

**“BEGINNING THE WORLD ANEW:
THE MECHANICS OF CREATIVITY IN EARLY AMERICA”**

Colleen E. Terrell
Georgia Institute of Technology

Presented to the Georgia Workshop in Early American History and Culture
University of Georgia, Athens
August 26, 2005

A work in progress: please do not quote or distribute without the permission of the author.

Thomas Paine's call for an American declaration of independence, issued as *Common Sense* early in 1776, included Paine's analysis of what he saw as a fundamental defect in the English constitution, namely, the inadequacy of its method for enabling the people to "check" the power of the king. "The provision," he wrote, "is unequal to the task [. . .]; for as the greater weight will always carry up the less, and as all the wheels of a machine are put in motion by one, it only remains to know which power in the constitution has the most weight, for that will govern." This description of government as a machine was a familiar one in the 18th century, a time when one might, like Philadelphian William Hicks, acknowledge the English constitution as "a nice piece of machinery which has undergone many changes and alterations," and yet agree with John Adams that "the great machine will not go any longer without a new wheel. [England] will make this herself. We think she is making it of such materials and workmanship as will tear the whole machine to pieces."

In *Common Sense*, Paine stressed the fact that a break with Britain would allow the colonists to replace the flawed machinery of English government with an improved model of their own design. Governments, being man-made structures, were subject to intentional *re-*making. It was, he suggested, a uniquely creative historical moment, a chance "[t]o begin government at the right end," by which he meant that developing government around the pre-existing fact of a king was a little like putting the cart before the horse. Instead, he suggested, "the articles or charter of government should be formed first, and men delegated to execute them afterward." In the event of American independence, Paine urged, "we have every opportunity and every encouragement before us, to form the noblest purest constitution on the face of the

earth. We have it in our power to begin the world over again.”¹

Paine’s rhetorical framing of the task of independence as a problem in the redesign and construction of an improved machinery of government represents but one piece of a rhetorical pattern running widely through American literature of the revolutionary and early republican eras. One can find, if one looks for them, an amazingly diverse array of images that couch the various tasks of “forging” the union—from ordering individual farms and educating a virtuous citizenry to framing a unified government and narrating the nation’s emergence—in mechanical terms, using metaphors of machinery. “Literature” should be understood broadly here, for a mechanistic rhetoric can be found not only in the period’s *belles lettres*, but also in its political documents, scientific textbooks, educational treatises, and works of philosophy, medicine, and religion. The figures of speech are sufficiently pervasive to constitute what we might call an early American discourse of mechanism, and this study seeks to understand the ways in which such a discourse functioned. It is an inquiry into the relationship not only between language and culture, but also, ultimately, between words and things.

Paine’s repeated expression of the symbiosis between revolution and the creation of a new world suggests that, at its most basic, a discourse of mechanism captured the sheer creative possibility of founding. If, as Christopher Looby has written, the United States was “‘the first new nation’—that is, the first modern nation deliberately fabricated *de novo*, founded in a self-conscious act of new political creation,” then a discourse of mechanism highlighted the fact that “fabrication” and “creation” have their literal as well as their linguistic dimensions.² Functional nationhood cannot long persist beyond the moment of independence without an accompanying

¹ Thomas Paine, *Collected Writings*, ed. Eric Foner (New York: Library of America, 1995), 11, 43, 52; Hicks qtd. in Bernard Bailyn, *Ideological Origins of the American Revolution* (Cambridge, MA: Belknap/Harvard UP, 1992), 176; John Adams, *The Works of John Adams*, ed. Charles Francis Adams, vol. 4. (Boston: Little, Brown and Company, 1850-56), 108.

² Christopher Looby, *Voicing America: Language, Literary Form, and the Origins of the United States* (Chicago: U of Chicago P, 1996), 3.

structure of governance. As Paine pointed out, independence offered American colonists the opportunity to design such a structure from the beginning.

Couching that design process in mechanical terms reflects, in the first place, what historian Brooke Hindle has characterized as an “infectious enthusiasm for mechanization” in early America. Such associations were not, of course, exclusively American, but the context in which they appeared was. One need only browse the *Encyclopédie*'s nearly 3000 full-page plates depicting (as Garry Wills has put it, in “lovingly etched detail”) a vast assortment of trades, craft processes, and machines to sense that mechanics had an important place at the heart of the age of Enlightenment.³ Yet a discourse of creative mechanicism acquired new dimensions in the New World, where it was irrevocably linked to material conditions. Such language, I would suggest, came easily to the Founding generation not only because it was the lingua franca of Enlightenment progress, but more importantly because it was rooted in the material culture of daily life, in the actual experience of designing and building things.

Crusoe in America

Paine's notion that Americans could “begin the world over again” in 1776 was not the first time they had confronted such an inaugural condition. Colonists struggling to establish settlements in the new world had the same thought, although their expressions of it often intimated hard, wearying necessity as much as creative opportunity. John Winthrop explained in 1668 that “[p]lantations in their beginnings have work ynough [...] there beinge buildings, fencings, cleeringe and breakinge up of ground, lands to be attended, orchards to be planted, highways & bridges & fortifications to be made, & all thinges to doe, as in the beginnige of the

³ Brooke Hindle, *Emulation and Invention* (New York: New York UP, 1981), 4; Garry Wills, *Inventing America: Jefferson's Declaration of Independence* (New York: Vintage/Random House, 1979), 99.

world.” Winthrop was not alone in his impression of being on the edge of time; the image was repeated often in early American writing, from Jared Eliot’s desire to instruct settlers, of whom “It may be said, That in a Sort, *they began the World a New*,” in the proper methods of farming, to Jefferson’s wish that his countrymen might build of stone rather than wood, because, he argued, wooden structures surviving at most fifty years, “[e]very half century then our country becomes a tabula rasa, whereon we have to set out anew, as in the first moment of seating it.”⁴ Clearing, ploughing, constructing: the trope of beginning the world anew conveyed the extent to which early Americans were actively engaged in the work of transforming the natural environment into a built environment, wilderness into civilization.

