

- administrators, June 1813; Préfecture du Dépt. des Bouches du Rhin, broadsheets in French and Dutch, 12 February 1813 (Bois-le-Duc: Lion [1813]).
62. Napoleon, *Mémoires*, 4, pp. 211-15. By 'forty million people' Napoleon was referring to the population of imperial France. See also his bitter views on the savants and the metric system in Napoleon, *Sainte-Hélène, Journal inédit de 1815 à 1818*, ed. Gaspard Gourgaud (Paris: Flammarion, 1899), 1, p. 95; 2, p. 28.
63. UBL MS1872, Delambre to Moll, 7 May 1814.
64. On Delambre's second change of residence, see CUS, Delambre to Mlle Delambre (his sister), 18 November 1815; Delambre, 'Lui-même'. As Permanent Secretary, Delambre had a salary of 6000 francs, but he lost his salary as Treasurer of the University, which was much larger - 12,000 francs; see *ASPV* 6 (27 March 1816), p. 43. On Delambre's defence of the savants' political neutrality, see Delambre to Min. Int., 18 April 1816, in Bigourdan, 'Bureau des Longitudes' (1928), p. A49.
65. For the Report to the Emperor, see Jean Dhombres, 'Introduction' to *Rapports à l'Empereur sur le progrès des sciences, des lettres et des arts depuis 1789*, vol. 1, *Sciences mathématiques*, ed. Jean Dhombres (Paris: Belin, 1989), pp. 13-37.
66. CUS, Delambre to Cagnoli, 6 August 1810.
67. For the only comparable history of science prior to Delambre's work, see the history of (applied) mathematics begun by Montucla, with volumes 3 and 4 completed by Lalande in 1802; see Montucla, *Histoire des mathématiques*. For the relationship of Delambre's *Histoire* to his *Traité*, see Delambre, *Astronomie moderne*, 1, p. lii. For an appreciation of Delambre as a historian, see I. Bernard Cohen, 'Introduction', in Delambre, *Histoire de l'astronomie moderne* (New York: Johnson Reprint, 1969), pp. ix-xx.
68. On his historical method, see Delambre, *Histoire de l'astronomie ancienne* (Paris: Courcier, 1817), 1, pp. xviii-xx, xxxvi. He especially attacked the speculative *ancien régime* histories of Bailly; see Delambre, *Histoire de l'astronomie du moyen-âge* (Paris: Courcier, 1819), pp. xxxiv-xxxvii. For Delambre's interest in the Egyptian expedition, see BI MS1041, Nouet to Delambre, 21 fructidor IX [8 September 1801]; 8 floréal X [28 April 1802]. Delambre and Méchain were the Académie's examiners for the results brought back from Egypt by Nouet and Jérôme-Isaac Méchain; see *ASPV* 2 (1 floréal X [21 April 1802]), p. 495. For his doubts about the pyramid claims, see BI MS 1042 fol. 388, Delambre, *Recherches sur les sciences de l'Égypte* par M. Fourier, n.d. Delambre, *Astronomie ancienne*, 1, pp. 89-90. Delambre, *Astronomie du moyen-âge*, pp. vi, lcv.
69. Delambre, *Astronomie moderne*, 1, p. xli; 2, p. 235, emphasis in original.
70. Delambre, *Astronomie moderne*, 2, pp. 199-200.
71. On Descartes' skull, see Delambre, 'Crâne venu de Suède et que l'on dit être celui de Descartes', *ASPV* 7 (14 May, 8 October 1821), pp. 193-7, 232-3.
72. On Delambre's destruction of private letters and papers, see Charles Dupin, 'Notice nécrologique sur M. Delambre', *Revue encyclopédique* 48

