cal and physical resource survival is equivalent to a functioning nation and, in turn, an international power." Not only is this equation false, he argues, it completely ignores "*what kind* of entity remains to fend for itself in the postattack world."

Viewed from this qualitative perspective, even small-scale nuclear attacks like those contemplated in current nuclear doctrine and crisis relocation planning may have consequences that are qualitatively unacceptable—that is, not worth risking under any circumstances, regardless of the national interest at stake. A "key lesson" of his inquiry, Katz tells us, is that "the weapons requirements necessary to create unacceptable damage are significantly smaller than we have been willing to acknowledge." Some 70 percent of industrial installations in either the Soviet Union or the United States could be destroyed by only 1300 weapons capable of generating 6 pounds per square inch overpressure 1.5 nautical miles from their point of detonation. However, a facility need not be destroyed to be rendered inoperable. Because of the highly interdependent nature of modern industrial economies, supply bottlenecks caused by the destruction of particular industries whose output is largely consumed as input to other industries would lead to an aggregate loss of production far greater than that represented by the facilities actually destroyed. A modern industrial society can be crippled so seriously by an attack of even 100 equivalent megatons, Katz argues, that its social, political, and economic life will be altered in ways that most citizens would consider to be "unacceptable damage." Of particular relevance is Katz's analysis of crisis evacuation planning, which in the case of a severe attack would only serve to heighten the disproportion between surviving resources and population, postponing but by no means eliminating the genocidal character of nuclear war. In the case of more limited attacks, crisis relocation would do nothing to alleviate the devastating social and economic effects of such attacks and would itself be the cause of serious economic disruption and conflict, in addition to enlarging the circumstances under which the fighting of a nuclear war could appear to be an acceptable option to national leaders.

Though much of Katz's lengthy volume may appear to some readers as an exercise in belaboring the obvious, clearly his message is not obvious to everyone, including high officials of the present administration, who would benefit by a careful reading of all three of these exceptional books.

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Higher Education: The Past Reappraised

American Collegiate Populations. A Test of the Traditional View. COLIN B. BURKE. New York University Press, New York, 1982 (distributor, Columbia University Press, New York). x, 374 pp. $35. New York University Series in Education and Socialization in American History.

In 1931 Lyman Butterfield wrote an elegant essay entitled *The Whig Interpretation of History* (*1*) in which he commented upon the predominant tendency among English historians to view Protestants and Whigs as the instruments of progress while portraying Catholics and Tories as reactionary, misguided, and obstructionist. Whig historians saw the past as a march toward the beneficent institutions of their own day. Butterfield bemoaned this brand of relevance and urged historians instead to elucidate the "unlikeness between past and present." Historians, he said, must try to "see life with the eyes of another century than our own." Thus the word "Whig" evolved into an adjective applied to any historical interpretation that used present-day institutions as a standard of moral judgment and as a guide for selecting key developments in the past. Bernard Bailyn (*2*) popularized the term among American educational historians in 1960 when he criticized standard public school histories written earlier in the 20th century. By equating "education" with "schooling" and searching for 17th-century precursors of modern public school systems, these Whig historians had fundamentally misunderstood the shared educational roles of family, church, workplace, and school in colonial America. Subsequent revisionist historians have deepened the critique of public school history, challenging the benevolence of state-regulated education and writing sympathetic accounts of groups who tried to go their own way in educating their children.

