AC 2010-724: ENGINEERING 'MANPOWER' SHORTAGES, REGIONAL ECONOMIC DEVELOPMENT, AND THE 1960 CALIFORNIA MASTER PLAN FOR HIGHER EDUCATION: HISTORICAL LESSONS ON ENGINEERING WORKFORCE DEVELOPMENT

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Engineering 'Manpower' Shortages, Regional Economic Development, and the 1960 California Master Plan for Higher Education: Historical Lessons on Engineering Workforce Development

As demonstrated by accounts such as Thomas Friedman's The World is Flat[1] and the Engineer of 2020 investigations by the National Academy of Engineering,[2] engineering educators are once again focusing on necessary changes to our national engineering workforce. If there ever were an opportunity draw useful lessons from history, it would surely be on this topic. Concerns about an "engineering manpower" crisis persisted throughout the Cold War years in American history, fueled by massive federal expenditures and the emphasis placed on science and its application to the nation's arsenal and economic wealth. Even as we proceed to transform, if not dismantle, the institutional apparatus developed to meet the exigencies of the Cold War period, it may well pay to look at the original architects who transformed the American system of higher education in their efforts to deliver upon the new demands for a technically trained workforce.[3]

As drawn from a larger book project, this paper aims to provide new historical insights by looking at how the engineering 'manpower' crisis of the 1950s contributed to the 1960 Master Plan for Higher Education in California, and how the Master Plan, in turn, shaped engineering education within the state.[4] The California public system of higher education was already set up as a relatively novel, tripartite system that created separate estates for junior colleges, state colleges, and the University of California system. However, as documented by California historians such as Roger Lotchin,[5] the massive expansion of Southern California's defense sector, along with demographic shifts in the college-going population, made questions of technical workforce development a major issue in California's political scene. This regional development also intersected with ongoing national dialogues about engineering education and engineering manpower shortages, which although exacerbated and politically amplified by Sputnik, pre-dated the specific crisis.

At the heart of this paper will be a close examination of the precise extent to which technical workforce issues shaped the overall political discourse leading up to the 1960 Master Plan for Higher Education in California. Given the legislative, and indeed constitutional stature granted to the University of California, much of the debate over California's Master Plan occurred within the halls of political institutions, including the State Board of Education, which prior to the Master Plan had direct responsibility over the State College system.[6] However, the burgeoning defense industry employment in Southern California, along with new enrollments in Santa Clara in the soon-to-be-called "Silicon Valley" upset the tri-partite balance by creating unique demands for technical training especially at the master's level.[7] Clearly, the overall terms of the California Master Plan were shaped by the baby boom, along with various calls for "democratizing" higher education. The resulting system, which vastly expanded California's system of junior colleges in order to contain the costs of higher education while simultaneously providing students with a chance to seek a better vocation or to gain a second chance to enter a baccalaureate program, were clearly the product of such broader political and demographic pressures.

Yet, it was no accident that two of the most vocal advocates for reform, the state college presidents Malcolm Love from San Diego State and John Wahlquist from San Jose State, were from the two regions most affected by new technical workforce demands. Nor was it coincidental that technical training in the Junior Colleges mapped onto a national dialogue initiated by ASEE (and extending as far back as the Wickenden Investigations of 1923-29[8]), which called for a vast expansion in technical institute-type training. Crucial to this story will also be the efforts of Llewellyn M. K. Boelter, the founding Dean of Engineering at UCLA. Sitting at the heart of Southern California's defense industry, Boelter broke new ground by creating a unified, science-based engineering curriculum as well as a novel non-residential system of graduate instruction that supported Southern California's expanding engineering workforce. Especially in considering the audience for this paper—engineering educators and administrators who make up the ASEE—this paper will place special emphasis on Boelter and his fate.

The overall structure of this paper is based on what anthropologists would call a multi-site, multi-scale analysis.[9] This approach is based on the idea that modern, complex institutions cannot be understood through a close study of any single site, or any particular scale of analysis. Thus, it was not the State Legislature or the University of California President's Office, nor Boelter and his faculty at UCLA that determined the course of California's postsecondary educational institutions. Nor were these institutions built through the simple aggregation of these efforts. Rather, it was the extensive interaction between these and other constitutive organizations that defined the field of opportunities for remaking the California system of higher education. Through the course the following, interwoven narrative, it will become evident how the effort to develop a coherent occupational hierarchy in engineering served to articulate and stabilize the tripartite structure of California's higher education institutions, which in turn defined the direction and content of engineering programs within the state.

The Development of Engineering at UCLA

By the late 1940s, engineering recruitment advertisements, similar to the one reproduced on this page, could be found in any popular technical journal or magazine such as Aviation Week and Scientific American. Following the brief lull at the end of the war, the Southern California aviation industry rebounded during the latter part of the 1940s, driven by Cold War tensions and the emergence of advanced new strategic weapons systems. Still but a relatively minor industry during the interwar period, one stunted by the Great Depression, it was the massive scale of war production, and then Cold War research, development, and production that brought the aviation industry into full fruition. In the process, this industry catapulted Southern California's economy past its traditional base in agriculture and natural resources-based extractive industries. This meant that


Lockheed
California Calling engineers

There's a better life waiting for you and your family in Southern California—at Lockheed. Here, in beautiful, sun-swept San Fernando Valley, you find living and working conditions beyond compare.

So why not enjoy both your work and your life in Southern California? Lockheed's long-range production program has created many new openings. Engineers are needed immediately on commercial and military aircraft.

What's more, higher salary rates are now in effect. Lockheed also offers generous travel allowances to those who qualify. Full pay if additional training necessary.

Positions now open include:
Electronics Engineers
Aircraft Design Engineers
Stress Engineers and Analysts
Production Design Engineers
Engineering Technical Writers
Flight Manuals Engineers
Aircraft Equipment Engineers

Send today for free illustrated booklet, describing the wonderful living and working conditions at Lockheed in Southern California. Use handy coupon below.

Mr. John Hare
Salary Supervisor
Lockheed Aircraft Corporation
Burbank, California

Please send me your free illustrated booklet describing *the better* living and working conditions at Lockheed.

Name
Street Address
City and State

LOCKHEED
AIRCRAFT CORPORATION

Figure 1. Lockheed advertisement, Scientific American (May 1951). Reproduced, Courtesy Lockheed Martin Corporation. The advertising copy reads, in part:

> "There's a better life waiting for you and your family in Southern California—at Lockheed. Here, in beautiful, sun-swept San Fernando Valley, you find living and working conditions beyond compare. So why not enjoy both your work and your life in Southern California. … higher salary rates are now in effect. Lockheed also offers generous travel allowances to those who qualify. Full pay if additional training necessary."

engineering, and the university system as a whole remained relatively underdeveloped in Southern California. The University of California at Los Angeles, as it was called at the time, gained the right to award PhDs only in 1933; more importantly, UCLA had no Engineering Department before World War II. This meant that during the early postwar period, professional recruitment by California's aviation firms necessarily occurred on a national scale. The very field of industrial recruiting came to maturity in the context of Southern California's booming postwar aviation industry.[10]

Boelter was among those who responded opportunistically to the economic transformation of Southern California. Born in Winona, Minnesota in 1898, Boelter received his bachelor's degree in mechanics and his master's degree in electrical engineering from the University of California. Staying on at the university, Boelter became recognized for his analytical approach to heat transfer problems while working in a College whose growing reputation was tied to the development of California's infrastructure. Boelter rose to the position of Associate Dean by 1943. The earliest proposal to offer an engineering curriculum at the Los Angeles campus dated back to 1937, but it was only in the context of war preparedness that the University of California Regents finally authorized an engineering degree program in 1941, initially in industrial technology. It was through direct legislative intervention, as backed by a special appropriation as well as through the vocal support of a UCLA alumni organization, that UC President Robert Gordon Sproul was compelled to open a new College of Engineering at UCLA in 1944. Involved in the planning process, Boelter placed himself in the candidate pool for the deanship.[11]

Boelter is generally credited with pioneering a unified engineering curriculum. However, the statements made by Boelter during the planning process, as well as by the dean of engineering at Berkeley, Morrough P. O'Brien, and their other departmental colleagues, reveal that this group's ideas were mainly an extension of a national dialogue that could be traced back to ASEE, and its precursor, the Society for the Promotion of Engineering Education. Indeed, the idea of focusing on science and fundamentals could be found in the earliest, 1918 Mann Report, if not in the origins of SPEE itself. The issue received renewed emphasis during the 1923-29 Wickenden Investigations, and SPEE's most recent, 1940 Hammond Report specifically called for pushing most specialized training into the postgraduate years.[12] Still, what remained a difficult change for an established college was significantly easier to accomplish in a school built from scratch. It also helped that aviation firms, for technical reasons[13] as well as for reasons of a desperate labor market, were willing to hire any and all engineers and offer them specialized training at "full pay" on company time, as stated in the Lockheed ad. There was also the explicit expectation that Boelter would develop a program complementary to the one at Berkeley. Finally, Boelter had no choice but to begin with a single, unified curriculum. With but a limited appropriation, which provided no money for new buildings, Boelter opened the doors to his college in August 1945 with a small handful of faculty and but 25 students. During its first few years, the engineering faculty operated out of classrooms and laboratory spaces borrowed from across UCLA's still limited campus.[14]

The postwar enrollment boom, and the special interest that students expressed in technical subjects, ensured that Boelter would receive the appropriations necessary for expanding his faculty and facilities. However, in terms of the College's early postwar growth, a more rapid, and exciting expansion occurred in the area of off-campus graduate instruction.

