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How Science Became Militarized:

The Case of the University of California at Berkeley

Shizue HINOKAWA*

Abstract

This paper will examine how science became militarized, focusing on a few years from the late 1930s, when the plan to construct the 184-inch cyclotron emerged, through the early 1940s, when the University of California set up a system to mobilize for war. Part I will describe the close relationship that grew up between Ernest O. Lawrence (1901–1958), inventor of the cyclotron and head of the Berkeley Radiation Laboratory (the Rad Lab), and his supporter Alfred Lee Loomis (1887–1975), who, as an investment banker and amateur scientist, brought Lawrence into contact with industrialists in the course of developing the 184-inch cyclotron. Part II discusses the way Loomis brought Lawrence into the web of military-industrial ties. The urgent need to develop a high-power, high-frequency oscillation tube, which was a component technology needed for both radar and the cyclotron, provided common ground for getting Lawrence involved in defense research. Part III will focus on the question of overhead to explore the University of California's handling of defense research contracts at a time when the government was creating a system to mobilize science and engineering for the war. This process led to the development of big science, which has the following three characteristics: the development of equipment that utilizes advanced technology; the need for enormous research funds; and the organization of researchers and thorough division of labor in the laboratory. Each of these characteristics engenders another aspect: The first leads to close cooperation between the research laboratory and industry in developing the technology; the second invites investment by huge foundations and contracts with the government and the military; and the third makes it impossible for researchers to continue their research except as part of a project and team, thereby robbing them of their independence. Some of the changes in the socioeconomic foundations of science and technology that were promoted by a special kind of coercion during the war became built into the postwar social structure in the form of the military-industrial-academic complex, making it impossible to think of postwar policy without them.

Keyword: Militarization of Science, University of California in the 1930s, Big Science, Cyclotron, Research Contract, Military-Industrial-Academic Complex

Introduction

Science is an indispensable part of humanity's intellectual heritage. At the same time, however, science today has become a tool of war to such an extent that

* Shizue Hinokawa is Visiting Researcher at the Institute for Research in the Humanities, Takushoku University, Tokyo, Japan. shinokaw@ner.takushoku-u.ac.jp

Ttranslated from Japanese by Barbara Sugihara.

it threatens human survival. Elucidating how this came about is an important theme in the study of modern history.

Taking cyclotron development at the University of California as an example, this paper will examine how the emergence of big science changed the research laboratory and how the university responded to the system that the United States government created to mobilize science and technology for defense.

In the early 1930s, the cyclotron, a particle accelerator used to study the atomic nucleus, was invented at the University of California's Berkeley campus, making Berkeley the birthplace of big science. The uranium bomb dropped on Hiroshima in August 1945 and the plutonium bomb dropped on Nagasaki at the end of World War II would probably have been impossible without the research that took place at Berkeley's Radiation Laboratory, which had a 60-inch cyclotron, the world's largest and the only one in operation at the time. This machine produced the artificial element plutonium and revealed the characteristics of plutonium 239, which could be used for an atomic bomb. Moreover, the electromagnet slated for use on a 184-inch cyclotron then under construction at Berkeley was employed to develop an electromagnetic method for separating the 235 isotope from natural uranium, paving the way for the uranium bomb.

In the course of researching cyclotron development in the 1930s,[1] I have come to realize that big science has the following three characteristics: the development of equipment that utilizes advanced technology; the need for enormous research funds; and the organization of researchers and thorough division of labor in the laboratory. Each of these characteristics engenders another aspect: The first leads to close cooperation between the research laboratory and industry in developing the technology; the second invites investment by huge foundations and contracts with the government and the military; and the third makes it impossible for researchers to continue their research except as part of a project and team, thereby robbing them of their independence. Viewed from the perspective of science as our intellectual heritage, these features of big science, which today are considered to be normal, contain many problems that cannot be overlooked. Many other scholars have examined big science from a variety of perspectives,[2] and like them, I see these problems as an important theme in my study of the history of science, partly because the characteristics of big science seem to have given rise to the American military-industrial-academic complex that became so conspicuous after World War II.

This paper will examine how science became militarized, focusing on a few years from the late 1930s, when the plan to construct the 184-inch cyclotron emerged, through the early 1940s, when the University of California set up a system to mobilize for war. Part I will clarify the close relationship that grew up between Ernest O. Lawrence (1901–1958), inventor of the cyclotron and head of the Berkeley Radiation Laboratory (the Rad Lab), and his supporter Alfred Lee Loomis (1887–1975), who, as an investment banker and amateur scientist, brought Lawrence into contact with industrialists in the course of developing the 184-inch

cyclotron. Part II will describe the way Loomis brought Lawrence into the web of military-industrial ties. Loomis was already studying microwaves himself, convinced that they were important as military technology. This gave him a strong interest in developing a high-power, high-frequency oscillation tube, which was a component technology needed for both radar and the cyclotron, creating common ground for getting Lawrence involved in defense research. Part III will focus on the question of overhead to explore the University of California's handling of defense research contracts at a time when the government was creating a system to mobilize science and engineering for the war.

In a paper describing the process by which the University of California mobilized for war, "The University of California and the Mobilization of Science for National Defense," Robert W. Seidel states that he hopes "to indicate how the partnership between the government and the University was created, and how this affected national security decision-making in the war and post-war eras."[3] Focusing on the activities of the scientists that Lawrence selected to participate in developing the atomic bomb, he says that: "As a consequence of these actions by Lawrence, the University of California was deeply committed to the war effort even before the outbreak of hostilities in December, 1941. This led to a series of contracts with the NDRC [National Defense Research Committee] and OSRD [Office of Scientific Research and Development] …"[4] He goes on to say that one advantage to the government in mobilizing the university for scientific research and development was low overhead charges, "but it was patriotism, rather than profit, which seems to have motivated Lawrence and other faculty members to offer their services through the University to the OSRD."[5] In short, Seidel concludes that patriotism was the primary factor in mobilizing the University of California for the war.

My approach in Part III differs from Seidel's and endeavors to clarify the significance of government research contracts from the perspective of the universit y's finances, focusing on the overhead attendant on the contracts in order to examine the way the university handled them from the business side.

I. Linking Academia, Foundations, and Industry: Alfred Lee Loomis' Role[6]

On April 3, 1940, the Rockefeller Foundation's board of trustees awarded a grant of $1,150,000 to the University of California's Radiation Laboratory for the construction of a new 184-inch cyclotron. The foundation was staking its prestige on this project, the given purpose of which was to produce mesons artificially, thus substantiating theoretical predictions.[7] Loomis worked hard for this decision, maintaining a close relationship with Warren Weaver (1894–1978), the foundation's director of the natural sciences. Subsequently, he fulfilled such a significant role in the construction process that Lawrence called Loomis his "partner." I consider Lawrence's complete faith in Loomis, whose influence brought Lawrence

into contact with government science administrators, to have been among the factors that changed Lawrence's perception of the war situation, hence drawing the University of California's Radiation Laboratory into military research.