An early American discourse of mechanism was grounded in this concrete work of colonization, a process that was both “mechanical” in nature and required the use of actual machines. In the eighteenth century the latter might be as simple as a shovel or a spade, implements that Defoe referred to as machines in *Robinson Crusoe*; Crèvecoeur used the word to describe a wagon, a ship, and a crude frontier baby’s cradle “ingeniously fixed” from “a piece of round bark.” These uses suggest the ways in which the concept of a machine once encompassed a much wider range of objects, including things that didn’t necessarily have moving parts or automatic motion. They invoke an older and more capacious understanding of a machine as “[a]n apparatus constructed to perform a task or for some other purpose,” a definition whose emphasis falls on creation, on the deliberate manufacture of the thing so described. One connection between a machine and the word “mechanical” is precisely the latter’s early sense of “manual or practical work,” trades or occupations that involved “handicraft, craftsmanship, or

⁴ Winthrop qtd. in Silvio Bedini, *Thinkers and Tinkers: Early American Men of Science* (New York: Charles Scribner’s Sons, 1975), 23; Jared Eliot, *Essays Upon Field Husbandry in New England and Other Papers, 1748-1762*, ed. Harry J. Carman and Rexford G. Tugwell (New York: AMS Press, 1967), 7; Thomas Jefferson, *Notes on the State of Virginia*, ed. William Peden (Chapel Hill, NC: U of North Carolina P for the Institute of Early American History and Culture, 1982), 280.

artisanship.”⁵ As persons, “mechanics” in the eighteenth century were essentially indistinguishable from artists or artisans; the term applied equally well to cobblers and coopers, smiths and carpenters, watchmakers, bricklayers, and so on. Mechanics worked at building an infinite variety of structures, from shoes to ships to ploughs, and their skills were in great demand in early America.

In England mechanics were frequently identified as belonging to a low social class; hence the adjective “mechanical” could be employed as an epithet, a derogatory reference to persons and things of low or vulgar origin.⁶ Yet in its migration from the old world to the new the role of the mechanic shed some of its social stigma. As persons engaged in the multiplicity of productive work necessary to develop a civilization in the wilderness, mechanics acquired immense practical value and a measure of occupational prestige. William Penn, for example, highlighted the need for prospective colonists to bring with them “all sorts of Apparel and Utensils for Husbandry and Building and Household Stuff,” and he issued an early call for the emigration to America of “Industrious Husbandmen and Day-Labourers.” A century later, Jefferson, in *Notes on the State of Virginia*, exempted “artificers” from his general recommendation to discourage the emigration of foreigners. Instead, Jefferson urged, one should “[s]pare no expense in obtaining them. They will after a while go to the plough and the hoe; but in the mean time, they will teach us something we do not know.” Benjamin Franklin, himself functioning as a professional mechanic in his capacity as a printer, explained in his 1784

Information to Those Who Would Remove to America that “The Husbandman is in honor there,

⁵ Daniel Defoe, *Robinson Crusoe*, ed. Angus Ross (1719; New York: Penguin, 1965), 90, 98; J. Hector St. John de Crèvecoeur, *Sketches of Eighteenth-Century America*, in *Letters From an American Farmer and Sketches of Eighteenth-Century America*, ed. Albert E. Stone (New York: Penguin, 1981), 393; “machine,” *Oxford English Dictionary* [hereafter *OED*] (Oxford University Press, 2005; Georgia Institute of Technology, July 4, 2005 <<http://dictionary.oed.com>>), def. 6a; “mechanical,” *OED* (July 6, 2005 <<http://dictionary.oed.com>>), def. 1 and 2.

⁶ Raymond Williams, *Keywords: A Vocabulary of Culture and Society* (New York: Oxford UP, 1983); “mechanical” *OED*, def. 3.

& even the Mechanic, because their Employments are useful.”⁷

All of these urgent appeals for settlers with mechanical skills imply a distinction between the artisan exclusively practicing his trade, either in a shop or itinerantly, and the husbandman working his land. In doing so, however, they obscure the degree to which farmers in early America were often obliged to function as mechanics, too. The line dividing mechanic from husbandman was not nearly so sharply delineated. Francis Hopkinson, author, justice of the peace, and signer of the Declaration of Independence, made use of this fact to poke fun at the British during the Revolution, contrasting “the ignorance and narrow-mindedness of the general British population” with the wide-ranging intellect and talents of the Americans. “The lowest Tradesman” in America, he wrote, “is not without some Degree of general Knowledge. They turn their hands to every thing—their Situation obliges them to do so. A Farmer, there, cannot run to an Artist upon every trifling Occasion. He must make & mend and contrive for himself.”⁸ While one might suspect Hopkinson of satirical exaggeration, his observation—of the Americans, at least—was grounded in truth. Practicing mechanics were in fact particularly scarce in rural areas, so colonists learned to meet their own needs, of necessity acquiring skills in such mechanical arts as carpentry and smithing.⁹ Machines were part of the daily fabric of colonial existence, and many colonists, routinely required to alter or repair the implements in use on the farm or in the shop, lived with mechanism and handicraft at a level of intimate familiarity that is almost unimaginable today.

The image of the farmer-as-mechanic figured prominently in one of the most influential

⁷ Penn qtd. in Wayne Franklin, *Discoverers, Explorers, Settlers: The Diligent Writers of Early America* (Chicago: U of Chicago P, 1979), 95; Jefferson, *Notes* 85; Benjamin Franklin, *Information to Those Who Would Remove to America* (Passy, 1784), in *Writings*, ed. J. A. Leo Lemay (New York: Library of America, 1987), 977.

