SCHOOLS OF EMPIRES: THE ROLE OF HIGHER EDUCATION AND COLONIZATION IN THE AMERICAN WEST AND JAPAN

by

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DEDICATION

For Bessie, Lincoln, Eowyn, and Theophilus, with love.

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ABSTRACT

The historical relevance of the role of the university is related to research in both local and global exchanges, the accessibility to forms of higher education, and the decentralization and use of scientific knowledge. Using institutions at Göttingen, Amherst, New York, Bozeman, and Sapporo, this dissertation interrogates how geographical space, settler colonialism, and socio-cultural contexts inform scientific, agricultural, and engineering practices, research, and education from the nineteenth into the twenty-first century. Beginning with Wilhelm von Humboldt's twin pillars of academic freedom and the combination of research and teaching, this dissertation traces the migration of approaches to higher education from German schools to the American East. American conceptions of higher education evolved as educators like Frederick A. P. Barnard called for reform and academics returned from abroad. In the 1860s, the land grant school and the school of mines provided models to reshape the educational and geographical landscape of the country. As settlers colonized the American West, boosters established new schools based on civic or religious interests before state and industrial entities funded other institutions. In Montana, proximity to mining facilitated the establishment of its first school of mines and political interests led to the decentralization of the state schools. After the Meiji Restoration, Japan sought new forms of knowledge to strengthen its imperial rule, and in the colonization of Hokkaido, Kiyotaka Kuroda identified the land grant model displayed under William Smith Clark's leadership in Massachusetts as the ideal example to adopt. Both case studies demonstrate higher education's adaptability and its tenuous relationship with government expectations and funding. As Japan's empire crumbled, evolving geopolitical matters influenced the American government to increase federal funding opportunities leading to the alignment of schools and programs with the Academic-Military-Industrial Complex. Laboratories such as the Electronics Research Laboratory at Montana State University demonstrate how this relationship affected new forms of technology and research. Based on archival research and personal interviews, this dissertation analyzes the historical, multifaceted role of the university, its accessibility, and how Humboldtian ideals, reflected in practice, shape our understanding of the present and future role of higher education.

INTRODUCTION

"WHAT'S IN A NAME?": SCIENTIZING THE MASSES FOR SETTLEMENT

> What's in a name? that which we call a rose
> By any other name would smell as sweet
> —Shakespeare, *Romeo and Juliet*

What's in a name? When I first set foot on Montana State University (MSU) campus in Bozeman, the terrain was foreign, and my only knowledge of the place came from a campus map I printed the day before. The map showed the outline of buildings and their names. Most I did not recognize, but a few, such as Lewis and Colter, reminded me of stories about early explorers in the American West. As I walked across campus, I wondered about the people the University had memorialized by placing their names upon the various buildings. MSU is a land-grant school, and from this information, I surmised that some of the names had to be early scientists, engineers, and agriculturalists. However, I did not realize then that I was walking through a constructed landscape memorializing the transmission of scientific knowledge from German laboratories, to eastern American classrooms, and finally to western American practical schools and beyond.

The places on the campus map also tell a story of continual change. Since beginning this project, new names and objects have appeared on the map of MSU, each telling a different story of the campus – its past, present, and future. Additionally,

buildings undergo remodeling, renaming, and removal.[1] Each of these buildings, honor the people who taught and developed programs, invested money, or helped evolve the form and function of this University.

At present, the campus contains a few buildings dedicated to the first faculty and administrators of the school. Some of these are important to this dissertation, as they memorialize key individuals in the transmission and adaption of scientific and engineering knowledge and applications from schools in the eastern United States. Especially apparent is the connection between MSU and the Columbia School of Mines in New York.[2] Further, the University itself has had a few name changes in its history from The Agricultural College of the State of Montana to Montana State University.[3]

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[1] For example, Morrill Hall, named in honor of Justin Morrill, the congressman who wrote the Morrill Land-Grant Act of 1862, is no longer present on MSU's campus, yet the building that once bore this name is still standing. It is now Linfield Hall, named in honor of Frederick Linfield, who was the dean of agriculture and the director of the Agricultural Experiment Station from 1913 to 1937; See Robert Rydell, Jeffrey Safford, and Pierce Mullen, *In the People's Interest: A Centennial History of Montana State University* (Bozeman, MT: Montana State University Foundation, 1992), 11.

[2] For example, Traphagen Hall bears the name of Frank Weiss Traphagen, a graduate of the Columbia School of Mines and MSU's first science professor, who was also instrumental in creating Montana's first school of mines in 1888. On the north side of campus is Cobleigh Hall, named for William Cobleigh, who came to MSU after studying at the College of Montana and eventually graduated from the Columbia School of Mines before returning to Bozeman to teach engineering and administer the department. Before 1993, the building directly to the east of Cobleigh Hall was Ryon Labs, named for the first President of Montana State University, Columbia School of Mines graduate, and co-developer of the first school of mines in Montana, Augustus M. Ryon.

[3] Rydell, et al., *In the People's Interest*, 11 and 96; In 1913, the legislation that created the chancellorship of the university system referred to the school as Montana State College of Agriculture and Mechanical Arts. The institution referred to itself as the Montana College of Agriculture and Mechanic Arts from 1893 to 1896. In 1897, the name changed to Montana State College of Agriculture and Mechanic Arts. The agricultural extension bulletins referred to the institution with various names including

Focusing on the idea of schools as tools of empire, this dissertation analyzes how knowledge flowed and universities developed in relation to centers of knowledge creation, the empires that created them, and the organizations that used them.[4] The historical relevance of the role of the university is related to research in both local and global exchanges, the accessibility to forms of higher education, and the decentralization and use of scientific knowledge. This dissertation shows a direct link between institutions of higher education in present-day Germany, the American East, the American West, and Japan. It focuses on the scientists, engineers, and agriculturalists who engaged in a transnational exchange of theoretical and practical knowledge and models of education. It reveals the impact of the geographical, material, and cultural context that influences how laypersons use scientific knowledge. Therefore, it reveals the direct connection between historical, socio-cultural, and political contexts and scientific implementation. It discloses historical lessons for understanding present and future roles of higher education, institutions, and research in geographically diverse areas and discusses how this research influences industrial, agricultural, and environmental practice up through the present day.

This dissertation then has three main objectives. First, it explains how and why these institutions such as those found at Göttingen, Amherst, New York, Bozeman, and

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Montana Agricultural College. In 1921, President Alfred Atkinson preferred Montana State College as the name.

[4] I titled my dissertation: "Schools of Empires: The Role of Higher Education and Colonization in the American West and Japan" after reading Daniel Headrick's book *Tools of Empire*. Daniel R. Headrick, *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century* (New York: Oxford University Press, 1981). According to Daniel R. Headrick, Western industrial technology has had a greater impact on the world than any religion, war, or leader.

Sapporo, through trained experts and transmittable forms of knowledge, provided venues for the colonization and resettlement of imperial spaces and state building. Second, it explores what exactly the relationships are between these institutions, extractive energy acquisitions, and the academic-military-industrial complex in the creation of our modern global economy. Third, it demonstrates how a humanistic approach to understanding the movement, dissemination, and practices of science and technology is relevant and a necessity in the current and future role of the university.

In 1893, Governor John E. Rickards signed a bill establishing Bozeman as the location of the first state-supported college in Montana.[5] This college was not the first in Montana, but it did become the first land-grant school and the first college of agriculture and the mechanical arts. It joined a few religiously affiliated schools in Montana, one of which housed the Montana School of Mines.[6] Schools of mines in America, like land-grant schools, were new educational institutions in the latter part of the nineteenth century. The first sustainable school of mines opened at Columbia College in New York in 1864, two years after the passing of the Morrill Land-Grant College Act of 1862. These two models of scientific education provided the framework for scientists, engineers, and agriculturalists to venture into geographical frontiers and create new spaces for innovative and creative forms of knowledge production and transmission. This dissertation traces the transnational movement of science and engineering knowledge and

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[5] Rydell, et al., *In the People's Interest*, 1.

[6] F.W. Traphagen, "The Montana School of Mines." *The School of Mines Quarterly, A Journal of Applied Science XI*, no. 1 (1889): 40. The school was the College of Montana at Deer Lodge. In time, the school of mines moved to Butte and became Montana Tech of the University of Montana.

practices, and discusses the regional adaptions made by educators and reformers in American and Japanese higher education in science, engineering, and agriculture. In doing so, historians can observe these institutions and their focus on resource extraction, their relationships with both governmental and industrial entities, and their reliance on the power of associated technology and education to colonize new spaces and control its people.[7]

New Ideas and Networks of Knowledge

When Vannevar Bush introduced his groundbreaking scientific policy piece *Science – The Endless Frontier* in 1945, he began not with his own ideas about the future of the United States and its relationship with science, but with a quote from President Franklin D. Roosevelt. In a response to a letter from Bush, Roosevelt had written, "New frontiers of the mind are before us, and if they are pioneered with the same vision, boldness, and drive with which we have waged this war we can create a fuller and more

[7] According to James Kip Finch, *A History of The School of Engineering: Columbia University* (New York: Columbia University Press, 1954), 9, science and engineering had a connection as "science took over and explored the organized various facts and observations that had resulted from the practical experience of engineering – such as geometry (i.e., land measurement) and mechanics. On the other hand, as science became free of the entanglements of religion, philosophy, and magic, engineers did not hesitate to appropriate and use such bits of scientific knowledge they found of value." Furthermore, David F. Noble's *America by Design: Science, Technology and the Rise of Corporate Capitalism* (New York: Alfred A. Knopf, 1982) discusses the wedding of science to the useful arts (engineering) in three ways: "The Rise of Science-Based Industry" 3-19; "The Development of Technical Education," 20-32, and; "the Emergence of the Professional Engineer," 33-49. From these two authors we see a clear connection and relationship between these two domains.

fruitful employment and a fuller and more fruitful life."[8] Roosevelt set the stage for the future of the United States and its alignment with scientific practice and knowledge production. It echoed earlier sentiments found within the Morrill Land-Grant College Act of 1862, which established the foundation for several colleges and universities to acquire public funds to maintain and develop programs focused on agriculture and the mechanical arts (or engineering).[9] The purpose of this act was for:

> The endowment, support, and maintenance of at least one college [per state] where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the state may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life.[10]

According to historian Paul K. Nienkamp, graduates of these schools were to have the technical skills and experiences to "adapt quickly to changes in equipment and process and implement advances in scientific knowledge in American homes, fields and

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[8] Vannevar Bush, *Science the Endless Frontier: A Report to the President on a Program for Postwar Scientific Research.* (Washington DC: National Science Foundation, [1945] reprinted 1960), ii and 4.

[9] On the history of the Morrill Land-Grant Act, see Edward Eddy, *Colleges for Our Land and Time: The Land-Grant Idea in American Education* (New York: Harper & Brothers Publishers, 1957); Earle D. Ross, *Democracy's College, the Land-Grant Movement in the Formative State* (New York: Arno Press and The New York Times, 1969); Roger L. Williams, *The Origins of Federal Support for Higher Education: George W. Atherton and the Land-Grant College Movement* (University Park: Pennsylvania University Press, 1991); Scott Key, "Economics or Education: The Establishment of American Land-Grant Universities." *The Journal of Higher Education 67*, no. 2 (1996); and Coy F. Cross II, *Justin Smith Morrill: Father of the Land-Grant Colleges*. (East Lansing, MI: Michigan State University Press, 1999), 77-94.

[10] Morrill Act of 1862, sec 4.

factories."[11] In essence, the passing of the Morrill Land-Grant College Act of 1862 married the future of the industrial and middle classes with a pursuit of scientific knowledge for the purposes of progressing the nation's industrial, agricultural, and economic interests.

Recent scholarship has also identified that the passing of this Act married these institutions of higher education to settler colonial practices. In their attempts to civilize and make legible the American West, Congress passed a series of Acts built on the dispossessed lands of Indigenous peoples. In 1862, along with the Morrill Act, Congress passed the Homestead Act and Pacific Railroad Act. These "civilizing" Acts gave white Americans and businesses an opportunity to expand to the American West with land available from years of American Indian dispossession.[12] According to Sharon Stein, within romantic and revisionist histories of land-grant institutions, "its colonial origins" are often overlooked.[13] Stein argued, "The US state's genocidal efforts to conquer the literal frontier helped to solidify a colonial template of state facilitated capital accumulation that is premised on the conquest of a perpetual frontier." She continued by

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[11] Paul K. Nienkamp. "Engineering national Character: Early Land-Grant College Science and the Question for an American Identity" in *Science as Service: Establishing and Reformulating American Land-Grant Universities, 1865-1930,* ed. A. Marcus (Tuscaloosa: The University of Alabama Press, 2015), 116.

[12] Margaret A. Nash, "Entangled Pasts: Land-Grant Colleges and American Indian Dispossession," *History of Education Quarterly* 59, no. 4 (Nov. 2019): 437-467. See also Robert Lee and Tristan Ahtone, "Land-grab Universities," *High Country News,* March 30, 2020, https://www.hcn.org/issues/52.4/indigenous-affairs-education-land-grab-universities.

[13] Sharon Stein, "A Colonial History of the Higher Education Present: Rethinking Land-Grant Institutions through Processes of Accumulation and Relations of Conquest," *Critical Studies in Education* (Dec. 2017): 2.

stating that, “Rather than serve as a foil for the present, land-grant legislation illustrates how from the very beginnings, US public goods like education have both *depended on* and been *vulnerable to* the demands of perpetual accumulation.”[14]

Throughout the nineteenth century, the United States government accumulated land that provided the right conditions for the possibility for land-grant institutions, in what Stein calls an, “*indirect but dependent* relationship.”[15] The government did not intentionally accumulate these lands for the express purpose of creating schools of agriculture and engineering; however, without that accumulation, the government could not grant land as parcels or scrip to fund the building of these schools. Historian Margaret Nash added to this history tracing the lands and associated monies from parcels scattered throughout western states to both western and eastern schools.[16] Further, Richard Lee recently compiled a database that connected land-grant schools, Indigenous peoples, and associated lands.[17]

As these studies demonstrate, the relationship between settler colonialism and higher education in the United States is an entangled one. As institutions of higher education come to terms with their past, new grounds of research and reconciliation are in order. For example, in Colorado, the name of a hall had a negative history with moral

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[14] Stein, “A Colonial History,” 2.
[15] Stein, “A Colonial History,” 8.
[16] Nash, “Entangled Pasts,” 452-467.
[17] Robert Lee, “Morrill Act of 1862 Indigenous Land Parcels Database,” *High Country* News, March 2020, https://www.landgrabu.org/.

complexities that historian Patricia Limerick questioned.[18] David H. Nichols was influential in the establishment of the University of Colorado at Boulder, but he was also an active participant in the 1864 Sand Creek Massacre in eastern Colorado. Nichols was directly involved in the subjugation and erasure of Native Americans, which played into the larger role of the United States' imperial practices through its expansion into and colonization of the American West. The University of Colorado renamed the building Cheyenne Arapaho Hall in 1989, in honor of the two tribes who were directly affected by the Sand Creek Massacre.[19] If the renaming of Nichols Hall to Cheyenne Arapaho Hall brought a spotlight on institutions of higher learning and their role in the expansion of the United States through the colonization and settlement practices in the American West, then imagine what the work of Stein, Nash, and Lee will do to the future of higher education in the United States.

This future, however, is not solely concerned with interests within the borders of the states and the nation itself. In 1887, Congress passed the Hatch Act, which mandated the creation of agricultural experiment stations for scientific research. This development was actually part of what Mark R. Finlay calls "a broader international consensus that scientific investigations of agriculture could benefit societies as a whole and that international cooperation among experts in the field could facilitate such

[18] Patricia Nelson Limerick, "What's in a Name? Nichols Hall: A Report" (Center of the West University of Colorado Boulder, September 1987), http://centerwest.org/wp-content/uploads/2013/06/nichols_hall_report.pdf.
[19] Limerick, "What's in a Name?," 135-150.

developments."[20] German schools developed a system of education with field schools that served as a model for other European and American schools to copy.[21] This was not the first time that Americans copied or used German approaches to education and science. Throughout the nineteenth century, Americans interested in science and engineering travelled to European schools, with many of them spending time under German tutelage.[22] Some of these students returned to America to help develop land-grant schools, schools of mines, and reform established higher education institutions and practices.[23] A few were hired to provide their services to Japan, during the Meiji period, to modernize the nation, and establish and develop the Sapporo Agricultural College (now Hokkaido University).[24] Therefore, the scientific interests and educational practices of the United States had international connections and formed networks of knowledge exchange throughout the nineteenth and into the twentieth century.

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[20] Mark R. Finlay, "Transnational Exchanges of Agricultural Scientific Thought from the Morrill Act through the Hatch Act" in *Science as Service: Establishing and Reformulating American Land-Grant Universities, 1865-1930,* ed. A. Marcus (Tuscaloosa: The University of Alabama Press, 2015), 34.
[21] Finlay, "Transnational Exchanges of Agricultural Scientific Thought," 40.
[22] Robert V. Bruce, *The Launching of Modern American Science 1846-1876* (New York: Alfred A Knopf, 1987).
[23] Brander Matthews, Chair, *A History of Columbia University, 1754-1904* (New York: The Columbia University Press, 1904), 355-56 and John Maki, *A Yankee in Hokkaido: The Life of William Smith Clark* (Lanham, MD: Lexington Books, 2002) 27-47 and 77-84.
[24] David Forsyth Anthony, "The Administration of Hokkaido under Kuroda Kiyotaka 1870-1882: An Early Example of Japanese-American Cooperation" (Ph.D. dissertation, Yale University, 1951); Hokkaido Prefectural Government, ed. *Foreign Pioneers: A Short History of the Contribution of Foreigners to the Development of Hokkaido.* (Sapporo: Hokkaido Prefectural Government, 1968); Fumiko Fujita, *American Pioneers and the Japanese Frontier: American Experts in Nineteenth-Century Japan* (Westport, CT: Greenwood Press, 1994); and Maki, *A Yankee in Hokkaido,* 117-197.

Central to these networks of knowledge were the focus on education practices and extractive resource acquisition through applied scientific agriculture and engineering practices and research. Until recently, little work has explored the complex relationships developed globally between land-grant schools and schools of mines and the effects they had on practice and its relationship with political and industrial interests.[25] Other scholarship has addressed the globalization of science and engineering practices through mining and technology.[26]

This dissertation will expand and more fully develop the role that schools of mines and land-grant schools played in the development of the scientific state by employing underutilized archival sources related to these institutions and applying new theoretical insights from the history of science, environmental history, and the history of the American West. Although a focus on extractive resources, such as fossil fuels, precious metals and minerals, and other forms of energy, has shaped our understandings of policy and environmental effects, investigating the implication of the links between governmentally-funded, corporate-supported, and state-driven educational systems that evolved from the Morrill Land-Grant College Act of 1862 will demonstrate how knowledge acquisition and dissemination has changed and been directly influenced by these links in ways often in direct conflict with the original intention of higher education.

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[25] Frank Uekötter, "Why Care About Dirt" Transatlantic Perspectives on the History of Agriculture, "Bulletin of the German Historical Institute 39 (Fall 2006): 65-77; Finlay, "Transnational Exchanges of Agricultural Scientific Thought", 33-60.

[26] Stephen Tuffnell, "Engineering Inter-imperialism: American Miners and the Transformation of Global Mining, 1871-1910," *Journal of Global History* 10 (2015): 53-76.

Science, Technology, and the State

Although the signing of the Morrill Land-Grant College Act of 1862 created the opportunity for states to develop schools focused on educating future generations in scientific agricultural and industrial knowledge, how states did this and to what degree they emphasized science remained a question. Before this Act, one could describe the American development and interest in science as occurring in *fits and starts*. In time, further governmental legislation helped provide some direction with new sources of funding and research which led to an ever-entwining relationship between government, corporate, and scientific interests. One sees this relationship become a complex organism during and after World War II when Vannevar Bush laid out a plan for the National Science Foundation and what became a series of legislative decisions investing time, money, and people into what one might ideally call a scientifically literate state.

Historians have inquired about the emergence of this American form of science and its close association with a variety of institutions that have developed to house and transmit it to the public. In his Pulitzer Prize winning book, *The Launching of Modern American Science, 1846-1876*, Robert Bruce outlined the history of American science in the nineteenth century, early scientists and their relation to European forms of education, and the development of associations, schools and other institutions that helped develop and make science accessible to more people.[27] Other historians of science have also analyzed these scientists and their institutions, many of which resembled more developed

[27] Bruce, *The Launching of Modern American Science*.

institutions in Europe, especially in Great Britain and the German states.[28] Over the course of the nineteenth century, these American scientists formalized their practice and began to develop specializations in terms of education, professional careers, and knowledge creation.

