, [year III-IV]), 5.

69. AN F12 1288 M. Fontaine, 1792; Société populaire de Livry (Bayeux), year II; Simon, arpenteur, 24 vendémiaire, year III [15 October 1794].

70. Tillet and Abeille, *AP* (6 February 1790), 11:466. Talleyrand, *AP* (9 March 1790), 12:106.

71. Condorcet and Talleyrand seized on a speech in Parliament in 1790 advocating international standards of measurement. However, no legislation was ever directly submitted to the House of Commons. See John Riggs Miller, *Speeches in the House of Commons upon the Equalization of the Weights and Measures of Great Britain* (London: Debrett, 1790).

72. Jefferson to Short, 28 July 1791, in C. Doris Hellman, "Jefferson's Efforts toward the Decimalization of United States Weights and Measures," *Isis* 16 (1931), 286.

73. Archives de l'Académie des Sciences, Dossier: Lavoisier, Lavoisier to Arbogast, 16 April 1793. Roger Hahn, *Anatomy of a Scientific Institution* (Berkeley: University of California Press, 1971), 252–85.

74. *AP* (1 August 1793), 70:70–74. The "temporary" meter had been announced the previous year at the insistence of Interior Minister Roland, who cited the urgent need of French business for "some standard, whatever it might be." *AP* (3 April 1792), 41:100.

75. The decree of 20 August 1790 set the Academy's budget at 93,458 *livres* (*CIP*, 1: 260n); whereas the initial grant for the meridian survey alone came to 300,000 *livres*. For a memorandum proposing that sum, see AN F12 1289 [Académie des Sciences], 19 March 1791.

76. AN F12 1289 Borda (President of the Commission des poids et mesures) to Pavé (Interior Minister) 12 brumaire, year II [2 November 1793]; also various contracts for the year IV with Le Noire, Mercklein, etc.

77. Delambre, *Base*, 1:57; Heilbron, *Measure*, 230–31.

78. Jean-Baptiste-Joseph Delambre, *Grandeur et figure de la terre* (Paris: Gauthier-Villars, 1912), 202–3, 213.

79. Laplace, "Mathematiques," in *Séances*, 5:203–14. For the earlier period, see Mary Terrall, "Representing the Earth's Shape: The Polemics Surrounding Maupertuis's Expedition to Lapland," *Isis* 83 (1992), 218–37.

80. Louis-Sébastien Mercier, *Le nouveau Paris* (Brunswick, 1800), 3:44.

81. Delambre, *Base*, 3:581–655.

82. Talleyrand, *AP* (9 March 1790), 12:106.

83. Thomas Bugge, *Science in France in the Revolutionary Era*, ed. Maurice Crosland (Cambridge: MIT Press, 1969), 205–11.

84. Estimates varied from Laplace's value of 1/148 to Legendre's 1/320. Delambre, *Base*, 3:92, 554–55.

85. The international commission reset Borda's calibration, but he was vindicated in 1870. Guillaume Bigourdan, *Le système métrique des poids et mesures* (Paris: Gauthier-Villars, 1901), 86–87, 147.

86. Méchain discarded a whole set of "accursed" (*maudite*) results that, in fact, provide a value much closer to the one presently accepted. Delambre, *Grandeur*, 222, 238–34. Bigourdan, *Système métrique*, 152–54.

87. William Hallock, *Outline of the Evolution of Weights and Measures and the Metric System* (New York: Macmillan, 1906), 59.

88. Delambre, *Base*, 3:447–62.

89. Delambre, *Grandeur*, 224–36.

90. Delambre, *Base*, 3:101–3, 545–46, 557.

91. In his article, "The Congress on Definitive Metric Standards, 1798–1799: The First International Scientific Conference?" *Isis* 60 (1969), 230, Maurice Crosland denies that foreign delegates were under pressure to acquiesce to a French *fait accompli*. But see Laplace's letter to Delambre of 10 pluviôse, year VI [29 January 1798], in which he assures his colleague that the meeting is a "mere formality." Yves Laissus, "Deux lettres inédites de Laplace," *Revue historique des sciences* 14 (1961), 287–88.

92. Baker, "Science and Politics."

93. Theodore Porter, "Objectivity as Standardization: The Rhetoric of Impersonality in Measurement, Statistics, and Cost-Benefit Analysis," *Annals of Scholarship* 9 (1992), 19–59.

94. Haüy, *Instructions*, (1st ed.), xii.

95. *Feuille du Cultivateur* 38 (9 messidor, year III [27 June 1795]), 227–28. Though the journal had originally supported Tillet and Abeille's proposal for standards based on the Parisian measures, it welcomed the law of 18 germinal, year III. *Feuille* (15 January 1791), 118; (12 floréal, year III [1 May 1795]), 160.