- (December 1822), pp. 12-13. For his autobiography and biography, see Delambre, 'Lui-même'; Mathieu, 'Delambre', *Biographie universelle*, pp. 304-8.
73. For Delambre's death certificate, see AN Etude CVIII 987, Jean-Eustache Montand, 'Actes de décès: Delambre', 26 August 1822. For the sale of Delambre's large collection of fifteen hundred books, see AOP 22569, *Catalogue des livres composant la bibliothèque de feu M. le Chevalier Delambre*, 10-20 May 1824 (Paris: Gaudfroy et Bachelier, 1824). For his eulogy, see Joseph Fourier, 'Eloge de M. Delambre', 2 July 1823, *MA* 4 (1824), pp. cciv-ccxxviii. For Fourier's appointment, see *ASPV* 7 (26 August 1822), p. 362.
74. UBL MS1872, Delambre to Moll, 21 July 1820.
75. For Delambre's last biography of Méchain, see Delambre, 'Méchain', *Histoire de l'astronomie au dix-huitième siècle*, ed. Claude-Louis Mathieu (Paris: Bachelier, 1827), pp. 755-67. Lalande himself said in his eulogy for Méchain that he had met the young man through a correspondence; see Lalande, 'Nécrologie', *Monteur* 22 (7 nivôse XIII [28 December 1804]). Delambre wrestled several times in his manuscripts with the phrase: *funeste résolution d'en faire mystère*; see BYU folder 32, Delambre, 'Méchain'; also BI MS2041 fol. 10, Delambre, 'Méchain'. Delambre also wrote a mini-biography of Méchain, published in 1821, which takes much the same tone; see Delambre, 'Méchain', *Biographie universelle*, ed. Michaud (Paris, 1821), 28, pp. 464-8.
76. Delambre, 'Méchain', *Astronomie au dix-huitième*, pp. 766-7.
77. Delambre, *Grandeur*, pp. 231, 234.
78. The sealed manuscripts were presumably opened by Guillaume Bigourdan at the very end of the nineteenth century, although he made no use of them in his *Système métrique* of 1901.

## Chapter 12 The Metred Globe

1. G. K. Chesterton, 'The Rolling English Road', *The Flying Inn* (London: Methuen, 1914).
2. Josephus, *Jewish Antiquities* (1, p. 61), in *Works*, trans. H. St. J. Thackeray (London: Heinemann, 1930), 4, p. 29. Cain was the first to lay out territorial boundaries and to build a city.
3. John Quincy Adams (Secretary of State), 'Weights and Measures', US Senate, 22 February 1821; 16th Congress, 2nd Session, no. 503, Class 10, vol. 2, pp. 656-750; see p. 672. The report was written in response to a request made by the Senate on 3 March 1817 and echoed by President James Madison. See US House of Representatives, 15th Congress, 2nd Session, no. 463, pp. 538-42.
4. Armand Machabey, 'Aspects de la métrologie au XVII<sup>e</sup> siècle', *Les Conférences du Palais de la Découverte*, Series D, 14 (1955), p. 5.
5. J. Q. Adams, 'Weights and Measures', p. 699.
6. Jefferson to J. Q. Adams, 1 November 1817, in Jefferson, *Writings*, 7, p. 87.