⁸ Francis Hopkinson, *The Miscellaneous Essays and Occasional Writings of Francis Hopkinson*, vol. I (mss. American Philosophical Society, Philadelphia, PA), 176, 179.

⁹ Stevenson Whitcomb Fletcher, *Pennsylvania Agriculture and Country Life, 1640-1840* (Harrisburg, PA: Pennsylvania Historical and Museum Commission, 1950), 91.

representations of American husbandry in the eighteenth century, Crèvecoeur's *Letters from an American Farmer*. First published in London in 1782, Crèvecoeur's text was popular in at least six countries, on both sides of the Atlantic. It was widely read in Britain both as a book and in excerpts reprinted in many leading British periodicals—excerpts which were then copied and reprinted verbatim, according to the standard practice of the time, in American newspapers and magazines, including Matthew Carey's *American Museum*. Editions of the book were immediately issued in Dublin and Belfast; translations were soon printed in both Holland and Germany; and Carey published an American edition in Philadelphia in 1793. The twelve short pieces originally published in London represented only a portion of the essays that Crèvecoeur had written in English, and he incorporated much of their excluded content, along with entirely new material, into two French editions, published as *Lettres d'un cultivateur américain* in 1784 and 1787. Purporting to be simple “translations” of the English *Letters*, the French texts—each longer than its predecessor—were substantially different works, and they testify to Crèvecoeur's continuing popularity as the author of the *Letters*.¹⁰

Modern critics often read *Letters from an American Farmer*, along with Jefferson's *Notes on the State of Virginia*, as a master-text of the American pastoral ideal. Its famous string of all the things that could *not* be found in the new world, including “no great manufactures employing thousands,” stands beside Jefferson's equally famous rejection of manufactures in *Notes*; together the two have long provided a foundation for the powerful analytical opposition between the machine and the garden.¹¹ Yet *Letters*, as well as the companion pieces excluded from its

¹⁰ For a more complete account of *Letters*'s eighteenth-century publication history and reception, see Howard Rice, *Le cultivateur américain: étude sur l'oeuvre de Saint John de Crèvecoeur* (Paris: Librairie Ancienne Honoré Champion, 1933), esp. 45-106; and Robert de Crèvecoeur, *Saint John de Crèvecoeur, sa vie et ses ouvrages (1735-1813)* (Paris: Librairie des Bibliophiles, 1883), 295-309.

¹¹ J. Hector St. John de Crèvecoeur, *Letters from an American Farmer* (London, 1782), 46. The machine in the garden is a figure first analyzed by Leo Marx in *The Machine in the Garden: Technology and the Pastoral Ideal in America* (New York: Oxford UP, 1964).

original publication and often collected now as *Sketches of Eighteenth-Century America*, not only displays in rich abundance the ploughs, axes, hand-mills, compasses, guns, and other tools and implements necessary for colonial frontier life, but also takes sheer delight in their creation and use. Crèvecoeur's writings may warn against the onset of industrialization, but they fully embrace individual *machines* and the human ingenuity at work in them. They exemplify the creative aspects of an early American discourse of mechanism.

Crèvecoeur's husbandmen undertake exactly that deliberate fabrication of the new world that Winthrop outlined nearly a century previously. Inviting his European readers to "quit the sea-shore and go three hundred miles into the wilderness and see how men begin the world," Crèvecoeur suggests that every colonist settling on the new world frontier has literally to create it afresh. In his representation, however, the joys of creation far outweigh the difficulty and uncertainty of the labor. In "Thoughts of an American Farmer on Various Rural Subjects," an essay now in *Sketches*, Crèvecoeur describes a colonist who

[w]ith cheerfulness [...] quitted the paternal estate he enjoyed, and prepared to begin the world anew in the bosom of this huge wilderness, where there was not even a path to guide him. He had a road to make, some temporary bridges to make, overset trees to remove, a house to raise, swamps to convert into meadows and to fit for the scythe, upland fields to clear for the plough—such were the labours he had to undertake, such were the difficulties he had to overcome. He surmounted every obstacle; he was young, healthy, vigorous, and strong-handed. In a few years this part of the wilderness assumed a new face and wore a smiling aspect.

Crèvecoeur's ideal farmer never loses his optimism in the face of the hard labor of original

colonization; instead, he is perpetually buoyed by the goal of his activity—the creation of his own freehold—and his delight in the opportunity thus afforded by the American wilderness.¹²

Seizing that opportunity required a fair amount of technical knowledge. As Crèvecoeur wrote of immigrants from the Scottish islands, “it is not easy for those who seldom saw a tree, to conceive how it is to be felled, cut up, and split into rails.” Crèvecoeur’s eponymous farmer James, the fictional author and narrator of *Letters*, himself possesses significant artisanal skill, noting that he had “been tolerably successful” “in inventing and executing machines, which simplify my wife’s labour.” He tutors new immigrants in the use of an axe and in which types of ploughs are best suited for American soil. In the last letter, as he prepares to move his family deep into Indian territory on the frontier, James comforts himself with the knowledge of his mechanical skills. He imagines that their utility might make a place for him among the natives. He plans to distribute quirns as gifts, of which he had “built many for our poor back settlers,” and he muses that “[a]s I am a carpenter, I can build my own plough, and can be of great service to many of them.” He also plans for his children’s future, intending to show them “how to hew wood, how to construct their own ploughs; and with a few tools how to supply themselves with every necessary implement, both in the house and in the field.”¹³

In Crèvecoeur’s texts, nearly anyone who can split rails for fences, mend shoes, fix gears, ploughs, and carts is operating from within a mechanical sensibility, and James’s—or Crèvecoeur’s—experience suggests that a variety of such skills are indispensable to the typical American husbandman. Crèvecoeur described the difficult situation of an isolated farmer who has no access to local specialized artisans in “Reflections.” “What is he to do,” Crèvecoeur asks, “in all possible cases of accidents, sickness, and other casualties which may befall his family, his

¹² Crèvecoeur, *Sketches* 272, 409.