96. Legendre, *L'agence temporaire*, 5. The chastened journal even reprinted this rebuke. *Feuille* 44 (7 thermidor, year III [25 July 1795]), 258.

97. *CIP* (24 thermidor, year III [11 August 1795]), 6:532–37. Prieur had initially suggested using Breton names for the measures.

98. Baudin, in Delambre, *Base*, 3:651. Baudin was engaged at the time in a campaign against political factions (motivated by a feared renewal of Babeuf's revolt), in which he justified elite governance by reference to the transcendent neutrality of science. See M. Staum, "Public Relations of the Second Class of the Institute in the Revolutionary Era," *Proceedings of the Annual Meeting of the Western Society of French Historians* 16 (1989), 213–14.

99. Legendre, *L'agence temporaire*, 1, 18. Emphasis in original.

100. Baudin, in Delambre, *Base*, 3:651.

101. C.-A. Prieur, *Rapport . . . sur la nécessité et les moyens d'introduire dans toute la République les nouveaux poids et mesures*, in *CIP* (10 ventôse, year III [28 February 1795]), 5:551–63. See also *Projet de décret*, ibid. (1 vendémiaire, year IV [23 September 1795]), 6:671.

102. François-Alphonse Aulard, ed., *Paris pendant la réaction thermidorienne et sous le Directoire* (Paris: Cerf, 1898–1902), (25 February 1798), 4:556–57; (30 December 1798), 5:287; (June–July 1799), 5:632.

103. François-Alphonse Aulard, ed., *Paris sous le Consulat* (Paris: Cerf, 1903), (November–December 1799), 1:65; (12 September 1801), 2:521.

104. AN F12 1288 Roland (Interior Minister) to President of the National Assembly, 19 May 1792.

105. AN F12 1288 Amis de la République (Carcassonne) to General Assembly, 11 December 1792.

106. Agence temporaire, *Notions élémentaires sur les nouvelles mesures* (1st ed.; Paris: Imprimerie de la République, year IV [1795]), 1, 3–4.

107. Agence temporaire, *Notions élémentaires sur le nouvelles système des mesures* (2d ed.; Paris: Imprimerie de la République, year VI [1797]), 4. Emphasis added.

108. *AP* (9 March 1790), 12:106.

109. Condorcet, *Observations*, 377.

110. Agence temporaire, *Notions élémentaires sur les nouvelles mesures* (1st ed.; Paris: Imprimerie de la République, year IV [1795]), 1, 3–4.

111. Ibid., 10.

112. Condorcet, *Mémoires sur les monnoies*, 3–4, in Champagne, "Role," 60.

113. Interior Minister to Departmental Administrations, 23 fructidor, year V [9 September 1796], in Kula, *Measures*, 241, 254–55.

114. Champagne, "Role," 208–27.

115. Scores of these appeared in the 1790s and early 1800s. For instance: Bonnin, *Vocabulaire étymologique des poids et mesures de la République française* (Paris: Fournier, year VII).

116. Bugge, *Science*, 204–5.

117. Legendre, *L'agence temporaire*, 2.

118. François Gattey, *Tables des rapports des anciennes mesures agraires avec les nouvelles* (2d ed.; Paris: Michaud, 1810), 6. Kula, *Measures*, 247–48.

119. Marquet, "Anciens mesures, anciens poids," *Amis du vieux Saint-Etienne* 35 (1957), 4.

120. Legendre, *L'agence temporaire*, 9.

121. Agence temporaire des poids et mesures, *Avis instructif sur la fabrication des mesures de longueur à l'usage des ouvriers* (Paris: Imprimerie de la République, year III [1795]). *CIP* (2 messidor, year III [20 June 1795]), 6:314–15. Monge, "Adresse," 249.

122. AN F12 1310 *Extrait des Registres du Comité du Salut Public*, 27 floréal, year III [16 May 1795]. AN F12 1311 Council on Weights and Measures to [*Atelier*], 8 floréal, year IV [27 April 1796].

123. Alder, "Forging," 555–608. Prieur blamed the failure of the new system principally on the shortage of meter sticks, etc. C.-A. Prieur, *Rapport sur l'exécution des lois rélatifs aux poids et mesures* (Paris, Imprimerie Nationale, year VI), 7, 8, 11–13.

124. Law of 27 brumaire, year VII [17 November 1798]. Bigourdan, *Système métrique*, 186–87. The law was amplified on 7 brumaire, year IX [29 October 1800], and again on 16 June, 1808. Désiré Dalloz, ed., *Jurisprudence générale* (Paris: Bureau de la Jurisprudence Générale, 1845–70), 35:983–85.