Loomis is a little-known figure. Henry L. Stimson, Secretary of War during World War II, was his cousin. Journalist Jennet Conant, granddaughter of then-president of Harvard University, James B. Conant, has published Loomis' biography, which makes it clear that he not only attained enormous wealth as a financier and enjoyed the friendship of major corporate heads, but also set up a private research laboratory in the New York suburb of Tuxedo Park. In the 1930s, he had a strong interest in microwave technology and worked in close connection with the Sperry Gyroscope Company to develop it. He conceived of using microwaves for remote detection of flying objects and for radio guidance of landing planes and was convinced that these technologies would be important for defense.[8]

In this part, I will analyze the records of the correspondence between Lawrence and Loomis in the Lawrence Papers held in the Bancroft Library on the Berkeley campus of the University of California to clarify Loomis' role in the Rockefeller Foundation's decision to support construction of the 184-inch cyclotron and also in procuring the materials for its construction.[9]

（1） The Berkeley Meeting

On Friday, March 29, 1940, a group of men gathered on the Berkeley campus. A photograph recording the occasion shows that those present, in addition to Loomis and Lawrence, were Vannevar Bush, director of the Carnegie Institution; Harvard University president James B. Conant; Massachusetts Institute of Technology president Karl T. Compton; and the latter's brother, Arthur H. Compton, professor of physics at the University of Chicago.[10] These men, well known to have been the government's science administrators, were deeply involved in creating the system for mobilizing American science and technology for defense. The Rockefeller Foundation was scheduled to hold a meeting of its trustees on April 3 to decide on grants to be awarded, including one for Berkeley's 184-inch cyclotron. Because the Berkeley gathering was held immediately before the foundation's grant-making decision, I believe it to have been a reevaluation meeting for the foundation. Weaver, the director of the Rockefeller Foundation, strongly desired that the trustees make a decision on a grant for the cyclotron's construction at this board meeting and wanted to obtain full backing to justify the plan.[11]

Documentary evidence indicates that the meeting in Berkeley was actually planned not by Weaver, but by Loomis at Weaver's request, substantiating the close relationship between the two. In a letter to Lawrence dated December 14, 1939, Loomis thanked him for his hospitality during Loomis' first visit to the Rad Lab and goes on to say that he had phoned Weaver in the morning and was planning to have lunch with him the same day. He promised Lawrence another letter after that meeting.[12] On December 21, Loomis reported that on the 14th he had spent the entire day with Weaver and that their discussion had been highly

interesting. Loomis also wrote that he had spent considerable time discussing the plan with Bush and had gained great confidence in it. He added that in mid-January he planned to spend a week at his private island in South Carolina with K. T. Compton, whose opinion, he felt, would be very significant in the future.[13]

Loomis' prediction seems to have been on target: Weaver attached importance to the anticipated comments from Compton, who was scheduled to attend the April 3 board of trustees meeting as a new member. Because of this, the week Compton presumably spent with Loomis, must have been an important opportunity for him to consider a variety of problems, including the technical feasibility of building a 184-inch cyclotron. The results of this visit appeared immediately in Compton's response to a questionnaire that Weaver sent on January 25 regarding approval for the plan. Compton replied that he was "most enthusiastic" about its feasibility and gave it his full support.[14]

In fact, Compton had first heard about the outlines of the plan from Lawrence at a meeting that included Loomis in late October or early November 1939, when Lawrence had been east for a meeting of the National Academy of Sciences.[15]

The specific date of Friday, March 29, 1940 first appears in a letter dated January 26 in which Loomis informed Lawrence that he had asked Compton, who would be lecturing in San Francisco on the evening of March 28, to keep Friday, March 29, open so that he might visit the Berkeley Radiation Laboratory.[16] This was followed by a letter dated February 6 in which Loomis included copies of Weaver's questionnaire and Compton's reply, which he felt would interest Lawrence. The letter included a brief hand-written note mentioning that he would be meeting with Weaver that afternoon.[17] Although he gives no details, the date of this meeting is noteworthy because Weaver had originally given up presenting the plan at the April board meeting due to a trip to Europe. The trip was cancelled, however, so he again decided to present it in April, recommencing work on the presentation at a February 8 meeting with Raymond B. Fosdick (1883–1972), president of the Rockefeller Foundation.[18] Coming immediately before this, and given the close relationship between Loomis and Weaver, it seems quite probable that Weaver's February 6 meeting with Loomis involved a detailed consultation on restarting preparations for the board meeting presentation.

Given this chain of events, I consider the March 29, 1940 meeting in Berkeley to have been a Rockefeller Foundation-sponsored reevaluation meeting that would have been impossible without Loomis' efforts to coordinate it. Thus, the Rockefeller Foundation's decision to finance construction of the 184-inch cyclotron brought Lawrence, through Loomis, close to the circle of science administrators who were creating the setup that would facilitate mobilizing American science and technology for defense.

(2) Purchasing Materials for the Cyclotron

Building the cyclotron was to begin with constructing an enormous magnet that would require 300 tons of copper and 3,700 tons of steel. As an investment

banker, Loomis had close connections with corporate heads, which he utilized to negotiate materials procurement and which enabled him to give Lawrence valuable advice. Naturally, Lawrence came to trust him fully and called Loomis his "partner" in the project.[19] This relationship between the two, and especially the role Loomis played as a "partner," is well substantiated by the tremendous volume of letters and telegrams they exchanged, not to mention telephone calls, for which no record exists. I feel that Lawrence's complete faith in Loomis gradually changed Lawrence's personal convictions and led him to accept that he could not avoid the war effort.[20]

I would like to examine Loomis' role in materials procurement in more detail. On May 1, a month after the Rockefeller Foundation's April 3 board meeting, Loomis had Lawrence and his right-hand-man Donald Cooksey (1892–1977), assistant director of the Rad Lab, come to New York and took them to visit major firms that Loomis had connections with that were in lines of business related to the project. Documents indicate that they met U. S. Steel Corporation's chairman, Edward Reilly Stettinius, Jr., and got him to promise to support the project. On that occasion, they were also introduced to the company's vice president, R. E. Zimmerman. On the same day, they met Luis S. Cates, president of the Phelps-Dodge Corporation regarding copper materials, who introduced them to Wiley Brown of Phelps-Dodge Copper Products Corporation. Much attention was paid to the quality of the materials. The steel was to be the lowest-carbon steel available, and the copper material was be high-conductivity copper known as PDCP.[21]

Because of the war in Europe, many difficulties were foreseen just in procuring the materials, but in the end, both companies agreed to supply Lawrence with the steel and copper materials he wanted, so Loomis' role that day was clearly highly significant. Choosing the suppliers, however, was subject to bidding, and insofar as the documents reveal, Loomis did not push Lawrence to select these firms, but throughout the negotiations, offered advice and kept watch over Lawrence's decision-making. When all the firms had laid their figures on the table and the time came for the final decision, however, Loomis provided decisive advice and personal assistance.

Next let us look at Loomis' advice regarding the steel and copper purchases. Shipping the heavy steel by rail would be more expensive than shipping by sea, but Loomis stressed the importance of rail transport on two counts: the risk of the steel plates getting bent during sea shipment and the dangers of sea transport due to the war. Loomis considered the latter point the most important, noting that sea transport would become very irregular in the next few months, that even merchant ships might be requisitioned for defense purposes, and that the Panama Canal might be closed to most commercial shipping.[22] Following Loomis' advice, Lawrence decided to have Columbia Steel Company, a branch of U. S. Steel, supply the steel material by rail at a flat rate of $244,000. On July 23, Cooksey wrote to Loomis reporting that the university regents had approved the contract that day.[23] Three days later, Lawrence informed Loomis that he was very pleased with

the contract because the price of the steel materials was $30,000 lower than their estimated budget.[24] This figure indicates not only that the contracted price was below Lawrence's projected budget but also that Columbia had knocked $20,000 off the initial bid of $264,000. Although Loomis' letters say nothing specific regarding this discount, he doubtlessly approached the company about it.