¹³ Crèvecoeur, *Letters* 14-16, 44, 307, 311-12.

cattle and horses; breaking of the implements of husbandry, etc.?” Such men, Crèvecoeur asserts, “are and must be everything”: “now ploughmen, now mechanics, sometimes even physicians.” The farmer, in order to succeed, must be “a universal fabricator like Crusoe.”¹⁴

Defoe’s novel *Robinson Crusoe* was enormously popular in eighteenth-century America, not least for the reason that, simultaneously farmer and mechanic on his lone island, Crusoe stood as the archetype of creative ingenuity in a New World context.¹⁵ Crusoe’s survival roughly follows the old adage that necessity is the mother of invention, a theme Crèvecoeur elevates to a defining condition of the American character. Although *Letters* suggests that new immigrants sometimes receive helpful instruction from already established settlers, in “Reflections” Crèvecoeur provides a strongly determinist account of the origins of the colonists’ mechanical talents: the conditions of America itself bred mechanical ingenuity. In Defoe’s novel, Crusoe observes that when he first turned his hand to a craft he was initially “but a sorry workman, tho’ time and necessity made me a compleat natural mechanick soon after, as I believe it would do any one else.” Crèvecoeur sketches an almost identical scene, writing of the rural American farmer that

Does either his plough or his cart break, he runs to his tools; he repairs them as well as he can. Do they finally break down, with reluctance he undertakes to rebuild them, though he doubts of his success. This was an occupation committed before to the mechanic of his neighbourhood; but necessity gives him invention, teaches him to imitate, to recollect what he has seen. Somehow or another ’tis done...It answers the purposes for the present. Next time, he arrives nearer perfection. Behold him henceforth a sort of intuitive carpenter!

¹⁴ Crèvecoeur, *Sketches* 256, 258.

¹⁵ For a discussion of *Robinson Crusoe*’s popularity in America, see Jay Fliegelman, *Prodigals and Pilgrims: The American Revolution Against Patriarchal Authority, 1750-1800* (Cambridge: Cambridge UP, 1982), 39.

Crèvecoeur's "intuitive carpenter" represents the American type of Defoe's "compleat natural mechanick," and this transformative experience is in fact how *Letters*'s farmer James first acquired his own carpentry skills. In *Letters*'s very first letter, the minister encourages James to try his hand at writing by pointing out that "[h]ad you never tried, you had never learned how to mend and make your own ploughs."¹⁶ James learned by doing.

In Crèvecoeur's sketch, carpentry represents only a small portion of the typical farmer's talents. The range of his skills continues to expand under pressure, eventually satisfying the needs of both farm and hearth: The farmer's "ingenuity in the fields is not less remarkable in executing his rural work in the most expeditious manner. He naturally understands the use of levers, handspikes, etc." He mends his children's shoes, and then attempts to make an altogether new pair; "[t]hey are coarse, heavy, ponderous, and clumsy; but they are tight and strong and answer all the intended purposes. What more can he want? If his gears break, he can easily repair them. Every man here understands how to spin his own yarn and to [make] his own ropes."¹⁷

These experiences contribute to what Hindle has called "fingertip knowledge," familiarity with machines acquired through the actual hands-on manipulation of machinery.¹⁸ In his own life Crèvecoeur himself probably had a fair share of both fingertip and book knowledge, having been trained in mathematics and having worked as a surveyor, cartographer, and engineer before turning to agriculture.¹⁹ His portrayal of the representative life of a rural eighteenth-century American, however overly rosy, nonetheless reflects the basic truth that many colonists functioned in some degree as jacks-of-all-trades. The point, however, is that a vast number of early Americans possessed similar "fingertip knowledge" of the mechanical arts, including

¹⁶ Crèvecoeur, *Sketches* 89, 257; *Letters* 15.

¹⁷ Crèvecoeur, *Sketches* 258.

¹⁸ Hindle, *Emulation and Invention* 5.

¹⁹ Albert E. Stone, Introduction to Crèvecoeur, *Letters From an American Farmer and Sketches of Eighteenth-Century America*, 9-10.

members of the Founding generation, including those individuals whom we now identify as the Founding Fathers. One thinks, for example, of the record, in Jefferson's letters, of the cyclical process through which he modified the ploughs and seed drills at work in his own fields, wrote to acquaintances such as George Washington and Edward Rutledge to share his improvements, and acquired new machines in turn recommended to him only to modify them again; of the ways in which Franklin served as a "factotum" in his print shop, repairing his presses and supplying makeshift ink and type as a matter of course and necessity; of Paine's early occupation as a corset maker, or Washington's experience as a surveyor, or Rittenhouse's career as a maker of clocks and scientific instruments. Several signers of the Declaration of Independence had experience in the mechanical arts: one was an ironmaster; one, Roger Sherman, was a shoemaker; and at least four had experience in surveying. Many were part- or full-time farmers. One suspects that many of these men handled tools and crafted material objects on a regular basis.