Over the last few decades, historians and sociologists of science have focused less on *what* these scientists knew and more on *how* they came to know it. The emphasis shifted away from ideas and concentrated on culture and scientific practice. The shift then spurred scholars' attention to the sites of knowledge production and to the various social, material, and ideological resources used in the creation and concentration of that knowledge into specific metropoles that dictated the distribution of knowledge to the hinterlands.[29] These scholars hoped to gain insights into complex social arrangements that provided the foundation for the formation of knowledge. Since the creation of scientific knowledge was foundationally social, some scholars determined that empirical

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[28] See for example, Sally Gregory Kohlstedt, *The Formation of the American Scientific Community: The American Association for the Advancement of Science, 1848-1860* (Urbana: University of Illinois Press, 1976); Sally Gregory Kohlstedt, Michael M. Sokal, and Bruce V. Lewenstein, *The Establishment of Science in America: 150 Years of the American Association for the Advancement of Science* (New Brunswick, NJ: Rutgers University Press, 1999); John C. Greene, *American Science in eh Age of* Jefferson (Ames: University of Iowa Press, 1984); George H. Daniels, *American Science in the Age of Jackson* (New York: Columbia University Press, 1968); Stephen Case, " 'Insufferably Stupid or Miserably Out of Place': F. A. P. Barnard and His Scientific Instrument Collection in the AnteBellum South," *Historical Studies in the Natural Sciences,* 39, no. 4 (2009): 418-443; and William Chute, *Damn Yankee!: The First Career of Frederick A. P. Barnard* (Port Washington, NY: Kennikat Press, 1978); Paul Lucier, "The Professional and the Scientists in Nineteenth-Century America" *Isis* 100, (2009): 699-732.

[29] For example, Bruno Latour and Steve Woolgar, *Laboratory Life: The Construction of Scientific Facts* (Princeton: Princeton University Press, 1986).

evidence could fit any theory. Other historians and sociologists found that the materiality of scientific objects and practices associated with experiments do function to limit the potential of manipulations of evidence toward ideological ends.[30] Although scholars disagreed over the exact nature of how scientists produce scientific knowledge, there was an agreement that social relations and values do play an important role in shaping what one considers knowledge.

The realization of the "social construction" of scientific knowledge provided some important perspectives on any study on the development, movement, and concentration of scientific knowledge and practices. For many of the American scientists in the nineteenth century, this knowledge became a currency to take with them from European institutions to America and abroad, working through the social issues where they acted as a colonizer in a new space. Therefore, scientists had to develop a way to create a social network to communicate these new forms of knowledge and develop their own. The scientists had to traverse what Mary Louise Pratt calls the "contact zones" of cross-cultural interactions where some level of "transculturation" or cultural exchange occurred.[31] In this way, these scientists eventually developed the social practices and expectations of what science is and how one does it. Similarly, this process could be an

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[30] Martin J. S. Rudwick, *The Great Devonian Controversy: The Shaping of Scientific Knowledge among Gentlemanly Specialists* (Chicago: University of Chicago Press, 1987); Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society* (Cambridge: Harvard University Press, 1987); Bruno Latour, *We have Never Been Modern* (Cambridge: Harvard University Press, 1993).

[31] Mary Louise Pratt, *Imperial Eyes: Travel Writing and Transculturation, 2nd ed.* (New York: Routledge, 2008): 7-8; Pratt defines the contact zone as being "the space of imperial encounters, the space in which peoples geographically and historically separated come into contact with each other and establish ongoing relations."

example of replacing local knowledge through a process of assimilation and removal, two common approaches used by colonization.[32] Institutions of education, such as land-grant schools and schools of mines, became the sites of this social exchange and knowledge creation, which affected the way farmers and industrial workers labored.[33] In recent years, other historians have also honed in on the distinct connection between these colleges and science, the evolution of agricultural and engineering practices, and the developing and entwining relationship between science education, industry, and government.[34] As formalized scientific knowledge moved from Europe, to and across the American landscape, and then to Japan through these institutions, this process of creating

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[32] James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven: Yale University Press, 1998): 311-341.

[33] For example, Alan I. Marcus, *Agricultural Science and the Quest for Legitimacy: Farmers, Agricultural Colleges, and Experiment Stations, 1870-1890* (Ames: Iowa State University Press, 1985); Alan I. Marcus, ed. *Engineering in a Land-Grant Context: the Past, Present, and Future of an Idea* (West Lafayette, IN: Purdue University Press, 2005); Alan I. Marcus "The New Agricultural College and the New Agricultural History" *Agricultural History* 87.4 (Fall 2013), 525-533; Alan I. Marcus, ed. *Science as Service: Establishing and Reformulating American Land-Grant Universities, 1865-1930* (Tuscaloosa: The University of Alabama Press, 2015); and Alan I. Marcus, ed. *Service as Mandate: How American Land-Grant Universities Shaped the Modern World,1920-2015* (Tuscaloosa: The University of Alabama Press, 2016).

[34] See for example, Roger L. Geiger, *To Advance Knowledge: The Growth of American Research Universities, 1900-1940* (Oxford: Oxford University Press, 1986); Roger L. Geiger, ed., *The American College in the Nineteenth Century* (Nashville: Vanderbilt University Press, 2000); Roger L. Geiger and Creso M. Sá, *Tapping the Riches of Science: Universities and the Promise of Economic Growth* (Cambridge: Harvard University Press, 2008); Roger L. Geiger and Nathan M. Sorber, eds. *The Land-Grant Colleges and the Reshaping of Higher Education* (New Brunswick: Transaction Publishers, 2013). For a deeper perspective on the role of science in the federal government, see A. Hunter Dupree, *Science in the Federal Government: A History of Policies and Activities* (Baltimore: Johns Hopkins University Press, 1986).

social spaces for knowledge creation and application gradually replaced much of the local knowledge in each of these geographical spaces.

Studies of space and place have recently attracted the attentions of historians of science and environmental history. The so-called "spatial turn" has opened new understandings of the connections between imperialism and culture.[35] Works such as Edward Said's *Orientalism* questions the use of language and designation of the "other," whereas Paul Carter highlights the process of naming places to connote possession, both culturally and imperially.[36] Others, such as D. Graham Burnett continue this focus in his analysis of the science behind the surveying and boundary making of Guiana.[37] Historians of exploration have also begun to parse out the role of empire and colonial forms of science and knowledge acquisition.[38]

The development of the "spatial turn" provided historians an understanding that science was, and is, a form of local knowledge. The introduction of formalized scientific practices and knowledge displaces earlier forms of local knowledge. The way that knowledge solidified as it moved from private laboratory spaces to public spaces and the

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[35] See Michael S. Reidy, *Tides of Nature: Ocean Science and her Majesty's Navy* (Chicago: University of Chicago Press, 2008); Michael S. Reidy, "From Oceans to Mountains: Constructing Space in the Imperial Mind," in *Knowing Global Environments: New Historical Perspectives on the Field Sciences*, ed. Jeremy Vetter (Rutgers University Press, 2010), 17-38; Michael S. Reidy and Helen Rozwadowski, "The Spaces In-Between: Science, Ocean, Empire," *Isis* 105, no. 2 (2014): 338- 351.
[36] Edward Said, *Orientalism*, Vintage Books ed. (New York: Vintage Books, 1994); Paul Carter, *The Road to Botany Bay: An exploration of Landscape and History* (Minneapolis: University of Minnesota Press, 1987).
[37] D. Graham Burnett *Masters of All They Surveyed: Exploration, Geography, and a British El Dorado* (Chicago: University of Chicago Press, 2000).
[38] Dane Kennedy, ed. *Reinterpreting Exploration: The West in the World* (Oxford: Oxford University Press, 2014).

field has been the focus of some studies.[39] Additionally, Latour's idea of "immutable mobiles" and "centers of calculation" is useful in understanding that the standardization of scientific objects keeps them in a relatively stable state to move across space.[40] This is particularly useful in analyzing how scientific, agricultural, and engineering knowledge and technology moved from Europe to the American East, the American West, and Japan and their role as tools of empire to colonize new spaces and its peoples.[41]

This dissertation will focus specifically on the influence that local institutions, such as land-grant schools and schools of mines, had on the displacement and replacement of local knowledge with formalized scientific knowledge and how this occurs at multiple spaces with their own history and cultural conceptions of science. The connections between these spaces and the specific links in the chain that connected them help us understand how knowledge is transferrable and to what effect socio-cultural and geographic contexts assimilate and add to it.

This dissertation will contribute to the history of science by exploring how scientists, agriculturalists, and engineers created knowledge and how they moved this knowledge and associated objects across land and sea. Further, this project will explore

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[39] Robert E. Kohler, *Landscapes and Labscapes: Exploring the lab-Field Border in Biology* (Chicago: University of Chicago Press, 2002); David N. Livingstone, *Putting Science in Its Place: Geographies of Scientific Knowledge* (University of Chicago Press: Chicago, 2013); Jeremy Vetter, ed. *Knowing Global Environments: New Historical Perspectives on the Field Sciences* (New Brunswick: Rutgers University Press, 2011).
[40] Latour, *Science in Action.* An immutable mobile is something that is easily transportable without changing its core. Centers of calculation are sites where knowledge develops based on its movements with other places.
[41] Masao Watanabe briefly describes how Western science influenced Japanese science in *The Japanese and Western Science* (Philadelphia: University of Pennsylvania Press, 1976).

the origins of what will become the academic-military-industrial complex and its controlling influence on the shape and direction of scientific research. In terms of government decisions, this study will show that both American and Japanese officials saw the need to expand into new territories and the role that technology and scientific knowledge played in that expansion and colonization. This is especially evident in Morrill's call for a scientific education, "in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life," and in Japan's pursuit of modernity and its relationship to science and technology.[42] Further, this study highlights individuals who act as conduits for the creation and dissemination of scientific knowledge. Some of these individuals directly connect German approaches to American and Japanese practices as they work through the "contact zones" to come away with new socially constructed perspectives of science and society.[43]

By focusing on how scientific knowledge developed and travelled across borders and societies, this dissertation seeks to demonstrate not only how land-grant colleges and schools of mines provided the spaces for scientific knowledge creation and application, but how they also provided a means for industry and government to affect the American and Japanese public's localized knowledge. In doing so, the project will show the ways that industry and government shaped science, but also how science shaped governmental practice and industrial processes, especially in the expansion, colonization, and development of new territories.

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[42] Morrill Act of 1862, sec 4.
[43] Pratt, *Imperial Eyes*, 7-8.

Environment, Extraction, and the State

In recent years, environmental historians paralleled and contributed to the studies in the history of science and technology, in the way human and non-human agents perceived and used specific environmental spaces, and in the fields' focus on engineered spaces, mining, and the environmental effects of humankind trying to control the local, national, and global environments. In his examination on the connections between urban development and environmental degradation, Gray Brechin studied the rise of San Francisco as an imperial space. Brechin explored the several stages of development of San Francisco through the concept of the Pyramid of Mining.[44] This concept provided a foundation for understanding the relationship of dominance between economic interests, mining, military, and industrialization. Other scholars have analyzed the environmental effects of urbanization by drawing attention to unintended consequences of these engineered spaces.[45] Further, Robert Fairbanks analyzed the role that civil engineering

[44] Gray Brechin, *Imperial San Francisco: Urban Power, Earthly Ruin* (Berkeley: University of California Press, 2006), 13-70.

[45] See for example, Carl Abbott, *How Cities Won the West: Four Centuries of Urban Change in Western North America* (Albuquerque: University of New Mexico Press, 2008); John Findlay, *Magic Lands: Western Cityscapes and American Culture After 1940* (Berkeley: University of California Press, 1993); Matthew Klingle, *Emerald City: An Environmental History of Seattle* (New Haven: Yale University Press, 2009); Catherine McNeur, *Taming Manhattan: Environmental Battles in the Antebellum City*, (Cambridge: Harvard University Press, 2014); Martin Melosi, *Garbage in the Cities: Refuse, Reform, and the Environment, 1880-1980*. (College Station, TX: Texas A&M University Press, 1981); Martin V. Melosi, "Humans, Cities, and Nature: How Do Cities Fit in the Material World?" Journal of Urban History 36, no. 1 (January 1, 2010): 3–21. doi:10.1177/0096144209349876; Adam W. Rome, *The Bulldozer in the Countryside: Suburban Sprawl and the Rise of American Environmentalism.* Studies in Environment and History. (Cambridge: Cambridge University Press, 2001).

education had in the creation and development of the urban landscape.[46] This connection suggested that land-grant schools and engineering played a key role in growth of the nation and in the use of extracted resources to meet this end.

Over the last few decades, environmental historians and other scholars studied another engineered landscape – the mine. Over the years, scholars have focused on the development of mining practices and the professionalization of mining engineering. Early works rested on Frederick Jackson Turner's frontier thesis.[47] These works tended to perceive mining in a positive light and reflected some of the broader themes of progress within historiography of the American West prior to 1980.[48] Since then, historians looked at these engineered spaces with fresh eyes. Scholars like Elliot West analyzed the contentious relationship between Anglo-American settlers migrating to Colorado and the Indigenous peoples who inhabited the region.[49] Feminist social historians also perceived these spaces with new perspectives looking at the complex social and familial

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[46] Robert B. Fairbanks, "The Morrill Land-Grant Act and American Cities: The Neglected Story," in *Science as Service: Establishing and Reformulating American Land-Grant Universities, 1865-1930,* ed. A. Marcus (Tuscaloosa: The University of Alabama Press, 2015), 175-192.

[47] Turner, Frederick Jackson. "The Significance of the Frontier in American History," Proceedings of the Forty-First Annual Meeting of the State Historical Society of Wisconsin (1894).

[48] Rodman Paul, *Mining Frontiers of the Far West, 1848-1880* (New York: Holt, Rinehart and Winston, 1963); Clark Spence, *British Investment and the American Mining Frontier, 1860-1901* (1958; Moscow: University of Idaho Press, 1995); Clark Spence, *Mining Engineers and the American West: The Lace-Boot Brigade, 1849-1933* (New Haven: Yale University Press, 1970; Reprint, Moscow: University of Idaho Press, 1993).

[49] Elliot West, *The Contested Plain: Indians, Goldseekers, and the Rush to Colorado* (Lawrence: University of Kansas, 1998).

relationships within the mine and affiliated city or camp.[50] In terms of environmental history, three works highlight this field's approach to mines: Timothy LeCain's *Mass Destruction*, which looked at two large, open-pit copper mines and their connection to environmental destruction and the rise of consumption within American society; Andrew Isenberg's *Mining California*, which addressed the connections between mining, agriculture, and industrialization and its continued environmental effects; and Thomas Andrews, *Killing for Coal*, which analyzed the mining community and their militant stand against mine owners and its use of military tactics to control the community.[51]

The focus on mining, especially on mining engineers, is of interest to this dissertation. Many of the works listed above highlight the role of these engineers in shaping mining practices, but it is also important to analyze where they received their mining education and how it influenced their practice. Few scholars have approached this topic in recent years. Some, for example Kathleen Ochs, analyzed American mining engineers in a case study of the Colorado School of Mines.[52] Other scholars provided a more in-depth analysis of the influence of European pedagogy, research practices, and

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[50] Mary Murphy, *Mining Cultures: Men, Women, and Leisure in Butte, 1914-41* (Chicago: University of Illinois Press, 1997); Elizabeth Jameson, *All That Glitters: Class, Conflict, and Community in Cripple Creek* (Chicago: University of Illinois Press, 1998); Susan Johnson, *Roaring Camp: The Social World of the California Gold Rush* (New York: Norton, 2000).

[51] Timothy LeCain, *Mass Destruction: The Men and Giant Mines That Wired America and Scarred the Planet* (New Brunswick: Rutgers University Press, 2009); Andrew Isenberg, *Mining California: An Ecological History* (New York: Hill and Wang, 2006). Thomas Andrews, *Killing for Coal: America's Deadliest Labor War* (Cambridge: Harvard University Press, 2008)

[52] Kathleen H. Ochs, "The Rise of American Mining Engineers: A Case Study of the Colorado School of Mines." *Technology and Culture 33*, no. 2 (1992).

curriculum development on the foundation of American higher education, particularly schools of mines such as the Columbia School of Mines.[53]

In addition to a focus on mining, environmental historians have also analyzed other uses of land, including agriculture. The land-grant schools focused on scientized education for agricultural and engineering purposes. Therefore, it is imperative that this dissertation also focus on the environmental history of agriculture and its relationship to the transnational movement of this form of knowledge and practice. Some scholars have noted the role of experts on the state of agriculture and engineering access to water.[54] Similar to mining, agriculture is what Alan Marcus states as both "extractive and invasive."[55] This perspective of agriculture shows that while one may see an open pit mine filled with toxic water, as is the case in the Berkeley Pit in Butte, Montana, the engineered space of the family or corporate farm is also a site of potentially negative effects on the natural, manmade, and bodily environment. The cost of these mining and agricultural effects and their connection to land-grant schools, "experts," and governmental policy shed light on the power of these extractive resources on the modern world.

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[53] Timothy J. LeCain, "Moving Mountains: Technology and the Environment in Western Copper Mining." (Ph.D. diss., University of Delaware, 1998); Read, Thomas Thornton. *The Development of Mineral Industry Education in the United States* (New York: The American Institute of Mining and Metallurgical Engineers, 1941), 11-53; Spence, *Mining Engineers and the American West*, 18-53.

[54] See for example, Donald Worster *Dust Bowl: The Southern Plains in the 1930s* (Oxford: Oxford University Press, 2004); Mark Fiege *Irrigated Eden: The Making of an Agricultural Landscape in the American West* (Seattle: University of Washington Press, 1999); Donald J. Pisani, *From the Family Farm to Agribusiness: The Irrigation Crusade in California and the West, 1850-1931* (Berkeley: University of California Press, 1984)

[55] Marcus, "The New Agricultural College," 529.

In terms of Japan, Brett Walker in *The Lost Wolves of Japan* analyzed the environmental and ecological effects of American engineering and agricultural practices in Hokkaido.[56] The Japanese government employed agricultural and engineering experts from America to help transform Hokkaido into a colonial space for Japan. In the process of this transformation, the American experts completely changed the local flora and fauna and disrupted the Indigenous way of life. Through an analysis of primary and secondary sources, this dissertation will focus on how the American experts approaches in Japan and how this shaped scientific practices and knowledge development in Hokkaido, specifically concerning extractive resources. It will also address the political and socio-cultural contexts that shaped this venture and complex relationship between the Meiji government and Hokkaido.

This dissertation will seek to address these connections through an analysis of the field of mining engineering, agriculture, and the institutions of education that trained them. Through mining engineers, I will analyze the origins and approaches to their training at Columbia and Montana School of Mines. In doing so, I will be able to address the localization of engineering and mining knowledge and what the relationship is between the theoretical and practical education and practice of these engineers not only in American mining communities but also internationally.

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[56] Brett L. Walker, *The Lost Wolves of Japan* (Seattle: University of Washington Press, 2005).

American West and Japan

The American West has attracted the attention of historians of science and the environment, especially in histories of mining and agriculture.[57] The American West has also been the site of discussions about terms such as *frontier* and *pioneer*, both of which frequently figure into titles of articles and books featured in this project.[58] Additionally, the American West, in recent scholarship, has proved to be an evolving field with a trend toward placing the American West within a global perspective, in part, as a way to challenge American exceptionalism.

For historians of the American West before the New Western history movement, the term *frontier* was front and center. One way of interpreting this use of the term is through Frederick Jackson Turner's frontier thesis, which conceives frontier as a historical process rather than a place.[59] Since Turner, other historians have debated the meaning of this term, specifically its focus on process or place, and how it recognizes indigenous people, gender, and ethnic groups.[60] Within this discussion, Kerwin Klein

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[57] For example, Andrews, *Killing for Coal;* Fiege, *Irrigated Eden,* and LeCain, *Mass Destruction.*

[58] For example, Hokkaido Prefectural Government, ed. *Foreign Pioneers;* Fumiko Fujita, *American Pioneers and the Japanese Frontier.*

[59] Turner, "The Significance of the Frontier in American History."

[60] See for example, Patricia Nelson Limerick, *The Legacy of Conquest: The Unbroken Past of the American West*, (New York: W. W. Norton & Company, 1987); Limerick, et al. *Trails: Toward a New Western History*; Limerick, "Going West and Ending Up Global"; William Cronon, "Revisiting the Vanishing Frontier: The Legacy of Frederick Jackson Turner." *Western Historical Quarterly* 18, no. 2 (1987):157-176; William Cronon, George Miles and Jay Gitlin, eds. *Under an Open Sky: Rethinking America's Western Past* (New York: W.W. Norton & Company, 1992). Webb, *The Great Plains*; and David Wrobel, "Global West, American Frontier," *Pacific Historical Review* 78, no. 1 (2009): 1-26.

offered an interesting perspective.[61] He suggested that there are two divisions in this type of history – the regionalists (those adhering to the New Western history) and the Greater West. The regionalists call for a break from Turner and the use of frontier, which they interpret to represent only white, European interests with "free land" and fail to demonstrate that universal frontiers exist. The Greater West does not necessarily adopt Turner completely, but they do see that the frontier is not limited in scope to the region between Mississippi and into the Pacific.