Let us next consider the procurement of the copper material that was needed to make the excitation coil of the mammoth electromagnet. The material was ordered with a view to forming the coils. Because of this, not only the unit price of the copper material itself, but also the precision and uniformity of the processing were important factors in deciding the contract. Documents indicate that 1/4 × 4 inch copper strips were to be wound in pancake-like layers that could be connected in various ways to form the coils.[25] In letters written on June 5, both Lawrence and Cooksey informed Loomis that they had decided on the dimensions of the copper strips in the following way: A 350 kW motor generator set owned by the University of California would be used as the power source to excite the coil, so the strips were to be 1/4 inch thick by 4 inches wide so as to get the "magnet resistance which will require the full voltage at full current rating of the 350 kilowatt generator."[26]

Once the shape had been decided, it finally became possible to order the copper. About 20 days earlier, Loomis wrote to inform Lawrence and Cooksey that he was engaged in serious negotiations regarding the copper materials with Chase Brass and Copper Company (a subsidiary of Kennecott Copper Company) and Phelps-Dodge Corporation.[27] After that, he sent them samples demonstrating the quality of the material and the precision of the processing. Clearly, Loomis was acting as an intermediary between Lawrence and the relevant firms in other ways as well. Finally, in early June, Cooksey (substituting for Lawrence, who was ill), accompanied by the university's engineer, W. B. Reynolds, and Edwin M. McMillan, a young scientist who had Lawrence's confidence, went east. At this point, the university regents had already given permission to enter into contracts for the steel and copper materials, and Lawrence hoped that while they were east, Cooksey and his team would consult with Loomis and conclude the contract procedures.[28] Nonetheless, it was only on June 25 that he was finally able to place the order for the copper with a corporation that Loomis had introduced and they had talked with on May 1.[29]

Without exaggeration, Lawrence obtained the steel and copper for his 184-inch cyclotron through Loomis. This was a role that only Loomis, the financier-scientist who enjoyed the friendship of major corporate executives, could fulfill, and it was certainly his role in procuring materials for the enormous machine that linked academia to the business world in this case. Because of the success of this relationship, Lawrence placed complete faith in Loomis, so it seems only natural that Loomis influenced him greatly.

II. Creating Military-Industrial-Academic Ties

It is common knowledge that the main projects based on wartime defense research contracts at the University of California's Rad Lab were related to developing a uranium bomb. However, in a letter dated October 3, 1940, Vannevar Bush (1890–1974), Chairman of the National Defense Research Committee, appointed Lawrence to Division D of the NDRC, which was chaired by Karl Compton and was concerned with radar development.[30] Lawrence was assigned to the D1 Section under Loomis, who was also vice-chairman of the division. The D1 Section was to develop microwave technology for radar, which required the same high-power, high-frequency oscillator tube technology that was used to form a high frequency magnetic field to accelerate charged particles on the cyclotron.

This part will examine Loomis' initiatives and Lawrence's response in order to trace the process through which development of a high-power, high-frequency oscillator tube led to defense research contracts between the University of California and the NDRC, which transformed heretofore free research within the university into secret defense research under the NDRC. When Bush wrote to Lawrence on October 3 informing him of his appointment to the NDRC, Bush emphasized that the work of the NDRC was highly classified and that Lawrence would have to preserve the maximum secrecy regarding everything he came in contact with as a committee member. Bush explained that the projects handled by the NDRC originated from the army and navy and that even within these services, only high-ranking officers could decide who should be informed of the research results. Because of this, member scientists could not discuss anything about their research with anyone except persons designated by the NDRC or its officially authorized representatives.[31]

(1) Pressure from Industry

David H. Sloan, a graduate student on loan to Berkeley from the General Electric Company since the summer of 1930, just after Lawrence invented the cyclotron, was in charge of developing the indispensable high-frequency, high-power oscillator tube. In May 1940, he was working on this with Lauriston C. Marshall of the university's electrical engineering department, creating what came to be known as the Sloan-Marshall tube, or the "resnatron." When informed in a letter from Cooksey dated May 14, 1940, that they had recently attained a peak output of 2.5 kW at a 50 cm wavelength,[32] Loomis immediately took action, writing to Lawrence and Cooksey on May 16 to tell them that microwave development had become very urgent due to the war and that he would provide details later.[33] Having received this letter, Lawrence wrote on May 25 asking Loomis what to do about the impending announcement of Sloan and Marshall's research results: They were scheduled to deliver a paper at the upcoming American Physical Society conference in Seattle and had already submitted an abstract.[34] Documents indicate that

Loomis contacted Lawrence by phone and also informed the Sperry Company of the state of Sloan and Marshall's research.[35] Subsequently, Sperry's head research engineer, H. Hugh Willis, contacted Lawrence and Marshall directly, saying that he would like to talk with Lawrence and Sloan about Sloan's microwave tube.[36] At the same time, Willis strongly urged that the resume not be published until he actually met Sloan and Marshall.[37] On June 19, Marshall sent Willis a telegram stating that the abstract contained no information that would be problematic but that he and Sloan would not attend the conference and would remain in Berkeley to welcome him.[38] This apparently resulted in obstructing Sloan and Marshall's conference presentation, effectively restricting publication of what had thus far been free academic research.

Although Lawrence, Sloan, Marshall, and Willis certainly must have met at Berkeley, the details of their discussion cannot be confirmed from documentary materials. However, a letter from Lawrence to Loomis written on June 25, presumably after this meeting, indicates that a new problem had arisen.[39] Namely, the Sperry Company had requested that Sloan and Marshall's microwave tube research, along with the researchers themselves, be transferred from the University of California at Berkeley to Sperry. Of course, Loomis had concurred in this plan, the grounds for which were to promote Sloan and Marshall's research.[40] As might be expected, however, Lawrence could not agree to this request, and in the June 25 letter to Loomis clearly expressed his consternation and judgment of the situation. He had discussed the matter with Loomis over the phone the previous evening and stated that after the call he had continued thinking about the matter and in the morning discussed it at length with Sloan and Marshall. The conclusion reached was that, at least for the time being, Sperry should not be allowed to handle the development of the Sloan-Marshall tube. Mentioning that he had already wired Loomis to that effect, he also made it clear that he failed to see the reason Loomis thought that development of the Sloan-Marshall tube would not make sufficient progress without Sperry's direct intervention.[41]

Loomis, however, had not given up, and in an attempt to get Lawrence and his associates to change their minds, appealed to Howard A. Poillon, chairman of Research Corporation. Research Corporation was a non-profit organization that actually held the patent for Lawrence's cyclotron by virtue of having provided research funds. It had granted non-exclusive licenses that enabled a variety of research organizations to construct cyclotrons. This corporation also held the patent for the X-ray tube developed by Sloan and had granted the University of California $4,500 to support the development of the Sloan-Marshall tube.[42] In a letter to Lawrence dated June 28, Poillon admitted that he did not know enough to make an independent judgment, but that in the current tense times there was considerable pressure to have Sloan and Marshall's work proceed with the greatest possible speed. He felt that a number of possibilities were conceivable, but stated that he wanted to protect the integrity of the research and researchers, adding that Research Corporation would be willing to consider changes in its

policy and program if it would facilitate rapid progress.

In this letter to Lawrence, Poillon had enclosed a copy of a letter sent to Marshall the same day. In the letter to Marshall, Poillon strongly encouraged Sloan and Marshall to transfer to Sperry's San Carlos laboratory. He noted that Loomis and Sperry had agreed to this proposal, explaining that the reasoning behind it was the Sloan-Marshall tube's potential relationship to national defense. He stressed that not only Loomis, but Bush and K. T. Compton of the NDRC were of the same opinion. In this letter, he also said that he would be grateful if Marshall would inform him about Sperry's development plans and the role Sloan and Marshall would play in them. Stating that he knew nothing about the situation, he wanted to know more clearly how completion of the Sloan-Marshall tube related to it.[43]

Here Poillon honestly revealed that he had taken Loomis at his word and was acting with no understanding of the situation. One wonders how Lawrence and his associates must have viewed this. That circumstances did not allow them to ignore this proposal completely becomes clear from a July 1 letter in which Lawrence brought Loomis up to date. Lawrence wrote that on the previous Friday, Sloan and Marshall had visited Sperry's San Carlos laboratory and found that it clearly did not have the equipment to enable the Sloan-Marshall tube to be completed quickly. In particular, it lacked the shop facilities for working with the heavy machine tools that would be necessary to produce the power oscillator tubes. He went on to say that the best way to speed up the development would be to expand the equipment in Berkeley's machine shop using money from the 184-inch cyclotron budget. He added that this should present no problem, since the equipment would not be needed for the cyclotron until the following spring.[44]

With Lawrence this insistent that the Sloan-Marshall tube be developed at Berkeley, Loomis stopped trying to persuade Sloan and Marshall to move to Sperry. On July 9, Loomis wrote to Lawrence reporting that on the previous evening he had had dinner with people from Sperry, including Willis, and that all looked forward to progress at Berkeley and would do anything they could to help.[45] Superficially, Loomis acted as if he had accepted Lawrence's plan, but this did not mean that he had given up on intervening directly in the development of the promising Sloan-Marshall tube, and, in fact, he already had another means to this end up his sleeve.