From the standpoint of the industrial recruiters, who were given the resources to draw from a national labor pool, there was little to be gained from favoring the graduates of an underdeveloped and untested engineering program. Where industry executives and recruiters turned more eagerly to Boelter was in the area of continuing education. Many a young engineer had been lured to Southern California by defense industry salaries, and in so doing, they had forgone the option of attending graduate school. However, given the wartime contributions of science, and the contract structures of a hypercompetitive defense industry that created strong incentives for firms to demonstrate advanced research and design capabilities, specialized training at the graduate level became the accepted gold standard for professional advancement. Here, there was a young workforce, many of whom had yet to form a family, who held clear expectations about their upward social mobility. A longstanding vision for ASEE, the principle of lifelong learning now played into the actual incentives of a major segment of the workforce, as backed by employers willing to pay for the continuing education of their employees.[15]

The earliest arrangement was with a federal facility, the Navy Electronics Laboratory at China Lake. The Dean of Los Angeles' Graduate Division, Vern Knudsen, approved the arrangement as a unique opportunity for Boelter's faculty to become affiliated with an area of engineering in which it had little strength. But soon, Boelter forged similar arrangements with private corporations located not only in Los Angeles, but in San Diego, even as he expanded his on-campus graduate Extension offerings. In most cases, Boelter hired research scientists and engineers from participating firms and labs as adjunct instructors, who in turn taught their own staff members—and whomever else happened to enroll—in facilities provided by their own employers. The Southern Section of the Academic Senate' Graduate Council approved the arrangement—they were then more flexible than the Northern Section, which oversaw the academic programs at Berkeley—based on Boelter's arguments about credentials. Many of these adjunct instructors had highly specialized knowledge in areas not covered by the university; most also held a PhD at a time when the engineering faculty at UCLA and elsewhere, including Boelter himself, had no PhD. The Council had insisted that Boelter offer the courses through University Extension. But as reported to Sproul by the Registrar, when it became an issue that the Graduate Council would not permit graduate extension work to count towards an advanced degree, "[we] devised the scheme of requiring the prospective student in these courses to file an application for regular graduate status in the University and registering them, through the agency of an Extension representative, as regular students on the Los Angeles campus." At its peak during the mid 1950s, Boelter's college had some 500 graduate students and 300 courses listed in its catalog (many co-listed through university extension), not including unlisted topics courses.[16]

Boelter's entrepreneurial zeal can be found in other aspects of the College's early history. More predictably, he encouraged his faculty to obtain research contracts from industrial organizations as well as the State of California and the federal government. These research projects ranged from aircraft heat transfer, to cargo handling, to artificial limbs. In addition to these standard contracts, Boelter inaugurated a "Service to Industry" program, where much smaller contracts, generally under $5,000 due to university accounting regulations, gave the region's smaller scientific and engineering firms access to the scientific instruments, laboratories, and testing facilities assembled by the college. Later, in 1955, Boelter also developed an Engineering Executive Program in offering the professional Master of Engineering degree to mid-career

engineers ready to step into the executive ranks. Boelter described all his efforts, including a lecture series, in a periodic "News-Letter." He also laid out his department's work in an elegantly bound Annual Summary.[17] In mid 1947, O'Brien briefly stepped down from his position as Dean of Engineering at Berkeley. During the search for his successor, Baldwin Woods, the Vice President for University Extension, wrote this about Boelter:

> Usually regarded as one of the most challenging spirits in the educational world. In my opinion, he is doing the job best suited to him at Los Angeles and should on no account be moved, unless he wants to and believes that he should. … The structure he is building at Los Angeles is original, advanced, and challenging. Only he can carry it through. I recommend increased authority to him in his work there and a vote of confidence. He might serve as joint dean for both colleges, but I fear the effects on his health and morale.[18]

Ascent of the California State Colleges

Today we may think of California State University, with its 450,000 students, as the largest university system in the United States, whose "high-quality, accessible, student-focused" approach to education lives up to the tripartite division asserted by the 1960 Master Plan.[19] However, during the immediate postwar period, the California State Colleges remained, in large measure, a teacher's college overseen by the State Department of Education, and geographically dispersed across the state specifically to serve the regional demand for teachers in the state's elementary and secondary schools. In 1946, the seven largest campuses had only between 600 and 4,000 students each, each one headed by a president whose stature in no way measured up to that of the president of the University of California.[20]

As told by John Aubrey Douglass, Sproul was nevertheless aware of the potential for the postwar growth of the state colleges. Sproul had in fact made an attempt, during the 1930s and early 40s, to absorb the state college system, but was rebuffed by the State Legislature, and by his own faculty and Board of Regents, in part. After the postwar return to normalcy, Sproul shifted his strategy to that of working with State Department of Education officials in attempting to establish a clear functional differentiation among the different segments of higher education. Influenced by the prevailing management and organization movement that placed a premium on efficiency and eliminating any needless duplication of effort, the resulting 1948 Strayer Report provided the first significant articulation of the tripartite division in California's system of higher education. As interpreted through subsequent administrative and legislative actions, the junior colleges were understood to be responsible for offering "vocational" training via two-year terminal degrees as well as preparing students to move on to a four year college. State colleges were authorized to offer a "wide variety" of bachelor's degrees in "occupational" fields, as well as master's degrees in teaching related fields. The University of California, meanwhile, was given exclusive domain over "professional" education, and for research and scholarly endeavors including all graduate work towards the PhD. Based on a review of the actual degree programs offered by the state colleges and the University of California, the Strayer Report reworked the traditional, binary distinction between vocation and profession. Its endorsement of a tripartite division was based on the committee's conviction that there existed a separate "occupational level for which the state colleges are offering training," one that lay between the "two-year

training of the junior colleges and the professional schools of the University."[21] The Strayer Report's conclusions produced, for the moment, a sense of consensus on how to conduct the different segments of higher education. While a Liaison Committee that reported to the University of California and the State Department of Education existed since 1945, the Strayer Report also gave this committee legitimacy and purpose, namely that of maintaining the agreement.[22]

However, Boelter was not the only individual, nor the University of California the only institution to respond opportunistically to California's postwar demands for an augmented workforce. Malcolm Love arrived to San Diego State having already served as the president of the University of Nevada, specifically because he felt there were greater opportunities and challenges in Southern California. Upon arriving there in 1952, Love set out to expand the schools' curricular programs: While staying in line with the Strayer report, he sought specifically to support the new workforce demands from the region's heavy industries and associated businesses. Changes at San Jose State College were more gradual by comparison. Insofar as it was the oldest and largest of the state colleges, it already had a more diversified set of degree programs. Nevertheless, as Frederick Terman's efforts as Dean of Engineering at Stanford began bearing fruit by spawning a regional military electronics industry, San Jose, under John Wahlquist, proceeded to develop and expand its engineering offerings in support of this new industry.[23]

Indeed the entire group of CSC presidents was an opportunistic lot. Like Love, many had been recruited during the postwar period, either to head up a new campus or to replace a predecessor due to the increased administrative turnover of the postwar period. Many, including Love and Wahlquist, both of whom began their presidency in 1952, arrived after the Strayer Report and were initially less than completely familiar with its strictures. Many were eager to support regional interests, and responded favorably to any faculty member with the energy and initiative to launch a new degree program. State legislators, meanwhile, were all too happy to endorse such initiatives, insofar as it benefited their local constituencies.[24]

In order to help plan the growth of the state colleges, the state college presidents began placing greater emphasis on their monthly meetings as the Council of State College Presidents. In principle, the state colleges were administered by the Department of Education and its Division of State Colleges and Teacher Education, as overseen by the State Board of Education. However, the Board's primary focus remained the state's primary and secondary schools, this being a highly politicized issue amidst California's demographic explosion. In large measure, the Board continued to look at state colleges as teacher training schools. Those within the Department of Education, including Superintendent of Public Instruction, Roy Simpson, had broader aspirations. But Burton Vasche, the chief of the Division of State Colleges and Teacher Education, was given neither the staff nor the stature to compete with the UC President's office. Indeed, in the absence of any strong central administration for the state college system, the Council of State College Presidents began serving as the executive body responsible for state college operations. By 1954, the minutes of the Council began routinely to note that "the meeting" ordered its members to execute a specific decision, whether this was to complete a questionnaire distributed by the California Taxpayer's Association, or to present new master's

degree proposals before the Council. The Council also served as the default curriculum committee for the state colleges.[25]

The Crisis in California Higher Education

The standing historical interpretation, as provided by Douglass, is absolutely correct in that the crisis during the 1950s in California higher education was driven by broad demographic trends. The postwar baby boom and internal migration into California, along with renewed postwar expectations for social mobility, translated into an exponential growth in the demand for higher education. California's defense industries contributed to the shift, especially with respect to more widespread professional aspirations, but the occupational growth that drove the changes in the state's educational system was much more broadly based. At the same time, politics often requires a spark to ignite the tinder; and as Douglass himself has noted, though without complete articulation, engineering was a crucial topic, a "wedge issue" that broke open the debate. How exactly engineering did this is explored through a study of several key episodes.[26]

-The 1953 Engineering Agreement-

Indeed, it was the state colleges' engineering offerings that initially broke the truce established by the Strayer Report. There was also, in this instance, a problem of nomenclature, one that played into the longstanding professional ambiguity of engineering. The Strayer Report had stipulated that professional training was the exclusive domain of the University of California, but Engineering, which was broadly recognized as a profession, also remained wedded to a four-year undergraduate model for which the state colleges were given definite responsibilities. UC officials began to suspect encroachment around 1952.[27] In order to mount a defense, the State College presidents organized an Engineering Committee chaired by none other than Frederick Terman from Stanford. Terman's report, delivered later that year, declared in no uncertain terms that there was no duplication between the two programs. Working off of the language of the Strayer Report, Terman's committee concluded that "It is the level between the technical training of the junior college and the professional and research department of the university towards which the occupational curricula of the state colleges is pointed."[28] Furthermore, given the present severity of engineering manpower shortages—the report was issued in the middle of the Korean War—the committee declared that it was imperative for the State to give immediate support to the state college engineering programs.