The use of the term *frontier* recognizes how the individuals at the time used the term and as it adheres to the idea of both a geographical place and a process of innovative knowledge creation. In the early decades of the nineteenth century, the institutions of higher education within the eastern states of America were a frontier for European science. In time, these institutions established themselves not as spaces for pioneering scientists and engineers but as stabilized centers of knowledge production. With the creation of the Morrill Land-Grant College Act of 1862, states west of these established centers then became the sites for creative engagements in developing scientific frontiers. Likewise, Japan in the 1860s and 1870s became another site for new scientific frontiers and knowledge to develop. In time, geographically frontier states like Montana, and frontier regions like Hokkaido, became sites of creative and pioneering forms of science and knowledge production primarily due to their distance from the metropoles of scientific knowledge. In other words, one can consider Montana and its institutions of

[61] Kerwin Lee Klein, "Reclaiming the 'F' Word, or Being and Becoming Postwestern," *Pacific Historical Review* 65, no. 2 (1996): 179-215.

higher education as frontier states that generated their own knowledge in scientific frontiers in the space of the American West. Likewise, Hokkaido, due to its location, can be considered a frontier province that generated its own knowledge in pioneering scientific frontiers, and due to similarities between it and what the Japanese considered the American West in the 1860s and 1870s, one may go as far to say that Hokkaido may be included within historians' discussions of the American West.[62]

In recent years, the globalization of the American West has carved out a niche within the field's broader historiography. James Belich compared the history of the American West with that of "The British West," (Australia, New Zealand, Canada, and South Africa) analyzing the four stages of settler colonialism.[63] Other scholars have approached the American West through a global lens through an analysis of labor and economic development in the Pacific, the transnational interconnection of agricultural production due to guano and the fertilizer industry, and the roll of settler colonialism and settler capitalism in displacing and eliminating indigenous peoples.[64] Through this

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[62] The geography, flora, and fauna and presence of indigenous people – the Ainu -- allowed for some in the Japanese government and American experts to liken Hokkaido to the American West, see Walker, *The Lost Wolves of Japan,* 130.

[63] James Belich, *Replenishing the Earth: The Settler Revolution and the Rise of the Anglo-world* (Oxford: Oxford University Press, 2011).

[64] For the Pacific see Matt Matsuda, *Pacific Worlds: A History of Seas, Peoples, and Cultures* (Cambridge: Cambridge University Press, 2012); Kornel Chang, *Pacific Connections: The Making of the U.S. – Canadian Borderlands* (Berkeley: University of California Press, 2012). For the transnational interconnection of agricultural production see Gregory T. Cushman, *Guano and the Opening of the Pacific World: A Global Ecological History* (Cambridge: Cambridge University Press, 2014); and for settler colonialism and capitalism see Donald Denoon, *Settler Capitalism: The Dynamics of Dependent Development in the Southern Hemisphere* (Oxford: Oxford University Press, 1983); Patrick Wolfe, "Settler Colonialism and the Elimination of the Native" *The Journal of Genocide Research,* 8(4) (2006): 387-409.

framework, one can comparatively analyze knowledge creation and policy application within the American West and extend it to European and Japanese localities as well. Additionally, this framework challenges earlier conceptions of the movement and development of knowledge by analyzing the global transactions as a cultural exchange and less from a Eurocentric approach.[65]

So, what's in a name? For many the name on a campus building is only important in its use as a description of where their class is or where their dorm resides. Yet, these buildings and their names tell an interesting history that moves far beyond the confines of the campus. For some, the legacy of the names became less about the role the individual monumentalized on the building played in the history of the campus, state, or nation and instead came to represent the amount of funding that an individual gave or the influence of capital and industrial interests on campus. However, in terms of land-grant schools and schools of mines, we see that the name matters, even the very description of the institution as a land-grant matters as it alludes to an interesting historical relationship between the government, industry, and scientific interests. The United States developed institutions under the provisions of the Morrill Acts of 1862 and 1890 with federal money and dispossessed lands. The purpose of these colleges was, in writing, to provide an education for the industrial masses with a focus on scientific agriculture and mechanical arts. However, the actual purpose was more self-serving. By marrying the future of the

[65] In terms of earlier historiography, George Bassalla, "The Spread of Western Science" *Science*156, no. 3775 (1967): 611-622, describes how modern science developed around the world. In his description, it is Eurocentric in nature and does not consider the role of cultural exchange and the cyclic nature of knowledge creation and transmission.

American nation and its industrial masses to scientific knowledge and practice, the country shaped the land through settler colonialism, controlling new regions of territory for farming and mining more efficiently, extracted the wealth from the material world, and displaced indigenous peoples, all to make the United States more productive, modern, and powerful. Japan, in its desire to ensure that it did not fall to foreign powers, adopted a similar approach by equating modernity with science, technology, and the creation of its own empire.

Chapter Summary

Beginning in German institutions, this dissertation travels to the American East, the American West, and Japan before concluding with a unique case study in Montana after World War II. The idea behind the structure of the chapters is to represent the movement of knowledge, people, and institutions from Europe to the United States and then to Japan, before demonstrating the interconnected, global nature of these geopolitical centers of knowledge creation and the institutions they created up to the present day.

Chapter 1, "European Ideas: Mining a Model Education," explores the origins and evolution of German institutions of higher education in the nineteenth century. Wilhelm von Humboldt and his contemporaries serve as the central figures of reform in German institutions of higher education in the early decades of the nineteenth century. Out of these modifications, three contradictory reforms develop: academic freedom, the relationship between teaching and research, and the role of the laboratory. Friedrich

Wöhler and Justus von Liebig serve as exemplar professors to discuss how these reforms worked in practice, especially the development of laboratory education. Additionally, Wöhler and Liebig become beacons of scientific knowledge development that inspires educational pilgrims to travel to their laboratories. Amongst these pilgrims are several Americans, who use their experiences to transform American institutions of higher education and knowledge production. The Humboldtian reforms and the development of laboratory education forever changed American approaches to higher education that continue to ripple into our present classrooms.

Chapter 2, "American Interpretations: Education, Practices, and Institutions," analyzes the scholarship surrounding the history of American higher education in the nineteenth century and introduces the reader to Frederick A. P. Barnard, a transitional figure in nineteenth century American higher education. Using Barnard's life, this chapter traces the changes and reception to higher education, the role of science and science education, regionality, and the role of practical and coeducational approaches in higher education in the latter decades of the nineteenth century. Barnard also serves as a bridge to the social-political, industrial, and educational events that set the stage for the evolution of higher education and development of novel approaches and institutions, specifically with the development of the land-grant school, the school of mines, and the university. Like Humboldt, Barnard sought reform for institutions of higher education and their role in society. At the turn of the twentieth century, the state and direction of higher education in the United States has changed with the influence of new models of education and the infusion of Germanic approaches.

Chapter 3, “Montana’s ‘Fourth Division of Government’: Evolution of Higher Education in the American West’s Big Sky Country, 1868-1948,” traces the movement of science and engineering education and practices to a colonized territory in the American West - Montana. Higher education in the American West evolved as American institutions adapted Germanic approaches and developed new models. Specifically, the development of higher education in the American West followed patterns of religious and civic responses to its colonization. One such response originated with William A. Clark who helped organize and develop Montana’s first institution of higher education and provided the means to create the state’s first school of mines. In time, Montana decided to develop its own state-run institutions creating what became Montana State University, as well as three other institutions. The history of Montana State University, its early professors, and administrators, draws on the connections between Montana and eastern institutions, primarily Columbia University. As for the entirety of Montana’s various institutions of higher education, Dr. Melvin A. Brannon and his definition of the “fourth division of government” provides a means to retell the history and the successes, failures, and issues individual institutions and the collective system encountered up to the 1930s. Finally, the chapter analyzes the role of institutions of higher education in the conquest and colonization of the American West, and the long-term issues and educational contradictions, first observed in the early decades of Montana’s institutions they continue to plague higher education to the present day.

Chapter 4, “‘Boys Be Ambitious’: Japanese Higher Education and the United States,” discusses the relationship between Japan and the United States and the role that

American educators and agricultural, scientific, and technological experts had on Japanese colonial and educational practices. In 1868, Japan restored the emperor with the ending of the Tokugawa *bakufu* known as the Meiji Restoration. During this period, Japan sought ways to reform their society including their approach to education. Men like Yukichi Fukuzawa, Tomomi Iwakura, and Kiyotaka Kuroda played key roles in the establishment of the new government, reforms, and in the colonial offices of the Kaitakushi. Through the Kaitakushi, Japan hired American experts to disseminate different forms of modernity through models of colonization and education. Americans such as Horace Capron, Benjamin Smith Lyman and William Smith Clark took up the call and came to Japan and forever changed the direction of the northern island, Hokkaido. William Smith Clark is of importance as he not only connects Japan to American institutions of higher education with his role in the development of both Massachusetts Agricultural College and Sapporo Agricultural College (Hokkaido University), but he also received his advanced training under Frederick Wöhler at Göttingen. Under the stewardship of Clark and other American educators, Sapporo Agricultural College serves as a template of colonialism and imperial motives that would continue as Japan expanded its empire into the twentieth century. The College's evolution to an imperial college and the reestablishment of relations with the University of Massachusetts-Amherst in the twentieth century are, in part, due to the lasting effects of Clark and his final statement to his Japanese students: "Boys, Be Ambitious!"

Chapter 5, "'New Frontiers of the Mind are Before Us': Scientific States after World War II," highlights the Electronics Research Laboratory (ERL), its history and its

faculty, staff, and students, to analyze Montana State University's relationship with the Academic-Military-Industrial Complex in the 1950s through the end of the century. President Eisenhower first defined the Military Industrial Complex in his "Farewell Address" in 1961. Later in the decade, Senator Fulbright added "Academic" to this complex as he noted the direct relationship between institutions of higher education and the Military Industrial Complex. Both men provided caution about this relationship but by this point it was difficult to separate these entities. The Academic-Military-Industrial Complex originated research and development groups during the first half of the twentieth century and continues to be a massive entity. Through Stanford University and the development of the Stanford Research Institute, came the seed for ERL at MSU. In time, ERL created its own path and earned a variety of military and industrial contracts that had direct influences on the type and direction of education it offered its students. These students and members of ERL developed a wide-range of local, national, and international projects. It also led to spinoff companies affiliated with MSU and, in time, the disappearance and legacy of ERL. Although ERL is no longer an entity, the University's relationship with the Academic-Military-Industrial Complex continues to this day.

The Epilogue, "A Nineteenth Century Model in a Twenty-first Century World," looks at the changing role of the university and the legislatures that have begun to defund land-grant schools throughout the United States, such Oregon, Wisconsin, and to a lesser extent, Montana. Through this process, the focus on research has diminished, replaced instead by an emphasis on education that has the more practical goal of job placement, in

some ways a reversal of tenets in the land-grant model, and in others, a reprisal. Additionally, the role of nostalgia and its detrimental effects on current practice and legislation concerning higher education continues to provide problems for educators and administrators. Further, we see how the integration of global corporations and interests in education and land-grant schools affects its relationship to how Humboldt's model of education and Bush's view of science came to fruition. Finally, I address the purposes of higher education and its place in twenty-first century society.

CHAPTER ONE

EUROPEAN IDEAS: MINING A MODEL EDUCATION

In 1874, American James M. Hart wrote about his experiences studying and living in Germany during the latter part of the 1860s. Hart took this time to convey his experiences in German universities to inform Americans of German approaches to education and as a guidebook for interested students. In defining German universities, he stated, "the collective idea of a university implies a *Zweck*, an object of study, and two *Bedingungen*, or conditions. The object is *Wissenschaft*; the conditions are *Lehrfreiheit* and *Lernfreiheit*." [66] By *Wissenschaft*, Hart was referring to "the ardent, methodical, independent search after truth in any and all of its forms, but wholly irrespective of utilitarian application."[67] In other words, the German university focused its purpose around the pursuit of knowledge in all of its theoretical forms, "and leaves to other institutions the practical and technical … The German university has one and only one object: to train thinkers."[68] In order to accomplish this lofty goal, universities used *Lehrfreiheit* and *Lernfreiheit.* Hart defined *Lehrfreiheit* as, "the one who teaches, the professor or *Privatdocent*, is free to teach what he chooses, as he chooses," whereas, *Lernfreiheit*, "or the freedom of learning, denotes the emancipation of the student from

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[66] James Morgan Hart, *German Universities: A Narrative of Personal Experience, Together with Recent Statistical Information, Practical Suggestions, and a Comparison of the German, English and American Systems of Higher Education.* (New York, G. P. Putnam's Sons, 1874), 249-250.
[67] Hart, *German Universities*, 250.
[68] Hart, *German Universities*, 251.

Schulzwang, compulsory drill by recitation."[69] Later Hart clarified the role of the professor by saying that he "is not a teacher, in the English sense of the term; he is a specialist. He is not responsible for the success of his hearers. He is responsible only for the quality of his instruction. His duty begins and ends with himself."[70] The focus on theoretical knowledge and the academic freedom for professors to teach how they wanted to teach changed the way universities worked and was the result of several new reforms.

Beginning in the first decade of the nineteenth century, university reformers began to construct a new purpose for higher education. Before these reforms, the role of the European university, or its social function, was to train men for one of three fields: public (civil) service, the church, or for liberal professions.[71] These three fields shaped the political, economic, religious, and social lives of the various levels of society, especially among the elite, who at this time directly benefitted from the potential to attend institutions of higher education.

Three reforms changed the direction of higher education in the nineteenth century. These reforms affected the role of funding and freedom of the institutions and professors, the relationship between pedagogy and research, and both the accessibility and type of learning environment desired for scientific education. These reforms were often

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[69] Hart, *German Universities*, 250.
[70] Hart, *German Universities*, 264. Earlier in his book, Hart described the actions of professors and students. Hart "learned a good many peculiarities of university language; for instance, that a professor never 'instructs' or 'lectures,' he 'reads;' the students do not 'study,' they 'hear.' I learned also that instruction in a German university runs in sharply defined channels" (Hart, *German Universities,* 6).
[71] Peter Lundgreen, "Education for the Science-based Industrial State? The Case for Nineteenth-Century Germany," *History of Education* 13, vol. 1 (1984): 60.

contradictory in nature. However, this did not stop them from changing Germanic educational approaches, and then, other European, American, and Japanese public and private institutions of higher education. As a result, these mobile and adaptable reforms re-shaped the trajectory of higher education to the multi-purpose schools operating today. Each of these institutions or schools continue to work with and around the historical contradictions within which these reforms were created. These experiences called into question and revised the overall purposes of each institution.

Appearing from Germanic schools, these reforms have often been clumped together under the idea of a "German Model" of higher education.[72] Often, this "model" is referencing the first two reforms and their origination with the University of Berlin and Wilhelm von Humboldt. Although historians denote a "German Model" as the foundation for higher education in the United States and other European nations, there is not a single model that achieved this goal; instead, an amalgamation of Humboldtian principles; historical, laboratorial, and geographical practices; and international exchanges of knowledge and societal need shaped a variety of models that individuals transported to their home institutions to create the modern university of the nineteenth century.

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[72] See Mark R. Finlay, "Transnational Exchanges of Agricultural Scientific Thought from the Morrill Act through the Hatch Act," in Alan I. Marcus, ed., *Science as Service: Establishing and Reformulating American Land-Grant Universities, 1865-1930* (Tuscaloosa: The University of Alabama Press, 2015), 39; James Turner and Paul Bernard, "The German Model and the Graduate School: The University of Michigan and the Origin Myth of the American University" in Roger L. Geiger, ed., *The American College in the Nineteenth Century* (Nashville: Vanderbilt University Press, 2000), 221-241.

This chapter outlines the transformation and evolution of higher education in German institutions in the nineteenth century. The chapter will focus on Wilhelm von Humboldt and his contemporaries as the central figures of reform in German institutions of higher education. Starting with Humboldt's idea of state-funded universities that housed professors with academic freedom — the first contradictory reform — the chapter will then address his second reform, the relationship between teaching and research. The chapter will then focus on the role of scientific education, especially the role of the laboratory— the third reform—and innovative professors, such as Friedrich Wöhler and Justus von Liebig. This will lead into a brief discussion about American experiences in Germanic universities, the development of American colonies, the influence of politics on school enrollments, and the transformation of American education and knowledge production. The chapter will then conclude with a discussion of the effects of these reforms on American approaches to higher education and the lasting effects of these models on higher education.

Humboldtian Education

In 1896, historian Bruno Gebhardt published a biography of Wilhelm von Humboldt.[73] Within the biography, Gebhardt included a previously unpublished fragment of Humboldt's writing concerning education and its relationship to the state. Humboldt's "On the Internal Structure of the University in Berlin and its Relationship to Other

[73] Bruno Gebhardt, *Wilhelm von Humboldt als Staatsman* (Stuttgart: J. G. Cotta, 1896) https://archive.org/details/wilhelmvonhumbo01gebhgoog.

Organizations" clearly outlined his vision for higher education and its place in society. Based on the focus of the manuscript, historians dated its writing to 1809 and the development of the University of Berlin. Coupled with his other writings on education, these ideas provided the foundation for what 20th century historians and educators termed as the "Humboldtian model" of education.

The twin pillars of the "Humboldtian model" are the freedom of research and the autonomy of the teaching staff. These two premises allowed scholars to study science and conduct research without the interference of political or external entities. This was because Humboldt did not want politics to misuse science. However, this autonomy and freedom was not an attempt to lock university teachers away from society in an ivory tower, which was in direct opposition to his views of education and its vital role in society. Further, Humboldt did not advocate for private education; in fact, in his time in control of educational reform and administration, he did all in his power to eliminate the privatization of knowledge and the vestiges of status it entailed. This is evident in Humboldt's legislation to place the Prussian Academy of Arts and Sciences under the control of the state and Berlin University in 1809.[74]

In the creation of the University of Berlin and in his foray into the role of the state and society in higher education, Humboldt was trying to define the purpose of universities and their relationship to the state. According to editors Louis Menand, Paul Reitter, and Chad Wellman, Humboldt was crafting an argument for the "social value of

[74] Daniel Fallon, *The German University: A Heroic Ideal in Conflict with the Modern World*, (Boulder, CO: Colorado Associated University Press, 1980): 21-22.

an institution dedicated to the creating and transmission of a particular kind of knowledge, one that met certain standards of authority and moral worth, while also servicing the needs of society."[75] For Humboldt, the university was an integral part of society, where knowledge, developed by the university, informed society, which, in turn, supported the institution with a steady stream of capital and students.

Since the early decades of the twentieth century, historians of higher education have begun to use Humboldt's work, especially ideas derived from the manuscript, first published in 1896, to create the "Humboldtian Model" of higher education.[76] Recently, historians have historicized Humboldt and his ideas as part of a complex network of reformers and educators who wrote and spoke in the latter part of the eighteenth and early part of the nineteenth centuries.[77] Humboldt, along with Johann Gottlieb Fichte, Friedrich Schleiermacher, and others have been attributed as progenitors of what became the research university.[78] Humboldt, Fichte, and Schleiermacher all interacted with each other in the first decade of the nineteenth century and were each associated with the University of Berlin. The principal difference between these three men is Humboldt's role in the government at the time. His writings, though found near the end of the

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[75] Louis Menand, Paul Reitter & Carl Wellman, *The Rise of the Research University: A Sourcebook*, (Chicago: The University of Chicago Press, 2017): 106.
[76] See Robert D. Anderson, "Germany and the Humboldtian Model" in *European Universities from the Enlightenment to 1914*, (Oxford: Oxford University Press, 2004), 51-65.
[77] See Anderson, "Humboldtian Model", Sylvia Paletschek, "The Writing of University History and University Jubilees: German Examples" *Studium: Tijdschrift voor Wetenschaps- en Universiteitsgeschiedenis Revue d'Histoire des Sciences et des Universités* 5, no. 3 (2012), 142-155.
[78] See Louis Menand, et al., *The Rise of the Research University*, 45-83, 105-119.

nineteenth century, provided a clear description of what he defined as the role of the university.

The development of the research university, synonymous with the "Humboldtian model" and with reforms in German institutions of higher education throughout the nineteenth century, shifted the direction of higher education worldwide. Before detailing these reforms and highlighting the life and ideas of Wilhelm von Humboldt and his contemporaries, one must review the state of German approaches to higher education at the beginning of the nineteenth century.

Since its inception, the university has drawn students from both local and distant places to its hallowed halls of learning. Beginning as religious centers of knowledge, European universities evolved and reacted to the social and cultural changes in the regions where they were founded.[79] By the end of the eighteenth century, the modern university began to take shape and new forms of institutions of higher education appeared as well.[80] Germanic universities saw a great emphasis placed on science and scientific knowledge, which by the nineteenth century enabled these institutions, such as Leipzig, Göttingen, Halle, and others, to become not only a beacon for German students, but also for other nations both in Europe and abroad.