The significance of this request for a change in the research base bears examination. To what extent Lawrence and his associates were aware of the implications of their refusal remains unclear, but I consider their refusal extremely significant because it demonstrates that, at this juncture, researchers still had the freedom to refuse such a request. The question arises of what situation development of the Sloan-Marshall tube would have been placed in had it been transferred to Sperry at this time. As his letters indicate, Loomis focused on the Sloan-Marshall tube because he saw its potential as an important component of defense technology for the war. Sperry had also been working on microwave research

from the same perspective as Loomis. Loomis must have felt that rather than have this research done in a university, where it would be predicated on the publication of the results, it would be better to have it done in a situation where the results could remain an unpublished company secret. Because of Lawrence's refusal to transfer the project to Sperry, Loomis' desire to be directly involved in developing the Sloan-Marshall tube seems to have led to a defense research contract concluded by the NDRC and the University of California.

(2) Toward Research Contracts with the NDRC

On June 27, 1940, The National Defense Research Committee was set up under the Council of National Defense by order of President Roosevelt. In his letter of July 9, Loomis had asked Lawrence if he could take responsibility for organizing the microwave tube development project on a large scale and carrying it out as a major University of California defense research project. Regarding research funds, Loomis felt that, if unobtainable from other sources, the NDRC would probably be able to provide anything that was essential.[46] As discussed above, however, at this juncture Lawrence was probably totally unable to consider becoming responsible for a major defense research project of the University of California such as Loomis was proposing. He asked Loomis, who was gradually becoming absorbed in defense research on microwave technology, not to forget that he was a partner in constructing the 184-inch cyclotron, which seems to have been Lawrence's overriding concern at this point.[47]

Nonetheless, as will be discussed below, the University of California as a business organization had already made its own decision on defense research contracts with the NDRC and was handling the situation accordingly.

Let us examine how the development of the Sloan-Marshall tube was transformed into military research under the NDRC, e.g. the process leading up to Lawrence's appointment to the NDRC insofar as it is revealed by correspondence between Loomis and Lawrence.

In a letter written on July 16, Loomis expressed his delight that the University of California had made the Sloan-Marshall tube, one of its important defense research projects. He also informed Lawrence that he had advised Research Corporation's Poillon, who planned to visit Berkeley in a few days, to bring back all the documents necessary to provide the data needed to apply to the NDRC for financial support. Loomis also referred to internal procedures, adding that for the university's application to be approved by the main body of the NDRC, it would first be necessary to get the approval of the members of the microwave section.[48] After Poillon's return from Berkeley, Loomis met with him and on July 30 wrote to inform Lawrence that he had received Poillon's report on the latest information from Berkeley and would submit it to the NDRC the next day. In this letter, he said that he hoped to get NDRC funding as quickly and smoothly as possible,[49] probably because he knew that Lawrence's all-out support for Sloan and Marshall's research was a considerable financial burden for Lawrence. In fact, not

only was Lawrence purchasing equipment for the machine shop, but he was also drawing on his private research funds to hire two shop assistants to help speed up the research.[50] In his July 30 letter, Loomis had included a $2,000 check from his private research institute.

In mid-August, Loomis told Lawrence that he was confident of obtaining $20,000 in research funds from the NDRC.[51] Nonetheless, the summer passed into autumn without any change. On September 17, Loomis wrote to Lawrence informing him that a number of different laboratories were concurrently working from several different perspectives on the problem of obtaining high power for microwaves, because of which the Sloan-Marshall tube would have to face considerable competition for funds. He pointed out that for defense purposes it clearly had also become very important that the microwave oscillating tube have an extremely high power output of over 1,000 megacycles frequency [with a wavelength of 30 cm].[52] Despite the stiff competition, on September 24 Loomis was able to inform Lawrence that he was overjoyed to report that the desired funds for the Sloan-Marshall tube had been obtained very smoothly.[53] Thus, just as Loomis had wanted, development of the Sloan-Marshall tube was incorporated into the defense research program of the NDRC that he was directly involved in. In consequence, as the University of California's head scientist, Lawrence was relieved of the burden of financial support for the research and he was appointed to the NDRC.

I consider the main factors transforming the development of the Sloan-Marshall tube at Berkeley into defense research to have been the creation of the NDRC and the university's policy on entering into research contracts with that organization. Lawrence had unwavering faith in Loomis with regard to the 184-inch cyclotron and also had come to feel certain of America's participation in the war. As we have seen, however, Loomis' intentions and those of the researchers were not necessarily always in agreement. For this very reason, the existence of the NDRC's research contract system and the stance of the university as party to the contracts take on great significance in the militarization of science at the University of California.

III. Research Contracts and Overhead at the University of California

The University of California not only undertook defense research during World War II but continued doing so thereafter, as well. The situation during the war is elucidated by the research contracts the university entered into with the NDRC and the OSRD, which was set up in June 1941. According to data for June 30, 1945, the University of California had 106 contracts with the OSRD, far more than any other university or research institution apart from corporate research laboratories. Of course the number of contracts does not necessarily reflect the total value of the contracts, and the same data notes that in this respect the Uni-

versity of California ranked 5th at $14,384,506.98. Massachusetts Institute of Technology, which was in charge of radar development, topped the list with 75 contracts worth a total of $116,941,352.05, followed by California Institute of Technology, Harvard University, and Columbia University.[54]

In this section, I will examine the university's handling of the overhead related to research contracts. Discussion of this issue should be predicated on the financial situation the university faced in the 1930s, during the Great Depression, when the university's income from the State of California was reduced by 25%.[55] The Report of the President of the University of California for 1932–1934 reveals that:

> In the year 1933–34, State funds available for research purposes under the Board of Research amounted to $76,500 as compared to $97,495 in the previous year, and considerably less than in other recent years. Also…diminished, have been supplementary donations from outside sources in support of various individual and departmental research projects…
>
> The aim in respect to University research has been to restrict its prosecution for the present to the most essential investigations. But the severe reductions under the present budget are hampering progress even on important projects. The State appropriations are barely sufficient to take of current research programs. They do not adequately provide for undertaking new work.[56]

Being faced with financial limitations to this extent forced a change in research conditions within the university, most notably creating the need to obtain research funds from elsewhere. Even before a Board of Research meeting held on October 6, 1933, many university researchers had already applied for extra-mural support for their projects. At this meeting, four conditions for outside research funds were discussed, namely that:

> a. Full rights as to publication should be reserved by the University, in accordance with established policy; b. Arrangements as to funds should be clearly defined, the account to be handled by the Comptroller; c. The fund should be listed as a donation for research, not as a fellowship; d. Statements as to direction and coordination of work should be clarified, with full rights in this respect reserved to the University.[57]

Clearly, at this juncture, Robert Gordon Sproul, who served as university president from 1930–1958, was clearly cognizant that these rights must be reserved to the university in order for it to fulfill its role in society as a state university.