7. Mathieu pointed out that there was no need to remeasure the meridian should the Archive Metre be damaged, since its length was also known in relation to a pendulum; see AP2 111 (10 May 1837), p. 29. Laplace's son claimed the measure was equal to an 'aliquot' part of the meridian; see AP2 112 (12 June 1837), p. 496.
8. Anon., in AP2 111 (20 May 1837), p. 482. The physicist was Joseph-Louis Gay-Lussac. For the history of the legislation, see AP2, Min. de Commerce Martin du Nord, 107 (28 February 1837), pp. 627, 690-2; Rapport de Mathieu, 111 (10 May 1837), pp. 28-36; Débats, 111 (20 May 1837), pp. 478-84; Min. de Commerce Martin du Nord, 112 (27 May 1837), pp. 19-21; Rapport de Laplace, 112 (12 June 1837), pp. 495-500; Débats, 112 (16 June 1837), pp. 637-46, 779-80; Débats, 113 (22 June 1837), pp. 151-61; Débats, 112 (24 June 1837), pp. 305-6, 347-50; Débats, 112 (27 June 1837), pp. 462-7. The vote in the House of Deputies was 224 to 9; in the House of Peers, 65 to 21.
9. Charles Gilles, 'Ma Varlope' [c. 1848], in Pierre Brochon, ed., *Le pamphlet du pauvre, du socialisme utopique à la Révolution de 1848* (Paris: Edition Sociales, 1957), p. 112. 'Bravant la routine et sa haine / Dans sa valeur puisant son droit, / La mesure républicaine / A détrôner le pied de roi.' Quoted and translated in Eugen Weber, *Peasants into Frenchmen: The Modernization of Rural France, 1870-1914* (Stanford: Stanford University Press, 1976), pp. 30, 509. See also the instructional verses in Anon., *Complainte sur les poids et mesures* (Paris: Esclulier, 1840).
10. The riot in Clamecy, dépt. de Nièvre, was sparked by 'new' measures, which were a decimal version of the 1825 'usual' measures, see *Moniteur* 109, 116 (19, 26 April 1837), pp. 923, 1002. Also *Echo de la Nièvre*, 9 April 1837, in Gustave Tallent, *Histoire du système métrique* (Paris: Soudier, 1910), pp. 88-91.
11. Anon., 'Les nouveaux poids et mesures', Tallent, *Système métrique*, p. 92. 'De quoi qu'un nous sert c'te loi nouvelle? / A c'heur' nous ne pourrions plus jamais / Demander un liv' de chandelle, / Pas même un quart ron de beurre frais. / Faudra qu' dans l'épic'rie / On mett' de vrais sorciers, / Ou que l'Académie / Fourniss' des épiciers. / Chorus: / Ce n'est pas d' nos faiseurs de lois / L' système / Décimal que j'aime. / Viv' les mesur' d'autrefois! / Au diabl' les nouveaux poids.'
12. For the continued use of the old measures, see Weber, *Peasants*, p. 36; Gaudetroy, *Mesures anciennes en usage à Amiens*, p. 30; Arthur Edwin Kennelly, *Vestiges of Pre-metric Weights and Measures Persisting in Metric-System Europe, 1926-1927* (New York: Macmillan, 1928), p. 30.
13. The Dutch law of 21 August 1816 made the metric system (minus the nomenclature) obligatory throughout the Low Countries on 1 January 1820 (delayed until 1821). The Belgian law of 18 June 1836 reinstated the Classical nomenclature. On Belgium, see J. Mertens, 'L'introduction du système métrique dans les Pays-Bas Méridionaux', *Janus* 60 (1973), pp. 1-12. On Holland, see Van Swinden to Delambre, 28 June 1802, in Bigourdan, *Système métrique*, pp. 242-4. On Luxembourg (and the rest of the Low Countries), see Henri Thill, 'Esquisse de l'histoire du système métrique dans notre pays', *Institut grand-ducal de Luxembourg: Section*