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[79] See Hilde de Ridder-Symoens, ed. *A History of the University of Europe: Volume II: Universities in Early Modern Europe (1500-1800)* (Cambridge: Cambridge University Press, 1996); Heike Jöns, "Modern School and University" in *A Companion to the History of Science*, ed. Bernard Lightman (West Sussex, UK: Wiley Blackwell, 2016), 310-16.

[80] See Walter Rüegg, *A History of the University of Europe: Volume III: Universities in the Nineteenth and Early Twentieth Centuries (1800-1945)* (Cambridge: Cambridge University Press, 2004); Jöns, "Modern School," 314-19.

One of these institutions, Göttingen, served as a model for other research institutions from its creation in 1734 in the Electorate of Hanover. In the middle of the eighteenth century, the Elector of Hanover also reigned in England as King George II, who was persuaded by Gerlach Adolph von Munchhausen to establish a new institution of higher learning at Göttingen.[81] Munchhausen was not only the founder of this new institution, but he was also the most important contributor to its development for the next thirty-three years. One of Munchhausen's contributions was the establishment of the *Kameralwissenschaft* (Cameralia) or public administration as a core part of the curriculum.

In time, Göttingen and its public administration lectures were a destination for students desiring to become prominent officials in their own countries. At the same time, Göttingen offered courses in history, modern literature, science, medicine, chemistry, metallurgy, and agriculture. To meet the demands of Munchhausen and the students who came to Göttingen, the university had several excellent facilities, including the first research library, science laboratories, an observatory, and an anatomical theater. Due to the excellent library and laboratory resources, the students at Göttingen undertook more independent research and the professors conducted more original research than those at other eighteenth century universities.[82] Additionally, due to the freedom to

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[81] Harold Perkin, "History of Universities" in *The History of Higher Education, Third Edition*, eds. Leonard Foster, Harold S. Wechsler, Lester F. Goodchild, and Linda Eisenmann (Boston: Pearson Custom Publishing, 2007), 19; reprinted from *International Higher Education: An Encyclopedia* vol. 1, ed. Philip Altbach (New York: Garland Publishing, Routledge, Taylor & Francis, 1991).

[82] Harvey Lindsly, *A Brief Sketch of some of the Principal Universities of Europe and of the United States* (Washington: Jacob Gideon, Jr., 1856), 10-12.

pursue their own interests and decent salaries and pensions, scholars flocked to the university's staff. In terms of science, many of Göttingen's science professors came together to establish the Göttingen's Academy of Science.

The successes at Göttingen led Prussian minister Friedrich Gedike to scout the institution for his 1789 report on German universities for King Friedrich Wilhelm II. This report was a way for Gedike and the Prussian government to evaluate their own institutions through others outside of Prussia, including Göttingen. This fifty-nine-folio page report discussed faculty, university libraries and buildings, and identified elements of higher education to incorporate into Prussia's own institutions. In the section on Göttingen, Gedike wrote that the school "sustained royal munificence from its founding" and "is more well-known and better regarded than any other university in Germany."[83] Later, Gedike praised the library, its "thirty thousand volumes," had proved to him "that nothing is more conducive to a university's public recognition, flourishing, and fame than a great library."[84] Göttingen's student population was also unique, as it had "far fewer poor students than at other universities…" and "no other university has so many sons of rich, prominent, and noble families."[85] Among this elite class of students were two

[83] Friedrich Gedike, "Report to King Friedrich Wilhelm I of Germany" in *The Rise of The Research University: A Sourcebook,* eds. Louis Menand, Paul Reitter, and Chad Wellmon (Chicago: The University of Chicago Press, 2017), 14; trans. Paul Reitter and Chad Wellmon from Richard Fester, ed., "Der Universitäts-Bereiser" *Friedrich Gedike und seeing [1789] Bericht an Friedrich Wilhelm II,* Archiv für Kulturgeschichte, sup. 1 (Berlin: Duncker, 1905).
[84] Gedike, "Report," 18.
[85] Gedike, "Report," 20.

brothers who shaped nineteenth century science, linguistics, education, and knowledge—Wilhelm and Alexander Humboldt.

The Humboldts

At the end of the eighteenth and beginning of the nineteenth centuries, a generation emerged that bore witness to the dismantling of absolute monarchies because of the French Revolution, the rise and fall of Napoleon, and the emergence of a new Europe. Alexander and Wilhelm Humboldt, whose names may have been forgotten by the lay population, were among this generation who survived the upheaval to reform and modernize Europe in science and education.

Alexander and Wilhelm were the sons of Alexander Georg von Humboldt, a Prussian gentleman-in-waiting, by his second marriage to the widowed Baroness von Holwede. Due to their position, the brothers received private tutoring but had opposite interests. In a letter written to his wife in 1804, Wilhelm stated: "Since our childhood, we have moved poles apart although we have always remained fond of each other […] From an early age, his inclination has been to the outside world, while I preferred the inner life, even when I was very young."[86] Based on family tradition, Wilhelm was expected to study law and Alexander finance. Both brothers enrolled in the University of Brandenburg in Frankfurt-an-der-Oder in the fall of 1787. However, by the following

[86] Wilhelm von Humboldt, *Wilhelm von Humboldt, Sein Leben un Wirken dargestellt in Briefen Tagebüchen und Dokumenten seiner Zeit* [Wilhelm von Humboldt: His Life and Work through Letters, Diaries and Contemporary Documents], comp. by R. von Freese, (1953): 531, as cited in Gerd Hohendorf, "Wilhelm von Humboldt," *Prospects* 23, no. 3–4 (September 1, 1993): 666.

semester, the Humboldts moved to Göttingen. As the brothers reached adulthood, their divergent interests shaped their individual careers and legacy. Alexander traveled the world for scientific purposes and then compiled his experiences into a collected works. Wilhelm's interest in the "inner life" led him to government and civil service roles, including an ambassadorship to the Vatican in Rome, from which he was recalled in 1808.[87]

In recent years, historians of science have reintroduced us to the work and influence of Alexander.[88] Yet, outside of historical linguistic studies and the history of higher education, we know relatively little of his elder brother, Wilhelm. This is likely due, as mentioned earlier, to the fields in which each brother focused their lives and, for Alexander, the international fame he garnered from his important exploration of South America and his many scientific works. Wilhelm, on the other hand, spent his time indoors in government and the civil service. He wrote about language and the role of education in society, where his most important work was lost, then found, incomplete, at the end of the nineteenth century. Perhaps the reason why Wilhelm is not as well-known as his brother is because of the importance we place on new knowledge and exploration, but not to how we teach this knowledge. As this dissertation shows, how we teach is

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[87] Hohendorf, 668; In 1789, Wilhelm joined the Prussian civil service as a law clerk to the Supreme Court of Berlin but left after a year.

[88] See Andrea Wulf, *The Invention of Nature: Alexander von Humboldt's New World* (New York: Vintage Books, 2015); Aaron Sachs, *The Humboldt Current: Nineteenth-Century Exploration and the Roots of American Environmentalism* (New York: Viking, 2006); and Laura Dassow Walls, *The Passage to Cosmos: Alexander von Humboldt and the Shaping of America* (Chicago: University of Chicago Press, 2009).

integrated into all forms of society through sharing or silencing various forms of knowledge and its relation to the needs and wants of the state, industry, and public.

Wilhelm and Education

After leaving Rome in 1808, Wilhelm Humboldt was appointed head of the newly created Section for Culture and Public Education within the Ministry of the Interior. In this position, Wilhelm instituted reforms into all levels of education and drew on ideas he first publicized in 1792.[89] In this publication, Wilhelm saw the need to limit the role of the state, which had the duty to protect its citizens within its borders from external attacks.[90] Overall, Wilhelm feared the state's role in education had the potential to "'always favour one particular form,'" which was problematic when it related to the moral being, and individuality of the citizen.[91] He also believed that "all educational development has its sole origin in the inner psychological constitution of human beings, and can only be stimulated, never produced by external institutions."[92] Education was a

[89] Hohendorf, 668-669; In 1790, Wilhelm began work on a publication entitled *Ideas for an Endeavor to Define the Limits of State Action*, which he completed in 1792, but it was not published in its entirety until long after his death. However, in December 1792, he did publish a section of this work in the *Berlinische Monatsschrift* under the title "On Public State Education."

[90] Hohendorf, 668; Wilhelm von Humboldt, *The Sphere and Duties of Government*, trans. Joseph Coulthard (Bristol, England: Thoemmes Press, 1996).

[91] Wilhelm von Humboldt, *Gesammelte Schriften: Ausgabe der Preussischen Akademie der Wissenschaften* [Collected Writings: Prussian Academy of Sciences Edition], 17 vols., (Berlin, 1903-1936): I, 143, as cited in Gerd Hohendorf, "Wilhelm von Humboldt," *Prospects* 23, no. 3–4 (September 1, 1993): 668.

[92] Marianne Cowan, *Humanist without Portfolio: An Anthology of the Writings of Wilhelm von Humboldt* (Detroit: Wayne State University Press, 1963): 126, translated from Wilhelm Humboldt *Über Religion.* (About religion.), 1789, in *Wilhelm von Humboldt's Gesammelte Schriften, vol. I* (Berlin: Königlich Preussische Akademie der Wissenschaften, 1903): 70.

personal experience shaped by the stimuli presented. Wilhelm described the sole purpose of education was to "shape man himself" and, therefore, the state's role must be reversed: "if there's one thing more than another which actually requires free activity on the part of the individual, it is precisely education, whose object it is to develope [sic] the individual," and man, educated in this way, must then join the State, "in the position […] Which he has spontaneously chosen, he is not only himself by, the state constitution also subject to a reciprocal influence."[93] Therefore, man is a subject who helps shape society and not an object of the state. These ideas follow in-line with those found in Count Mirabeau's *Discourse on National Education*. Humboldt even quoted Mirabeau in a footnote: "Education will be good to the extent that it suffers no outside intervention; it will be all the more effective, the greater the latitude left to the diligence of the teachers and the emulation of their pupils"[94] Humboldt's views on the role of the state in education came full circle; in 1809, he became a representative of the state as it began to reform the Prussian educational system and administration.

In this new position, Wilhelm joined a cadre of men trying to reform Prussia in the wake of Napoleon's invasion. However, reforming a society and its people was proving to be difficult as conservative elements resisted and, as Hohendorf explains, due to the "the inadequate level of education of the citizens."[95] The administration of Baron von und zum Stein decided that Humboldt was the man to lead the reform. According to

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[93] Wilhelm von Humboldt, *The Sphere and Duties of Government*, trans. Joseph Coulthard (Mansfield Centre, CT: Martino Publishing, 2014): 66.
[94] von Humboldt, *Gesammelte Schriften*, I, 146, cited in Hohendorf, 669.
[95] Hohendorf, 669.

Diesterweg, "Their idea was to strengthen and elevate the nation by removing the burdens weighing on it and also through education. They endorsed a proposal made by the great Swiss thinker and, after regaining their freedom, took action by setting up teacher training establishments."[96] The Swiss thinker was Pestalozzi, whose ideas had influenced two of Humboldt's colleagues by 1808 – Johann Heinrich Ludwig Nicolovius and Johann Wilhelm Süvern. These men offered scholarships for young teachers to study Pestalozzi's methods in Yverden, with the idea that upon their return, the teachers disseminate the methods in the schools in which they taught. At first Humboldt was leery of Pestalozzi's methods, but, possibly due to the influence of Johan Gottlieb Fichte's *Addresses to the German Nation*, he soon adopted the approach.[97]

By early 1809, Humboldt had become head of the Culture and Education section of the Ministry of the Interior, but the Minister had changed from Stein to Count von Dohna. Dohna disagreed with many of Humboldt's ideas, which may be due to Humboldt's insistence that the government create a Ministry of Education separate from the Ministry of the Interior. Unfortunately for Humboldt, this did not occur until 1817.[98] Humboldt also ran into issues with his desire to create a State Council and to have more collegiality. Although the Minister of the Interior and Finance, von Bülow, disagreed with this approach, Humboldt introduced a collegial form of management in his own section.

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[96] F. A. W. Diesterweg, *Sämtliche werke I,* begründet von H. Deiters, bearbeitet von R. Hohendorf. Bd. XIV, Berlin, 1979, 41, as cited in Hohendorf, 670.
[97] Johann Gottlieb Fichte, *Address to the German Nation*, ed. Gregory Moore (Cambridge: Cambridge University Press, 2008).
[98] Hohendorf, 671.

In March 1809, Humboldt wrote two letters that provided an insight into his plan for education. To his wife, Humboldt described a plan "for schools to be paid for by the nation alone."[99] He wanted a system in place that included a fund for schools to run and for teachers to earn wages that were independent from any external influence, including government. This contradictory expectation is one of many that plagued the new "modern" system of higher education. He added to this idea in his letter to Nicolovius: "Education is a matter for the nation and we are preparing (admittedly with great caution) to diminish the powers of the State and win the nation over to our own interests."[100] While he advocated for an "education…for the nation," Humboldt never fully supported a fully Prussian system of national education; instead, he looked to the whole of German peoples.

For Humboldt, education was divided into three stages, and thus required three distinct types of schools: elementary, secondary, and university education. Each of these stages led to the next. Humboldt clarified this in his *Guiding Ideas on a Plan for the Establishment of the Lithuanian Municipal School System* (1809), where he argued that "this whole education system therefore rests on one and the same foundation. The

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[99] Wilhelm von Humboldt, *Wilhelm von Humboldt, Sein Leben un Wirken dargestellt in Briefen Tagebüchen und Dokumenten seiner Zeit* [Wilhelm von Humboldt: His Life and Work through Letters, Diaries and Contemporary Documents], comp. by R. von Freese, (1953): 591, as cited in Gerd Hohendorf, "Wilhelm von Humboldt," *Prospects* 23, no. 3–4 (September 1, 1993): 671.

[100] Wilhelm von Humboldt, *Wilhelm von Humboldt, Sein Leben un Wirken dargestellt in Briefen Tagebüchen und Dokumenten seiner Zeit* [Wilhelm von Humboldt: His Life and Work through Letters, Diaries and Contemporary Documents], comp. by R. von Freese, (1953): 594, as cited in Gerd Hohendorf, "Wilhelm von Humboldt," *Prospects* 23, no. 3–4 (September 1, 1993): 671.

commonest jobbing worker and the finest graduate must at the outset be given the same mental training, unless human dignity is to be disregarded in the former and the latter allowed to fall victim to unworthy sentimentality and chimera."[101] He sought a complete education for all levels of society, including its poorest members. This included finding opportunities for those who lacked the necessary resources to have the opportunity for higher education from the advocated national fund. Although the three successive tier system of education made sense to Humboldt, it failed to gain acceptance in the nineteenth century and has not been completely implemented since then.

By the end of 1809, the death of Humboldt's father-in-law caused him to have an extended leave of absence, which led to his resignation in June 1810. In his retirement, Humboldt wrote: "I had drawn up a general plan which covered everything from the smallest school to the university and in which all the component parts fitted together; I was at home with all these parts."[102] Nicolovius ascended to Humboldt's vacated position; however, Humboldt maintained his position as the chairman of the founding committee of Berlin University.

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[101] von Humboldt, *Gesammelte Schriften*, XIII, 278, cited in Hohendorf, 672.
[102] Wilhelm von Humboldt, *Wilhelm von Humboldt, Sein Leben un Wirken dargestellt in Briefen Tagebüchen und Dokumenten seiner Zeit* [Wilhelm von Humboldt: His Life and Work through Letters, Diaries and Contemporary Documents], comp. by R. von Freese, (1953): 662, as cited in Gerd Hohendorf, "Wilhelm von Humboldt," *Prospects* 23, no. 3–4 (September 1, 1993): 673.

Humboldt and the Founding of Berlin University

Before Wilhelm von Humboldt left Rome for his educational position in the Prussian government, plans for the creation of a university in Berlin already existed.[103] It was not until Humboldt that these plans along with his own ideas produced a new form of higher education. Humboldt envisioned a university that united teaching and research. In his own words, this new system had "a special feature of the higher scientific establishments that they treated science as a problem that is never completely solved and therefore engaged in constant research."[104] Additionally, this university focused on a general education that taught all forms of science but did not include a focus on occupational training.[105]

The university fit into his three-tier system of education in that it continued the general education established in elementary and continued in secondary education; however, the type of teaching and the core of the university must be different from the

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[103] See Johann Gottlieb Fichte, *A Plan, Deduced from First Principles, for an Institution of Higher Learning to Be Established in Berlin, Connected to and Subordinate to an Academy of Sciecnes* in *The Rise of The Research University: A Sourcebook*, eds. Louis Menand, Paul Reitter, and Chad Wellmon (Chicago: The University of Chicago Press, 2017), 67-83; trans. Damion Searls from J.G. Fichte, *Deduzierter Plan einer zu Berlin zu errichtenden höhern Lehranstalt, die in gehöriger Verbindung mit einer Akademie der Wissenschaft Stehe*, in *J. G. Fichte Gesamtausgabe der Bayerischen Akademie der Wissenschaften*, II, 11, ed. Reinhard Lauth, Hans Gliwitzky, Peter K. Schneider, and Erich Fuchs (Stuttgart-Bad Cannstatt: Friedrich Frommann, 1998); and, Friedrich Schleiermacher, *Occasional Thoughts on Universities in the German Sense, with an Appendix Regarding a University Soon to Be Established (1808)*, trans. Terrence N. Tice and Edwina Lawler (Lewiston, NY: Edwin Mellen, 1991).
[104] von Humboldt, *Gesammelte Schriften*, X, 251, cited in Hohendorf, 673.
[105] Wilhelm von Humboldt had observed the Hohe Karlsschule in Stuttgart in 1789, which focused on a vocational orientation of education. His distaste for this form of education led, in part, to his closing of the Prussian cadet corps when he came to office, and the denial of this form of education in his new university, see Hohendorf, 673.

other two tiers. In terms of university teachers, Humboldt did not see their role as central to the training in university: "The university teacher is therefore no longer a teacher and the student no longer someone merely engaged in the learning process but a person who undertakes his own research, while the professor directs his research and supports him in it."[106] The relationship between the teacher and the student should be close and each should be in contact with the other, so that the student is able to conduct independent scientific work.

As stated earlier, Humboldt viewed education at all levels to be interconnected and function together. This is true of the three-tier education system – elementary, secondary, and university education – as well as other institutions of knowledge creation including museums, libraries, and academies. In other words, the university is not a single institution beholden to itself; instead, it forms an integral piece of knowledge construction and dissemination in the larger society. This is evident in Humboldt's more official "Request for the Establishment of the University of Berlin."[107]

In the beginnings of the University of Berlin, Humboldt organized its foundation, procured the required resources and building, and selected the faculty and attended their lectures.[108] Members of the faculty included W. M. L. de Wette and P. Marheineke in

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[106] Humboldt, *Gesammelte Schriften*, XIII, 261, cited in Hohendorf, 673.
[107] Wilhelm Humboldt, "Request for the Establishment of the University of Berlin, May 12-14, 1809" in *The Rise of The Research University: A Sourcebook*, eds. Louis Menand, Paul Reitter, and Chad Wellmon (Chicago: The University of Chicago Press, 2017), 116-119; trans. Paul Reitter and Chad Wellmon from *Wilhelm von Humboldts Gesammelte Schriften*, vol. 10, ed. Königlich Preussischen Akademie der Wissenschaften (Berlin: B. Behr, 1903).
[108] The building was the former palace of Prince Heinrich on the Unter den Linden.

theology, F.E.D. Schleiermacher in theology-philosophy, J.G. Fichte in philosophy, F.A. Wolf in classical philosophy, F.K. Savigny in Law, S. Hermbstädt in chemistry and technology, M.H. Klaproth in chemistry, and J.C. Reil in medicine.[109] Humboldt, however, disappointedly failed to extract Johann Carl Friedrich Gauss, the famed mathematician and physicist, from Göttingen. Even without Gauss, Berlin University opened with an exceptional faculty.

The reform Humboldt sought was *Wissenschaft* or the advancement of learning through disinterested scholarship.[110] Humboldt thought that self-expression and personal freedom were important for university scholars and fought for this at the University of Berlin. Humboldt wanted the university to have its own revenue sources so that it had fiscal autonomy. However, his successor as Prussian minister of education, von Schuckmann, disagreed with this position. The fear of the potential unchecked power and knowledge production of the universities led to a somewhat tumultuous relationship between the state and the universities themselves. This is one example of the contradictory nature of Humboldt's plan for the university – freedom from state or external influence, but reliant on state funding.