Further light is shed on the university's financial situation by an article by John A. Douglass titled "The University of California and Four Periods of Fiscal Crisis: 1868–1960," in which he discusses the way financial issues influenced the university's history. The third of the crises falls during the Depression years of the 1930s. Douglass presents the following figures for this period. In its semi-annual budget for 1932, the state of California was able to get only 72% of the income necessary to maintain public utilities. Because of this, the governor adopted a thoroughgoing stringency policy, which also affected the University of

California. In 1933, the state subsidy to the university was reduced by 24%, from some $8,000,000 to around $6,000,000. Naturally, the university undertook to reduce expenses drastically, including cutting down the number of faculty and slashing salaries by about 12%.[58] At the same time, the student enrollment at the tuition-free university increased by 25% over a period of 10 years, rising from 21,000 in 1932 to 29,000 in 1939, increasing the university's expenditures. Simultaneously, the student-teacher ratio rose from 17: 1 to 21: 1, increasing the burden on faculty.[59]

When he took office in 1930, Sproul foresaw a lengthy depression and considered a business management policy to see the university through it. On the basis of recommendations from the academic senate's budget committee and a newly established policy committee, Sproul and the regents proposed three ways to deal with the situation: 1) reducing the number of students, the total number of faculty, and expenditures; 2) reducing faculty salaries, which made up a large part of operating expenses; and 3) setting tuition fees for the first time in the university's history. According to Douglass, the proposal to set tuition fees was rejected due to a growing feeling among the state's citizens that the university had become the home of elitists and no longer reflected the desires of the people. Regarding reducing the student enrollment, competition with the state colleges to get students resulted in actually increasing enrollment.[60]

The only remaining choice was to reduce the number of faculty and cut back faculty salaries and other expenditures. Douglass does not analyze the results in detail, presumably because his purpose was to consider the university's financial crises in a broad context, but for the purposes of this paper, which seeks to find the origins of the military-industrial-academic complex, and particularly the inclusion of academia, in the depression years of the 1930s, elucidation of this point becomes important. Focusing on the University of California's internal circumstances, and particularly on areas directly involved in education and research, this paper will look at how the university responded to the financial crisis and how this subsequently affected the nature of the university.

Although a thorough analysis of the University of California's financial situation at the time is not possible in this paper, the probable relation to university finances should be kept in mind as we examine the research contract setup and overhead on those contracts as revealed in the available material, primarily the record of an interview with Robert M. Underhill[61] and the papers of Robert G. Sproul, University of California president during this period.[62]

（1） Underhill and Defense Research Contracts

Robert M. Underhill (1893–1988) was the central figure in creating the University of California's setup for receiving research contracts. When Robert G. Sproul (1891–1975) became university president in 1930, Underhill was appointed secretary of the Regents, and in 1933 was also named treasurer of the Regents. This team continued working together from 1930 until Sproul retired in 1958.[63]

Let us examine the research contract system as Underhill described it to Norberg. Underhill first got interested in research contracts sometime around November 1940, when he visited MIT and learned that they had 1,400 people working in a laboratory to develop radar under a research contract with the NDRC. Witnessing the way these contracts were changing MIT seems to have awakened him to the significance they could have for the business side of the university. Heretofore uninterested in research contracts, Underhill now became enthusiastic about them and at that point began to create a system for handling them within the university. (In May the next year, Sproul would write to J. H. Corley, the university comptroller, that he, too, was enthusiastic about the university acting as a business agent.)[64]

On returning to California, Underhill immediately informed Sproul of the situation at MIT and, with Sproul's support, also reported it to the Finance Committee, the Regents' most powerful committee, which was composed of the university president, an attorney, the treasurer, and the secretary of the Regents. But because Underhill was serving as both treasurer and secretary of the Regents, only three people actually deliberated the research contracts, and he was given authority to handle urgent situations without holding a meeting of the Finance Committee. They set up a Secret Defense Committee on campus, and, as its chairman, Underhill was put in charge of defense contracts. According to Underhill's account, in emergencies he sought advice from the faculty member interested in accepting the contract or the head of the relevant department (chemistry, physics, engineering, and Lawrence of the Rad Lab), and an attorney, but not from other faculty members. When the United States entered the war in December 1941, the name of this committee was changed to the War Committee and faculty members were included.[65] This course of events indicates that the University of California began mobilizing for defense even before America entered the war by creating this system for handling research contracts.

In the interview, Underhill states that his standards for accepting a research contract were the presence of staff to carry it out, that it was a scientific project, that the university had the space to carry it out, that sufficient electricity was available, and that it would place no financial burden on the university.[66] At another point he states that the university had an obligation to comply with the government's requests, so he had no interest in the nature of the projects to be handled under the contracts. His overriding concern was that the university would suffer no financial losses from them, a problem he solved by having payment made in advance.[67] In other words, he did not question the content of research contracts that were military secrets and, in the face of the emergency, he was given the authority to reply to a request received by telegram in the morning with a telegram of acceptance the same afternoon.[68] These two statements make it clear that his overriding concern was to protect the university from any form of damage, including financial liability. Herein seems to lie the true nature of research contracts for the university as a business organization, and they must

certainly have provided it with a source of income.

（2） The Handling of Overhead Reveals the Intrinsic Value of Research Contracts

I have turned my attention to the question of overhead in the research contracts because it seems to provide a clue to the true nature of government research contracts for the university. Arthur L. Norberg, Underhill's interviewer, states that setting overhead costs was one of the most difficult problems with regard to concluding contracts between the university and the government during the war.[69] If research contracts were a means for the university to secure funds, naturally the university would be intent on obtaining large amounts for overhead. Let us first examine how Sproul and Underhill handled overhead.

First, the term "overhead" needs clarification. Underhill explains that it referred to the administrative costs to the university in implementing the contract.[70] In another place, he says that when drawing up a contract in line with government directions, he included a figure for overhead that satisfied him, because the university had no refined cost-accounting system.[71] He also says that federal law allowed no more that 7% of a contract's value for overhead, but there was no legal restriction on adding overhead to salaries that were part of the expenses related to the contract.[72] In the early years of the research contracts that Underhill discusses, this lack of regulatory accounting and legal systems seems to have made it possible to set overhead at 50%. Because this provided a source of income for the university, it also functioned to make it easier for the government to mobilize the university for defense purposes. The question, however, is how the use of overhead was discussed and what policy was set within the University of California. Norberg does not pursue this question in depth, but it is one important indicator of whether research contracts were a means for the university to secure income. Another important indicator pertains to how the university responded when the rate was reduced from 50%. These two points will be examined below.

When asked how overhead was handled, Underhill replied clearly that the overhead on research contracts was put into the university's general funds, but because he was not involved in budgeting, he had no knowledge of how the money was used.[73] Six months had elapsed since Underhills's MIT visit when the university administration discussed establishing a policy for handling overhead. In a memo to Sproul written on April 29, 1941, the university's chief accountant, Olof Lundberg, wrote that on defense contracts, "a sum equal to fifty percent of the expenditure for salaries and wages may be set aside as an allowance for overhead." With a few government contracts in the past, this figure had been 10%, but these funds were not spent by departments or individuals associated with the research but, after deducting a bit of sales tax, were considered to be in the same category as university revenue. Given that adjustments would probably be needed later, he felt that some kind of arbitrary regulations should be adopted and made three recommendations: 1) Divide into two separate accounts the overhead

allowance based on estimates for salaries and wages to be paid under the research contract; 2) One of these would be used at the discretion of the department or individual responsible for the project, under the condition that expenditures be specifically approved by the business manager on the campus concerned; 3) The other part should be reserved for transfer to general income and used for accounting, attorneys' time, and other management expenses that are not included in the estimate of costs under the contract.[74]

Sproul, however, replied immediately indicating his disagreement with this suggestion. Sproul felt that basically all the overhead attached to a research contract should be placed in the general funds of the university, apportioned only where there was a demonstrable need, and reverted to the general funds if not used for the stated purpose. Sproul directed Lundberg to consult with the university comptroller, James H. Corley, about this issue.[75] During May and June, Underhill and other members of the university administration who were concerned with the problem exchanged their views on the issue.[76]

Corley, for example, wrote to Lundberg on June 9 expressing agreement with Lundberg's proposal, suggesting that: 1) overhead be divided into two parts; 2) one part be kept in reserve for any emergency situations that might arise in the course of carrying out the contract; and 3) the other part be allotted to the general overhead costs of the university. With regard to 2), however, the money should be paid out upon approval of the local business manager on the campus where the project would be carried out, and with regard to 3), the allotments for all research contracts should be put into one account for the university as a whole and used for administrative expenses of the university.[77] Corley's proposal differs slightly from Lundberg's. Although both proposed dividing overhead costs into two parts, they differ regarding 2). Whereas Lundberg had left the use of this part to the discretion of the department or individual implementing the contract, Corley's proposal was to reserve this part for emergencies.