The Founders' hands-on experience with mechanism, moreover, arguably extended well beyond the "necessity" of livelihood and into the realm of genuine enthusiasm. For example, Jefferson's serious inquiry into whether a threshing machine is better constructed with cogwheels and gears or "bands & whirls" suggests not only an eye for cost and efficiency but also a pure fascination with parts and arrangements in and of themselves, a suggestion borne out by his numerous other practical (or not so practical) creations.²⁰ From Franklin's myriad inventions and Paine's model for an iron bridge to Hopkinson's design for an improved candle case and Charles Willson Peale's impassioned quest to perfect his polygraph, the activities of America's intellectual and political elite both before and after the Revolution reveal a startlingly broad collective interest in and talent for actual mechanical pursuits. One gains the sense from

²⁰ *Thomas Jefferson's Farm Book*, ed. Edwin Morris Betts (Princeton, NJ: Princeton UP, 1953), 73.

these various accounts and others like them that a joyous and practically unfettered creativity inhered in early American mechanical activity, an exultation in sheer inventive possibility over and above any practical advantage it might bring.

Machines were everywhere in early America. Rural landscapes and urban townscapes alike contained a multiplicity of mechanical objects, including windmills and waterwheels; intricate clockworks, looms and printing presses; firearms, cannon, and other military engines; wagons and wheelbarrows; levers, pumps, pulleys; and all sorts of specialized agricultural, surveying, and scientific equipment. Mechanical design and construction permeated the American scene. There is, in short, an intriguing correspondence between the actual, material lives of the Founders and their mechanical discourse of nation-building. The production of a new government can be understood at some level as a natural extension of material practice.

A Compleat Mechanick

At the beginning of one of James Ferguson's popular eighteenth-century textbooks on natural philosophy one finds a brief history of the author's life. Among other details, Ferguson gives an account of the origin of his "taste for mechanics," which, he says, "arose from an odd accident." As a young boy "about 7 or 8 years of age," he witnessed his father using a prop and lever to raise and thus repair part of his home's decaying roof. "[T]o my great astonishment," Ferguson records,

I saw him, without considering the reason, lift up the ponderous roof as if it had been a small weight. I attributed this at first to a degree of strength that excited my terror as well as wonder: but thinking further of the matter, I recollected that he had applied his strength to that end of the lever which was furthest from the

prop; and finding, on enquiry, that this was the means whereby the seeming wonder was effected, I begun making levers (which I then called bars); and by applying weights to them in different ways, I found the power gained by my bar was just in proportion to the lengths of the different parts of the bar on either side of the prop.

Hopeful of achieving still greater feats, Ferguson soon began to experiment with a rope attached to the lever at one end and wound around the axle of a wheel at the other, discovering by trial and error that the power gained by the wheel was proportional to the difference between its diameter and that of its axle. He then started to think about the properties of a wedge, but, he confesses, he “happened not to think of the screw.” He compiled his findings in written form, complete with sketches, “imagining it to be the first treatise of the kind that ever was written: but found my mistake when I afterward shewed it to a gentleman, who told me that these things were known long before, and shewed me a printed book in which they were treated of: and I was much pleased when I found, that my account (so far as I had carried it) agreed with the principles of mechanics in the book he shewed me. And from that time my mind preserved a constant tendency to improve in that science.”²¹

Ferguson’s tale begins with an account of activity that is “mechanical” in the artisanal sense—his father’s raising of the spar to fix the roof. Yet the tool used in this task—a lever—naturally led to an altogether different meaning of “mechanics.” If Defoe suggested that necessity and ingenuity could make of a man a “compleat natural mechanick,” William Penn argued that something more was required to make him a mechanic in the fullest sense of the term. Only an artisan who could explain the rules underlying his practice, he said, deserved to be

²¹ James Ferguson, *Select Mechanical Exercises: Shewing how to construct different CLOCKS, ORRERIES, and SUN-DIALS, on plain and easy principles*, 2nd ed. (London, 1778), iii-iv.

known as a “compleat Mechanick.”²² And insofar as mechanics (in the artisanal sense) used or built implements and machines in their work, they relied upon a knowledge of rational mechanics.

A branch of what we would today identify as physics, the field of rational mechanics involves the application of pure mathematics to analyses of the forces acting upon, and the subsequent motion or equilibrium of, physical bodies. Rooted in the idea that the natural phenomena of the physical world were comparable to working machines, seventeenth- and eighteenth-century mechanical (or “corpuscular”) philosophy sought to explain those phenomena according to mechanical principles, that is, “from the Motion, Rest, Figure, Position, Magnitude, &c. of the minute Particles of Matter.”²³ A mechanical analysis of Ferguson’s spar would reveal that lifting the beam required an upward force greater than the downward pull of gravity. Ferguson’s father needed the mechanical advantage afforded by the lever, which multiplied his merely human strength.

The lever brings us to a more specialized definition of a “machine,” the scientific sense of the word corresponding to its use in rational mechanics. A lever was recognized—then as now—as one of the elemental “simple machines” of classical mechanics. As John Harris explained in his *Lexicon Technicum: Or, An Universal English Dictionary of Arts and Sciences*,

MACHINE, [...] or Engine, in Mechanicks, is whatsoever hath Force sufficient either to raise or stop the Motion of a Body. These Machines are either Simple or Compound.

Simple Machines are commonly reckoned to be Six in Number, viz. the

²² Penn qtd. in George H. Eckhardt, *Pennsylvania Clocks and Clockmakers: An Epic of Early American Science, Industry, and Craftsmanship* (New York: The Devin-Adair Company, 1955), 37.

²³ John Harris, *Lexicon Technicum: Or, An Universal English Dictionary of Arts and Sciences...*, 2 vols., 5th ed. (London, 1736), s.v. “Mechanical Philosophy.”

Balance, Leaver, Pulley, Wheel, Wedge and Screw. To these might be added the Inclined Plane, since 'tis certain that the heaviest Bodies may be lifted up by the means thereof, which otherwise could scarce be moved.

Compound Machines, or Engines, are innumerable, in regard that they may be made out of the Simple, almost after an infinite manner.²⁴

Each simple machine had its own working principles; all could ultimately be explained by the laws of motion and principle of gravitation fully codified by Newton in his *Philosophiæ Naturalis Principia Mathematica*.