Science, Technology, and European Society

The rapid expansion of European interests around the world and the specialization of knowledge production led states and universities to invest more resources in the

[109] Fallon, *The German University*, 21.
[110] Hart, *German Universities*, 250.

studies of science and technology. The first technical colleges emerged in France and Germany in the 1790s. The model that shaped technical education in Holland, Switzerland, Austria, and Germany was the *École Polytechnique* in Paris. In terms of research, the University of Berlin provided the model for future research-minded universities.

The *École Polytechnique* served as a model for the Federal Institute of Technology in Zurich (1848). This institution, in turn, became the model for *Technishe Hochschulen* of Germany and Austria. The goal of these institutions was to train scientist-technologists and factory managers. *Technishe Hochschulen* were located in Vienna, Berlin, Munich, Augsburg, Hanover, Stuttgart, Karlsruhe, Nuremberg, Darmstadt, Aachen, and Brunswick.

Science played a major role in the German universities. The founding of the University of Berlin established research as a key function of higher education. New universities emerged to rival Berlin with research as its focus, such as Bonn and Munich; while older institutions, such as Heidelberg, reorganized. However, this early foray into research-based education had more of a humanistic feel to it and, by 1840, began to receive criticism from scientific individuals such as Justus von Liebig.

In 1840, Justus von Liebig, the famous chemist at Giessen, observed that chemistry in Prussia was at the point of stagnation in industry, agriculture, pharmacy, physiology, and medicine.[111] This stagnation was due to the virtual neglect of the subject

[111] Justus Liebig, "Der Zustand der Chemie in Preussen," *Annalen der Chemie und Pharmacie,* 34 (1840): 97-136, and issued with minor changes, *Ueber das Stadium der*

throughout Prussian society and in education. For Liebig, this neglect was due to the *Bildung* ideology, the "idolatrous veneration of philology and dead languages," and with the harmful influence of *Naturphilosophie* on the experimental sciences.[112] These two approaches to higher education distracted potential chemists from pursuing the types of research and study that Liebig thought the field of chemistry needed to be effective.

After the Franco-Prussian War, some thirty years later, German science and technology was synonymous with excellence. Foreign delegates observing German approaches to military and economics often studied the German system of education and higher learning, including their focus on science technology, to discover potential patterns to replicate in their home countries. It appeared to most observers that Germany was a model for the science-based industrial state, but according to Peter Lundgreen, we must also look at the "rhetoric and social privileges of the traditional educational system used so often for recruitment into the elites."[113] This rhetoric can disguise the supposed transformation in the mid-1800s from a burgeoning industrial state to a science-based one and blur the actual role that science and technology played in this transformation.

As stated earlier in this chapter, the role of the European university, or its social function, was to train men for one of three fields: public service, the church, and liberal professions. As the sciences fought for academic status during the late-eighteenth and early nineteenth centuries, two fields began to pull away from this expected social

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Naturwisenschaften und über den Zustand der Chemie in Preussen in Justus von Liebig, *Reden und Abhandlungen* (Leipzig: C.F. Winter'sche Verlagschandlung, 1874), 7-36.
[112] R. S. Turner, "Justus Liebig versus Prussian Chemistry: Reflections on Early Institute-Building in Germany", *Historical Studies in the Physical Sciences,* 13 (1982): 129.
[113] Lundgreen, "Education for the Science-Based Industrial State," 59.

function: chemistry and engineering. These two fields had real-world usefulness with links to material production and utilitarian principles. Chemists and engineers joined the private sector of the economy as the first *academically* trained manpower. This, then, provides historians two examples of what Lundgreen calls the "'*emancipation*' *of science and technology inside and outside the university*."[114]

Chemistry is the field that exhibits "emancipation" from the inside. Despite the many changes the German university experienced because of Humboldt's pursuit of a research imperative, most universities' experimental sciences had not achieved this goal. After Liebig's letter in 1840, many of his colleagues questioned the idea of full-time research conducted in laboratories. The appropriateness, they claimed, of this type of work was better suited for technological chemistry and industrial education, whereas "the university must represent *primarily* theoretical instruction in chemistry, in which students of *all* disciplines can take part without any practical-chemical orientation."[115] They continued by critiquing Liebig's own work at Giessen either as "an imported French evil" or as the "weapon of English industry abroad."[116]

Despite this critique, between 1840 and the early 1860s, the creation of chemistry institutes at Prussian universities went ahead at a moderate pace. This was due in part to their connection with medical and pharmacy education. In the 1870s, industrial demand for academically trained chemists skyrocketed, and even though the existing institutes

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[114] Lundgreen, "Education for the Science-Based Industrial State," 60.
[115] Turner, "Justus Liebig," 137.
[116] Turner, "Justus Liebig," 160. Liebig was trained, in-part, in Paris in the laboratories of Joseph Louis Gay-Lussac.

had not predicted this sudden change, they were able to respond to the needs of the chemistry industry. As a result, the several state-financed institutes exemplified chemistry's "emancipation" inside the university. In terms of ideology, this emancipation led to "a new pride as to the importance of university science for Imperial Germany combined with the rhetoric stressing the theoretical aspects of chemistry, its academic tradition, its contribution to *Bildung*, and the nonessential nature of its industrial linkages."[117] However, the universities often were not as flexible when it came to the need for specialization. The competing *Technische Hochschulen*, home to chemistry education from its inception, was more adaptable to the changing needs of the field.

The German polytechnic school, or *Technische Hochschulen*, provided the site for the other field — engineering — the field that experienced "emancipation" outside the university. *Technische Hochschulen* evolved out of the tradition of specialized schools of the eighteenth century – *écoles spéciales*, *écoles d'application*. These schools took a different line than the universities, whose focus was on non-practical education. However, schools such the *Bauakademie* in Berlin (1799) and Paris's *écoles des ponts et chaussées* (1775) also specialized in civil servant training, which put them in direct competition with the universities. In the final decades of the nineteenth century, Germans debated the place of *Technische Hochschulen* in relation to the universities. The debate was on equal rights (*Gleichberechtigung*), which the Emperor settled by placing the *Technische Hochschulen* on equal footing with the university. These schools became

[117] Lundgreen, "Education for the Science-Based Industrial State," 61; and, Turner, "Justus Liebig", note 30.

strongholds for the sciences and "for the foundation of power and of intellectually demanding, 'true' education for the functional elites."[118] Due to their new status, *Technische Hochschulen* and universities formed a dualism for higher education options. However, this was not the only dualism present.

Internally, technical education, as it dealt with the sudden demand for engineers and technicians in an industrializing economy, experienced a bifurcation in the purpose and direction of this form of education. Trade schools emerged in Prussia and the German Middle States before the 1870s as a state-driven reaction to this demand. For example, Prussia established a separate Trade School (*Gewerbeinstitute*), which remained independent until 1879 when it was absorbed by the *Bauakedemie*. Before the 1870s, the bifurcation within technical education consisted of:

> Institutional segments training for public service, early demanding a highly mathematized course of instruction, distancing themselves from the world of material production, and on the other, institutional segments training for private industry, demanding less educational preparation, less rigour of instruction, and suffering lower esteem socially.[119]

Between 1820 and 1870, this bifurcation slowly faded away because of academization, or the upgrading of the trade school section. It appears that it was not the rise of industrial needs that caused this academization but the approaches of teachers and graduates through academic training that emancipated themselves and their discipline as part of the functional elites. In other words, it was the high-level civil servant and the business

[118] Lundgreen, "Education for the Science-Based Industrial State," 61.
[119] Lundgreen, "Education for the Science-Based Industrial State," 61.

minded entrepreneur that "provided the social figure of orientation and identification" for technicians and scientists.[120]

From the 1870s onward, the place of science and technology in higher education was no longer questioned in general. The developing research-based infrastructure helped in this evolution. The differences observed in the forms and approaches of teaching chemistry in higher education do vary from country to country. This was likely due to social factors and entrepreneurial attitudes to the scientific and technological knowledge and the industries developed to use that knowledge. In Germany, during the 1860s, the beginnings of contract research appeared between developing industrial entities and institutions of higher education. The relationship was short-lived, as by the end of the nineteenth century, most of this form of research occurred within industrial research centers. This was due in part to the role that the professor held within the institution and, in terms of the *Technische Hochschulen*, the quest to avoid appearing to be inferior by focusing on practical, applied science instead of the disinterested, theoretical science preferred by universities.[121]

As this form of research moved out of the hands of the institutions of higher education and into the new professions of scientists and technicians, higher education increased its own specialization within the fields of science and technology to meet the needs of the industrialized state. To cope with the various problems associated with operating an industrialized society, the state began to realize the necessity of science and

[120] Lundgreen, "Education for the Science-Based Industrial State," 62.
[121] Lundgreen, "Education for the Science-Based Industrial State," 63-65

technology. As such, they served two functions during this period: "the instrumentalist function by offering problem solutions; and the legitimizing function by offering an allegedly 'neutral' procedure of conflict regulation."[122] These two functions led to the creation of other institutions and state-backed laboratories to address problems and concerns within the science-based, industrialized society. The new laboratory-based institutions often modeled themselves after the laboratory-based educational system developed by chemists like Liebig and Friedrich Wöhler, and other university-based scientists.

Justus von Liebig and Higher Education

In terms of science teaching, the most important development associated with the new focus on research was the laboratory. German scholars did not invent the laboratory, but they adapted laboratory research with pedagogical practices to create a doctorate that merged instructional and research approaches.[123] One progenitor of this system was Justus von Liebig at the University of Giessen in the 1830s. Another scholar that modeled this system was Friedrich Wöhler at Göttingen. According to American James M. Hart, "The handsomest building in town is (or was in my day) the Laboratory, built under the supervision of Wöhler himself."[124] Both chemists had worked together at various times in their careers and used the laboratory experiences to teach their students about chemical properties and concepts. These laboratories inspired other universities to do the same, and

[122] Lundgreen, "Education for the Science-Based Industrial State," 65.
[123] Laboratories existed at the *École Polytechnique* and the Museum d'histoire naturelle in France and at the Royal Institution in England.
[124] Hart, *German Universities*, 9.

as a result, many of the well-known German scientists were members of university faculties.[125] In time, this model of research-based education drew students from not only the entirety of Europe but also from countries overseas, especially America.

From 1815 to the early decades of the twentieth century, American students steadily made the pilgrimage over to German universities to enroll in courses and experience graduate programs that ranged from science to the arts. Among these experiences were the relationships formed between students and professors and between the students themselves. Scientists like Liebig and Wöhler, and many others, had lasting impacts on their students and on the professional careers that those students had after their time in Germany.[126]

Justus von Liebig is the most famous German chemist of the nineteenth century. Along with Friedrich Wöhler, Liebig changed the face of chemistry education with his use of laboratory-based practices. In terms of numbers, Liebig had far fewer American students than his contemporary Wöhler, but his and his students' contributions to agricultural sciences propelled him in historical memory above Wöhler.[127] Liebig began his laboratory at the University of Giessen in 1824. In 1852, longing for a change of pace,

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[125] These include the mathematician Gauss; the physiologist, Muller; the physicist, Weber; and others such as Dubois-Reymond, Helmholz, Virchow, and Koch.

[126] Hawkins, "Transatlantic Discipleship", 196-210., traces one such collegial relationship with his study on Ernst Heinrich Ehlers (1835-1925) a biologist at Göttingen and two of his students who correspond for thirty and forty years after their leaving Ehlers' tutelage.

[127] Between 1850 and 1880, Wöhler had seventy-nine American students. According to Margaret W. Rossiter, *The Emergence of Agricultural Science: Justus Liebig and the Americans, 1840-1880* (New Haven, Yale University Press, 1975), 184-195, Liebig's American students were forty-nine from 1841-1872.

Liebig moved to the University of Munich, where he continued to teach until his death in 1872.[128] At Munich, Liebig traded his role as the laboratory educator for one as a lecturer. In particular, in 1866, Liebig lectured on the development of scientific ideas, in which he described the relationship between the search for knowledge via schools and the inspiration for invention.[129] Later, he described the division between the intellectual and producing classes, and how by the end of the eighteenth century, with the exclusion of Latin from the curricula, this barrier fell.[130] Although he does not specify how this relates to his time as an instructor, he does highlight the relationship between different types of learning – theoretical and practical – and their relation to each other.

Liebig's first American student was John Lawrence Smith (1818-1883), who had graduated from the University of Virginia in 1835. He then earned his MD in 1840 the Medical College of South Carolina, before continuing his studies in Paris and, then, finally reaching Giessen. In 1842, the *Annalen* published Smith's work on spermaceti – "On the Composition of Spermaceti and its Oxidation by Nitric Acid." Upon completing his studies with Liebig, Smith returned to South Carolina, where his work with soils led to his selection by then, Secretary of State, James Buchanan to go to Anatolia as an advisor on the feasibility of cotton culture there. However, when he arrived in Ottoman territory, the mineral resources of the Ottoman Empire diverted his interests. In time, he

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[128] H. S. van Klooster, "Liebig and His American Pupils," *Journal of Chemical Education* 33, no. 10 (1956): 493.
[129] Justus von Liebig, "The Development of Ideas in Physical Science" in *The Culture Demanded by Modern Life; A Series of Addresses and Arguments on the Claims of Scientific Education* ed. E. L. Youmans (New York: D. Appleton & Co., 1867), 367.
[130] Liebig, "The Development," 368.

returned to the United States and became a professor of chemistry at the University of Virginia in 1852, and a professor of medical chemistry and toxicology at the University of Louisville in 1854, where he remained until his retirement in 1866.[131]

Liebig's second, and most well-known, American student was Eben Norton Horsford (1818-1893). Horsford's first career was that of a civil engineer. He graduated from Rennselaer Institute in 1838, after completing the two-year course in a single year. He then conducted surveys of New York State, while assisting with chemical lectures at the Albany Female Academy. This second job led to his appointment there as a science teacher in 1840. He then worked with Samuel Morse and Thomas Cushman, while he lectured at Newark College in Delaware.[132] All these experiences led to a relationship with John W. Webster, professor of chemistry at Harvard. Webster encouraged Horsford to go to Giessen and work with Liebig.[133]

From 1844 to 1846, Horsford apprenticed with Liebig at Giessen. He worked on the nitrogen content of vegetables including an analysis of wheat, rye, oats, corn, and the ash of clover.[134] In time he also worked on the ammonia content of glaciers and the decomposition components of glycocol. In March of 1846, Horsford learned that he was on the shortlist for the Rumsford professorship at Harvard. With the support of Webster and Liebig, Horsford was selected for this professorship and ended his studies at Giessen

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[131] Liebig, "The Development," 368; In 1874, Smith became the president of the American Association for the Advancement of Science. Later, he was the president of the American Chemical Society in 1877.
[132] Liebig, "The Development," 494.
[133] See, Samuel Rezneck, "The European Education of an American Chemist and its Influence in 19-th Century," *Technology and Culture* 11, no. 3 1970: 366-388.
[134] van Klooster, "Liebig," 495.

short of earning his PhD.[135] At Harvard, Horsford attained a position in the recently opened Lawrence Scientific School. Here, Horsford developed a practical laboratory modeled after Liebig. In this way, Horsford was able to replicate the scientific and practical chemical analyses and research developed by Liebig and his protégés and began to change American approaches to chemical education.[136]

Horsford continued in his position at Harvard and Lawrence Scientific School until he retired and was replaced by another Liebig student, Oliver Wolcott Gibbs. Gibbs was a Columbia graduate, whom many at Columbia thought would be an ideal president of the college; instead, Gibbs became the next Rumsford professor and continued to teach chemistry based on his experiences at Giessen and other European universities.[137] Gibbs was a founder and a president of the National Academy of Sciences and continued in his role as Rumsford professor until his retirement in 1887.

Liebig's students helped develop and spread what became agricultural sciences from Liebig's laboratory in Giessen across the continent and to American institutions of higher education. Students like Horsford and Gibbs provided a direct link from German approaches to American practices. This agricultural knowledge, or what historian Frank Uekötter labels the "agricultural knowledge system," rested upon such epistemic tools, such as "direct observation, practical experience, and sensitivity to local environments,

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[135] Rezneck, "The European Education," 377-380.
[136] Rezneck, "The European Education," 380-383.
[137] van Klooster, "Liebig", 495-6. Gibbs studied under K. F. Rammelsberg and Heinrich Rose before going to Giessen. However, he did not do any doctoral studies under Liebig. Later, he attended lectures of Laurent, Dumas, and Regenault in Paris.

climates, and cultural norms."[138] These tools were the focus of Liebig's laboratorial approach and, thus, became an integral part of his students' approaches in their own university laboratories, classrooms, and experimental stations in the United States.

Liebig's effect on American and other European countries' approaches to chemistry and the agricultural sciences is evident in his students' textbooks outlining the laboratory education experienced at Giessen. Two of Liebig's students and assistants C. Remigius Fresenius and Heinrich (Henry) Will published books detailing the approaches taught at the Giessen Laboratory. Fresenius outlined the elementary instruction of mineral analysis in his *Elementary Instruction in Qualitative Chemical Analysis*. In the book's preface, Liebig praised Fresenius's work by saying it was "extremely useful as an introduction to Professor H. Rose's excellent manual."[139] Henry Will published *Outlines of the Course of Qualitative Analysis Followed in the Giessen Laboratory* soon thereafter, which became a manual followed by students in laboratories and universities throughout Europe and America. In the "Preface to the American Edition," the editor described the "Hundred Bottles" course, where a student, armed only with a textbook and

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[138] Finlay, "Transnational Exchanges," 34-35. See also Frank Uekötter, "Why Care About Dirt": Transatlantic Perspectives on the History of Agriculture," *Bulletin of the German Historical Institute* 39 (Gall 2006): 65-77; and Frank Uekötter, "Know your Soil: Transitions in Farmers' and Scientists' Knowledge in Germany," in J. R. McNeill and Verena Winiwarter, eds., *Soils and Societies: Perspectives from Environmental History* (Isle of Harris, UK: White Horse Press, 2006), 322-340.

[139] Justus Liebig, "Preface" in C. Remigius Fresenius, *Elementary Instruction in Chemical Analysis* ed. J. Lloyd Bullock (New York: D. Appleton & Co, 1844): iii. Heinrich Rose *Handbuch der analytischen Chemie* Erster Band (Berlin: Ernst Siegfried Mittler, 1833).

his teacher, has to ascertain the contents of each bottle.[140] The course begins with solutions of acids, then bases before solids then bottles containing several acids, until the final bottles contain "from ten to twenty ingredients."[141] The text was first translated into English for use at the Royal College of Chemistry in London under the direction of Professor Hoffman and was then adopted in the United States. Liebig also wrote a short preface for Will's text saying that "the want of an introduction to chemical analysis, adapted for the use of a laboratory, has given rise to the present work, which contains an accurate description of the course I have followed in my laboratory with great advantage for twenty-five years."[142] A later edition, published in 1855 was dedicated to Professor E. N. Horsford who used the text at the Lawrence Scientific School.[143] As a result, Liebig is, in part, responsible for the type of institution-building and international cooperation needed to incubate and develop an embryonic field and change pedagogical and epistemic approaches in chemistry and agriculture science classrooms.

Friedrich Wöhler and Higher Education

Friedrich Wöhler was a 19th century chemist, who dedicated nearly a half-century of his life to Göttingen University and hundreds of chemistry students, including over eighty from the United States. According to Van Klooster, "Göttingen, the third in the list

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[140] Henry Will, *Outlines of the Course of Qualitative Analysis Followed in the Giessen Laboratory*, trans. Daniel Bree and Lewis H Steiner (Boston: James Munroe and Company, 1847): iii-iv.
[141] Will, *Outlines*, iv.
[142] Liebig, "Preface" in Will, *Outlines*, vi.
[143] Heinrich Will, *Outlines of Chemical Analysis Prepared for The Chemical Laboratory at Giessen*, (Boston: James Munroe and Company, 1855): iii.

of four German universities most favored by Americans (the other three being Berlin, Leipzig, and Heidelberg), had close to twelve hundred American students in the period from 1810 to 1910."[144] Wöhler's first American student was James Curtis Booth in 1833.[145] By then, Wöhler had isolated beryllium and aluminum (1827) and synthesized urea (1828). He was not a university professor, but he was teaching at the newly founded industrial school (*Gewerbeschule*) in Cassel. Unlike his contemporary, friend, and coworker Liebig, Wöhler was not as well known. The first American chemists who studied under Wöhler at Göttingen were Newton Spaulding Manross (1828 – 62) and William Smith Clark (1826 – 86).[146] In 1852, Clark obtained his degree with a doctoral thesis on "metallic meteorites," which was published in the *Annalen*.[147] Wöhler was so impressed with Manross's doctoral thesis, also published in the *Annalen,* that on March 18, 1852, he wrote to Liebig: "I am sending an article by Manrosz [sic] on the 'artificial production of crystallized minerals.'"[148] Manross was a graduate of Yale (1850) and taught at Amherst College (1861-1862) before joining the Union Army and meeting his untimely end at the Battle of Antietam. Clark, who graduated from Amherst (1848),

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[144] H. S. van Klooster, "Friedrich Wöhler and His American Pupils," *Journal of Chemical Education,* April 1944, 158.
[145] Friedrich Wöhler, Letter to Gössman, 31 October 1858, from "Letters of Friedrich Wöhler" in Frederick Tuckerman, Joseph B. Lindsey, and Charles Wellington, *Charles Anthony Goessman* (Cambridge, MA: The Riverside Press, 1917), 114-118, Wöhler asks Goessman if he has made the acquaintance of Booth.
[146] Friedrich Wöhler, Letter to Gössman, 25 February 1876, from "Letters of Friedrich Wöhler" in Tuckerman, et al. *Charles Anthony Goessman,* 134-5
[147] William S. Clark, "Analysen von Meteoreisen" *Annalen* 82 (1852), 367-368.
[148] Newton S. Manross, "Versuche über die künstliche Erzeugung krystallisirter Mineralien" *Annalen* 82 (1852): 348-361.

became professor of chemistry at his alma mater.[149] He and Manross joined the Union Army together, where Clark attained the rank of colonel before leaving military service in 1864. Clark, as we will see in Chapter 4, was instrumental in establishing Massachusetts' land-grant school in Amherst, where, in 1868, he was president of the institution. In 1876, he took a year's leave of absence to establish and reside over a land-grant school at Sapporo on Hokkaido, Japan.