It seems that the matter of this slight difference was solved by a letter from Corley dated June 25 and titled "Overhead Allowance on Defense Contracts," in which he lays out the following as his own ruling: Under the contract, the only expenditures allowed to the department or individual responsible for carrying it out are those for the necessary equipment and materials and for the salaries and wages of essential assistants; there is no allotment whatsoever for overhead expenses associated with the project. Should the costs be estimated at too low a figure and additional research funds become necessary, application for additional funds will probably be made to the government through the local business manager.[78] In short, although opinions were exchanged among the university personnel concerned, this letter confirms the policy outlined in Sproul's May 1 letter. Namely, the university as a business organization decided to put all overhead on research contracts into the university's general funds, which seems to confirm my contention that the university considered research contracts as a means to obtain income. Presumably, this was not only Sproul's view but also that of Underhill,

who, as a member of the Finance Committee, served as secretary and treasurer to the Regents.

Let us now consider the second point, namely the reduction in the overhead rate and the university's response. This was not necessarily a disadvantageous change, at least not for the University of California, and it is unrelated to the question of patriotism that Seidel points to.

The overhead ratio was actually changed as of July 1942,[79] but it seems that a variety of issues pertaining to research contracts, including overhead, were being deliberated by a reviewing committee in the fall of 1941, a year and four months after the NDRC was set up.[80] Documentary evidence indicates that in connection with this review, Walter A. Jessup, chairman of The Carnegie Foundation for the Advancement of Teaching, had instructed Purdue University controller R. B. Stewart to look into the problems NDRC contracts were creating on a number of campuses, including the University of California. On October 11, 1941, Stewart wrote to Jessup reporting the results of the conferences he had held for this purpose.[81] Stewart's report stated that it was impossible and unfair to apply to all NDRC research contracts a universal rule that overhead be set at 50% of total salaries, wages, and social security taxes. Another problem he pointed out was that the cost of hazard insurance for those employed was being included in overhead costs rather than direct expenses.

Subsequently, R. B. Stewart, Underhill, University of Illinois comptroller Lloyd Morey, and MIT treasurer Horace Ford were asked to prepare a report as special advisors to Vannevar Bush, head of the Office of Scientific Research and Development, and frequent exchanges between these four advisors and Irvin Stewart, executive secretary of the OSRD, were still taking place well into February.[82] In January 1942, prior to the completion of their report, however, I. Stewart warned Sproul that the ratio of overhead on major research contracts exceeding $150,000 would be changed.[83]

In the meanwhile, in March, Underhill advised Sproul that no adjustments should be made in overhead arrangements until after the OSRD advisors' report was completed and Bush initiated changes.[84] Underhill's advice seems to reveal the essence of the university's insistence on 50% overhead on research contracts, in other words that it used this policy as a means to procure income for the university itself. Nonetheless, in April Bush informed Sproul that a new system would take effect as of July 1.[85]

On August 20, Underhill wrote to inform Irvin Stewart that he had agreed to the new scheme of 30% overhead on research contracts that started on July 1. In this letter, Underhill reconfirms that the cost of employees' compensation insurance would be covered as direct expenses rather than being paid from overhead, as had been the practice thus far.[86] Underhill's insistence on this point implies that this policy would help minimize the reduction in the amount of overhead that could be put into general university funds under the new 30% rate, especially because the new system was imposed at a time when the number of people em-

ployed in the research was expected to rise, thereby increasing insurance expenditures.

In short, given that the University of California seems to have been in a position to set the particulars of the arrangement, it appears that the change in the overhead ratio was not necessarily disadvantageous to the university. The question of overhead on research contracts was one of many issues that arose when the university used these contracts as a source of income, and at the same time, it was also an incentive that the government could use to mobilize the university to undertake defense research.[87]

Conclusion

In conclusion, I would like to confirm the significance and purpose of this paper in light of outgoing President Dwight D. Eisenhower's *Farewell Address,* delivered on January 17, 1961.

> We now stand ten years past the midpoint of a century that has witnessed four major wars among great nations. Three of these involved our own country. Despite these holocausts, America is today the strongest, the most influential, and most productive nation in the world. Understandably proud of this pre-eminence, we yet realize that America's leadership and prestige depend, not merely upon our unmatched material progress, riches, and military strength, but on how we use our power in the interests of world peace and human betterment.[88]

Despite Eisenhower's hopes, however, America has continued to wage wars throughout the world using the most powerful military force it could obtain. One of the factors in this has been the military-industrial-academic complex that America established through World War II. In the period between the two world wars, movements were already afoot to change the role of science and technology in society. Valuable research has been done on this point by scholars such as Robert Kargon and Elizabeth Hodes, who point out that:

> Between the two world wars, there emerged within the scientific community of the United States a powerful and effective leadership whose attitudes on important issues underwent a significant evolution in the course of the two decades. Just as an ideological shift occurred among some influential and outspoken businessmen, academics, and others concerned with the relationship between industry and government, the staunch "laissez-faire" views of the earlier scientific leaders gave way to attitudes more receptive to government support for science and for long-range planning in science. In industry, "corporate liberals", drawing on the experience of the war, attempted to replace an ideology of competition with one of market stability and (within limits) of cooperation and planning. Wanting to rationalize their economic situation, they attempted to forge a new alliance with government and to impose the corporate model on other segments of society. One area that began to respond to the call for organization building and intersectorial planning was the scientific enterprise itself.[89]

The question is how the changes indicated by Kargon and Hodes developed

during the depression years and from the late 1930s up to the war. Shuhei Okuyama points out that some of the changes in the socioeconomic foundations of science and technology that were promoted by a special kind of coercion during the war were built into the social structure after the war's conclusion, making it impossible to think of postwar policy without them.[90] He goes on to say that America's system of national monopolistic capitalism seems to have begun in the New Deal era and taken form through the Second World War, eventually taking the form that became the military-industrial complex.[91] Okuyama, too, sites Eisenhower's parting address in discussing the decisive changes that took place in the socioeconomic foundations of science and technology in American society.