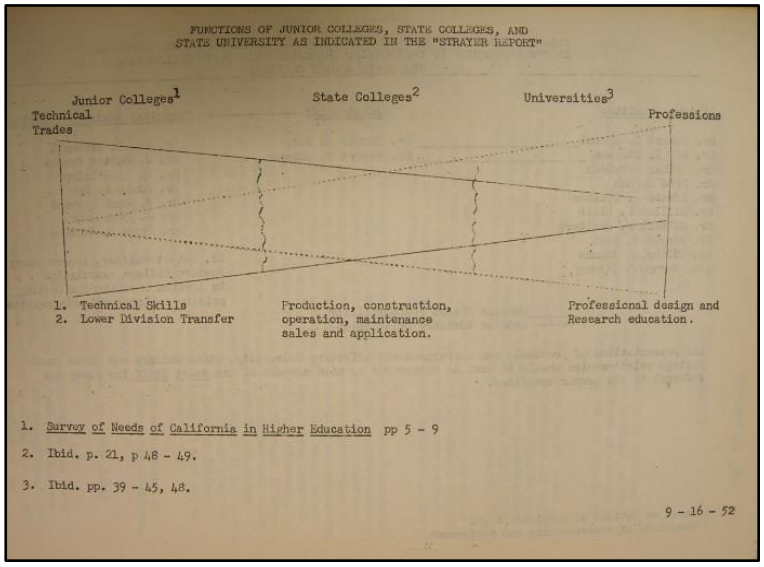

Figure 2. Superimposition of ECPD and ASEE dialogue about engineering occupational and professional classification onto the tripartite structure of the Strayer Report.

As captured in an illustration produced by the Department of Education based on Terman's report (fig. 2), Terman also drew on a national conversation within ASEE as well as the Engineers' Council for Professional Development's

Committee on Engineering Schools, to which Terman—and Boelter—belonged.[29] (ECPD was the precursor to ABET.) At the time, ECPD was concerned about the threat to professional standards posed by the proliferation of engineering specializations and so-called new "fringe" disciplines—fields such as agricultural engineering, engineering physics, and engineering management.[30] At ECPD's request, ASEE had just launched a thorough-going review of curricular standards, the outcome of which would be the 1955 Grinter Report.[31] In 1952, the conversations leading up to this report generated renewed interest in the functional differentiation of engineering curricula, with one branch devoted to areas such as production, construction, maintenance, and operations, and another focused more on research, product development, and engineering design.[32] This was almost exactly the language reproduced in Terman's report. As accompanied, then, with earlier calls for expanding technician training, this division mapped readily onto California's tripartite system of higher education.[33]

At the request of the State College Presidents, Superintendent Simpson brought the general issue, along with Terman's report, before the Liaison Committee of the University of California and State Department of Education. The Liaison Committee passed the issue onto its "Joint Staff," as represented, respectively, by educational specialists, T. C. Holy and Hubert Semans. Given that the state colleges had already developed substantial degree programs in engineering, what was on the table was not any curtailment of these programs, but meaningful restrictions designed to ensure that the state college programs remained "occupational" rather than "professional" in character. After consulting with a new Technical Advisory Committee created by the Liaison Committee that included O'Brien, Holy and Semans asked each institution to compile a list of the "distinguishing characteristics" of their existing programs, as based on an assessment of the program's objectives, instructional emphasis, faculty, facilities, admissions requirements, graduation requirements, and accreditation status. Holy and Semans then compiled a side-by-side comparison of the state college and University of California's engineering degree programs. Noting significant differences in the stated characteristics (and thus confirming the Terman committee's more general assessment), Holy and Semans recommended that the Board of Education take specific measures to ensure that such differences were sustained.[34]

Specifically, they recommended that engineering programs at the state colleges a) continue to uphold their heavier general education requirements, b) maintain all instruction at the undergraduate level, c) develop their staff and facilities in support of undergraduate education, not research, d) ensure that any further expansion of the state colleges' engineering programs be tied to "long-term opportunities for employment" (i.e. projected labor market requirements), and e) develop no programs to meet ECPD accreditation criteria, nor seek such accreditation. At the time, discussions in preparation for ASEE's 1955 Grinter Report, which were expected to serve as the basis for new ECPD accreditation criteria, suggested that faculty research would be an important criteria for accreditation. The notion of "professional" accreditation, as embedded in the name of the accrediting organization (again, Engineers' Council for Professional Development), also clashed with the occupational versus professional focus intended for the state colleges. Holy and Semans also recommended that the University of California focus, albeit not exclusively, on upper division and graduate instruction, and to accept a larger number of junior college and state college transfer students as a means of augmenting its capacity for producing the most highly trained engineering graduates. As approved by the Liaison Committee and the two respective boards, this became the 1953 Engineering Agreement.[35]

-Master's Degrees and the 1955 Restudy-

The most significant outcome of the 1953 Engineering Agreement, from the standpoint of the larger politics of California higher education, was that it restored the principle of functional differentiation. Those involved with the process fully understood that solving the engineering issue would provide a template for creating meaningful distinctions in other occupational areas. The agreement also demonstrated that meaningful criteria for differentiation could be built through a close study of the state colleges' and University of California's actual degree programs. But this was also a procedure that could invite conflict.

Back in 1949, following the recommendations of the Strayer Report, the State Legislature passed a bill authorizing state colleges to offer master's degrees. Strayer's intent had been to allow master's degrees in teaching-related fields only—the master's had come to play a necessary part in the politics of teacher certification—but the law, as passed, placed no such restriction on what kind of master's could be offered by the state colleges. In recognizing the intent behind the law, Simpson instructed the state college presidents to initiate master's programs only in teaching-related fields, but this still left a legal ambiguity.[36] Given that the discussions over the Engineering Agreement produced a more clear demarcation between what constituted an occupation versus a profession, the state college presidents began to discuss in earnest master's degrees in other, "occupational" fields. Specifically, the state colleges began considering fields such as business, public administration, and even nursing and public health, where they already offered four year degrees, but for which four years of training no longer seemed entirely adequate. In their view, these fields were clearly distinct from the true professions, meaning law and medicine, which remained the acknowledged domain of the University of California; expansion into these areas involved no research component and could be done through further practical training. California's growth had augmented workforce demands in these and other areas, and the University of California had not expanded their graduate programs sufficiently to meet this growing demand. Engineering was specifically excluded from this discussion because of the 1953 agreement, but the problem of curricular compaction in engineering, and the associated conversations about a necessary fifth year of training irrespective of whether this led to professional recognition or certification, contributed to the broader dialogue.[37]

Holy and Semans proceeded once again to compile a side-by-side comparison of the distinguishing characteristics of the master's programs sought or offered by the state colleges and the University, working once again with the Technical Advisory Committee.[38] While the movement in this direction could be seen as continued opportunism on the part of the state college presidents, they had been quite earnest, at least until this point, in their desire to uphold the Strayer Report. From their point of view, they were simply trying to serve regional workforce demands, as backed by student interest as well as the initiatives of their faculty. Still, even Semans became wary of the apparent slippage in the state college presidents' position, and decided to press them on a number of "assumptions" before he disclosed what he hoped to present before the TAC. Specifically, he required the state college presidents to affirm that they were still committed to the differentiation of function defined in the Strayer Report, to confirm that they were only seeking to offer graduate work as an extension of occupationally centered curricula, and to verify that they therefore expected the characteristics of a state college master's degree to be truly different from those offered by the University of California. Having secured the presidents' assent to each assumption, Semans reported how the University representatives to

the TAC had already conceded that there may well be a need for five year programs in certain occupational fields, and that graduate instruction in these fields would be permissible.[39]

The only point on which the TAC could not reach agreement was whether such a degree could be called a master's degree. From the University's point of view, if there was no research component, the degree could not be called a master's degree. From the point of view of the state college representatives, if the degree was not called a master's degree, it carried little status, and therefore impacted recruiting and the viability of such a degree program. Holy and Semans recommended a compromise, suggesting that the state colleges be allowed to use the word "Master" as in "Master of Public Administration" or "Master of Business," but not the traditional Master of Science or Master of Arts degrees. UC administrators remained uneasy about this compromise, viewing it as contributing to the further degradation of the master's degree. They preferred instead that the state colleges offer some kind of occupational certification. George Robbins, the Dean of the School of Business Administration at UCLA, also complained of the direct assault on the status of his own MBA program, noting, quite frankly, that "the state colleges are not very much concerned with the quality of the work, as we are. They are interested in numbers and in 'trading up.'"[40]

Given the reticence on the part of UC officials, the state college presidents withdrew their support, noting in a 7 May 1954 resolution that the limitations recommended by the TAC "will bind the state colleges to commitments which they should not be required to make in light of present legislation granting them authority to offer master's degrees, and which may retard unduly and unnecessarily the proper development of the colleges in their responsibilities for serving the needs of the present students and the projected enrollments in the colleges."[41] Love, in particular, was angered by the University of California officials' rebuke, and proposed that the Council of State College Presidents, in their capacity as a curriculum committee, simply approve new master's programs proposed by any of the member colleges at its May 1954 meeting.[42]

The impasse over the master's was addressed in the 1955 Restudy of the Needs for California in Higher Education, although here in particular it was the broader, demographic issues that forced this study to occur. Finding little evidence of an economy of scale in higher education in institutions beyond a certain size, the Strayer Report had stipulated an upper limit to the size of the state colleges and UC campuses, citing quality of instruction. However, being the first report of its sort, Strayer's committee underestimated actual enrollment growth, especially on certain campuses. San Jose State, in particular, had already reached an enrollment of 7,400 students by 1955, as against its stipulated ceiling of 6,000 students, making it difficult for Wahlquist to secure the necessary appropriations to run his college. Other state colleges saw themselves in the same position a year or two down the line. The 1955 restudy, which relied heavily on financial metrics, reversed the Strayer Report's findings, supposedly demonstrating that economies of scale did operate in higher education. As a result, the study recommended relaxing enrollment ceilings, this being a less expensive way to expand enrollment. While legislators, as driven by anxious parents eager to ensure that their children would have a nearby college to attend when they came of age (dormitories, at the time, were still rare), refused to be bound by the agreement, the 1955 Restudy insisted that all proposals for new campuses be subject to the review of the Liaison Committee and be approved by both governing boards.[43]

With respect to the higher occupations and the Master's degree, the 1955 Restudy specifically assessed the validity of a differentiation of functions in selected fields—public administration, business administration, home economics, nursing, teacher education, and social work—with the 1953 engineering agreement continuing to serve as the governing model. The 1955 Restudy wound up endorsing the 1954 Joint Staff recommendations, and in fact went considerably further. They recommended that the state colleges be allowed to offer master's degrees not only in occupational fields, but in liberal arts fields once they acquired adequate faculty capabilities in a discipline. They clearly favored regional economic development and fiscal efficiency over an unenforceable and presently unenforced standard for the master's degree. The Restudy also recommended placing the decision squarely within the hands of the Board of Education rather than any voluntary coordinating mechanism.[44]

-Off Campus Graduate Programs and Engineering Accreditation-

The next, more involved crisis revolved around off-campus graduate programs and unresolved issues having to do with engineering accreditation. Boelter was directly involved in this controversy.