The first New Yorker to take his degree under Wöhler was Charles Aram Joy (1823-91). Joy completed his studies in the usual two years, but in his last year, he was heavily active in the American Colony at Göttingen. In the records of this organization, Joy received the title "Patriarch," a position held by chemistry students for the next five years. During the 1850s, chemists were the largest percentage of American students at Göttingen. Like Manross and Clark, Joy had his thesis published in Liebig's *Annalen*.[150] Upon returning home, Joy took up a position at Union College, his alma mater. In 1857, he moved to New York City to teach chemistry at Columbia College. After the creation of Columbia's School of Mines in 1864, Joy joined the faculty and continued to teach in this institution until 1877. When Joy returned to New York, he was not alone. Joy was one of the few American students in Germany, who developed a relationship with a

[149] Another student of Wöhler's graduated in 1852, was John William Mallet (1832 – 1910) whose thesis focused on "the chemical examination of Celtic antiquities." Mallet was an Irishman who returned to Dublin in 1853 before responding to an urgent request from Clark to come to Amherst that same year. Mallet did not stay long in Massachusetts, as he began a distinguished career at the University of Virginia.

[150] C. A. Joy, "Analyse des Narwall-Zahns und des Gehäuses von Helix pomatia" *Annalen*, 82 (1852): 365-367.

German (Hanoverian) woman and married during his second trip to Germany in 1855.[151] Joy is also responsible for suggesting that Charles Frederick Chandler (1836-1925) attend Göttingen and study under Wöhler. In 1864, Chandler was one of the architects of the Columbia School of Mines and, later, the American Chemical Society.[152]

Throughout his many years at Göttingen, Wöhler actively communicated with his friend Liebig. Some of these correspondences have been published in the "Liebig-Wöhler Briefwechsel".[153] These correspondences also helped many of Wöhler students receive letters of introduction to Liebig, which led to some students experiencing the teaching and research styles of both Wöhler and Liebig.

Wöhler also stayed connected with his former students as he traced their personal and professional lives in Europe and in the United States. This connection included a collection of letters sent to Charles Goessman, a German student who graduated from Göttingen in 1852 with his dissertation: *Ueber Die Bestandtheile der Canthariden*.[154] These letters, published in a memorial for Goessman, who spent the majority of his career teaching at the Massachusetts Agricultural College detailed Wöhler's life, his relationship

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[151] van Klooster, "Friedrich Wöhler", 159. This woman was from Minden and according to correspondences analyzed by van Klooster, kept a "lively" correspondence with Wöhler for many years.

[152] See chapter 2 for more detail on Chandler and his role in establishing the Columbia School of Mines, American Chemical Society, and furthering the profession in the United States.

[153] Justus Liebig and Friedrich Wöhler, *Aus Justus Liebig's und Friedrich Wöhler's Briefwechsel in den Jahren 1829-1873*, vol. 1, ed. Augustus Wilhelm von Hofmann (Braunschweig: Druck und Verlag von Friedrich Vieweg und Sohn, 1888).

[154] Tuckerman, et al. *Charles Anthony Goessman*, 175.

with former students, and scientific works from 1858 to 1876.[155] Among these letters, Wöhler discusses the plans to build a new laboratory and send an assistant to study the laboratories in Wiesbaden, Heidelberg, Stuttgart, Karlsruhe, and München.[156] Later, he detailed an investigation he performed on the Coca plant (*Erthroxylon coca*), which he crystallized and called "Cocaine," before he described the new laboratory and all the uses it had.[157]With the new laboratory, Wöhler explained that he had reorganized his staff. He conducted the daily *Practicum*, while some of his assistants oversaw the 24-hour *Practicum* and the 6-hour *Practicum*. He followed this explanation, saying, "All laboratory students have to report to me and are to pay all my fees…But the assistants receive from me, in addition to an increase of their fixed salaries, a certain share of the fees."[158] This description of the different *Practicums* and the fees provides some insights into the structure of the chemistry program Wöhler headed and the several assistants required to teach the amount of students he had by the 1860s.

In total, Wöhler had seventy-nine American students during his tenure at Göttingen. Twenty-nine of these students completed their studies under Wöhler and earned their doctorate in chemistry. Among his seventy-nine students, several went on to teach at land-grant schools or directed experiment stations in Massachusetts,

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[155] Friedrich Wöhler, Letters to Gössman, in Tuckerman, et al. *Charles Anthony Goessman*, 109-136.
[156] Friedrich Wöhler, Letters to Gössman, 31 October 1858, in Tuckerman, et al. *Charles Anthony Goessman*, 117.
[157] Friedrich Wöhler, Letters to Gössman, 12 March 1860, in Tuckerman, et al. *Charles Anthony Goessman*, 119-120.
[158] Friedrich Wöhler, Letters to Gössman, 12 March 1860, in Tuckerman, et al. *Charles Anthony Goessman*, 121.

Pennsylvania, New York, Wisconsin, North Carolina, and Nebraska, to name a few. Others went into the teaching profession in other public and private institutions, including Columbia, Union, Rensselaer Institute, and others. Some became consultants in chemical, agricultural, or mining firms. George William Maynard (1839-1910) spent a semester at Göttingen in the early 1860s but went on earn the distinction of "dean of American mining engineers."[159] Others, such as Clark, Joy, and Chandler, were influential in hiring or recommending their fellow Göttingen graduates or students to positions in the United States. These seventy-nine students shaped large sections of American chemical, mining, and agricultural study and practice into the twentieth century. Additionally, the experiences and successes of these students, and the reputation of Göttingen, even after Wöhler's retirement in 1880, enticed 108 American students to study chemistry at the institution from 1880 to 1910. Among these students were two future Nobel prize winners: T. W. Richards (1888-89) and Irving Langmuir (1903-06). Wöhler's Laboratory and Göttingen's chemistry program shaped the direction of the American chemical profession and approaches to chemical education for several decades. The infusion of research and teaching within a laboratory setting became a model for other European and American college chemistry classrooms for decades to come. The laboratories and individuals who developed these approaches also became destinations of study for interested students around the world.

[159] van Klooster, "Friedrich Wöhler", 162.

Student Organizations and the American Colonies

In response to Napoleon and his domination of the European continent, as well as the events that surrounded the French Revolution, universities began to become centers of liberation and nationalism. University students at Halle and other German institutes formed organizations to propel nationalistic thoughts and actions against Napoleon's government and other controlling entities. These organizations eventually led to the *Burschenschaften* groups. The *Burschenschaften* emerged out of the drinking and dueling fraternities, referred to as the *Landsmannschaften* and "Father" Friedrich Ludwig Jahn's new sports association for youth—the *Turngemeiden*. Throughout the early nineteenth century, some of these student groups became politicized and the government had to limit their actions through the Carlsbad Decrees of 1819.[160] After these decrees some *Burschenschaften* groups went underground to continue their political agendas. However, by the mid-nineteenth century, these organizations had lost much of their political fervor, as many of their demands had materialized. They did serve as a loose model for other student groups to develop, including the so-called "American Colonies" that sprang up throughout German universities from the 1850s onwards.

In the 1850s, young men from America came to the German states in larger numbers to study with experts in fields such as chemistry, literature, history, and law. For many of these students, the opportunity to gain experience from a master was worth the time and expense to study abroad. However, not all experiences were positive. According

[160] "Carlsbad Decrees: Confederal Press Law (September 20, 1819). Accessed on July 20, 2019, http://ghdi.ghi-dc.org/sub_document.cfm?document_id=235.

to historian Hugh Hawkins many students "faced loneliness and difficulties in adapting to a foreign country."[161] As a result, many American students banded together to form what they called "American Colonies." The colonies developed throughout the German higher education system, with the ones at Göttingen and Leipzig among the most well-known. For American students, these "Colonies" helped form a connection with fellow Americans that led to, upon returning to America, important developments for American higher education, based on "German examples — or at least what Americans thought they had witnessed in Germany — … the devotion of university teachers to research, concepts of academic freedom, the free elective system, lecture, seminar, and laboratory as teaching methods, and emphasis on the Doctor of Philosophy degree."[162]

American students studying in German universities began as early as 1769 at Halle, 1781 at Leipzig, and 1782 at Göttingen.[163] Throughout the 19th century, what started as a slow trickle of American students studying in Germany in the early decades increased as the century wore on. Anja Werner described this trickle as five phases of U.S. student migration. The first phase was from 1760-1810, with few students travelling to Germany and Halle being the institution drumming up the most interest. The second phase lasted from 1810 to 1830 and saw a larger number of students arrive in German institutions, many of whom studied at Göttingen. The third phase went from 1830 to the American Civil War. This period saw a boost in student enrollments, and Heidelberg

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[161] Hugh Hawkins "Transatlantic Discipleship: Two American Biologists and their German Mentor" *Isis* 71, vol. 2 (June 1980): 198.
[162] Hawkins, "Transatlantic Discipleship," 197.
[163] Anja Werner, *The Transatlantic World of Higher Education: Americans at German Universities, 1776-1914*, (New York: Berghahn Books, 2013), 53.

became the popular destination. The fourth phase, from 1865 to 1898, saw the height of American enrollments, with Leipzig taking the lead. Beginning in the late 1890s, the fifth phase, student numbers dropped at the four institutions mentioned above due to the outbreak of World War I.[164] In total, some 9,000 American students traveled to and received some form of education in German institutions from 1800-1914.

From 1855 to 1888, the American Colony at Göttingen recorded meetings and members. At the Summer 1855 meeting, the members suggested the idea of preserving the "doings of the Colony" for historical purposes.[165] According to Hungerford, this was a "collection of young men, intimately associating and still not united into a regularly organized body or Society…"[166] At this meeting, the members decided that the Patriarch purchase a book and provide a sketch of all past, current, and future American students at Göttingen.[167] Charles F. Chandler, a chemistry student and later founder of the Columbia School of Mines in New York City, took up the task and transcribed all notes and commencement materials dating back to 1815.[168] This notebook housed the names of all American students and colony members, some background on each, accounts of events hosted by the colony, historical notes, and songs sung on July 4th, 1878.

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[164] Werner, *The Transatlantic World*, 20.
[165] E. Hungerford, Göttingen, Sept 22. 1855, in *American Colony of Göttingen: Historical and other Data collected Between the years 1855 and 1888*, ed. Paul G. Buchloh and Walter T. Rix (Göttingen: Vandenhoeck & Ruprecht, 1976), 21.
[166] Hungerford, Göttingen, Sept 22. 1855, 21.
[167] The Patriarch appears to be the leader of this Colony. Charles A. Joy appears to be one of the first Patriarchs. Hungerford was the third. James M. Hart, the man who provided the quotes in the introduction, was the nineteenth Patriarch.
[168] Hungerford, Göttingen, Sept 22. 1855, 21.

American colonies developed around other universities as well. In Leipzig, the colony focused on networking as it "served to help students settle down, to meet fellow Americans or persons of interest in town, and to organize entertainment for the purpose of exchanging information as well as unwinding and smoothing over homesickness."[169] This colony included the American Students Club, the American Church, and other informal associations. By 1890, the American presence in Leipzig was so evident that the future Harvard zoologist George Howard Parker wrote, "When I started out for Germany I thought I was leaving America behind but I see about as many Cambridge people here myself as you almost and certainly feel very much at home."[170] Modeled after German academic clubs (*Burschenschaften*), the American Students Club "combined pragmatic academic networking with leisure and distraction, whereby the greatest importance was attributed to the creation of old boys networks especially as regarded the teaching profession."[171] The American Colony of Leipzig also provided the space for American students to socialize with American diplomats and esteemed scholars and teachers.

These colonies created networks based on the shared experience of attending university in German schools. Often the created networks followed these students back home, where colony members helped each other find positions in academia and industry. Additionally, these colonies occasionally reunited in the United States as a form of a reunion. In the end, the colonies provided a means for American students to have a built-

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[169] Werner, *The Transatlantic World*, 169.
[170] G.H. Parker to Family, 13 December 1891, as cited in Werner, *The Transatlantic World,* 170.
[171] Werner, *The Transatlantic World*, 171.

in network of scholars to help ease them into academic life in an unfamiliar environment. In terms of science and technology, the American Colony of Göttingen, especially in the 1850s and 1860s, was mostly comprised of chemistry students, many of whom went on to shape and define American approaches to chemistry education and practice.

The Research University and the Nineteenth Century

Beginning with Humboldt and the University of Berlin, the direction and focus of higher education in Germany changed from a more traditional, classical, possibly ecclesiastical education that matriculated men groomed for civil service, the church, or liberal professions to a reformed, modern system of research and knowledge development. This system was not without its issues, many of which came from the contradictory nature of its parameters, as initially laid out by Humboldt. These reforms affected the role of funding and freedom of the institutions and professors, the relationship between pedagogy and research, the accessibility of knowledge, and the type of learning environment desired for scientific learning.

Humboldt wanted a system in place that included a fund for schools to run and for teachers to earn wages that were independent from any external influence, including government. In other words, Humboldt thought that the state should pay for institutions of higher learning to exist and function, but not put any demands on the institution. The expectation was that the educated citizen was better for the state, and in this way, it was the state's responsibility to educate their citizenry. This idealized approach to higher education and the relationship between the university and funding bodies has been

problematic, at best. This is complicated further by the divide between theoretical and practical forms of education.

For Humboldt, the theoretical approach encompassed the purpose of the universities. As James Hart said, "The German university has one and only one object: to train thinkers."[172] What these thinkers did with their knowledge was up to the individual, but part of the expectations was that they continued their pursuit of more knowledge and helped the next generation as well. But, how might these institutions achieve this goal? For Humboldt, professors must marry research and instruction.

The second reform placed research on par with instruction and called for its inclusion in all matter of pedagogy. This innovative approach to teaching had its own contradictions and issues, including balance and purpose. Professors had to find a way to balance their workload between research and teaching, as well as their responsibilities to their students with their own research. For some, like Justus von Liebig, the research side of this life brought up bigger questions about the type of research, access, and pedagogical approaches for it.

As his 1840 critique of chemical research approaches attest, Liebig saw the need for changes in the system in order to better meet the needs of the discipline.[173] In part, this questioned the division of the higher education teaching along theoretical and practical lines. Theoretical knowledge drove university research, whereas practical knowledge drove technical schools. By the end of the nineteenth century, these technical

[172] Hart, *German Universities*, 251.
[173] Liebig, "Zustand".

schools or *Technishe Hochschulen*, began to favor theoretical education and relegated the practical education to state- or industry-supported research institutions. However, some university professors and their students continued to research practical approaches to their theoretical research.

Liebig and Wöhler also found another way to deal with the question concerning research and teaching by developing the laboratory. Students were able to get hands-on experience with their own research, but also learned through observation and experimentation about the subject matter of the instruction. This added another level to the instruction, where students experienced seminars and recitation plus laboratory experiences. For the professors, this form of active involvement in research helped them hone their teaching practices. However, it did become detrimental to some professors' careers. In time, Liebig left Giessen for Munich in part to reduce his load of research students. Wöhler had similar experiences where in the final years of his tenure, he was doing more teaching and less research due to the demands and expectations of his role as a professor and educator. This was also complicated by the steady rise in who had access to higher education.

Throughout the nineteenth century, student numbers continued to rise, as higher education, once the home of the elite classes of society, became an option for students of middle- and lower-class families. During the final decades of the century, women began to study at some universities for the first time. Additionally, international student populations continued to rise until World War I. It is difficult to demonstrate how these American students' experiences in German universities influenced their perceptions and

approaches upon returning to the United States. The fact that around 9,000 students enrolled in Germany between 1800 and 1914 — many of whom went on to hold positions as professors, deans, and presidents of American colleges and universities — certainly substantiates the influence of their experiences.

By the early twentieth century, due in part to international and internal political issues and both reforms and practices in other countries, the German universities no longer had the appeal that they did in the nineteenth century. By 1930, American universities became the destination of American and international students. These American universities, many of which evolved from Humboldtian and other German approaches to higher education, offered their own take on research-based education and scientific practices. No longer were American students as inclined to travel overseas to gain an education, when they were able to travel across their state or over a few state borders to gain a similar type of education from American and international scholars.

CHAPTER TWO

AMERICAN INTERPRETATIONS: EDUCATION, PRACTICES, AND INSTITUTIONS

During much of the nineteenth century, many prospective American engineers and scientists travelled to Europe to study. A lack of formalized undergraduate and graduate programs in the early part of nineteenth century America necessitated that American "pilgrims" travel to Scotland, England, France and the German states to develop their understanding of science and engineering.[174] Upon the completion of their studies, these students returned to America where they used their newfound knowledge to develop programs of study in American institutions of higher education. Through this process, many aspects of European pedagogy, research practices, and curricula development supplied the foundation for American higher education.[175] The result helped set up the beginnings of American science and engineering in eastern institutions of higher education, and eventually led to higher education in the western United States, including Montana.

Much has been written about the early history of higher education in the United States and its ties to European institutions and approaches.[176] This is an inevitable

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[174] See Robert V. Bruce, *The Launching of Modern American Science, 1846-1876* (New York: Knopf, 1987), 14-28, in which he describes the education and experiences of many of the first generations of American scientists in Europe.
[175] Timothy J. LeCain, "Moving Mountains: Technology and the Environment in Western Copper Mining." (Ph.D. diss., University of Delaware, 1998), 127.
[176] Laurence Veysey, *The Emergence of the American University* (Chicago: University of Chicago Press, 1970); James Axtell, *Wisdom's Workshop: The Rise of the Modern*

consequence of the country's own history as a collection of colonies of European, primarily English, empires. Institutions, such as Harvard, Yale, and others, modeled themselves after established European centers of knowledge like Oxford and Cambridge, based on the early founders and educators' own educational upbringing. Europe provided a model that was both mobile and helped to link colonial subjects in the periphery to the imperial core. This is further exemplified with colonial families either sending their sons for education in the colonial colleges or back to England. In doing so, interested imperial and colonial parties began to develop an understanding of the relationship between knowledge and empire.

After the American Revolution, higher education in the United States, no longer beholden to British imperial institutions, began to evolve their own practices. These included name changes, such as King's College becoming Columbia College, the rise of students studying in institutions outside of England, and in the creation of new institutions of higher education. Yet, questions about the relationship between knowledge and empire, or the state, remained. There was much discussion about the possibility and

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University (Princeton, NJ: Princeton University Press, 2016); Bruce, *Launching*; Carl Diehl, *Americans and German Scholarship, 1770-1870* (New Haven: Yale University Press, 1978); Roger L. Geiger, *The History of American Higher Education: Learning and Culture from the Founding to World War II*, The William G. Bowen Memorial Series in Higher Education (Princeton, NJ: Princeton University Press, 2016); Henry Geitz, Jürgen Heideking, and Jurgen Herbst, eds., *German Influences on Education in the United States to 1917*, (Washington, D.C.: Cambridge University Press, 2006); Louis Menand, Paul Reitter, and Chad Wellmon, eds., *The Rise of the Research University: A Sourcebook*, (Chicago: University Of Chicago Press, 2017); Anja Werner, *The Transatlantic World of Higher Education: Americans at German Universities, 1776-1914*, (New York: Berghahn Books, 2013); Roger L. Williams, *The Origins of Federal Support for Higher Education: George W. Atherton and the Land-Grant College Movement*, (University Park, Pa: Penn State Press, 1991).

role of a national university and whether it or other institutions would function along ecclesiastical, classical, theoretical, practical, or new lines of knowledge production. Students and instructors sought models of education from Europe to develop or create new systems of education in the post-colonial era of the United States, and in so doing, began to address questions about access and the relationship between education and the state.