The argument of the *Principia*, written in Latin and advancing through mathematical proofs, was only accessible to a specialized audience; Newton's theories were disseminated to the general public through lectures, demonstrations, and a plethora of textbooks that conveyed his principles to a more popular audience through the use of detailed explanation, simple physical experiments, and beautifully engraved plates. Carl Becker has pointed out that at least 40 books about the *Principia* were published in English alone before 1789, and several of these went through multiple editions over the course of the eighteenth century. Texts such as Colin Maclaurin's *Account of Sir Isaac Newton's Philosophical Discoveries*, J.T. Desaguliers's *Course of Experimental Philosophy*, Benjamin Martin's *Philosophia Britannica: Or a New and Comprehensive System of the Newtonian Philosophy, Astronomy and Geography, in a Course of Twelve Lectures*, and 'sGravesande's *Mathematical Elements of Physicks, prov'd by Experiments, Being an Introduction to Sir Isaac Newton's Philosophy* circulated widely in both Britain and America.²⁵

They were standard elements in the libraries and curricula of colonial universities such as

²⁴ Harris, *Lexicon Technicum*, s.v. "Machine." J. T. Desaguliers included the inclined plane outright as one of seven simple machines in his *A Course of Experimental Philosophy*, 2nd ed., vol. 1. (London, 1745), 92. Modern physics recognizes only five: the lever, the wedge, the wheel, the pulley, and the screw.

²⁵ Carl L. Becker, *The Declaration of Independence: A Study in the History of Political Ideas* (1922; New York: Knopf, 1964), 40-51, 74-75; Howard C. Rice, Jr., *The Rittenhouse Orrery: Princeton's Eighteenth-Century Planetarium, 1767-1954* (Princeton, N.J.: Princeton University Library, 1954), 3-6.

Harvard, Yale, and Princeton; private copies could be found in many personal collections, including, for example, those of Franklin and Jefferson.

While the *Principia* itself contained very little investigation into the practical applications of mechanics, many of the popularizations emphasized the way knowledge of the effects of natural forces enabled one to harness them in functional machines, accompanying theory with illustrations of its practical application. Maclaurin's text is typical in following up a chapter on rational mechanics, Chapter II, "Of the laws of motion, and their general corollaries," with a chapter on practical mechanics, Chapter III, "Of the mechanical powers." Such analyses were truly practical in orientation; they were intended to teach readers how to build actual working machinery and contained illustrations of and details about the workings of carriages, wind and water mills, cranes, an "engine for driving piles," pumps, pendulums, clocks, and projectiles, among others. Such technologies were, in the language of the day, "compound machines," built as complex combinations of the simple machines. Armed with the theoretical knowledge of rational mechanics at its most basic level—the laws of motion—one could deduce the workings of the most complex machine.

Applied here to machines, the dual process described above—first breaking a phenomenon down into its elemental component parts, and then reassembling them into a complete theoretical whole—together make up Newtonian scientific methodology. As Roger Cotes wrote of "experimental philosophers" in his preface to Andrew Motte's English translation of the *Principia* (1729), "They proceed therefore in a two-fold method, synthetical and analytical. From some select phænomena they deduce by analysis the forces of nature, and the more simple laws of forces; and from thence by synthesis shew the constitution of the rest." Cotes called this complementary, reciprocal method of analysis and synthesis the "incomparably best way of

philosophizing,” and it became a hallmark of Enlightenment reason.²⁶

Newton, in his own preface to the *Principia*, had written that, as he had derived the motions of “the System of the World” from the laws of motion, so he “wish[ed] we could derive the rest of the phaenomena of Nature by the same kind of reasoning from mechanical principles.” And indeed the analytical techniques of mechanical philosophy proved transferable to a wide variety of objects and phenomena in a spectrum of disciplines; during the seventeenth and eighteenth centuries natural philosophers sought mechanical explanations for everything from the motions of bodies in the heavens to those of pendulums, projectiles, and billiard balls on earth; from the behavior of static fluids to the reflection and refraction of light; from the circulation of the blood to the operation of joints and muscles. Yet eighteenth-century philosophers went still further, applying mechanical philosophy, as a formal analytical tool, not simply to concrete problems in physical science but also to empirical data of all kinds. As Ernst Cassirer has written of the “the mind of the Enlightenment,” given the method of scientific inquiry set forth by Newton, it “immediately begins to generalize. It is not content to look upon analysis as the great intellectual tool of mathematico-physical knowledge; eighteenth century thought sees analysis rather as the necessary and indispensable instrument of all thinking in general.”²⁷

Enlightenment reason extended its methods to nearly every branch of knowledge, encompassing not only natural history, physics, and mathematics, but the sciences of the human as well, including such fields as politics, history, psychology, and linguistics. Cassirer emphasized the methodological aspects of Enlightenment reason—its origins in science. But that science is fundamentally mechanical in nature. The concept of a machine undergirds Cassirer’s description of the “twofold intellectual movement” of reason in the eighteenth century, which

²⁶ Isaac Newton, *The Mathematical Principles of Natural Philosophy*, trans. Andrew Motte, 2 vols. (London, 1729) 1: n. p.

²⁷ Newton, *Mathematical Principles* 1: n. p.; Ernst Cassirer, *The Philosophy of the Enlightenment*, trans. Fritz C. A. Koelln and James P. Pettegrove (Princeton, NJ: Princeton UP, 1951), 12.

operates first by reducing a phenomenon or a form into its “simplest component parts” and then reassembling them into “a new structure, a true whole” once again. This, finally, corresponds to one of the oldest—and now most obscure—definitions of a “machine,” given by the *OED* as “[a] material or immaterial structure, esp. the fabric of the world or of the universe; a construction or edifice.”²⁸ *Material or immaterial*: in the eighteenth century, a “machine” need be neither human made nor even concrete; it was always a short step from an actual, physical machine to an abstract conceptualization. Its discursive scope encompasses anything that can be understood as a unified structure composed of myriad subordinate components, from simple and complex technological apparatuses; to cosmological, biological, and anatomical systems; to abstract constructs like the “machinery” of society and government.