Given the success of Boelter's off-campus programs, private firms and public laboratories located elsewhere in the state (and even in Los Alamos, New Mexico) began asking for off-campus graduate instruction offered by the University of California. Boelter encouraged O'Brien to pick up the requests that originated in Northern California, which included requests from Sacramento and San Jose, but O'Brien, who subscribed firmly to a research and applied science model, was not eager to devote his energies in this direction. Nor did the rules of the Northern Section of the Senate's Graduate Council's allow the same arrangement, for it stipulated a 50% residency requirement for all graduate degrees. O'Brien, on the other hand, was willing to let Boelter do the job, and so the two deans submitted a joint proposal to the Southern Section of the Graduate Council for the UCLA College of Engineering to run graduate extensions programs throughout the state. While voicing support for the arrangement in general, the Southern Section passed the decision up to Sproul, ruling that this was outside their jurisdiction. Boelter sent an urgent note to Sproul labeled, "action desired," which asked Sproul to place all of UCLA Engineering's off-campus graduate programs under the fiscal jurisdiction of University Extension, and to give him the authority to grant M.S. degrees at any location in California. However, with concerns about the quality of graduate instruction already in the foreground, Sproul delayed his decision, drawing O'Brien, the Dean of the Graduate Division, and the Northern Section of the Graduate Council into the discussions.[45]

The interest in San Jose resulted from the maturation of Terman's efforts at Stanford. It was firms such as Westinghouse, General Electric, and IBM, all of which had opened research and development facilities in San Jose that made the request. And while Terman was uninterested in offering graduate extension programs out of Stanford, for reasons similar to those offered by O'Brien, he was willing to redirect these firms to Wahlquist and his growing engineering faculty at San Jose State. However, the 1953 engineering agreement prevented a move in this direction.[46]

Meanwhile, parallel to this conversation was renewed concern over the undergraduate engineering program at the state colleges, this time over the issue of accreditation. Back in the late 1940s, the California State Board of Registration for Civil and Professional Engineers

decided to accept ECPD accredited programs as being equivalent to four of the six years of experience required for professional registration. This clearly placed state college graduates at a disadvantage within a market that was arguably more important for them. The Board of Registration subsequently granted two years of recognition to all state college programs (in fact, they had been compelled to do so by legislative action). But insofar as the state colleges failed to gain further ground during the 1953 engineering agreement, those who graduated from the state colleges continued to view this as an unfair situation.[47]

Compounding matters, the actual versus self-declared comparison of the state college engineering degree programs revealed little in the way of basic differences with the UC Berkeley engineering curriculum. Both had followed national trends, as reiterated in (if also reviled in many of the responses to) the 1955 Grinter Report, which had emphasized that fundamentals, and more importantly, the engineering sciences were necessary subjects for all engineers. State college engineering faculty, and their department heads, also faced a situation similar to Boelter's initial quandary at UCLA. Given their limited faculty, and limited facilities resulting from the imposed prohibition against research, state college faculty was predisposed to offer more general training in engineering, even in their traditional disciplinary based programs.[48]

Frustrated with both developments, Wahlquist approached Santa Clara's state legislative representative, Bruce Allen. While traditionally an ally of the University of California, Allen felt compelled in this instance to defend his constituency. After learning the details, Allen fired off an angry letter to Sproul. Allen argued that despite the clear growth in the demand for a more skilled workforce, the University of California was requiring the state colleges "to keep their engineering departments at a second level," even as it was "failing to meet its public responsibility if it is cutting down on the undergraduate education of engineers."[49] Sputnik also occurred in the midst of this exchange. Allen proceeded to arrange for the State Assembly's Education Committee to meet on the San Jose State campus. As noted by an observer from the University of California's Engineering Extension, "what began as a request for ECPD accreditation and graduate engineering at San Jose State College turned into a general plea by most State College representatives for complete freedom for State Colleges to develop whatever fields and to whatever extent necessary to meet regional needs."[50]

Allen also wrote to Sproul, shortly after Sputnik, that "I feel very strongly that the joint policy of March 10, 1953 is contrary to the public interest in California and also contrary to what should be our national policy."[51] Indeed, the immediate outcome of the dispute was a decision to reopen the 1953 Engineering Agreement. However, in this instance, the legislature also took the matter into their own hands by passing Assembly Bill No. 1 during the 1958 First Extraordinary Session, which granted state colleges the right to offer master's degrees in engineering, science, and mathematics. The Senate also passed a concurrent resolution, SCR 52, which authorized the state colleges to seek limited accreditation in engineering.[52] (Subsequently, the Liaison Committee's 1958 review of the engineering agreement recommended, and the respective boards granted state colleges the right to seek full ECPD accreditation after correspondence with the current ECPD president confirmed that, in actual practice, they found it necessary to recognize four year undergraduate engineering programs whose faculty were not actively engaged in research.[53])

But the broader consequence of this latest disagreement was that it exposed higher education officials, in both systems, to the direct scrutiny of state legislators. Certainly there were already highly public disagreements between the state colleges and the University of California, especially over the question of budgets and new campuses, but here the legislators had to acknowledge that their own actions had contributed to the dispute. However, the disagreement over the master's degree and over engineering accreditation was a disagreement over academic content and jurisdiction to which the legislators played no part. It also threatened the core principle of functional differentiation by suggesting that such deals could be fragile. Perhaps as important, it revealed an irreconcilable difference between the goals of the University of California, which sought excellence in research, and the goals of state college representatives (and legislators), who sought to serve regional interests by responding to the actual and immediate demands of California's growing regional economies. Far from ensuring efficient coordination, the endless squabbles seemed to produce not only needless duplication, but unnecessary restraints and gross inefficiencies in California's system of higher education. The acrimony surrounding this dispute invited direct interventions from the Assembly Education Committee, which led to the Assembly Concurrent Resolution, ACR 88, which required the Board of Education and the Regents to develop the Master Plan for Higher Education in California.[54]

The Master Plan and Its Aftermath

The Master Plan negotiations themselves are beyond the scope of this paper. As carefully researched and told by John Aubrey Douglass, the Master Plan represented one last opportunity for the state colleges and the University of California to redefine a meaningful tripartite division, one that struck a politically defensible and sustainable balance between the University of California's research aspirations and the California State College presidents' desire to meet regional workforce demands while also building up a strong academic institution. It was in the interest of both parties to settle their differences, lest both systems wind up with a system of governance vulnerable to the winds of legislative opinion.[55]

Table 1. Successive Enrollment Figures & Projections for California Public Institutions for Higher Education

	1947	1953	1958/60	1965	1970	1975
Strayer (1948)	(actual)		(est.-'60)			
Univ. California	42,667	-	49,151	59,740	-	-
State Colleges	19,281		38,505	46,800		
Junior Colleges	60,346		84,716	102,966		
Restudy (1955)*		(actual)	(est.-'58)			
Univ. California		32,700	39,100	57,400	-	-
State Colleges		25,300	41,700	72,300		
Junior Colleges		48,700	67,200	104,500		
Master Plan (1960)*			(act.-'58)			
Univ. California			43,101	66,250	89,150	118,750
State Colleges			44,528	98,950	145,200	180,650
Junior Colleges			91,162	169,650	225,900	288,950

*The 1955 Restudy provided low, medium, and high enrollment projections. The medium estimates are reported here. The "modified" projections based on more restrictive admissions to the UC and CSCs are used from the 1960 Master Plan. 1947 enrollments are higher than 1953 enrollments because of the postwar enrollment surge.