Students of higher education are now fomenting the same historiographical revolution. A Whiggish view of 19th-century colleges and universities had reigned almost unchallenged until the 1970's. Like public school history, it rested upon detailed monographs written before 1950. Whig historians of higher education took a dim view of the proliferation of small colleges in the pre–Civil War era, attributing it to sectarian competition and misguided hostility to state control. Donald Tewksbury, in the standard account (*3*), calculated that over 500 colleges were chartered in 16 states during the antebellum period, of which fewer than 20 percent survived into the 20th century. Tewksbury did not grieve about the high failure rate, for he viewed the colleges as "agents of denominational imperialism" that "maintained special privileges in the field of higher education." Happily, providence shone more brightly upon the eastern, reform-minded universities like Harvard and Brown, and upon new state universities. The latter were chronicled in Earle Ross's *Democracy's College* (*4*). According to the Whig version, universities became the dominant institutions after 1860, representing the triumph of democracy and science. No less a figure than Richard Hofstadter gave his imprimatur to this view in *Academic Freedom in the Age of the College* (*5*). He viewed the spread of small colleges as a "great retrogression," in contrast to the "new regime" of the late 19th century. Hofstadter's positive model, one recent critic has remarked, suspiciously resembled his own big, cosmopolitan Columbia University.

The challenge to this interpretation of college history has been building up for some time. Intellectual historians like Laurence Veysey (*6*) and Thomas Haskell (*7*) have certainly not viewed the rise of bureaucratic universities and specialized disciplines as the triumph of democracy and rationality, and other recent historians, chiefly David Allmendinger, James Axtell, Jurgen Herbst, James McLachlan, Natalie Naylor, and David Potts (*8–13*), have depicted the antebellum colleges as viable, local institutions. These revisionists have challenged Tewksbury's failure rate as exaggerated, softened the picture of pervasive denominational fervor, denied that small colleges were resistant to science and curricular reform, and called for more systematic research on the backgrounds and careers of 19th-century college students.

Colin Burke's *American Collegiate Populations* pursues these themes and answers the call for research on stu-

dents. Ten years of archival digging and sensitive compilation of data have yielded a profile that strongly supports the revisionist view.

Burke has demolished Tewksbury's figures for college foundings. He surveyed all the states, not just Tewksbury's skewed sample of 16; and he disregarded the many charters granted to institutions that never actually offered instruction. Other experts may come up with slightly different lists, but the basic picture is now clear. There were about 240 colleges operating at some point in the 19th century. The increase in numbers of colleges did not exceed the rate of population growth, and the increased enrollments were part of a general expansion at all levels of education. Moreover, the colleges were quite stable. Over 70 percent survived into the 20th century, and the denominational Protestant colleges experienced fewer failures than state, nondenominational, and Roman Catholic institutions. Despite the limits imposed by small faculties and meager funds, the new colleges were more responsive and diverse in their course offerings than the Whig stereotype suggested. On the other hand, the big institutions that boasted science laboratories and prestigious faculty members paid for reform not only through their endowments but through high tuition charges, often three to four times the average. Modernity's pricetag was elitism.

Turning to enrollment levels, Burke fires another broadside. The Whig historians, taking their cue from Francis Wayland and other antebellum reformers, held that enrollment declines of the 1840's and 1850's resulted from the irrelevance of the traditional classical curriculum. But even among the old New England colleges, Burke demonstrates, those with reformed curricula (Brown, Amherst, and Trinity, for example) experienced sharp declines while others with unreformed curricula (Williams, Dartmouth, and Bowdoin, for example) experienced substantial growth. Meanwhile, conservative Yale attracted more students from other regions than any other New England college.

Exploring regional differences, Burke considers the old view that while reform moved ahead in New England's more progressive colleges, enrollments in the Midwest and South suffered from educational inflexibility. The raw enrollment figures support the stereotype, but Burke reconsiders the data to produce an interesting perspective. He calculates adjusted, expected enrollment levels for each region based upon 1860 New England levels but controlled (through a regression analysis) for a region's per capita wealth, foreign-born population, and college students from other regions. By these adjusted standards, the Midwest actually surpasses New England, and the gap between New England and the South is much narrowed. Although Burke does not propose a new explanation of regional enrollment patterns, he does destroy the "curricular" thesis, and he provides a detailed description that future scholars can ponder.