Crèvecoeur actually makes the jump from materiality to abstraction in “Reflections on the Manners of the Americans” when he compares the whole process of planning a farm to the design of a machine. He describes how any colonist relocating to new land must first subject it to a frontiersman’s version of mechanical philosophy, sorting out the environment’s component parts and analyzing their cause and effect relations: “[H]e judges of the soil by the size and appearance of the trees”; his observations of the timber, weeds, and moisture “teach him all he wants to know.” The would-be settler carefully weighs his data, makes informed judgments, and plans the location of his future buildings, roads, fields, and crops. Crèvecoeur asserts that “In short, the complicated arrangement of a great machine would not do greater honour to the most skilful artist than the reduction and digesting of so many thoughts and calculations by this hitherto obscure man.”²⁹ In comparing a farm’s establishment to the process of mechanical construction, Crèvecoeur provides a compelling vision of the farmer as a mechanic in both a

²⁸ Cassirer, *Philosophy of the Enlightenment* 14; “machine,” *OED* (July 4, 2005 <<http://dictionary.oed.com>>), def. 1a.

²⁹ Crèvecoeur, *Sketches* 255.

theoretical and an artisanal sense, performing mechanic analyses, drawing plans, structuring the landscape, and constructing and fitting together the various pieces that will make up his functional farm.

Most Eligible Forms

Jefferson and William Byrd II also describe their plantations as machines; they use the metaphor to suggest the difficulty of coordinating laborers and tasks in such a way as to keep the work of the plantation moving along smoothly.³⁰ What one begins to see is that eighteenth-century references to the “machinery” of a plantation—or society, or government—are not empty metaphors. They refer, instead, to a very specific understanding of what a “machine” is, less a generic object than an abstract concept grounded in both a theoretical understanding of the nature of a machine and the material mechanical practices of daily life on a farm. Theory and practice are complementary, reciprocal activities; one cannot separate a “machine” from the theoretical principles underlying it.

In England, the social relegation of mechanics to a lower class status occasioned a split between theory and practice; theoreticians were often reluctant to engage in hands-on activity.³¹ Desaguliers complained that

It were to be wish'd that our Engine-makers, who often abound with Invention, and are generally quite ignorant of Mathematics, wou'd apply themselves to that Science; at least to know so much as wou'd direct them in their Works; or that some of our best Mathematicians wou'd not think it below them to direct

³⁰ Byrd qtd. in Rhys Isaac, *The Transformation of Virginia 1740-1790* (Chapel Hill, NC: U of North Carolina P for the Institute of Early American History and Culture, 1982), 40; *Thomas Jefferson's Farm Book*, ed. Edwin Morris Betts (Princeton, NJ: Princeton UP, 1953), 229-30.

³¹ Bedini, *Thinkers and Tinkers*.

Workmen, and consider Engines a little more than they do, which wou'd render their Speculations more useful to Mankind. There are some, who, being too clumsy, and wanting a nice Hand to make Experiments, are unwilling to own it, and therefore ridicule and despise Mechanical Performances; forgetting that the incomparable Sir *Isaac Newton*, whom They with all other Philosophers admire, has made as many as (if not more Experiments than) any Man living; and look'd upon Geometry as no farther useful than as it directs us how to make Experiments and Observations, and draw Consequences from them when made [. . .] ³²

In America, however, many intellectuals were at least as interested in practice as in theory. For example, Crèvecoeur's analogy of farm design as a mechanical process echoed the concerns of many in the eighteenth century to put the practice of agriculture on a soundly scientific basis. As John Beale Bordley wrote, "To conduct the business of a farm to full advantage, we must exercise our reasoning faculties, and build up principles which systematically embrace such a regular course of particulars as will best follow and depend on each other for obtaining the one whole design of farming."³³ Eighteenth-century agricultural texts sought to codify and teach those principles in the hopes that practice might coincide with theory.

Jefferson perhaps provides one of the best examples of the desire to merge theory with practice. Agricultural treatises—of which he owned many—frequently bemoaned the lack of principles in plough design; Francis Home, author of *The Principles of Agriculture and Vegetation*, "wish[ed] that some practical farmer, skilled in mechanics, would lay down the principles on which ploughs ought to be constructed, and ploughing conducted. He would merit much from the community" (176). Jefferson took up this challenge when he set out to design a more efficient mouldboard for a plough.

³² Desaguliers, *Course of Experimental Philosophy* 1:?.

³³ John Beale Bordley, *Sketches on Rotations of Crops* (Philadelphia, 1792), 31.