- des sciences naturelles, physiques et mathématiques, Archives*, new series, 20 (1951-3), pp. 95-130.
14. On Italy, see Kula, *Mesures and Men*, pp. 268-75.
15. For the international movement for the metric system, see Edward Franklin Cox, 'The Metric System: A Quarter-Century of Acceptance, 1851-1876', *Ouvrir* 13 (1959), pp. 358-79. On the statistics conferences, see M. Engel, ed., *Compte-rendu général des travaux du congrès International de Statistique dans ses séances tenues à Bruxelles 1853, Paris 1855, Vienne 1857, et Londres 1860* (Berlin: Imprimerie Royale, 1863), pp. xx, 56, 192-3.
16. For the impact of the 1851 World's Fair, see Leone Levi, *Theory and Practice of the Metric System of Weights and Measures* (London: Griffith, 1871), pp. 2-3. For 1867, see Michel Chevalier, ed., *Exposition Universelle de 1867 à Paris: Rapports du Jury International* (Paris: Dupont, 1868), 2, pp. 485-500.
17. For the development of German laws, see 'No. 28, Maas- und Gewichtsordnung für den Norddeutschen Bund', 27 August 1868, in *Bundes-Gesetzblatt des Norddeutschen Bundes* (1868), pp. 473-80. International Statistical Congress (5th), *Programme der fünften Sitzungsperiode* (Berlin: Königliche Geheime Ober-Hofbuchdruckerei, 1863), pp. 79-87, 201-6.
18. For the improved knowledge of geodesy, see L.-B. Francoeur, *Géodésie, ou traité de la figure de la terre* (Paris: Bachelier, 1835), pp. 189-93; Louis Puissant (vols 6 and 7) and E. Peytier (vol. 9), *Nouvelle description géométrique de la France*, part of *Mémoires du Dépôt Général de la Guerre* 6 (Paris: Piquet, 1832), pp. 42, 126-9; 7 (Paris: Maulde, 1840), pp. 601-44; 9 (Paris: Maulde, 1853).
19. Baeyer to Min. War of Prussia, 'Entwurf zu einer mitteleuropäischen Gradmessung', April 1861, in Levallois, *Mesurer la terre*, p. 152.
20. For histories of geodesy in the nineteenth century, see Georges Perrier, *Petit histoire de la géodésie* (Paris: Alcan, 1939); Marie-Françoise Jozeau, 'Mesure de la terre au XIXe siècle', in *La mesure, instruments et philosophie*, ed. Jean-Claude Beaune (Paris: Callon, 1994), pp. 95-106; Levallois, *Mesurer la terre*, pp. 141-56.
21. Le Verrier, *CR 57* (1863), p. 36. See the debate between Faye (speaking for the Bureau des Longitudes and pro-cooperation) versus Le Verrier (speaking for the Paris Observatory and anti-cooperation), in *CR 56* (1863), pp. 28-37.
22. On the proposal for a new expedition, see Pontécoulant, *CR 69* (27 September 1869), pp. 728-30. For the response, see Faye, 'Observations sur la lettre de M. de Pontécoulant', *CR 69* (4 October 1869), pp. 737-43.
23. Jacobi, Struve and Wild, 'Confection des étalons prototypes des poids et mesures métriques: Rapport de la Commission nommée par la Classe Physio-Mathématique de l'Académie des Sciences de Saint-Petersbourg', in *CR 69* (16 August 1869), pp. 425-8. These Russians were present at the Berlin meeting and reflect its views.
24. C. Bruhns, W. Foerster and A. Hirsch, eds, *Bericht über die Verhandlungen . . . der Europäischen Gradmessung* (Berlin: Reimer, 1868),