Eisenhower also spoke about the need for an enormous military organization and defense industry in order to maintain the peace:

> A vital element in keeping the peace is our military establishment. Our arms must be mighty, ready for instant action, so that no potential aggressor may be tempted to risk his own destruction. Our military organization today bears little relation to that known of any of my predecessors in peacetime, or, indeed, by the fighting men of World War II or Korea.
> Until the latest of our world conflicts, the United States had no armaments industry. American makers of plowshares could, with time and as required, make swords as well. But we can no longer risk emergency improvisation of national defense. We have been compelled to create a permanent armaments industry of vast proportions. Added to this, three and a half million men and women are directly engaged in the defense establishment. We annually spend on military security alone more than the net income of all United States cooperations ·· corporations.
>
> Now this conjunction of an immense military establishment and a large arms industry is new in the American experience. The total influence ·· economic, political, even spiritual ·· is felt in every city, every Statehouse, every office of the Federal government. We recognize the imperative need for this development. Yet, we must not fail to comprehend its grave implications. Our toil, resources, and livelihood are all involved. So is the very structure of our society.[92]

Okuyama goes on to point out that Eisenhower's "warning" led to discussion of the evils of the military-industrial complex, but Eisenhower did not criticize the problems inherent in the military-industrial complex per se. Rather, he recognized it as a given "imperative" to be dealt with. Okuyama states that for historical research this point needs to be elucidated.[93]

I concur with Okuyama's incisive view. Because of this, I have examined the formation of the military-industrial academic complex in relation to the University of California, where the cyclotron was invented. This machine for studying the atomic nucleus launched the era of Big Science. The resulting need for funds during the depression years led to the formation of the military-industrial-academic complex, and through the war years, to the militarization of science.

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Notes

1 Shizue Hinokawa, *Saikurotoron kara genbaku e* (From the cyclotron to the atomic bomb), (Tokyo: Sekibundo Shuppan, 2009).
2 Osamu Kanamori, *Kagaku no kiki* (Science in crisis), (Tokyo: Shueisha, 2015). For a similar work in English see James S. Allen, *Atomic Imperialism: The State, Monopoly, and the Bomb* (New York: International Publishers, 1952).
3 R. W. Seidel, "The University of California and the Mobilization of Science for National Defense," Paper submitted to a workshop on a Decade of Innovation/Los Alamos, Livermore and National Security Decision making [sic] in the 1950's, Livermore, CA, February 19–21, 1992, pp. 1–2, accessed Dec. 9, 2015.
http://www.osti.gov/scitech/biblio/5831759
4 *Ibid.,* p. 5.
5 *Ibid.,* p. 7.
6 Hinokawa Shizue, "Kariforunia Daigaku Hoshasen Kenkyujo henbo no kigen wo saguru — Alfred Lee Loomis no eikyo wo chushin ni," (The origins of changes in the University of California's Radiation Laboratory focusing on Alfred Lee Loomis' influence), *Kagakushi Kenkyu* (*Journal of History of Science, Japan*) 51, no. 264 (2012), pp. 199–209.
7 Hinokawa Shizue, "Rokkufera Zaidan ni yoru 184-inchi no saikurotoron keikaku e no enjyo ketei katei," (The Rockefeller Foundation's decision-making process in funding the 184-inch cyclotron project), *Kagakushi Kenkyu* (*Journal of History of Science, Japan*) 45, no. 238 (2006), pp. 81–91.
8 Jennet Conant, *Tuxedo Park: A Wall Street Tycoon and the Secret Palace of Science That Changed the Course of World War II* (New York: Simon & Schuster Paperbacks, 2002).
9 BANC film 2248, reel #70. Ernest O. Lawrence Papers, Carton 46, folder 8. "Personal — Loomis, Alfred L. 1939–40," The Bancroft Library (TBL), University of California, Berkeley.
10 Berkeley Meeting, University of California, Berkeley (March 29, 1940). The Manhattan Project, an interactive history, U. S. Department of Energy-Office of History and Heritage Resources, accessed May 6, 2018.
https://www.osti.gov/opennet/manhattan-project-history/Resources/photo_gallery/berkeley_meeting.htm
11 Weaver to Rockefeller Foundation president Raymond Fosdick, January 25, 1940, and Weaver to K. T. Compton, January 25, 1940, folder 182, box 12 series 205D, RG1.1, Rockefeller Foundation Archives, Rockefeller Archive Center, Sleepy Hollow, New York (RAC).
12 Loomis to Lawrence, December 14, 1939, Carton 46, folder 8, Ernest O. Lawrence Papers, TBL.
13 Loomis to Lawrence, December 21, 1939, Carton 46, folder 8, Ernest O. Lawrence Papers, TBL.
14 K. T. Compton to Weaver, January 29, 1940, Carton 46, folder 8, Ernest O. Lawrence Papers, TBL.
15 Lawrence to Loomis, November 7, 1939, Carton 46, folder 8, Ernest O. Lawrence Papers, TBL.
16 Loomis to Lawrence, January 26, 1940, Carton 46, folder 8, Ernest O. Lawrence Papers, TBL.
17 Loomis to Lawrence, February 6, 1940, Carton 46, folder 8, Ernest O. Lawrence Papers, TBL.
18 Warren Weaver, officer's diary excerpt, folder 183, box 12, series 205D, RG1.1, Rocke-

feller Foundation Archives, RAC.

19 Lawrence to Loomis, May 20, 1940, Carton 46, folder 8, Ernest O. Lawrence Papers, TBL.

20 As of September 1939, Lawrence considered the outbreak of war in Europe a tragedy and, hoping that it would not last long, felt that America would not get involved. (Conant, *op. cit.,* See note 8, p.141). But by May 1940, Lawrence had changed his view and stated that he completely concurred with Loomis on the need to create a system for mobilizing science and technology for defense (Lawrence to Loomis, May 20, 1940, Carton 46, folder 8, Ernest O. Lawrence Papers, TBL).

21 W. B. Reynolds, "Memorandum on the 184″ Cyclotron," June 16, 1945, Carton 29, folder 4, Ernest O. Lawrence Papers, TBL.

22 Loomis to Lawrence, July 9, 1940, Carton 46, folder 8, Ernest O. Lawrence Papers, TBL.

23 Cooksey to Loomis, July 23, 1940, Carton 46, folder 8, Ernest O. Lawrence Papers, TBL.

24 Lawrence to Loomis, July 26, 1940, Carton 46, folder 8, Ernest O. Lawrence Papers, TBL.

25 Reynolds, *op. cit.,* See note 21.

26 Lawrence to Loomis, June 5, 1940 and Cooksey to Loomis, June 5, 1940, Carton 46, folder 8, Ernest O. Lawrence Papers, TBL.