Burke's discussion of the numbers is very detailed, for two reasons. First, his device of using projected, expected rates of enrollment requires comparisons of actual and hypothetical numbers for each region or state being considered. Second, the regional organization of the discussion requires him to address each issue several times. The South was a distinct region in educational development as in so much else, but for New England, the Mid-Atlantic states, and the Midwest the differences within regions appear more important and predictable than interregional differences. Harvard, Pennsylvania, and Michigan resembled each other more than they resembled the smaller, newer, more rural institutions in their own regions. A college's age, size, and location on a rural-urban continuum predicted more about its students' backgrounds, age spread, and occupational destinations. Burke's regional organization of the discussion seems unnecessarily complex. If this is a flaw, however, it is more stylistic than analytic. This book brings the discussion of enrollments to a new level of sophistication, and the tables are invaluable.

Burke's picture of the students' backgrounds is also complex, occasionally even confusing. Still, there was a general trend. Higher education was expanding in the pre–Civil War decades to accommodate a broader clientele including more rural students and more poor students. The agents of this democratization were not the old colleges and new universities but the small colleges so maligned by earlier historians.

Burke's study of graduates' careers is a vast improvement over the only previous national study, Bailey Burritt's *Professional Distribution of College and University Graduates* (*14*). The ministry, Burke notes, was declining as a career for college graduates in the antebellum period, although the new colleges continued to produce more clergymen than the older urban institutions. Law, medicine, and education were the other major career categories. Burke argues that the failure of higher education to produce very many engineers, scientists, and agronomists had more to do with factors outside the colleges' control than with academic conservatism or inflexibility. Advanced training was a poor investment for occupations where entry requirements were uncontrolled and knowledge was uncodified; higher education itself could absorb only a tiny number of its graduates as teachers. The importance of external factors is one of the important themes of the book. Historians of the professions will benefit from Burke's discussion of the relationships between colleges, occupations, and the larger society.

Finally, Burke assaults the other side of the Whig interpretation: the alleged rise to dominance of the democratic, utilitarian universities. In his discussion of the postbellum period (1860–1900) Burke successfully argues that there was much more continuity with earlier institutions and functions than the Whig historians acknowledged, because the same constraints upon change continued to operate, largely outside the colleges' gates. Most college students of the postbellum period continued to attend small liberal arts colleges, not universities. Historians of higher education need reminding of this fact periodically. Moreover, most students in reformed, diversified institutions chose traditional courses. There was no revolution in higher education. It was still the domain of the Anglo-American middle class. College enrollments increased as a percentage of the population, but the big surge was not until the 1890's, and the absolute levels were still small compared to 20th-century figures. Much of the increase was due to the expansion of normal school and nursing programs for women and to the multiplication of law and medical schools. There was a market for trained doctors, lawyers, teachers, and nurses, but not for degree-holding farmers or scientists. Many applied fields like engineering and accounting had not yet achieved theoretical or procedural consensus. Practitioners improvised; credentials were not essential. In the face of these realities, university reformers turned to an ideology of professionalization and selectivity. Democratization would have to await a market for business majors, civil servants, and computer programmers. The revolution in higher education took place in the 20th century. The enrollment rate, about 4 percent of the 18- to 21-year-old population in 1900, climbed to 48 percent by 1970. It would be very useful if Burke would embark on a 20th-century sequel to this authoritative volume.

American Collegiate Populations vastly improves the numerical record and exposes some of the ahistorical norms of earlier accounts. It is not light reading, but it has many interesting discussions. There is a bit of overkill in the attack on Whig history, and the very end of the book is marred by the mysterious appearance of two tables containing recent student test scores that are not discussed in the text. But these distractions are outweighed by the fact that Burke makes his main points persuasively as the book unfolds. Scholars in a variety of fields will want to read it and know it as a reference work.

Burke's picture of antebellum colleges contributes to the rediscovery in social history of viable, local, voluntary, independent institutions in the early years of the republic. While it would be ahistorical and naïve to claim they are a model for the present, it was equally ahistorical for earlier historians to condemn them as dysfunctional and unprogressive. This book escapes both forms of presentism. In addition to setting the numerical record straight, Burke has added to a mounting reinterpretation of early-19th-century institutions on their own terms.