- p. 126. Countries which sent delegates to this meeting included Holland, Belgium, Italy, Russia, Switzerland and all the German states. The damage to the bar was due to the fact that Lenoir had constructed the 1799 bar *à bouts* (an end-standard defined by two projecting flanges at the ends of the bar), not *à traits* (a line-standard defined by two marks precisely placed on the bar). Steinheil, *Abhandlungen der Bayerischen Akademie* 4 (1837), p. 251. Morin et al., 'Procès-verbal de comparaison entre étalons prototypes', 5 March 1864, in *Annales du Conservatoire Impérial des Arts et Métiers* 5 (1864), p. 6. On the impurities in platinum, see McDonald and Hunt, *Platinum*, pp. 147-77.
25. For the French debate over the challenge to the metre, see Mathieu, Laugier and Faye, 'Rapport du Comité', 24 December 1867, in Bigourdan, *Système métrique*, pp. 253-4. See also Morin et al., 'Rapport... sur la révision des étalons des bureaux de vérification des poids et mesures de l'Empire français en 1867 et 1868', *Annales du Conservatoire Impérial des Arts et Métiers* 9 (1871), pp. 5-63. AN F17 3715, Min. Instruction Publique, 'Note sur la construction d'un étalon métrique', 24 July 1869; Dumas et al., 'Rapport sur les prototypes du système métrique', 23 August 1869, CR 69 (1869), pp. 514-19.
26. Min. Aff. Etr. to French diplomatic agents, 16 November 1869, in Bigourdan, *Système métrique*, pp. 272-3. Min. Commerce, 'Rapport à S. M. l'Empereur', 1 September 1869, in Bigourdan, *Système métrique*, pp. 265-72.
27. Adolph Hirsch, in Commission Internationale du Mètre, *Séance de 1870, Procès-verbaux des séances* (Paris: Baudry, 1871), p. 29. For the run-up to the meeting, see Morin, 'Notice historique sur le système métrique', *Annales du Conservatoire des Arts et Métiers* 9 (1871), pp. 573-640.
28. For the meeting of 1872, see Commission Internationale du Mètre, *Procès-verbaux des séances du Comité des Recherches Préparatoires*, April 1872 (Paris: Viteville, 1872). Commission Internationale du Mètre, 'Procès-verbaux', September-October 1872, in *Annales du Conservatoire des Arts et Métiers* 10 (1872), p. 3-229.
29. For the convention of 1875, see Charles-Edmond Guillaume, *La création du Bureau International des Poids et Mesures* (Paris: Gauthier-Villars, 1927); US Department of Commerce, National Bureau of Standards, *The International Bureau of Weights and Measures, 1875-1975*, NBS Special Bulletin 420 (Washington, DC: USGPO, 1975). For internal French debates, see AN F17 3715, Bureau des Longitudes, 'Rapport sur la proposition relative à l'adoption d'une annexe géodésique', 15 October 1875. The British and Dutch were also against the creation of a permanent international bureau.
30. For the making of the new metres, see Bigourdan, *Système métrique*, pp. 338-52.
31. For India, see Lal C. Verman and Jainath Kaul, eds, *Metric Change in India* (New Delhi: Indian Standards Institution, 1970).
32. [John Playfair], 'Base du Système Métrique', *Edinburgh Review* 9 (January 1807), pp. 373-91.
33. For Delambre's appreciation of Playfair, see Delambre, *Base*, 3, p. 308.

34. For measurement in nineteenth-century Britain, see Simon Schaffer, 'Metrology, Metrication and Victorian Values', *Victorian Science in Context*, ed. Bernard Lightman (Chicago: University of Chicago Press, 1997), pp. 438-74. A. D. C. Simpson, 'The Pendulum as the British Length Standard: A Nineteenth-Century Legal Aberration', in *Making Instruments Count: Essays on Historical Scientific Instruments*, eds R. G. W. Anderson, J. A. Bennett and W. F. Ryan (Cambridge: Variorum, 1993), pp. 174-90.
35. International Association for Obtaining a Uniform Decimal System of Measures, Weights and Coins, *Sixth Annual Report* (July 1862), p. 15.
36. William G. Armstrong, at BAAS, quoted in International Association for Obtaining a Uniform Decimal System of Measures, Weights and Coins, *Seventh Annual Report* (December 1863), p. 9.
37. For the most complete discussion of the nineteenth-century campaigns for metric conversion in Britain, see Edward Franklin Cox, 'A History of the Metric System of Weights and Measures, With Emphasis on Campaigns for its Adoption in Great Britain and in the United States Prior to 1914' (Ph.D. diss., Indiana University, 1956).
38. *The Times* was anti-metric, though it denied being anti-French. See Ewart, *The Times* (16 June 1864), p. 11.
39. James Yates, *What Is the Best Unit of Length?* (London: Bell and Daldy, 1858), pp. 20, 24-46.
40. For Herschel's axis inch, see John F. W. Herschel, 'The Yard, the Pendulum and the Metre' [1863], *Familiar Lectures on Scientific Subjects* (New York: Routledge, 1869), pp. 419-51. Also, John F. W. Herschel, 'The Battle of the Standards', *The Times* (21 June 1864), p. 7; (4 July 1864), p. 11; (2 May 1864), p. 12.
41. William John Macquon Rankine, 'The Three-Foot Rule', *Songs and Fables* (Glasgow: Maclehouse, 1874).
42. Anon., 'Chains of Habit', *Decimal Educator* 1 (September 1918), p. 19.
43. Editorial in *Toronto Star*, quoted in Grace Ellen Watkins, 'Metrication in the United States: A Social Constructivist Approach' (Ph.D. diss., Southern Illinois University, 1998), p. 305. See also Minister of Trade and Commerce, Government of Canada, *White Paper on Metric Conversion in Canada*, January 1970; Gerald Black, *Canada Goes Metric* (Toronto: Doubleday, 1974).
44. For American diversity, see J. Q. Adams, 'Weights and Measures', pp. 741-3. In the 1820s the number of tray grains in an avoirdupois pound still differed by as much as 5 per cent in customs houses up and down the Atlantic coast, and the capacity of a bushel basket by as much as 20 per cent. Louisiana had a different colonial experience and so different measures.
45. The best history of the metric system in America is Charles F. Treat, *A History of the Metric System Controversy in the United States*, National Bureau of Standards, Pub. 345-10 (Washington, DC: USGPO, 1971). See also, Cox, 'A History of the Metric System'. For the arrival of the 1799 iron metre in the US, see APS, Hassler, 'Confrontation des toises faite par le Comité des poids et mesures à Paris', November 1806. For