Clark Kerr, the former Chancellor of UC Berkeley, had replaced Sproul as UC President in July of 1958. With a background in labor relations, it was Kerr who recognized the need to enter back into negotiations; he had in fact courted the legislators in having them push for a master plan study. It is worth noting that Simpson, under pressure from the state college presidents, made a

futile attempt to scuttle the Master Plan by refusing to support a key resolution agreed upon in advance of a historic joint meeting of the UC Regents and the Board of Education. (The resolution called for deferring approval of new state college campuses until the Master Plan was completed.) Likewise, Love and Wahlquist, as joined by Glenn Dumke from San Francisco State, put forward a proposal that would have radically altered the functional differentiation between the state colleges and the University of California. Acting as members of a reconstituted Technical Advisory Committee (renamed the Joint Advisory Committee), Love, in particular, gave voice to a proposal for cordoning off the University California into the area of research and PhD level training that represented their avowed interests. Kerr, along with his assistant and chief strategist, Dean McHenry, responded firmly that the University would never accept such a deal. They fully recognized that the University could not maintain its strength in research without the undergraduate enrollments needed to amass the body of faculty necessary for strong academic programs. This event led Kerr to abandon the JAC as the group responsible for producing the Master Plan; it also resulted in the decision to create a separate Master Plan Survey Team that included representatives from private institutions as well as the junior colleges.[56]

Among the key issues to surface during the Master Plan negotiations were whether the state colleges could issue doctorates, and whether there would be a single governing board, or two separate boards whose differences would continue to be worked out through a voluntary system of coordination. (The Master's degree was already off the table as a result of the 1955 Restudy as well as legislative action following Sputnik; a voluntary system of coordination was viewed as helping to preserve institutional autonomy.) Separate from these disputed areas, a key feature of the Master Plan was the decision that the University of California and the state colleges would adopt more restrictive admissions policies by accepting only the top 12.5% and 33%, respectively, of California's high school graduates. The State would then keep the doors to higher education open by allocating additional funds with which to accelerate the growth of the State's Junior Colleges. The net effect was to contain the costs of higher education, while building new facilities that would accommodate the baby boomers as they began attending college. (Among other things, the scale of the anticipated increase in enrollments is captured in Table 1, above). The core idea of encouraging junior college transfers had its roots in the 1953 engineering agreement, even as the idea of expanding two-year technical training within the junior colleges could be tied to the engineering agreement as well as the 1948 Strayer Report.[57]

It is a tribute to deliberative political processes that the two principal parties, whose positions had clearly hardened, could pull through an eleventh-hour deal that resulted in the Master Plan. In the end, it was agreed upon that the state colleges would limit their graduate aspirations to joint doctorates whose quality remained checked by the University of California faculty; this gave UC administrators, most notably Kerr, the necessary assurances that there remained enough of a meaningful differentiation of functions for him to allow two separate governing boards. The intent, as stipulated in the Master Plan, was to freeze this new differentiation of functions via an amendment to the State Constitution. In the end, legislators refused to limit their own powers by allowing a constitutional amendment, but the changes enacted through statute turned out to be enduring. For those unfamiliar with the California system of higher education, the system retains, to this day, the broad outlines of the agreement laid out in the 1960 Master Plan, including the restriction limiting the state colleges to joint doctorates. Often regarded to be the most significant

outcome, this agreement gave Kerr the institutional stability and resources he needed to remake the University of California into an entire system of public research universities envied by all other states in the nation.[58]

While the University of California's successes are well known, the fate of the California State Colleges is a story less told.[59] It might seem that with the approval of joint doctorates, which also involved relaxing the restrictions placed on faculty research, the CSC presidents gained as much as they could hope for. However, from the point of view of many members of the CSC faculty, who were hired at a time when there was no stable definition of functions, the Master Plan represented an end to their growing hopes and aspirations, as had been backed by regional employers and civic organizations eager to see the Cal State Colleges become full rivals of the University of California. For many member of the faculty, the Master Plan meant being relegated to second class citizenship. Especially upon entering the tumultuous era of the 1960s, the relationship between the CSC faculty and administration on several of the campuses grew more contentious, especially over issues such as faculty salary, work load, and the development and recognition of an academic senate.[60]

Dumke, from San Francisco State, had served as the chief state college representative to the Master Plan Study Team, and he stepped up to become the first significant Chancellor of the new State College system. (The first chancellor, Buell Gallagher, arrived from City College of New York with clearly mistaken impressions about the position, and departed after just one year.) Dumke worked to uphold the Master Plan agreement, of which he had been an architect. This placed him at occasional odds with some of the CSC presidents who continued to hold greater aspirations. The CSC presidents continued to meet as an advisory body to Dumke. But once they lost their common adversary, and the legitimacy of their claims became chained to the Master Plan, they could no longer mount the concerted action necessary to advance their cause. Instead, as noted by Douglass, the presidents, along with Dumke and his new trustees, found themselves mired within "a growing labyrinth of personnel and budget controls of state agencies."[61] Their advisory meetings now revolved around the question of uniform salary scales, accounting procedures, and the like, which, as intended, cut further into the autonomy of the individual campuses.[62]

The Fate of UCLA Engineering

Nor did all parts of the University of California benefit from the Master Plan. A case in point was Boelter's program at UCLA. Trouble for Boelter began earlier. The very labor market that created a strong demand for off-campus instruction worked to draw away his faculty, with his program in off-campus instruction itself creating the social networks that allowed his faculty to find lucrative and quite often technically more intriguing positions in industry. Many expected Boelter to build a strong faculty in aeronautical engineering. However, amid the competition of industry salaries, this proved to be the most difficult faculty to attract and retain. UCLA Engineering wound up with very few faculty members and research programs in this area. Meanwhile, in an attempt to fill vacancies, both within the regular faculty as well as the extension program, Boelter made repeated and largely unsuccessful appeals to create a preferential salary structure and alternative appointment titles for use within his College.[63]

Then, by the late 50s, the demographics also shifted. The local engineering workforce was now ten years older, had families, and were settling into the ever expanding suburbs of Los Angeles. Following the Korean War, and in spite of Sputnik, there was a lull in defense spending, which produced a temporary surplus in the regional engineering workforce, and thus an end to the rapid pace of promotions within the industry. The basic incentives that had driven off-campus technical instruction now began to dry up, creating budgetary problems for the College.

The first significant inquiry into his department's activities in fact resulted from Boelter's recruitment and budgetary problems, although the immediate issue seems to have been a decline in the Service to Industry program. By then, all of the region's aviation firms had invested in major R&D facilities, which both directly and indirectly affected the scope of technical services UCLA could offer. Conjoined with high faculty salaries, Boelter began running a regular budget deficit from around 1957, this despite a strong admonition from Sproul that he had to either bring his budget in line or else terminate some of his programs.[64]

In response to one of Boelter's requests, that he be allowed to use the titles, "Affiliate Professor" and "Affiliate Associate Professor" to help recruit instructors for off-campus instruction, UCLA Chancellor Raymond B. Allen asked his Committee on Budget and Interdepartmental Relations to conduct an overall review Boetler's program. In addition to recommending against the use of such ad hoc titles, the committee took note of the fact that the College had, "only a few bona fide daytime graduate students, which is of course contrary to the practice at Berkeley or the other local engineering schools." The committee also added that, "The large evening and off-campus program should be examined rather closely for its effect on the morale and technical strength of the full time faculty, for its effect on the Department's ability to recruit and to retain strong staff members, and for its deleterious effect on the development of laboratories and of research programs on the Los Angeles campus itself."[65]

Allen did not immediately move to curtail Boelter's off-campus programs—if anything, the conversations about San Jose, which had just drawn to a close, suggested that the university had to do the opposite. But in the wake of the controversy over off-campus instruction, the Los Angeles Division of the Academic Senate's Committee on Undergraduate Courses, as well as a state-wide Senate Special Combined Committee on University Extension launched similar investigations, and arrived at similar conclusions. Amidst the policy changes that followed, Boelter could only appeal to the administration for special funds to help soften the blow while he worked to find other ways to sustain his extension program.[66]

The fact was, many of the faculty who elected to remain with Boelter chose to do so because of their dedication to teaching, and to the unique instructional program they had developed at UCLA. What seemed like a corruption of university standards in light of the conversations leading up to the Master Plan remained, to UCLA's committed engineering educators, an ideal program of unified engineering followed by an emphasis on lifelong learning. In June 1959, as the Master Plan negotiations were entering full swing, Boelter reached out to the Ford Foundation in search of financial relief for his work. As it happened, the Ford Foundation, in response to Sputnik, just launched a major program on engineering education, and was seeking out high-profile initiatives to support. A quick visit to UCLA by the foundation officer, Carl Borgmann, confirmed the appealing features of Boelter's program. Boelter submitted a proposal

that promised to accelerate the pace with which UCLA's unified curriculum could be reworked into one more compatible with the university's increased emphasis on resident graduate education and research.[67]

Within months, Boelter secured a $1.2 million award from the Foundation. However, Boelter's proposal called for paying for predoctoral and postdoctoral teaching fellows, as well as hiring new faculty using the grant, this being the stopgap measure he needed to reduce the impact of new Senate policies. Sensing that there were policy implications especially with regards to the new hires, Kerr chose not to immediately accept the award, but instructed Knudsen, who served briefly as UCLA's Chancellor after Allen, to refer Boelter's proposal to the Southern Section of the Academic Senate's Committee on Educational Policy. This occurred in November 1959, at the exact time of the final impasse in the Master Plan negotiations. The Master Plan had ignited multiple conversations about academic standards and academic excellence within the Senate. Kerr was also an advocate of shared governance, insofar as it strengthened his own claims about academic excellence and the strength of the UC faculty.[68]

However, the Committee on Educational Policy, instead of addressing the obvious policy question surrounding the proposed new hires, criticized the entire proposal, noting that it was "not convinced that the proposed emphasis on curricular analysis within the College is either necessary or desirable." The Committee had access to the earlier report produced by the Committee on Undergraduate Courses—indeed, the report had been addressed to them—and they were fully aware of the various circumstances within the College of Engineering. The Committee, in its own report, surmised that,

> During the past 15 years a massive effort has been made in Engineering at UCLA aimed at curricular study and revision and the end product to date is known as the "unified curriculum." … Needless to say, the Committee on Educational Policy views with approbation the efforts of departments of instruction to improve their course offerings… Indeed, this is one of the functions of the College of Engineering. However, the Committee on Educational Policy is concerned that other equally important functions should not be thereby subjugated (sic) to curricular studies.
>
> … A first class engineering college may be expected to play a key role in discovering new knowledge, in pointing out directions for its application, and in its dissemination by whatever tools, devices, or curricula are appropriate… . But [the curricula] should be recognized as tools and devices, not as ends in themselves. The question as to whether engineering and engineering knowledge and scholarship within the University are more important than engineering curricula should be one that is not even raised in a first class university either directly or by implication.[69]

The committee went so far as to ridicule Boelter's faculty for pursuing so-called "'research' in curricular reorganization or in studies aimed at discovering the contents of a 'discipline of design.'"[70]