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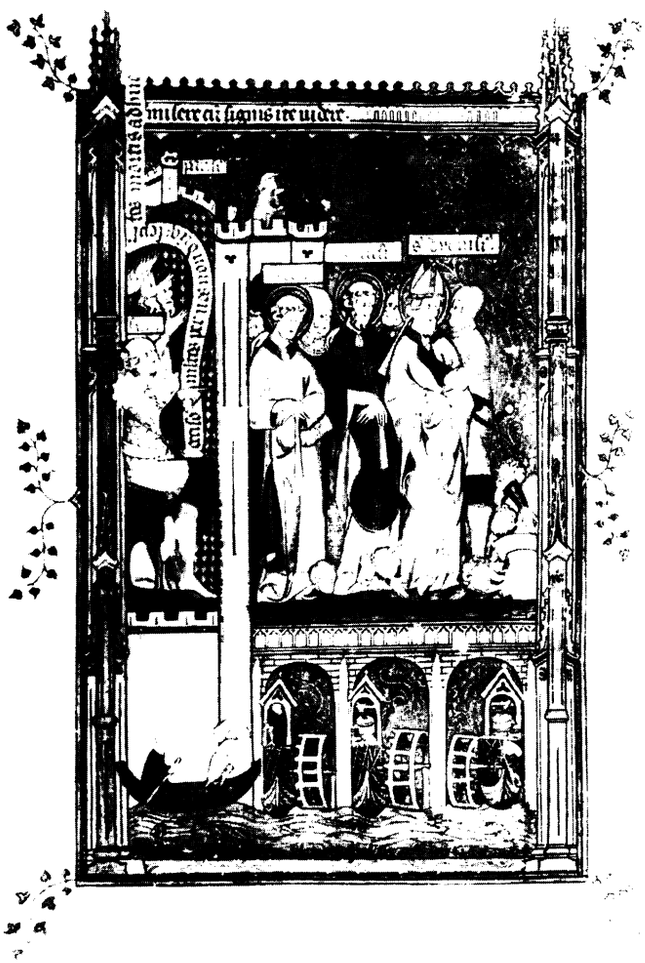
A Power Source in Its Context

Stronger than a Hundred Men. A History of the Vertical Water Wheel. TERRY S. REYNOLDS. Johns Hopkins University Press, Baltimore, 1983. xviii, 454 pp., illus. $35. Johns Hopkins Studies in the History of Technology, new series, no. 7.

The vertical water wheel was one of the most important developments in the history of technology. Terry S. Reynolds traces the ancient origins of this prime mover, or producer of power, and shows how it became the "mainstay" of Western power technology from the medieval period well into the 19th century. His lucid, technically precise, and comprehensive study of this key element in the evolution of Western society is a major scholarly contribution. It is also an extremely interesting and readable book that should appeal to anyone with an interest in energy, machinery, or innovation.

Reynolds is not one of the technological determinists who believe that energy usage is the one key factor in establishing the level of culture. He makes only the most reasonable claims for the role of energy and for the influence of the vertical water wheel. This particular prime mover had a tremendous effect on social and economic development, but Reynolds takes care to recognize the complex nature of culture and the diversity of forces that shape it. The vertical water wheel did reduce the amount of labor involved in many technical processes. It often allowed great increases in industrial productivity, and it made possible things that could not be done with existing power sources.

In order to explain the development and diffusion of the vertical water wheel, Reynolds has had to delve into such sujbects as geography, feudalism, monasticism, urbanization, technological



"Bridge mills under the Grand Pont in Paris, from a French manuscript of 1317." [Bibliothèque Nationale, MS franç 2092, fol. 37v, reprinted in *Stronger than a Hundred Men* from H. M. R. Martin, *Légende de Saint Denis* (Champion, Paris, 1908), courtesy of Honoré Champion and the Bibliothèque Nationale]