125. A.B.J. Guffroy, *Avis civique contre un projet liberticide* (Paris: Everat, year VII).

126. Pérès, *Rapport . . . relative aux peseurs publics* (21 vendémiaire, year VIII [13 October 1799]). Pérès professed himself a supporter of metrical uniformity.

127. Brillat et al., *Mémoire . . . sur le rapport fait par le représentatif Pérès* (Paris: Bailleul, [year VII]), 6, 17. Bigourdan, *Système métrique*, 187–89.

128. On the distinction, see Kaplan, *Provisioning Paris*, 47–48, 68–69.

129. Marquet, "Anciens mesures," 35:6–8; 36:8–11. On the Bureaux of inspection, see D. Roncin, "Mis en application du système métrique (7 avril 1795–4

juillet 1837)," *Cahiers de métrologie* 2 (1984), 33. And Robert Vivier, "L'application du système métrique dans le département d'Indre-et-Loire," *Revue d'histoire économique et sociale* 16 (1928), 211–14.

130. Reveillière-Lépeaux et al., 7 pluviôse, year IV [27 January 1796], in Antonin Debidour, ed., *Recueil des actes du Directoire-Exécutif* (Paris: Imprimerie Nationale, 1910–17), 1:492. Aulard, *Réaction thermidorienne* (August–September, 1798), 5:99. American bureaucrats in the 1990s have been having similar problems complying with legislation that insists that they convert to the metric system. House Committee on Science, Space and Technology, *Metric Conversion Activities of Federal Agencies in Compliance with P. L. 100-418, Section 5164, Metric Usage: 1992 Update* (Washington, D.C.: U.S. Government Printing Office, 1992).

131. Marquet, "Anciens mesures," 36:9.

132. Carnot et al., in Debidour, *Recueil* (11 frimaire, year IV [2 December 1795]), 1:162.

133. AHG 4c3/2 F. M. Aboville, *Mémoire*, 1 nivôse, year IV [22 December 1795]; 14 pluviôse, year IV [3 February 1796].

134. AHG 4c3/2 General Drouân, *Mémoire*, 3 vendémiaire, year V [24 September 1796].

135. AHG 4c3/2 War Minister to Central Committee of Artillery, 19 vendémiaire, year X [11 October 1801]. Chief Inspector of Revenue to Artillery General Songis, 25 fructidor, year XIII [12 September 1805].

136. Alder, "Forging," 704–27.

137. AHG 4c3/2 Central Committee of Artillery, *Observations*, 29 March 1806.

138. AHG 4c3/2 Anon., *Mémoire*, 1822. This pattern is corroborated by Heilbron's documentation on the hesitant reception that architects and technical writers accorded the new system in the early nineteenth century. Heilbron, "Measure of Enlightenment," 238–42.

139. AN F12 1289 Prefect of Department of Rhône to Interior Minister, 28 floréal, year VIII [18 May 1800]; Paque to Fauchat, 3 February 1815.

140. James Friguglietti, "The Social and Religious Consequences of the French Revolutionary Calendar" (unpublished Ph.D. dissertation, Harvard University, 1966).

141. Dalloz, *Répertoire* 35:983–84.

142. AN F12 1296 Anon., 2 March 1811. See also Bigourdan, *Système métrique*, 192.

143. Lucotte and Noiret, *Nouveau système des poids et mesures* (Dijon: Noellat, 1813), 89–100.

144. Interior Minister Montalivet, in Kula, *Measures*, 260.

145. Napoleon Bonaparte, *Dictionnaire, ou Recueil alphabétique des opinions et jugements de Napoléon I* (Paris: Au club de l'honnête homme, 1964), 179.

146. Bigourdan, *Système métrique*, 205–6, 222–25.

147. Eugen Weber, *Peasants into Frenchmen: The Modernization of Rural France, 1870–1914* (Stanford: Stanford University Press, 1976), 30–33. Arthur E. Kennelly, *Vestiges of Pre-Metric Weights and Measures Persisting in Europe, 1926–27* (New York: Macmillan, 1928).

148. Grégoire, *AP* (14 fructidor, year II [31 August 1794]), 96:153–54; also (16 prairial, year II [4 June 1794]), 91:318–27.

149. Patrice Higonnet, "The Politics of Linguistic Terrorism and Grammatical Hegemony during the French Revolution," *Social History* 5 (1980), 41–69.

150. Fourcroy, *AP* (11 September 1793), 73:669–70.

151. Benjamin Constant, *Cours de politique constitutionnelle* (Paris: Guillaumin, 1872), 2:170–75.

152. Benjamin Constant, *De l'esprit de conquête* (Paris: Librarie de Médicis, 1813), 53–54.

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