Myron Tribus, one of Boelter's loyal faculty members and one of the principal investigators for the grant, complained directly to Kerr about the committee's opinion—an opinion eagerly

endorsed by the new Dean of the Graduate Division. Chafing at what Tribus regarded to be a direct violation of academic freedom, he wrote that, "In a letter to the committee I have attempted to correct some false impressions committee members seem to have. … It is, I submit, a very unsatisfactory situation when a Professor of Engineering must explain to a Professor of Letters and Science that it is a legitimate form of engineering research to develop the abstract principles which underlie all of engineering design. Yet this is what the Dean and I are being forced to do."[71]

Franklin Murphy, who became UCLA's Chancellor in 1960, took a conciliatory approach to Tribus, and allowed the Ford Foundation grant to move forward. But he did not ease up on the pressure placed on Boelter. Working through the framework of the campus Academic Plan, which Kerr remade into an instrument for the implementation of the Master Plan, Boelter and his faculty were forced to articulate how they could contribute to the research based system of higher education specified for the University of California campuses. Boelter's faculty defended the notion of a unified undergraduate curriculum in a "Statement of Policy" issued in late 1960. Both they, along with Boelter, also pursued other strategies for preserving their legacy.[72] Nevertheless, what followed was a soul-searching exercise in departmental reorganization, during which the College, while retaining a single Department of Engineering, created subject-based "divisions" within it that helped to solidify faculty interests and enabled them to pursue research contracts and develop stronger PhD programs within these specified areas. (They insisted, on the other hand, in creating non-traditional engineering divisions based on a commitment to interdisciplinarity, and they retained the option, at least in principle, of the fluid movement of faculty across divisions.) By the time Boelter approached his retirement in 1965, Murphy could claim that, with a small exception having to do with the engineering course catalog, "We have now managed to bring this college back into the University in all respects…" Indeed, this was to say that the department had been remade in the image of the California Master Plan.[73]

Historical Lessons

I'd like to close by considering the historical lessons that can be gleaned from this episode. At the broadest level, this story is about opportunism and institution building in a political context, where existing political and educational institutions, along with postwar economic and demographic trends provided an effective environment for restructuring not only engineering education, but California's system of higher education as a whole.[74] The audience of this paper will no doubt be delighted to know that engineering educators played an important part in transforming one of the most important systems of higher education in the United States, if not higher education in the U.S. as a whole.[75]

Our present circumstances are clearly quite different from those of the early Cold War era. The very notion of a "quiet crisis," as attributed to the current situation with respect to our scientific and engineering workforce, stands in stark contrast to the boom and bust cycles of the Cold War era, when radical expansion in federal procurements and research expenditures fueled a national panic about the technical workforce. Even in leaving the present situation in California aside (since California's public institutions need not be the platform for our actions), it must be acknowledged that the strategies of entrepreneurialism and institution building described in this paper are unlikely to succeed in the present context, unaltered.[76]

For guidance on the uses of history, one could certainly do worse than Richard Neustadt and Earnest May's Thinking in Time.[77] Neustadt and May are famous for their work in using historical case studies to train policymakers and government officials at Harvard's Kennedy School of Government. For Neustadt and May, learning by analogy is only one of several uses of history, one prone to the hazards of a misleading analogy. While they also consider mapping out historical trajectories and paying attention to individual biography as other important ways for making use of history, the method on which they place special emphasis, and one especially relevant to this paper, is that of using history to identify and rethink our presumptions and thereby open up new pathways for action.[78]

Especially as paired with this paper's use of multi-site, multi-scale ethnography, one of the most important things for engineering educators to "rethink" is perhaps the need to look beyond our own initiatives in recognizing the full scope of the task that lays ahead of us when we speak about a transformation in engineering education. The transformation described in this paper was not simply about Boelter's unified engineering program, technical training in the junior colleges, or the state colleges' expansion of engineering degree programs to meet regional workforce needs. It is about how these ideas became integrated into a larger, statewide dialogue about educational transformation.

This is not to discount local initiatives. The work that Boelter, Wahlquist, and their more research minded colleagues did (along with countless others both named and unnamed), produced a fundamental epistemological shift in the foundations of engineering knowledge: A basic research ideology in the case of the UC faculty, and broad analytic training accompanied by intense specialization through corporate training and continuing education for the bulk of the graduates of the University of California and the state colleges. Drawing on the past several decades of "constructivist" scholarship in my own field of "science studies," we can recognize how this is an account not only of how knowledge is shaped by social contexts, but how esoteric knowledge remakes social institutions through complex interactions that wind up transcending the very notion of a distinct social "context."[79] Although I remind us once again that engineering education was constitutive of and not necessarily even foundational to the changes described, new occupational categories, new forms of knowledge, and a new system of higher education emerged out of these conversations. With this in mind, it would seem important to take special note of the entrepreneurial energies exhibited by Boelter and the state college presidents. Clearly a distinctive element of U.S. administrative culture, one contiguous with the opportunism exhibited all across California during the 1950s, these individuals transgressed bureaucratic traditions and linguistic conventions in ways that were conducive to institutional change. This is the level by which learning by analogy may work in ways that Neustadt and May might approve.

It is necessary, however, to balance this endorsement of entrepreneurialism with the fact that California was fortunate enough to have a sufficiently developed institutional structure for higher education—a tripartite system with one part protected by constitutional guarantees, and another accountable to legislative interests—in other words, a system developed enough to sort out the new initiatives into a coherent Master Plan. So when new Cold War institutions required California's educational system to accelerate its capacity for knowledge production, and to train a vast new technical workforce, the accompanying conversations and debates, however chaotic it

might have seemed at the time, were channeled into a deliberative process that produced a coherent outcome. In a very prescient remark made in the closing passages of his historical study of the Master Plan, Douglass notes that one of the major challenges for higher education today is that California, in any event, may no longer have the political and institutional structure necessary to navigate through changes comparable to the 1960 Master Plan.[80] But if our concern about economic globalization really presents us with an educational challenge equivalent to that of the early Cold War years, engineering educators must find an institutional platform that is both extensive and robust enough to produce a change of similar scale and scope. The current efforts of ABET and our own organization notwithstanding, there remains much work to be done.

Notes

[1] Thomas Friedman, The World is Flat: A Brief History of the Twenty-First Century (New York: Farrar, Straus and Giroux, 2005).

[2] National Academy of Engineering, The Engineer of 2020: Visions of Engineering in the New Century (Washington, D.C.: National Academies Press, 2004); National Academy of Engineering, Educating the Engineer of 2020: Adapting Engineering Education to the New Century (Washington, D.C.: National Academies Press).

[3] On the history of the 1960 California Master Plan and the discussions leading up to it, see John Aubrey Douglass, The California Idea and American Higher Education, 1850 to the 1960 Master Plan (Stanford, Calif.: Stanford University Press, 2000); On the national crisis in engineering manpower during the Cold War era, with a specific focus on Sputnik and its aftermath, see Juan Lucena, Defending the Nation: U.S. Policymaking to Create Scientists *and Engineers from Sputnik to the "War Against Terrorism"* (Lanham, Md.: University of America Press, 2005).

[4] A Master Plan for Higher Education in California, 1960-1975 (Sacramento: California State Department of Education, 1960).

[5] Roger Lotchin, Fortress California, 1910-1961: From Warfare to Welfare (New York: Oxford University Press, 1992).

[6] Again, on the Master Plan, see Douglass (2000).

[7] For a general history of Stanford and its contribution to the development of Silicon Valley, see Rebecca Lowen, Creating the Cold War University: The Transformation of Stanford (Berkeley: University of California Press, 1997); as well as Stuart W. Leslie, The Cold War and American Science: The Military-Industrial-Academic Complex at MIT and Stanford (New York: Columbia University Press, 1993).

[8] Society for the Promotion of Engineering Education, Report of the Investigation of Engineering Education, 1923-1929, 2 volumes (Pittsburgh: University of Pittsburgh, 1930, 1934).

[9] The question of the need to work across sites, and across multiple scales, became an especially acute problem for anthropologists, whose prior methods were rooted in identifying distinct cultures at a specific location. While it could be said that historians have been much more accustomed to integrating events that take place across different locations and at different institutional scales—the "world systems" model was not anything particular novel to historians—in practice, historical narratives have tended to focus on particular institutions and specific scales of analysis. This is not said as a critique of other historical texts—there are limits associated with any given perspective and approach. On multi-sited, multi-scale analysis, see George Marcus, Ethnography through Thick and Thin (Princeton, N. J.: Princeton University Press, 1998), as well as its application within the realm of science and technology studies, in Kim Fortun, Advocacy after Bhopal: Environmentalism, Disaster, New Global Orders (Chicago: University of Chicago Press, 2001).

[10] Virginia Richard, The Origin and Development of Graduate Education at UCLA, 1933-1964. (Los Angeles, UCLA Graduate Division, 1965); UCLA School of Engineering and Applied Science, 50th Anniversary Historical Review 1945 to 1995 (Los Angeles: UCLA School of Engineering and Applied Science). Reference copies, UCLA Archives. The word "at" in University of California at Los Angeles, which was used to connote a single multi-campus university, was officially replaced by a comma in 1958.

[11] George J. Maslach, Stafford L. Warren, and Joseph W. McCutchan, "Llewellyn Michael Kraus Boelter, Engineering: Berkeley and Los Angeles," obituary, University of California: In Memoriam, May 1968 (Berkeley: University of California Academic Senate); Baldwin M. Woods to Robert G. Sproul, confidential memo, 3 April 1937; R. G. Sproul to Regents, 10 January [1941]. CU-5, Ser 3, Box 39/9; UCLA SEAS, 50th Anniversary Historical Review, "Assembly Bill 1140" (No pagination); M. P. O'Brien to Sproul, 10 May 1943; Committee on Engineering Curricula at Los Angeles, "Recommendations," 2 August 1943; G. S. Watkins, memo, 29 June 1944. CU-5, Ser 4, Box 12/22. UC Bancroft Library, University of California.