His design joined one wedge shape—which he noted was “the most eligible form” for drawing a plow through the soil with minimal power—with a second wedge shape required to raise the soil and turn it over, measuring their resistance with a specially ordered dynamometer. In mathematically combining these two requirements for a mouldboard, Jefferson wrote, “a curved plane will be generated whose characteristic will be a combination of the principle of the wedge in cross directions, & will give what we seek, *the mould-board of least resistance*” (Betts, *Garden* 649-50). Jefferson’s comments on his design process closely echo textbook mechanical theory, whose authors explained of the wedge—one of the simple machines—that its mechanical powers “may be applied to the overcoming of any great Resistance. A remarkable Example of it may be seen in the *Wedge*, an Instrument serving to cleave Wood, and for many other Uses.”³⁴

By all accounts, Jefferson succeeded in his intentions. Contemporaries such as David Rittenhouse and Charles Willson Peale acclaimed the efficiency and simplicity of his plough, and one admirer even wrote that it was “formed from the truest and most mechanical principle of any I had ever seen.” The French Society of Agriculture at Paris awarded him a gold medal for the design. Jefferson himself was delighted with his achievement, observing that although the plough “has hardly been deemed worthy the application of science,” if it “be in truth the most useful of the instruments known to man, it’s perfection cannot be an idle speculation. [A]nd, in any case whatever, the combination of a *theory* which may satisfy the learned, with a practice intelligible to the most unlettered laborer, will be acceptable to the two most useful classes of society.” It was an interest in the real, practical application of theory that Jefferson demonstrated throughout his life; upon informing Eli Whitney of the status of patent application on the cotton

³⁴ Francis Home, *The Principles of Agriculture and Vegetation*, (3rd ed., London, 1776), 176; *Thomas Jefferson’s Garden Book 1766-1824*, ed. Edwin Morris Betts (Philadelphia: American Philosophical Society, 1944), 649-50; W[illiam] James s’Gravesande, *Mathematical Elements of Natural Philosophy, confirm’d by Experiments, Or, an Introduction to Sir Isaac Newton’s Philosophy*, trans. from Latin by J.T. Desaguliers (6th ed., London, 1747), 1:55.

gin, Jefferson inquired whether “the machine [had] been thoroughly tried in the ginning of cotton, or is it as yet but a machine of theory?” Jefferson wanted to know whether or not—and how well—something worked.³⁵

In designing his plough, Jefferson played the role of the mechanic perfectly. Maclaurin had declared that “The mechanical powers, according to their different structure, serve for different purposes; and it is the business of the skillful mechanic to chuse them, or combine them, in the manner that may be best adapted to produce the effect required, by the power which he is possessed of, and at the least expence.” It was not sufficient, in other words, merely to know the simple machines and their properties; one must also be able to combine them well. A young John Adams understood “genius” to consist in this talent for elegant structural solutions. In his diary for 1758 he wrote,

The Man, who has a faculty of inventing and combining into one Machine, or System, for the Execution of some Purpose and Accomplishment of some End, a great Number and Variety of Wheels, Levers, Pullies, Ropes &c. has a great Mechanical Genius. And the Proofs of his Genius, (unless it happen by mere luck) will be proportionably to the Number, and Variety of Movements, the Nice Connection of them, and the Efficacy of the entire Machine to answer its End. The last, I think at present, ought to be considered in [estimating?] any Genius. [. . .] For to this End a Man will be obliged to revolve in his Mind perhaps an hundred Machines, which are possible but too unwieldly or expensive, and to select from all of them, one, which will answer the Purposes mentioned.³⁶

³⁵Thomas Jefferson's *Farm Book* 52; *Thomas Jefferson's Garden Book* 653; Thomas Jefferson to Eli Whitney, November 16, 1793, Library of Congress, *American Memory* (June 13, 2005 <[http://memory.loc.gov/cgi-bin/query/r?ammem/mtj:@field\(DOCID+@lit\(tj080038\)\)>](http://memory.loc.gov/cgi-bin/query/r?ammem/mtj:@field(DOCID+@lit(tj080038))>)).

³⁶Colin Maclaurin, *An Account of Sir Isaac Newton's Philosophical Discoveries* (London, 1748), 178; John Adams, *The Earliest Diary of John Adams*, ed. Lyman H. Butterfield, et. al., *The Adams Papers*, Series I (Cambridge, MA: Belknap/Harvard UP, 1966), 72.

Where “machine” slides into “system” in Adams’s language—a not uncommon conceptual permeability—one glimpses the future political system-building in which Adams will be engaged.

It is perhaps now a commonplace to assert, along with Henry Steele Commager, “that the Old World imagined the Enlightenment and the New World realized it. The Old World invented it, formulated it, and agitated it; America absorbed it, reflected it, and institutionalized it.” Americans, in short, put European theory into practice. One might say that America provided a workshop in which its leaders could demonstrate their skill and the worth of their long, hard apprenticeship in European forms of government, a process of nation-building that is remarkably similar to the real, material practice of mechanical design. Robert Ferguson has written, in his work on the American Enlightenment, that “the higher goal” of the American intellectual was “to find and apply those portions of a universal knowledge that will work best in the unprecedented setting of new world republicanism”; “Jefferson, Adams, Franklin, and Madison pick and choose among European frames of reference.”³⁷ In this sense, one might think of something like Adams’s comprehensive survey of constitutional forms as a prelude to the real business of the mechanic, a compendium of those component parts, those “simple machines,” out of which governments might be built.

Constructing Paine’s “noblest purest constitution on the face of the earth” is thus a matter of finding the appropriate parts and combining them to suit the purpose. A discourse of mechanism reflects the ways in which the material experience of building real machines provided a pattern for constructing more abstract ones; the actual experience of mechanics, in both its artisanal and its scientific dimensions, provided the colonists with a method and a model

³⁷ Henry Steele Commager, *Jefferson, Nationalism, and the Enlightenment* (New York: George Braziller, 1975), 3; Robert A. Ferguson, “‘What Is Enlightenment?’: Some American Answers,” *American Literary History* 1.2 (Summer 1989): 259-60.

for building in improved machinery of government. As Jefferson wrote in 1788, “I know nothing so charming as our own country. the learned say it is a new creation; and I believe them; not for their reasons, but because it is made on an improved plan. Europe is a first idea, a crude production, before the maker knew his trade, or had made up his mind as to what he wanted.”³⁸

³⁸ Thomas Jefferson, *The Papers of Thomas Jefferson*, ed. Julian P. Boyd, et. al., vol. 12 (Princeton, NJ: Princeton UP, 1950-), 601.