Throughout the nineteenth century, the purpose and direction of higher education reflected the responses to these discussions and investigations. In time, interested parties abandoned the idea of a national university, though some continued to idealize their own institution as the country's best example of this mythical university.[177] Similarly, the American higher education landscape, much like their European contemporaries, had space for all these forms of knowledge production, but one approach provided a way for the creation of the modern American system of higher education. Although "German Models" of higher education supplied the foundation for the first true university, Johns Hopkins University, in the United States in 1876, research-based and scientifically driven models of higher education such as the Land-Grant Schools and Columbia School of Mines, helped bring science and technical education to the masses, increasing in number after the American Civil War. Further, "German Models" influenced educators and higher education since the early decades of the nineteenth century, as American scientists, engineers, and educators adopted and adapted German and other European

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[177] Robert McCaughey, *A Lever Long Enough: A History of Columbia's School of Engineering and Applied Science Since 1864* (New York: Columbia University Press, 2014), 52.

pedagogical and research practices in established and new institutions of higher education in the United States. In doing so, state and industrial interests also found ways to use these institutions both directly and indirectly to shape newly conquered and colonized territories in the West.

Where earlier scholarship highlighted the role of famous educational reformers, like Charles Eliot and Francis Wayland, or analyzed the role of Harvard or Yale, this dissertation will focus its attention on a lesser known reformer in Frederick A. P. Barnard and the institutions in which he taught or administered for over fifty years.[178] Barnard is instrumental to understanding approaches of regionality in science education, the role of politics in higher education, the development of the Columbia School of Mines, coeducation, and many other notable educational reforms he championed as president of Columbia College from 1864-1889. Although many of his initiatives were not realized due to differences with Columbia's trustees and other administrators within Columbia College, Barnard filtered through the various changes and reforms associated with higher education to create a modern system of education.

Through Barnard, this chapter will analyze larger themes and reforms in the nineteenth century. These include the role of science and scientific personalities like Alexander Dallas Bache and the creation of courses, schools, and institutions of higher education with a focus on scientific, technological, and agricultural forms of knowledge and their utilitarian use. From schools of science, to polytechnics, to the creation of land

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[178] See, for example, Veysey, *The Emergence of the American University*; James Axtell, *Wisdom's Workshop*; Bruce, *Launching*; Geiger, *American Higher Education*; Menand et al., *Research University*.

grant schools and schools of mines, the inclusion of scientific study changed the dynamic of higher education.

This chapter begins with the state of higher education in 1850 and introduces the reader to Frederick A. P. Barnard, a transitional figure in nineteenth century American higher education. Following Barnard's life from Yale, to New York, Alabama, Mississippi, and back to New York, this chapter will trace the changes and reception to higher education, the role of science and science education, regionality, and the role of practical and coeducational approaches in higher education. Through Barnard, the chapter will also bridge the socio-political, industrial, and educational events that set the stage for the evolution of higher education and development of innovative approaches and institutions. The chapter will then conclude with the state and direction of higher education into the twentieth century.

Frederick A. P. Barnard: Regionality, Access, and Science in the South

In 1850, Frederick A. P. Barnard was a professor of chemistry at the University of Alabama. He had come to Alabama in 1837 to teach science and, if possible, turn the school into a new node of American science. By 1848, he had earned the professorship in chemistry before political discord led him to leave for the University of Mississippi in 1854.[179] In time, the Yale educated, Episcopalian minister, would elevate two southern

[179] William J. Chute, *Damn Yankee!: The First Career of Frederick A. P. Barnard* (Port Washington, NY: Kennikat Press, 1978), 136-143. A series of letters published first in the *Mobile Register* in the Summer and Fall of 1854, provide evidence for this falling out with administrative decisions at the university: Frederick A. P. Barnard, "III. Letters on College Government," *American Journal of Education & College Review*, vol II, no. x,

university's science programs before the Civil War. During the Civil War, Columbia College in New York, which was developing a new, modern identity, elected Barnard as its new president. Charles King, the departing President of Columbia College, ceremonially handed the keys to the college to Barnard on October 3, 1864.[180] In his inaugural address to the college, Barnard preached that Columbia may "open wide the way to those rich treasures of science which the tireless spirit of modern investigation has wrung from nature by the direct interrogation of the glorious works of God."[181] Barnard's history as a science educator and his keen insight into the nature of scientific research, set the stage for developing Columbia College's scientific endeavors, which would fully cultivate a new School of Mines program and begin to transform the institution from a college to a university. As a result, Barnard serves as an ideal candidate to trace the history of higher education in America during the nineteenth century.

Born on May 5, 1809, in Sheffield, Massachusetts, Barnard joined a list of other notable historical figures like Abraham Lincoln and Charles Darwin born in that year. However, Barnard is not as well-known as his contemporaries, even though he influenced American science and education enormously. In 1828, Barnard graduated from Yale

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(October 1856): 321-339; Frederick A. P. Barnard, "IV. Letters on College Government," *American Journal of Education & College Review*, vol II, no. xi (November 1856): 415-435, and; Frederick A. P. Barnard, "III. Letters on College Government," *American Journal of Education & College Review*, vol II, no. xii (December 1856): 507-523.

[180] Board of Trustees, *Proceeding at the Inauguration of Frederick A. P. Barnard, S.T.D., LL.D., as President of Columbia College, on Monday, October 2, 1864* (New York: Hurd and Houghton, 1865), 10.

[181] Board of Trustees, *Proceeding*, 10; and Daniel J. Kevles, *The Physicists: The History of a Scientific Community in Modern America* (Cambridge, MA: Harvard University Press, 1987), 22-23.

College, where he met Benjamin Silliman, Sr., one of the central figures in the history of science education in America.[182] Silliman was a chemist and one of the first American professors of science. Although trained in America as a lawyer and scientist, he furthered his study in Edinburgh as an American pilgrim of science. Silliman, Sr. taught science at Yale and his travels to Europe to obtain scientific apparatus helped Yale lead the way in science education.[183] He also founded and edited the first American scientific journal, the *American Journal of Science and Arts*, also known as *Silliman's Journal*.[184] The desire to work under Silliman pushed Barnard to attend Yale.[185]

Barnard's interest in science drove his education and future career. At Yale, Barnard studied under Silliman, and upon graduation, he became a tutor at Yale. Due in part to his failing hearing, caused by the genetic disease otosclerosis which causes an abnormal growth of bone near the middle ear, Barnard took a teaching position at the New York Institution for the Deaf and Dumb. While in New York, he observed the Aurora Borealis in 1837. Published in *Silliman's Journal* Barnard's report, "On the Aurora Borealis of November 14, 1837" received favorable reviews in the science

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[182] Chute, *Yankee*, 6-42; Charles B. Davenport, "Biographical Memoir of Frederick Augustus Porter Barnard, 1809-1889" *National Academy of Sciences of the United States: Biographical Memoirs, Volume XX – Tenth Memoir*, Presented to the Academy at the Autumn Meeting, 1938, 259-272; and John Fulton, *Memoirs of Frederick A. P. Barnard D.D., LL.D., L.H.D., D.C.L.: Tenth President of Columbia College in the City of New York* (New York: MacMillan and Co., 1896), 22-40.
[183] Bruce, *Launching*, 14-15.
[184] Bruce, *Launching*, 15.
[185] Chute, *Yankee*, 19; and Fulton, *Memoirs*, 16.

community.[186] In fact, this publication and his other work in science led him to his next teaching position, this time in the South.

Regionality plays a significant role in the discussion of the type and direction of American higher education in the nineteenth century.[187] Often these discussions focus on the northeast with schools like Harvard and Yale. The early histories primarily present the college as an obstacle to the development of the modern higher education system.[188] In comparison to the twentieth century American university, the nineteenth century was its antithesis. These histories presented the college as small, highly religious, removed from society, fixated on a Latin and Greek-based curriculum focused on rote learning, lacking any initiative for advanced or practical education, and functioning as an undemocratic institution by serving only the upper classes. However, revisionist higher education historians like David Potts pushed for further study of institutions outside of Harvard, Yale, or other elite schools, and to analyze institutions in other regions.[189]

In terms of early nineteenth or late eighteenth century colleges, institutions like William and Mary or Thomas Jefferson's University of Virginia may be the most common representatives of the South. The University of Virginia had a unique approach to higher education; in a way it symbolized a form of freedom for the traditional American College. William and Mary is one of the oldest higher education institutions in the country, which meant that it modeled itself, not on other American schools, but on

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[186] Chute, *Yankee*, 70.
[187] See David B. Potts, "American Colleges in the Nineteenth Century: From Localism to Denominationalism," *History of Education Quarterly* 11, no. 4 (1971): 363-380.
[188] See, Freeman Butts, *The College Charts Its Course* (New York: McGraw-Hill, 1939).
[189] Potts, "American Colleges," 363-380.

English conceptions. The other southern colleges of the early nineteenth century patterned themselves after northeastern institutions, often persuading northern and northeastern educators to work in the South, as was the case with Barnard.

The state college best represented higher education in the South. In developing their constitutions, states like North Carolina and Georgia designated resources for the establishment of institutions of higher education. Despite these resources, it was South Carolina that held the distinction of being the first to receive regular state funds. According to historian Michael Sugrue, South Carolina's leaders saw the key role the college played in unifying future leaders politically.[190] In other words, the power of education could lead to political and state power. Like South Carolina, the governing elite also supported the University of Virginia during this time. This support prevented the potential legislative erosion suffered by other state colleges in the South and throughout the United States.

In terms of access, southern colleges catered to the political and social elite. These schools managed this limited access by making the cost of attendance amongst the highest in the country. This kept the student body at a manageable size and precluded the enrollment of men from society that did not fit the model of a gentleman. If a poorer student did happen to pass the strict entrance examinations, then he would have to figure

[190] Michael Sugrue, ""We Desire Our Future Leaders to Be Educated Men": South Carolina College, the Defense of Slavery, and the Development of Secessionist Politics" in Roger L. Geiger, ed., *The American College in the Nineteenth Century* (Nashville: Vanderbilt University Press, 2000), 92.

out a way to pay for his tuition and associated costs, potentially somewhere in the hundreds of dollars.[191]

The southern state colleges were secular institutions and avoided professional education. Many of these schools kept some form of religious observances, excluding the University of Virginia. Others, like South Carolina College, appointed faculty and administrators who did not pursue a more religious approach to higher education. The result of this secular, anti-professional, and expensive form of education led to other groups, primarily religious, to establish their own colleges across the South.

After 1830, denominational churches founded colleges with increasing frequency in the South. These institutions tended to cater to students from a lower social standing than those who could afford to attend a southern state college. In some cases, these denominational colleges provided "manual labor" opportunities for students to help fund their own education. The power dynamics between these church colleges and the state schools shifted in the 1850s, where the church colleges garnered considerable influence, especially outside the southern elite. Elsewhere, the state college dominated, as they educated the ruling class.[192]

It was into this environment that, in 1837, Barnard's report in *Silliman's Journal* led to his appointment as Professor of Mathematics and Natural Philosophy at the University of Alabama.[193] His venture into the South began his lifelong pursuit of spreading science into new areas of the country. At the University of Alabama, Barnard

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[191] Sugrue, "Educated Men", 96.
[192] See Sugrue, "Educated Men", 91-114.
[193] Fulton, *Memoirs*, 77-87.

continued to evolve and hone his teaching and science skills. He was able to capitalize on the public's interest in astronomy and the earth sciences by acquiring funding for the construction of an observatory in 1844.[194] Finished a year before a similar one at Harvard, this observatory enabled Barnard to help American scientists develop a better understanding of astronomy and meteorology in the South. This also helped Barnard begin to establish Alabama as a southern node of American science in the developing network of institutions and practitioners of science, and to the decentralization of American science from the firmly established New England base. He spent seventeen years teaching at the University of Alabama, the last six as a professor of chemistry.[195] Due to political changes and lack of options for advancement, he left Alabama in 1854 for the University of Mississippi. In 1880, the University of Alabama erected the new science laboratory building and honored him by naming it Barnard Hall.[196]

In 1854, Barnard accepted the position of Chair of Astronomy and Mathematics at the University of Mississippi.[197] Two years later, the board of trustees elected him as the President of the University, and then renamed the title of President to that of Chancellor, which is the title the University still uses today.[198] During this time, he began to become more outspoken about the state of higher education in the country. Early elements of this critique and discussion of the administration and direction of higher education first

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[194] Chute, *Yankee*, 91.
[195] Davenport, "Biographical," 260.
[196] Chute, *Yankee*, 143.
[197] Case, "Insufferably," 420, 429; Davenport, "Biographical," 260; and Fulton, *Memoirs*, 199.
[198] Davenport, "Biographical," 260; and Fulton, *Memoirs*, 202-203, 205.

emerged in the letters to the *Mobile Register* in Alabama and were reprinted for a larger audience in 1856.[199] In these letters, he discussed the role of governance, the role of the professor and instructor in relation to student education and discipline, the placement of schools in relation to urban centers, the negative effects of dormitory life, and rules and ages of students admitted to colleges.

In 1855, Barnard read a paper before the American Association for the Advancement of Education in New York.[200] This paper focused on general advice for changing the system of education in the country and highlighted the role of practical education, the use of scholarships, and the function of degrees, discipline, and government. Early in the paper, Barnard states: "our collegiate system is in fact materially defective, there exist certain serious obstacles in the way of any sudden or sweeping reforms."[201] Later, in discussing the classical curriculum of colleges, he suggested:

> It has, for example, been maintained, with a great deal of warmth, that our colleges have, in later years, failed to keep pace with the rapid progress of human knowledge; the subject of study, to which they mainly can find the student, are in part obsolete and in part useless; that they take no accounts of the prospective pursuits of the young men whom they undertake to train, but subject all alike to the same unvarying intellectual regimen, and, in

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[199] Frederick A. P. Barnard, "III. Letters on College Government," *American Journal of Education & College Review*, vol II, no. x (October 1856): 321-339; Frederick A. P. Barnard, "IV. Letters on College Government," *American Journal of Education & College Review*, vol II, no. xi (November 1856): 415-435, and; Frederick A. P. Barnard, "III. Letters on College Government," *American Journal of Education & College Review*, vol II, no. xii (December 1856): 507-523.

[200] Frederick A. P. Barnard, "IV. On Improvements Practicable in American Colleges" *American Journal of Education & College Review*, (January 1, 1856), 174-185; Frederick A. P. Barnard, "III. On Improvements Practicable in American Colleges" *American Journal of Education & College Review,* (April 1, 1856): 360-375.

[201] Barnard, "IV. On Improvements," 175.

> short, that they are far in arrear of the demands of an imminently utilitarian and practical age.

Barnard reminded his readers that the function of college is for "the systematic development and discipline of the faculties of the mind, in due proportion and in the natural order," and that the "college course ought not to embrace, and was never intended to embrace, anything which should not be capable of a direct practical application, in the business of life."[202] Instead, the focus of this classical form of education is for mental discipline. Later, he discussed the value of practical education, but stated: "How far they are practical, is to be made entirely subordinate to the higher objects of education."[203] But Barnard does not dismiss the value of a more practical, or useful form of education. He merely questioned how these forms of education will be valuable when added to the existing curriculum. For this, he had another suggestion.

If practical forms of education, or systems of knowledge, such as the sciences, enter into the collegiate curricula, then something must be done to the current approach to collegiate education. Barnard suggested two expedients: First, lengthen the time of the course of study to allow the inclusion of the new forms of knowledge.[204] The downside is that extra years of schooling would also increase the expense of college and limit the access to these new forms of knowledge. To remedy this issue, he offered a second expedient, "to increase the exactions required for admission into the lowest class, until, after time, we shall have forced the preparatory schools to do the entire amount of work

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[202] Barnard, "IV. On Improvements," 177, 178-9.
[203] Barnard, "IV. On Improvements," 181.
[204] Barnard, "IV. On Improvements," 183.

now complex in the first, or perhaps the first and second years."[205] This would ultimately result in the creation and sustaining of permanent preparatory schools, akin to the German gymnasia.[206] Along with this reform, Barnard called for the raising of the age of admission to the late teens instead the early- to mid-teens.

However, as Barnard continued, if colleges are unwilling or unable to make these changes, then access to practical and scientific courses of knowledge must be administered elsewhere. He suggested:

> Let practical sciences, like civil engineering and chemical analysis, go over to special schools, of which already several have arisen, either socially with colleges or disjoined from them, highly honorable to the country; and, until higher universities rise up among us, let the various branches of natural history find their encouragement, among associations of men whose tastes lead them to their cultivation. If, however, either the previously suggested expedients be deemed more eligible, let the concluding years in college be given, in great measure, to subjects of this nature; and, in order that the results may not continue to be as unsatisfactory as they are at present, let the principle of option be freely introduced into this part of the course, so that the efforts of individuals may not be rendered unproductive, by being frittered away upon an endless variety of subjects.[207]

In this way, colleges can meet the needs of the public demanding more useful, or practical, forms of knowledge, and fields of science and engineering have an opportunity to develop in the United States.

Barnard concluded his presentation before the American Association for the Advancement of Education by addressing the function of scholarships, the negative role of dormitories on student and academic life, and placement of colleges in relation to

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[205] Barnard, "IV. On Improvements," 184.
[206] Barnard, "IV. On Improvements," 185.
[207] Barnard, "III. On Improvements," 361.

towns. He viewed the dormitory system as an injurious situation with "the collecting together, in a … community apart from the observation of the public, … of a large body of young men fresh from the restraints of the family and the school, and surrounded by a multitude of novel temptations."[208] Instead, by doing two things — raising the entrance age of students and placing colleges near towns — colleges could avoid the expenses of building and maintaining dormitories, and in his estimate, student disciplinary issues would decrease. He continued to revise and discuss many of these issues and ideas concerning higher education, its curricula and governance, for the rest of his career.

At the University of Mississippi, Barnard developed an extensive collection of scientific equipment and apparatus. Some of this collection consisted of materials left to the University from John Millington, who held the position of chair of astronomy and mathematics before Barnard.[209] The collection was, at the time, the largest in the South. Barnard even commissioned the building of an observatory, which now bears his name, and ordered a nineteen-inch telescope for the observatory.[210] The grinding of the lens did not occur until the Civil War, and it never made its way to the University of Mississippi. Instead, it found a home at the Dearborn Observatory at the University of Chicago.[211] His venture to build another scientific node in the South dissipated, as political pressures and the secession of Mississippi from the Union ended his tenure as Chancellor of the University of Mississippi in 1861.[212]

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[208] Barnard, "III. On Improvements," 72.
[209] Case, "Insufferably," 429.
[210] Bruce, *Launching*, 293; and Davenport, "Biographical," 261.
[211] Bruce, *Launching*, 294; and Davenport, "Biographical," 261.
[212] Bruce, *Launching*, 294*;* Cute, *Yankee*, 185; and Davenport, "Biographical," 261.

Barnard and American Science Organizations and Education

During the American Civil War (1861-1865), Barnard's association with Alexander Dallas Bache and other scientists enabled him to obtain a position working with the Coastal Survey under Bache.[213] Bache, the great-grandson of Benjamin Franklin, was a leader in American science and helped found the American scientific group, referred to as the Lazzaroni (the Italian word for beggars) or simply "Bache and Company." The group consisted of several prominent scientists including Benjamin Pierce, Louis Agassiz, Joseph Henry, Oliver Wolcott Gibbs, Charles Henry Davis, Benjamin Apthrop Gould, John Fries Frazer, James Dwight Dana, and Cornelius Conway Felton.[214] The Lazzaroni modeled their group after the "X Club" in Great Britain. Members of this "X Club" included Joseph Hooker, John Tyndall, Thomas Huxley, Herbert Spencer and other prominent British scientists.[215]

Bache and Company used their status to dictate the direction of American science through appointments and professional organizations. This was evident in the 1860 American Association for the Advancement of Science (AAAS) election. In this election, Bache and the Lazzaroni led the AAAS to elect their friend Barnard as President. Before the election, Bache had invited Barnard to take part in an astronomical expedition to Labrador.[216] In 1860, he accepted the invitation from his friend Bache to go to Labrador

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[213] Bruce, *Launching*, 294; and Davenport, "Biographical," 261.
[214] Bruce, *Launching*, 217-224; and Nathan Reingold, *Science, American Style*, (New Brunswick, NJ: Rutgers University Press, 1991), 112.
[215] Bruce, *Launching*, 219.
[216] Davenport, "Biographical," 261; and Fulton, *Memoirs*, 260-269.

to observe the eclipse. Included in this venture were three southern scientists, including Barnard, Oscar W. Lieber, and Charles Scott Veneble, who both came from South Carolina, and Stephen Alexander the outgoing president of AAAS.[217] Only upon his return did Barnard learn of his election as the President of the AAAS.[218] With this election, he became the longest serving, though also long inactive, president (1860-66), as the Civil War forced the postponement of the next meeting in Nashville.[219] During the war, the AAAS nearly became a defunct organization. In 1866, Barnard, as acting president, called for the rejuvenation of AAAS and led the organization of the first meeting.[220]

Barnard's association with Bache and the Lazzaroni allowed him to become a founding member of the National Academy of Sciences and earn a position with the US Coastal Survey in 1863 after returning from the South. In addition, Barnard's association with members of the Lazzaroni, especially with Bache, provided the impetus for his eventual election as the president of Columbia College in 1864.[221] Columbia College, and his new position as president, enabled Barnard to pursue his desires for expanding the science, and eventually engineering, curriculum within general education.