[12] Charles Riborg Mann, A Study of Engineering Education (New York: Carnegie Foundation for the Advancement of Teaching, 1918); SPEE, Report (1930, 1934); SPEE, "Report of Committee on Aims and Scope of Engineering Curricula," Journal of Engineering Education **30/7** (March 1940): 555-566. Direct evidence of engagement with this dialogue can be found, for example, in O'Brien to Sproul, 15 April 1940. CU-5, Ser 4, Box 13/2. Bancroft Library, University of California.

[13] Seeking to demonstrate the value of general versus specialist training in the aviation industry, O'Brien amassed supporting evidence, specifically from a senior administrative engineer and a chief project engineer at Lockheed. Especially in the context of war production, a large proportion of critical engineering work occurred in production engineering, not in new aircraft design, despite the common association of aviation engineering with the latter. Expressed in terms of percentages, it was estimated that 89% of the engineering positions would benefit from a more basic training in mechanical engineering, as opposed to specialized training in the handful of aviation engineering programs then in existence across the country. B. C. Boulton to Hal Hibbard, 15 May 1940 and Walter Jones to B. C. Boulton, 27 May 1940. See also C. T. Reid (Director of Education, Douglas Aircraft Co.), "What the Aircraft Industry Expects of the Engineering College," 1 October 1940. All CU-5, Ser 4, Box 13/2. Bancroft Library, University of California. On production engineering in the industry during World War II, see Robert Ferguson, "Technology and Cooperation in American Aircraft Manufacture during World War II" (PhD diss., University of Minnesota, 1996).

[14] SPEE, "Report of Committee," (1939-40), 555-566; UCLA SEAS, 50th Anniversary Historical Review, "By August of 1945…."

[15] See also "Report of Committee on Engineering Education after the War," Journal of Engineering Education **35/1** (September 1944): 589-614.

[16] William Pomeroy (Registrar) to Sproul, 10 May 1950; Also Vern O. Knudsen to Sproul, 10 July 1946. RS 359, Box 283, Fld: 1 Engineering; Committee on Budget to Allen, 28 February 1957. RS 359, Box 313/Engineering; Committee on Undergraduate Courses (Los Angeles Division) to Committee on Educational Policy, Southern Section, "Review of the College of Engineering," 11 May 1959. RS 359, Box 326/Engineering. UCLA Archives. For a full series of correspondence related to the program, see "Off Campus Graduate Instruction Leading to Higher Degrees," CU-5, Ser 3, Box 17/6 (3 folders).

[17] Department of Engineering, Annual Summary, January 1 through December 31, 1952, n.d. RS359, Box 252, Fld: 1 Engineering; "News Letter," various issues, RS 359, Box 223, Fld: 1 Engineering; and RS 52, Box 1, Fld: 1 Engineering Extension, Engineering Executive Program, 1954-1963. UCLA Archives.

[18] Woods to Sproul, "Dean of Engineering at Berkeley," 12 March 1947. CU-5, Ser 4, Box 12/21. Bancroft Library, University of California.

[19] Quoted from CSU website, http://www.calstate.edu/. Accessed 1/8/2010.

[20] California State Department of Education, "Regular Session Equivalent Full-Time Student Enrollment," 7 May 1953. CSU 004, CSU Executive Council Minutes, bound volume. Box COU001A. CSU Archives. CSU Dominquez Hills.

[21] "A Report of a Survey of the Needs of California in Higher Education," 1 March 1948, 26, 31. Calisphere (University of California digital library), http://content.cdlib.org/ark:/13030/hb2p3004kd/. Accessed 1/8/2010. Evidence of a prevailing attitude towards the binary distinction of vocation and profession can be found, for example, in the 1947 legislative action authorizing state colleges to offer baccalaureate programs beyond of teaching related fields. The Strayer Report struggled with the stipulation that state colleges could offer either "vocational" training or "pre-professional" work conducive to a student's transfer to a university program, which legally left no clear mandate for "occupational" training.

[22] Douglass (2002), 149-155, 159-163, 179-180, 184-194.

[23] Compiled primarily from Council of State College Presidents, minutes. In CSU 004, CSU Executive Council Minutes. CSU Archives. Also Box 68, President's Office, Minutes of President's Council. SJSU University Archives. Also available, Malcolm A. Love Papers, Department of Special Collections, San Diego State University.

[24] See CSU 004, CSU Executive Council, Minutes. CSU Archives.

[25] See for example, Council of State College Presidents, minutes, 23-24 February 1954, 24. CSU 004, Box COU001, Fld: Minutes 1954. CSU Archives.
[26] Douglass (2000), 213-214.
[27] James Corley (VP, Business Affairs) to Sproul, 9 December 1952. See other documents in "Engineering Education in State Colleges, 1952-58." CU 5, Ser 3. Box 17/19. Bancroft Library, University of California.
[28] T. C. Holy and H. H. Semans, "Engineering Education in Publicly Supported Educational Institutions in California," December 1952, 3. RS 359, Box 285/27. UCLA Archives.
[29] State Department of Education, Division of State Colleges and Teacher Education, "Basic Problems in Planning for the Orderly Development of Higher Education in California," 16 September 1952. In CSU 004, Box COU001A, Minutes, 1952 (bound volume).
[30] S[olomon] C. Hollister, C. S. Crouse, L. F. Grant, and M. D. Hooven, "Report of Committee on Adequacy and Standards of Engineering Education," reprint, from ECPD, Nineteenth (1951) Annual Report, in Hollister Papers, Box 82/59. Division of Rare and Manuscript Collections, Cornell University; also S. C. Hollister, "Differentiating Characteristics of an Engineering Curriculum," Mechanical Engineering (February 1950), 122-123, 122.
[31] Formally, this was the "Report of the Committee on Evaluation of Engineering Education," Journal of Engineering Education **46** (1955-56): 26-60.
[32] See for instance, L. E. Grinter, "Questions Concerning the Engineering Curriculum," Journal of Engineering Education **42** (1951-52): 261-262. The notion of bifurcation and the functional differentiation of curricula can be traced back to the Wickenden Investigations and the 1940 Hammond Report. The phrase, "production, construction, operation, maintenance, repair, sales, and management" in its different variants, circulated broadly, and were mentioned by state college engineering department heads and Department of Education staff as well as by O'Brien and Boelter. See for instance C. W. Patrick, "A Report on Engineering Education in the California State Colleges," January 1949. CU-5, Ser 4, Box 16/3; [Boelter,] "Engineering at Berkeley and Los Angeles," 22 August 1944. CU-39, Box 5/24. Bancroft Library, University of California.
[33] See especially the Wickenden Investigations, SPEE, Report (1930).
[34] Technical Advisory Committee, minutes, 10 December 1952. CU-5, Ser 4, 16/3. Bancroft Library, University of California; Liaison Committee, minutes, 11 February 1953. F3752 Department of Education Records, Folder 126. California State Archives.
[35] Sproul and Simpson to Administrative Officers, et al., 10 March 1953; and Liaison Committee, "Engineering Education in the State Colleges and the University of California," 10 March 1953. RS359, Box 313/29. UCLA Archives.
[36] David Angus, "Professionalism and the Public Good: A Brief History of Teacher Certification" (Washington, D.C.: Thomas B. Fordham Foundation, 2001); "A Report of a Survey of the Needs," 1 March 1948.
[37] Council of State College Presidents, minutes, various, from 1953 and 1954. CSU 004, Box COU001A and COU001. CSU Archives; California State Department of Education, "Extension of Graduate Work in the California State Colleges," May 1953. RS359, Box 272, Fld: 27-Proposal. UCLA Archives.
[38] See "Characteristic Emphases," in "Joint Staff Recommendations on the State College Proposal," 29 January 1954, 26-29. RS 359, Box 272, Fld: 27-proposal. UCLA Archives.
[39] Council of State College Presidents, minutes, 12-13 January 1954, 13-17 and 23-24 February 1954, 30. CSU 004, Box COU001, Fld: Minutes 1954. CSU Archives; Sproul, "The Master's Degree in State Colleges," 10 June 1954. RS359, Box 272, Fld: 27-Proposal. UCLA Archives.
[40] "Comments on the giving of the Master's degree," 24 November 1953. Robbins is quoted from p.5; also Knudsen to Holy, 28 December 1953. RS359, Box 272, Fld: 27-Proposal. UCLA Archives.
[41] Council of SCP, "Resolution on M.A. Degree Programs," 7 May 1954. CSU 004, Box COU001, Fld: Minutes 1954. CSU Archives.
[42] Council, minutes, 23-24 February 1954, 30. CSU 004, Box COU001, Fld: Minutes 1954. CSU Archives.
[43] Douglass (2000), 213-222.
[44] T. C. Holy, H. H. Semans, and T. R. McConnell, A Restudy of the Needs of California in Higher Education (Sacramento: California State Department of Education, 1955), 96-101. Available through Calisphere, http://content.cdlib.org/ark:/13030/hb2n39n7ns/, Accessed 1/8/2010. With regards to the master's the Restudy suggested that the state colleges be allowed to offer masters degrees in liberal arts fields such as economics and political science, when the growth in related fields (business in the case of economics; public administration in the case of political science) resulted in a faculty capable of offering such a degree. They also felt that the same applied to liberal arts disciplines in general, insofar as training in a broad cross-section of the liberal arts were already offered via a teaching related master's. The report's specific position, in following a market-driven logic, was that

students were using the teaching related master's to obtain a master's degree in the liberal arts with no intention of going into teaching, which was their specific stance with regards to unenforceability. In any event, their key criterion was the strength of the faculty, whose talents were otherwise wasted according again to the logic of the study.