the sale of the measures, see APS, Hassler, 'Livres concernant les mesures de degrés' [1808]. Hassler also visited Lalande and Delambre in Paris in the 1790s to collect metrical standards and geodetic instruments, including a Borda repeating circle; see Hassler, *Memoirs*, trans. Emil Zschokke (Nice: Gauthier [1877], 1882), pp. 36-8, 53-7. Florian Cajori, *The Chequered Career of Ferdinand Rudolph Hassler* (Boston: Christopher, 1929), pp. 20-3, 35-6. For Hassler's report, see 'Weights and Measures', 29 June 1832, 22nd Congress, 1st Session, *Register of Debates* (Washington, DC: Duff Green, 1832), pp. 1-123. For general information on weights and measures at this time, see *North American Review* 97 (October 1837), pp. 269-92. National Academy of Sciences, *A History of the First Half-Century of the National Academy of Sciences, 1863-1913* ([Washington, DC]: n.p., 1913), pp. 206-13.

46. Josh Billings, in Aubrey Drury, *World Metric Standardization: An Urgent Issue* (San Francisco: World Metric Standardization Council, 1922), p. 157.
47. Charles Latimer, *Proceedings of the Ohio Auxiliary Society of the International Institute*, January 1887, in Treat, *History of the Metric System*, p. 89. Charles Latimer, *The French Metric System, or, The Battle of the Standards* (Chicago: Wilson, 1880), pp. 28-9. Edward F. Cox, 'The International Institute: First Organized Opposition to the Metric System', *Ohio Historical Quarterly* 68 (1959), pp. 54-83.
48. President Gerald Ford quoted in Susan Fraker Holt, revised by Gretchen Borges, *The United States and the Metric System* (Federal Reserve Bank of Minneapolis, December 1976), p. 36, emphasis added. Daniel V. De Simone, ed., *A Metric America: A Decision Whose Time Has Come*, National Bureau of Standards, Pub. 345 (Washington, DC: USGPO, 1971).
49. Bob Greene, 'Man from WAM! Puts His Foot Down', *Chicago Tribune* (11 April 1978), 2, p. 1.
50. For the US in the 1990s, see Gary P. Carver, *A Metric America: A Decision Whose Time Has Come - for Real* (Gaithersburg, MD: National Institute of Standards and Technology, June 1992). George Gallup, Jr, *The Gallup Poll* (Wilmington, DE: Scholarly Resources, 1991), p. 210.
51. Arthur G. Stephenson et al., 'Mars Climate Orbiter Mishap Investigation Board: Phase I Report', NASA, 10 November 1999. *Science* 286 (1999), pp. 18, 207. *New York Times* (21, 24 September, 1 October 1999).

### *Epilogue The Shape of Our World*

1. Jean-Paul Sartre, *La nausée* (Paris: Gallimard, [1938]), pp. 179-80.
2. On the Melun baseline in the nineteenth century, see ADSM MDZ333, Bassot et al., 'Vérification faite en 1882 des travaux géodésiques des astronomes Delambre, Laplace et de Prony', 12 August 1882. For the traffic accident, see Levallois, *Mesurer la terre*, p. 134.