27 Loomis to Lawrence and Cooksey, May 16, 1940, Carton 46, folder 8, Ernest O. Lawrence Papers, TBL.

28 Lawrence to Loomis, Cooksey to Loomis, *op. cit.,* See note 26.

29 Lawrence to Loomis, June 25, 1940, Carton 46, folder 8, Ernest O. Lawrence Papers, TBL.

30 Bush to Lawrence, October 3, 1940, Carton 27, folder 2, Ernest O. Lawrence Papers, TBL.

31 *Ibid.*

32 Cooksey to Loomis, May 14, 1940, Carton 46, folder 8, Ernest O. Lawrence Papers, TBL.

33 Loomis to Lawrence and Cooksey, May 16, 1940, *op. cit.,* See note 27.

34 Lawrence to Loomis, May 25, 1940, Carton 46, folder 8, Ernest O. Lawrence Papers, TBL.

35 Loomis to Lawrence, May 28, 1940, Carton 46, folder 8, Ernest O. Lawrence Papers, TBL.

36 Willis to Lawrence, June 5, 1940, Carton 16, folder 29, Ernest O. Lawrence Papers, TBL.

37 Loomis to Lawrence, June 18, 1940, Carton 16, folder 29, Ernest O. Lawrence Papers, TBL.

38 Marshall to Willis, June 19, 1940, Carton 16, folder 29, Ernest O. Lawrence Papers, TBL.

39 Lawrence to Loomis, June 25, 1940, *op. cit.,* See note 29.

40 H. A. Poillon to P. R. Basset of Sperry Company, June 26, 1940, Carton 16, folder 29, Ernest O. Lawrence Papers, TBL.

41 Lawrence to Loomis, June 25, 1940, *op. cit.,* See note 29.

42 Poillon to Basset, June 26, 1940, *op. cit.,* See note 40.

43 Poillon to Lawrence and Poillon to Marshall, June 28, 1940, Carton 16, folder 29, Ernest O. Lawrence Papers, TBL.

44 Lawrence to Loomis, July 1, 1940, Carton 16, folder 29, Ernest O. Lawrence Papers, TBL.

45 Loomis to Lawrence, July 9, 1940, *op. cit.,* See note 22.

46 *Ibid.*

47 Lawrence to Loomis, June 5, 1940, *op. cit.,* See note 26.

48 Loomis to Lawrence, July 16, 1940, Carton 16, folder 29, Ernest O. Lawrence Papers, TBL.

49 Loomis to Lawrence July 30, 1940, Carton 16, folder 29, Ernest O. Lawrence Papers, TBL.

50 Lawrence to Loomis, June 5, 1940, *op. cit.,* See note 26.

51 Loomis to Lawrence, August 12, 1940, Carton 16, folder 29, Ernest O. Lawrence Papers, TBL.

52 Loomis to Lawrence, September 17, 1940, Carton 16, folder 29, Ernest O. Lawrence Papers, TBL.

53 Loomis to Lawrence, September 24, 1940, Carton 16, folder 29, Ernest O. Lawrence Papers, TBL.

54 James Phinney Baxter 3rd, *Scientists Against Time* (Cambridge, Massachusetts, MIT Press), Paperback Edition, August 1968. Appendix C (pp. 456–7).

55 University of California, University of California Digital Archives, Robert Gordon

Sproul, accessed August 20, 2015.
http://www.lib.berkeley.edu/uchistory/general_history/overview/presidents/index2.html

56 Robert Gordon Sproul, "Report of the President of the University of California 1932–1934", University of California Bulletin, Third Series, Berkeley, December 1, 1934 • Vol. XXVIII, No. 10, p. 15, Call number: 308 de, Note: Report of the President/University of California, TBL.

57 University of California, Board of Research, Minutes of the Meeting of Oct. 6, 1933. Call number: CU–5, Ser. 2. Container/page: 1933: 354–420 (1933: 382). Note: University of California President, TBL.

58 John A. Douglass, "The University of California and Four Periods of Fiscal Crisis: 1868–1960", Fiscal Crisis in Historical Perspective: A Conference of the All-Group in Economic History, April 8, 9, and 10, 1994. P. 20, Table 4: UC Operating Income and Expenditures: 1901–1940. Location: Main (Gardner) Stacks, Call number: HB 3722. F57 1994.

59 Douglass, *ibid.,* p. 22, Table 6: UC Student Enrollment: 1868–1960.

60 Douglass, *ibid.,* pp. 21–23.

61 Robert M. Underhill, "Contract Negotiations for the University of California," interviewed by Arthur Lawrence Norberg, Copy No. 1, Call number: 79/126 C (History of Science and Technology Program, the Bancroft Library, University of California, Berkeley, 1979). This interview, which focuses on the early years of World War II, was conducted on February 10, April 27, and June 1, 1976, by Arthur L. Norberg, coordinator of the Bancroft Library's "History of Science and Technology Program" under a special grant awarded in 1975 from university contributions. Its purpose was to record the relationship between the University of California and the Los Alamos Scientific Laboratory, which was established to develop America's atomic bomb.

62 Call number: CU–5, Ser. 2 University of California President. Container/page: 1941: 741–751. Note: folder: 1941: 746 Contracts-Defense Research and Development (1/2), TBL.; Call number: CU–5, Ser. 2 University of California President. Container/page: 1941: 741–751. Note: folder: 1941: 746 Contracts-Defense Research and Development (2/2), TBL.

63 Arthur Lawrence Norberg in introduction to Underhill, *op. cit.,* See note 61, p. vi.

64 Sproul to J. H. Corley, May 3, 1941, *op. cit.,* See note 62, (1/2).

65 Underhill, *op. cit.,* See note 61, pp. 11–15, p. 23.

66 Underhill, *op. cit.,* See note 61, p. 12.

67 Underhill, *op. cit.,* See note 61, p. 16.

68 Underhill, *op. cit.,* See note 61, pp. 12–23.

69 Norberg, *op. cit.,* See note 61, p. iv.

70 Underhill, *op. cit.,* See note 61, p. 24.

71 Underhill, *op. cit.,* See note 61, p. 27.

72 Underhill, *op. cit.,* See note 61, pp. 25–26.

73 Underhill, *op. cit.,* See note 61, p. 27.

74 Lundberg to Sproul, April 29, 1941, *op. cit.,* See note 62, (2/2).

75 Sproul to Lundberg, May 1, 1941, *op. cit.,* See note 62, (2/2).

76 A number of exchanges among the people concerned with the matter indicate that they were working out a system for the University of California to handle research contracts: Corley wrote to Lundberg on May 12 and to George F. Taylor, assistant to the comptroller for the Los Angeles campus, on May 26. Lundberg wrote to Underhill on May 29 and wrote to Corley on June 4, *op. cit.,* See note 62, (2/2).

77 Corley to Lundberg, June 9, 1941, *ibid.*

78 Corley to Maclise, Norton, Lundberg, Durie, and Smith, June 25, 1941, *ibid.* Maclise and Norton were campus business managers.

79 Underhill to Irvin Steward, August 20, 1942, Call number; CU–5, Ser. 2 University of California President. Container/page: 1942: 731–748. Note: folder: 1942: 748 Contracts-

Government and federal, TBL. Irvin Stewart was the executive secretary of the Office of Scientific Research and Development. Copies were sent to Sproul, Lundberg, D. G. Maclise, and W. J. Norton.

80 I. Stewart to Sproul, January 28, 1942, *ibid.*

81 R. B. Stewart to Jessup, October 11, 1941, *op. cit.,* See note 62, (2/2).

82 Irvin Stewart to R. B. Stewart, Underhill, Morey, and Ford, memorandum on the thinking behind the overhead on OSDR contracts thus far, February, 1942; Morey to I. Stewart, R. B. Stewart, Underhill, and Ford, letter reporting the results of a conference in Washington with R. B. Stewart and I. Stewart on the research contracts held by various institutions and proposing, at R. B. Stewart's suggestion, that the four get together to compare notes before preparing the report, February 12, 1942; Underhill to Morey (cc to Ford and I. Stewart), letter expressing approval of the suggested meeting but stating that he would be unable to travel at the proposed time, so would probably be unable to meet with them. Call number: CU-5, Ser. 2 University of California President. Container/page: 1942: 731–748, Note: folder: 1942: 748 Contracts-Government and federal, TBL.

83 I. Stewart to Sproul, Jan. 28, 1942, *ibid.*

84 Underhill to Sproul, March 12, 1942, *ibid.*

85 Bush to Sproul, April 13, 1942, *ibid.*

86 Underhill to I. Stewart, August 20, *ibid.*

87 According to a postal telegram dated December 29, 1942 from Underhill to Farnham P. Griffiths, the OSRD's advisor for salaries and insurance for the west coast, Berkeley then had 708 scientific staff members on OSRD projects. *Ibid.*

88 Dwight D. Eisenhower, *Farewell Address,* accessed April 18, 2018. http://www.americanrhetoric.com/speeches/dwightdeisenhowerfarewell.html

89 Robert Kargon and Elizabeth Hodes, "Karl Compton, Isaiah Bowman, and the Politics of Science in the Great Depression," *ISIS,* 76 (1985), pp. 301–318.

90 Shuhei Okuyama, "Manhattan keikaku no seisakushiteki kenkyu no shiten (The Manhattan Project from the perspective of policy history studies)," *IL SAGGIATORE,* No. 14 (May 1985), p. 67.

91 *Ibid.,* p. 73.

92 Eisenhower, *op. cit.,* See note 88.

93 Okuyama, *op. cit.,* See note 90, p. 67.

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