[45] Graduate Council, Southern Section, 1 October 1954; Boelter to Sproul, "Action Desired," 8 February 1955. RS359, Box 283, Fld; 1 Engineering. UCLA Archives; "Report of the Sub-committee of the Graduate Council Appointed to Consider the Problem of Off-Campus Instruction in Relation to Higher Degrees," 16 April 1956. CU-5, Ser 3, Box 17/6 (2 of 3). Bancroft Library, University of California.

[46] T. C. Holy, "Memo on Discussion of the Engineering Agreement," 17 September 1957. CU-5, Ser 3, Box 17/6 (2 of 3). Bancroft Library, University of California; see also Douglass (2000), 253.

[47] J. Burton Vasche to Roy E. Simpson, 6 February 1956. CSU 004, Box COU002, Fld: All 1956 Meetings. CSU Archives.

[48] "Report of the Committee on Evaluation of Engineering Education," Journal of Engineering Education 46 (1955-56): 26-60.

[49] Allen to Sproul, 5 August 1957. CU-5, Ser 3, Box 17/6 (2 of 3). Bancroft Library, University of California. Allen here was misinterpreting or misrepresenting the decision, reinforced by the 1953 engineering agreement, for the University of California to reduce lower division instruction and focus more on upper division and graduate instruction.

[50] C. Tod Singleton, Jr. to Stanley McCaffrey, 14 November 1957. CU-5, Ser 3, Box 17/6 (1 of 3). Bancroft Library, University of California; For a more general study of the impact of Sputnik on engineering education, see Lucena, Defending the Nation (2005).

[51] Allen to Sproul, 15 October 1957. CU-5, Ser 3, Box 17/6 (2 of 3). Bancroft Library, University of California.

[52] This involved coming up with alternative accreditation procedures, with the Board of Education itself being considered for this work at one point. California Legislature, 1958 First Extraordinary Session. Assembly Bill No. 1. CU-5, Ser 3, Box 17/6 (1 of 3). Bancroft Library, University of California; Vasche to Simpson, 6 February 1956.

[53] Joint Staff, Liaison Committee, "A Review of the 1953 Engineering Agreement," March 1958. CU-5, Ser 4, Box 16/5. Bancroft Library, University of California; "Recommendations on Engineering Education Adopted by the Regents," 23 June 1958. RS 359, Box 326, Fld: 1-Engineering. UCLA Archives.

[54] While the legislature's increasing skepticism was an important factor in the origins of the Master Plan, the process, as noted below, was managed substantially by Kerr. See Douglass (2000), esp. 255-260 for details.

[55] Douglass (2000), 265-297.

[56] Douglass (2000), 259-264, 266-271. The JAC already had junior college representatives, which both UC officials and the state college presidents initially regarded as potential allies. Similar reasons were at work in including the private institutions.

[57] Ibid., 265-297. See also A Master Plan for Higher Education in California, 1960-1975 (Sacramento: California State Department of Education, 1960). Available at http://sunsite.berkeley.edu/uchistory/archives_exhibits/masterplan/MasterPlan1960.pdf. Accessed 3/15/2010.

[58] Douglass (2000), 295-309.

[59] CSU's history can be found in a recent book written by a former CSU President, Don Gerth. See Gerth, The *People's University: A History of the Califo*rnia State University (Berkeley: Institute of Governmental Studies Press, 2010).

[60] A record of the development, aspirations, and disappointments of the San Jose State College engineering faculty can be found, for instance, in the minutes of the SJSC President's Council. Box 68, Minutes of President's Council, Fld: SJSC Council, 1946-52 (binder). SJSU University Archives.

[61] Douglass (2000), 322.

[62] See CSU 004 CSU Executive Council Minutes, Box COU003-COU004.

[63] Records relevant to this point are numerous, but consider Boelter to Knudsen, 23 February 1960. CU-5, Ser 5, Box 92/8. Bancroft Library, University of California; "Report of the Study Committee on Faculty Salaries and Employment Practices," 3 October 1955. RS 359, Box 283, Fld: 1-Engineering; Boelter and O'Brien to Sproul, 20 February 1957. RS 359, Box 313, Fld: Engineering; Boelter to Allen, 5 October 1955, RS 359, Box 283, Fld: 1 Engineering. UCLA Archives.

[64] Sproul to Allen, 10 January 1957. RS 359, Box 313, Fld: "29"; Allen to Sproul, 17 April 1958, RS 359, Box 326, Fld: 1-Engineering.

[65] The Committee on Budget and Interdepartmental Relations to Chancellor Raymond Allen, 28 February 1957. RS 359, Box 313, Fld: Engineering. UCLA Archives.

[66] Committee on Undergraduate Courses, LA Division to Committee on Educational Policy, Southern Section, 11 May 1959. RS 401, Box 8, Fld: Eng. Engg Curriculum Study; Committee on Undergraduate Courses, LA Division to Committee on Educational Policy, Southern Section, 22 September 1959. RS 359, Box 342, Fld: 1 Engineering; Graduate Council, Los Angeles, "Report on Graduate Training in Engineering at UCLA," draft, 9 March 1964. RS 401, Box 8, Fld: 1-Engin. Engineering College, 1959-64. UCLA Archives.
[67] Boelter, "A Program of Research and Development for a Seven Year Engineering Curriculum," 1 June 1959; Carl Borgmann to Clark Kerr, 15 October 1959. RS 401, Box 8, Fld: 1-Eng. Engineering Curriculum Study. UCLA Archives. Boelter's Ford Foundation grant, and especially its general education component, but also the eventual fate of Boelter's College is described by Matthew Wisnioski in, "'Liberal Education has Failed': Reading Like an Engineer in 1960s America," Technology and Culture **50**(2009): 753-782.
[68] Kerr to Knudsen, 17 November 1959. RS 401, Box 8, Fld: 1-Eng. Engineering Curriculum Study. UCLA Archives; John Aubrey Douglass, "Shared Governance at the University of California: A Historical Review," Research and Occasional Paper Series, CSHE.1.98 (Berkeley: Center for Study of Higher Education, 1998).
[69] Robert D. Tschirgi to V. O Knudsen, 11 February 1960; "Ford Foundation Grant for $1,200,000 for Study of Engineering Curriculum at Los Angeles," 12 February 1960. RS401, Box 8, Fld: 1-Eng. Engineering Curriculum Study. UCLA Archives.
[70] Ibid.
[71] Myron Tribus to Kerr, 27 January 1960. RS401, Box 8, Fld: 1-Eng. Engineering Curriculum Study. UCLA Archives.
[72] Among these other strategies were the creation of a new Council of Engineering Deans, and the reinvigoration of an Engineering Advisory Council comprised of prominent engineering alumni and industry representatives, both of which reported directly to the UC President. This included the creation of an "Engineering Master Plan Study" in 1965, which went on to influence the national dialogue about engineering education reform, as noted below. See RS 52, Box 10/2-3, "Engineering Master Plan Study." UCLA Archives. Murphy chafed at what he regarded to be improper influence by the engineering deans. See Murphy to Kerr, 26 October 1964. CU-5, Ser 5, Box 46/19. Bancroft Library, University of California.
[73] "Statement of Policy, Department of Engineering, Los Angeles," 11 November 1960. RS 52, Box 2/12; Department of Engineering, "Report of the Special Committee on a Suggested Scheme of Organization," revision, 1 November 1961; "Academic Plan for the College of Engineering," draft, 1 March 1962. RS 52, Box 3/1; Murphy to Kerr, 21 October 1963. RS 401, Box 8, Fld: 1-Engin. Engineering College of 1959-1964. UCLA Archives.
[74] The developments described in this paper also influenced engineering education on a national scale. Although Boelter's unified engineering curriculum had various direct effects, another major influence was the 1965 "Engineering Master Plan Study," produced by the Engineering Advisory Council as mentioned above. This 1965 study, produced specifically as a result of the pressures introduced by the Master Plan, was cited by, and had a significant impact on ASEE's 1968 Goals Study, as directed by Penn State President Eric A. Walker. This included the Goals Report's extensive reliance on demographic trends, as well as its controversial recommendation to designate the master's degree as the first professional degree in Engineering.
[75] I wish to extend my deepest appreciation for the anonymous reviewers of this manuscript, who provided key insights that are incorporated into this conclusion, including this observation.
[76] Shirley Ann Jackson, "The Quiet Crisis and the Future of American Competitiveness," American Chemical Society, fall national meeting, 2005. Washington, D.C. Posted at http://www.rpi.edu/homepage/quietcrisis/ps082905-acs.html. Accessed 3/18/2010.
[77] Richard Neustadt and Ernest May, Thinking in Time: The Uses of History for Decision-Makers (New York: Free Press, 1986).
[78] While this does not contribute to efforts to understand the challenges of engineering education, one of the reasons for placing the reader squarely within the shoes of the historical actors, as I do in this paper, is the genuine hope that this will help the "narrative itself" carry valuable historical lessons. To the extent to which readers identify with historic actors—and again, I am presuming engineering educators to be the primary audience for this paper—acquired historical memories can inform how we read complex situations, and evoke different strategies of action. In the context of this paper, this could be the entrepreneurialism exhibited by Boelter, the concerted efforts of the state college presidents, or the institutional politics practiced by Kerr. The lessons, moreover, extend into the myriad ordinary "everyday" actions, from the Joint Staff's side-by-side comparison of academic programs, to the state college presidents' decision to allow "the meeting" to order an executive action, to Boelter's failed efforts to secure an "Affiliate" title for his adjunct faculty. Negative lessons are as important as positive ones in cultivating a sense for what actions are likely to succeed or fail within institutions analogous to those described in this historical

account. Drawn from the same underlying reason for focusing on individual biography as identified by Neustadt and May, this is also consistent with what they say about learning from analogy.

[79] For a useful review of the science studies literature and its application to the history of science, see Jan Golinski, Making Natural Knowledge: Constructivism and the History of Science, (Cambridge: Cambridge University Press, 1998).

[80] Douglass (2000), 324f.