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[217] Chute, *Yankee*, 179. Veneble would later play a role in the bombing of Fort Sumter, which began the Civil War.
[218] Bruce, *Launching*, 294; and Fulton, *Memoirs*, 269.
[219] Fulton, *Memoirs*, 269.
[220] Sally Gregory Kohlstedt, Michael M. Sokal, and Bruce V. Lewenstein, *The Establishment of Science in America: 150 Years of the American Association for the Advancement of Science* (New Brunswick, NJ: Rutgers University Press, 1999), 23, 30.
[221] Bruce, *Launching*, 294.

Upon accepting the position of President of Columbia College, Barnard began to push the college towards university status. At the time of his inauguration, the definition of "university" was unclear. Charles C. Felton, then president of Harvard, viewed the term as an "expanded country college with a somewhat larger library."[222] Others conceived of the institution as being a large, publicly endowed school. Out of this lack of clarity, three conceptions appeared that typified the transformation of colleges to university status. As the historian of science Robert Kohler notes, these conceptions included, "the aim of practical public service, … the goal of abstract research on what was believed to be the pure German model, and … the attempt to diffuse standards of cultivated taste."[223] Often associated with graduate study, as these programs developed in the latter quarter of the nineteenth century, more institutions of higher learning changed their name from college to university. According to educational historians Wayne Urban and Jennings Wagoner, as time went on, "the German ideal of 'pure' rather than applied research" did not develop in some American universities.[224] The idea of applied research fit the needs of society more than the German model. Thus, many universities in the late nineteenth century attached themselves to the idea of social utility to survive.[225]

This German model, as discussed in the first chapter, was a collection of several approaches in German institutions of higher education. According to James Turner and

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[222] Laurence, R. Veysey, *The Emergence of the American University* (Chicago: The University of Chicago Press, 1965), 11.
[223] Kohler, Robert E. "The Ph.D. Machine: Building on the Collegiate Base." *Isis 81*, no. 4 (1990): 639-640; LeCain, "Moving Mountains," 137; and Veysey, *Emergence*, 12.
[224] Wayne J. Urban and Jennings L. Wagoner, Jr. *American Education: A History, 5th ed.* (New York: Routledge, 2014), 163.
[225] Urban and Wagoner, *American Education*, 163.

Paul Bernard, there were four principal elements in the German Model.[226] The first dealt with the separation of the preparatory program, or *Gymnasium*, from that of higher learning. The second and third rested on Wilhelm von Humboldt's twin pillars: combination of teaching and research and academic freedom (*Lehrfreiheit* and *Lernfreiheit*). The fourth focused on institutional arrangements to pursue the first three, including seminars and the Ph.D. degree. American reformers did not necessarily wish to make their institutions as exact replicas of German schools, but these reformers used these four elements in varying degrees, depending on the institution, to eventually create a new form of school – the graduate school.

It is important to note, that this German model came in many forms and was selectively integrated with various levels of success throughout the nineteenth century. According to Hugh Hawkins, American educational leaders toured Europe, where they observed educational practices and brought home German ideas through books and journals. Additionally, immigrant scholars brought German approaches with them. However, the biggest contributor to German influence in American education came from "the study in German universities by American students."[227] These students sought ways

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[226] James Turner and Paul Bernard, "The German Model and the Graduate School: The University of Michigan and the Origin Myth of the American University" in Roger L. Geiger, ed., *The American College in the Nineteenth Century* (Nashville: Vanderbilt University Press, 2000), 222.

[227] Hawkins, 197. For examples of American perceptions, see Laurence R. Veysey, *The Emergence of the American University* (Chicago: University of Chicago Press, 1965), 125-133; Jurgen Herbst, *The German Historical School in American Scholarship: A Study in the Transfer of Culture* (Ithaca, NY: Cornell University Press, 1965); Carl Diel, *Americans and German Scholarship, 1770-1870* (New Haven: Yale University Press, 1978); Richard Hofstadter and Walter P. Metzger, *The Development of Academic Freedom in the United States* (New York: Columbia University Press, 1955), Ch. 8; Hart,

to improve their own collegiate experiences in the United States. Therefore, according to Turner and Bernard, "the origin of the *research* university—Germanic influence and all—comes into focus only when viewed as one outcome of a century-long struggle to redefine the American *college.*"[228]

In the redefining of the American college, two paradigms appeared. The first pushed modern languages, mathematics, and the sciences. This approach had the added claim that it provided a *useful* form of education for the modern world. The second grew out of the old classical system, continuing to emphasize Latin and Greek, but adding history, literature, and the fine arts. This approach accentuated the development of intellect and character over usefulness. In time, the first approach, utilitarian, became associated with the specialization of knowledge, whereas the second became the liberal arts.[229] This mixed approach – utilitarian, liberal arts, and German-influenced research and graduate studies – continues to shape higher education to this day. These reforms in the latter half of the nineteenth century began to transform the American college into the American university.

German Universities. In regards to German universities of the 19th century, see Fritz K. Ringer, *The Decline of the German Mandarins: The German Academic Community, 1890-1933* (Cambridge, MA: Harvard University Press, 1969), Ch. 1; Joseph Ben-David, *The Scientist's Role in Society: A Comparative Study* (Englewood Cliffs, NJ: Prentice-Hall, 1971), Ch. 7; Friedrich Paulsen, *The German University and University Study* (New York: Scribner's, 1906).

[228] Turner and Bernard, "German Model", 224.

[229] Turner and Bernard, "German Model", 224.

Schools of Mines, Land Grants, and the University

Barnard's ambitions to transform Columbia College to Columbia University began with his immediate support of the Columbia School of Mines, which, on November 15, 1864, opened its doors to students.[230] The Columbia School of Mines was not the first school dedicated to science or engineering. In terms of mining, and mining engineering, it was the first school to survive and become a model for other schools of mines throughout the country. It was also not even the first scientifically based model created in the 1860s. That distinction belongs to newly created land-grant schools, enacted in 1862 with the Morrill Land-Grant Act. However, both approaches to higher education have their roots in earlier scientific, technological, and agricultural forms of higher education in the United States.

Much has been written about Morrill Land Grant Act and its effects on higher education, agriculture, engineering, and the states in which they reside. For some historians, the land-grant model endorsed access to the average person, advanced agricultural practice, and focused on service-based education. Justin Smith Morrill encouraged these ideas but maintained a relative vagueness about the nature of these schools. For many historians of higher education, these associations tended to be celebrated rather than critically evaluated. Roger L. Williams described several historical accounts of the land-grant colleges as "romantic" and "deterministic."[231] Nathan Sorber

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[230] Bruce, *Launching*, 331-332; and Fulton, *Memoirs*, 335.
[231] Roger L. Williams, *The Origins of Federal Support of Higher Education: George Atherton and the Land-Grant College Movement* (University Park: Pennsylvania State University Press, 1991), 2.

adds to this critique by addressing regional differences in the application of the land-grant model, especially in the nineteenth century.[232] Similar to the supposed German Model, land-grant schools have been clumped together, erasing institutional diversity, with names such as "People's College," "Cow Colleges," or "Democracy's Colleges." For Sorber, he addresses one form of democratization, "defined as the degree to which the academic standards and curricula of land-grant colleges contributed to increasing access among previously underserved students to create a more egalitarian student profile."[233] In other words, did these institutions have the democratizing effect that previous historians attributed to them, or did these schools, at least in the early years of their development and in the nineteenth century, not quite address the "industrial masses" as they are called in the legislative act? At least in the northeastern states that Sorber studies, this was not the case.

As previously stated, the land-grant school and the Columbia School of Mines, emerged out of other educational approaches in science, technology, and agriculture. Both schools rested on the idea of "useful knowledge" which did not distinguish between pure and applied science, as "scientific knowledge by its very nature was considered to be inherently useful."[234] West Point, in 1817, was the first American institution to teach

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[232] Nathan M. Sorber, "Early Land-Grant Colleges and Students in the Northeastern United States: A History of Regional Access and Mobility Patterns in Maine, Massachusetts, and New York, 1862-1878" *Agricultural History* 92, 1 (Winter 2018): 101-123.
[233] Sorber, "Early Land-Grant Colleges", 119, note 4.
[234] Roger L. Geiger, "The Rise and Fall of Useful Knowledge: Higher Education for Science, Agriculture, and the Mechanic Arts, 1850-1875" in Roger L. Geiger, ed., *The American College in the Nineteenth Century* (Nashville: Vanderbilt University Press, 2000), 153.

engineering based on French military education. Norwich University began teaching another form of engineering and military education when it was still an academy in 1819.[235] In terms of agricultural education, the Gardiner Lyceum in Maine offered the first form between 1822-1832. The Franklin Institute of Philadelphia offered scientific and technical lectures in 1824.[236] The same year, Rensselaer School opened teaching a one-year course in science. By 1835, the course changed to civil engineering and the school changed its name to Rensselaer Institute.[237] Additionally, colleges began to experiment with a parallel "scientific course."

By 1850, American higher education had three distinct tracks of scientific or technical education, plus parallel scientific courses. First, it had the "schools of science" which were attached to established colleges, such as Sheffield Scientific School or Lawrence Scientific School. Second, it included the colleges of agriculture, which often developed out of agricultural associations. Finally, the "polytechnics" were schools focused on engineering and the mechanic arts. Each of these institutions provided a different form of education as compared to the standard American college. As is evident in Table 1, these institutions provided scientific and technical forms of education long before the Morrill Act of 1862 created land-grant schools and before the Columbia School of Mines opened its doors.

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[235] Gary T. Lord, "Alden Partridge's Proposal for a National System of Education: A Model for the Land-Grant Act," *History of Higher Education Annual* 18 (1998).
[236] Terry S. Reynolds, "The Education of Engineers in American before the Morrill Act of 1862," *History of Education Quarterly* 32, 4 (1992): 459-82.
[237] Reynolds, "Education of Engineers".

Table 1. Institutions for Higher Education in Applied Science.[238]

Schools of Science or Engineering Affiliated with Colleges	Date of Opening	Non-Land-Grant Schools for Agriculture or Engineering
Union College, Engineering School	1845	
Yale College, Sheffield Scientific School	1846	
Harvard University, Lawrence Scientific School	1847	
	1851	Rensselaer Polytechnic Institute
Dartmouth College, Chandler Scientific School	1852	Farmer's College (open)
University of North Carolina, School of Application of Science to the Arts Norwich Univ. 3-yr. Eng. Course	1853	Polytechnic College of the State of Pennsylvania
	1854	Polytechnic Institute of Brooklyn Farmer's College (chartered)
	1857	Michigan State Agricultural College
University of Virginia, Dept. of Applied Chemistry	1858	Maryland Agricultural College
	1859	Farmer's High School (Pennsylvania)
Columbia College, School of Mines	1864	
	1865	Massachusetts Institute of Technology
Lafayette College, Pardee Scientific Department	1866	Lehigh University Illinois Agricultural College
	1868	Worcester County Free Institute of Industrial Science
Dartmouth College, Thayer School of Civil Engineering	1871	Stevens Institute of Technology
Harvard University, Bussey Institution (agr.)		
Univ. of Pennsylvania, Towne Scientific School	1872	
Princeton College, Green School of Science	1873	
Columbian University, Corcoran School of Science		
Boston University, School of All Sciences	1874	Colorado School of Mines, Golden
	1885	Michigan Mining School, Houghton
	1888	Montana School of Mines, Deer Lodge

[238] Table adapted from Geiger, "Useful Knowledge," 156, to include other schools of science and engineering pertinent to this dissertation and outside the period addressed by Geiger.

These schools of scientific, technological, and agricultural education planted the seeds for what would develop into the Morrill Land-Grant Act and into engineering schools like the Columbia School of Mines and the Massachusetts Institute of Technology. Throughout the end of the nineteenth and into the twentieth century, these institutions of higher education, depending on regionality and direction of legislative decisions, continue to evolve to meet the needs of society. After 1870, there were no new schools of science in the northeastern states. What undermined the existence of these standalone schools was the implementation of the elective system. Under this new system, there was no longer a rationale for a separate school. After 1890, the American university ranked science, engineering, agriculture, and many other fields at the same level as literary studies. The Morrill Act had changed the landscape of American higher education which had, until the 1870s, contended that liberal studies and useful knowledge should be separate.

Barnard, Columbia College, and its School of Mines

The history of engineering and science in American higher education fluctuated throughout the nineteenth century. Some institutions, such as Harvard or Yale, created separate schools to teach science. Other institutions were standalone schools of science and technology like the Massachusetts Institute of Technology. However, there were some institutions that were reticent to include scientific or technology education in their hallowed halls. For Robert McCaughey, “the history of Columbia engineering sheds light on other ‘technology wary’ academic institutions, on the history of engineering

education, and on the changing place of technology in modern and post-modern America."[239] In terms of science and its relationship to the university, McCaughey added that, "achieving the favored place … has at times required that scientists posit a distinction between the disinterested ideological purity of their own calling and the market-driven, problem-solving, inventive ways of the engineers and applied scientists."[240] For this reason, some engineers believe that C. P. Snow's "two cultures" of 1959 is actually missing another level.[241] Snow described the two cultures as the humanists and the scientists. However, a third level – one for the engineers and applied scientists – may be a more proper representation and gets to the hierarchy between "pure" science and "applied" science. In this hierarchy, especially in academia, the "pure" sciences have maintained a far more privileged role.

Historically, it is important to note that Columbia was not so "technology wary." Samuel Johnson, the first president of King's College (Columbia University's former name), spoke of a science-friendly environment at the school's opening, saying:

> It is further the design of this college to instruct … In the arts of numbering and measuring, of surveying and navigation, of geography and history, of husbandry, commerce and government, and the knowledge of all nature in the heavens above, and in the air, water and earth around us, and the various kinds of meteors, stones, mines, and minerals, plants and animals, and of everything useful for the comfort, the convenience and elegance of life, in the chief manufacturers relating to any of these things.[242]

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[239] McCaughey, *A Lever Long Enough*, xxiv.
[240] McCaughey, *A Lever Long Enough*, xxiv.
[241] C. P. Snow, *The Two Cultures and the Scientific Revolution* (New York: Cambridge University Press, 1959).
[242] Herbert Schneider and Carol Schneider, eds., *Samuel Johnson, President of King's College: His Career and Writings* (New York: Columbia University Press, 1929) IV, 222-224; McCaughey, *A Lever Long Enough*, 9.

Johnson backed up this speech with hiring a young natural philosopher, Daniel Treadwell, who unfortunately died three years later. Treadwell's replacement was an even younger mathematician, Robert Harpur.[243]

Unfortunately, Samuel Johnson soon tired of his role and the trustees hired an Oxford-trained professor of moral philosophy, Reverend Myles Cooper, to replace him. Cooper wanted to "Oxfordize" the college and reduced the role of mathematics and science in the curriculum. As a result, between the 1780s and the 1850s, the faculty of Columbia College counted only two positions for science.[244] One was in mathematics and the other was in natural philosophy. In 1853, James Renwick retired his position as professor of natural philosophy. Trustees Samuel F. Ruggles and George Templeton Strong pushed for a young scientist who had the backing of the Scientific Lazzaroni – Wolcott Gibbs.

Gibbs was a former student of Renwick's and had graduated in 1841. He had gone to Europe to study chemistry and returned to New York to take up a position at the Free Academy of New York City. Unfortunately for Ruggles, Strong, and Gibbs, some of the trustees viewed Gibbs Unitarianism as a problem. Instead, over a series of votes Professor Richard McCulloch, a professor of natural philosophy at Princeton, and a Presbyterian won the most votes and claimed the vacant professorship. Gibbs remained at City College until 1861 when he beat Charles William Eliot for the new chemistry professorship at Harvard. In making this decision, the trustees halted scientific

[243] McCaughey, *A Lever Long Enough*, 10.
[244] McCaughey, *A Lever Long Enough*, 12.

advancement in favor of religious ideology. This would raise its head again in the early 1860s with the retirement of Charles King as president and the selection of Frederick A. P. Barnard as his replacement.

Before Barnard's appointment to the presidency, a young graduate of Yale and the *École des Mines* in Paris, Thomas Egleston, persuaded the trustees of Columbia in 1863 to open a school of mines.[245] According to Egleston,

> The object of the School of Mines and Metallurgy is to furnish the student the means of acquiring a thorough scientific and practical knowledge of those branches of science which relate to mining and the working up of the mineral resources of this country, and to the supply to those engaged in mining and metallurgical operations, persons competent to take charge of new or old works and conduct them on thoroughly scientific principles.[246]

Prior to bringing the idea of the school of mines before the other trustees, the physics professor Richard McCulloch, who replaced Renwick, had left his post to serve the Confederacy.[247] In his place the trustees elected Ogden N. Rood. Barnard was a late applicant for the position in which Rood was elected. Barnard had spent 25 years teaching mathematics and astronomy as well as presiding over the universities of Alabama and Mississippi before crossing union lines in early 1863. His brother, a General in the Union Army, secured temporary work for him in Washington.

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[245] Bruce, *Launching*, 331-332; Fulton, *Memoirs*, 334-335; and Matthews, *History*, 355-356.

[246] Thomas Egleston, "Proposed Plan for a School of Mines and Metallurgy in New York City" (New York, March 1863), Reprinted in 1914 by Charles F. Chandler, School of Mines Records (UA # 0098), Box 8, Folder 17, Series VI, Founding of the School 1863, 1865, 1914. Rare Book & Manuscript Library, Columbia University Library.

[247] Bruce, *Launching*, 273.

As fate would have it, the Columbia Board of Trustees became aware of Barnard, around the same time that President Charles King announced his intention to retire effective June 30, 1864. On March 26, 1864, sight unseen, the board of trustees elected Barnard as the tenth President of Columbia College. A converted Episcopalian (which likely helped his candidacy), Barnard was also a talented mathematician, astronomer, and a charter member of the National Academy of Sciences; however, these last accolades likely went unnoted by the trustees. In his inaugural address, on October 3rd, 1864, he confirmed that he spent the last three decades advancing, "the cause of higher education in the great Southwest."[248] In so doing he elevated the status of science in the South and sought reform in collegiate administration and instruction, or as he described:

> I have been a pioneer in the great educational army, laboring to clear new ways through the wilderness of ignorance, seeking to kindle new beacon-lights upon heights in advance of the grand march of intellectual culture across the continent. I have been endeavoring to build upon new foundations, and not to carry on toward completion an edifice begun by others.[249]

In terms of the role of the faculty and the freedoms they seek to pursue their profession in the manner they see as best, he stated:

> In his own proper province, each officer of a college should enjoy that freedom to which his superior acquaintance with all that relates to his peculiar domain entitles him. There is the less danger in the concession, inasmuch as the limits of this sovereignty are so clearly defined that the harmony of academic rule is not likely to be disturbed by resort to so violent measure as secession.[250]

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[248] Frederick A. P. Barnard, "Proceedings at the Inauguration of Frederick A. P. Barnard, S.T.D., LL.D., as President of Columbia College, on Monday, October 3, 1864" (New York: Hurd and Houghton, 1865), 25
[249] Barnard, "Proceedings at the Inauguration," 36.
[250] Barnard, "Proceedings at the Inauguration," 37.

He worded this point on academic freedom in relation to the events surrounding the American Civil War. He was also, likely, trying to convince some in the audience that his period of teaching and administering in southern colleges did not reflect his political and personal beliefs about secession.

In relation to the curricula and the impending opening of the new school of mines. Barnard took the time in his address to remind the audience of the challenges and critiques of the classical system. He applauded the system and its role in developing mental culture, but he did concede that there was room for reform within the system.[251] He thought reform should be restricted to branches of knowledge that would "secure the largest probabilities of success" and would quell the urgent "sense of a great public want."[252] For him:

> The physical sciences as applied to the arts: and the object now immediately proposed contemplates the opening of a department in which shall be taught the modes in which geological, mechanical, and chemical science may be brought to bear upon the development of the mineral resources of the country… It seems indispensable, in a country like this, where nature remains to so large an extent unsubdued, and the temptations to every description of industrial enterprise so vast, that the first attempts to expand educational institutions into the form of proper universities should be made with a view to take advantage of that practical spirit which will encourage more extended and more thorough teaching in the direction in which it finds it profitable to do so.[253]

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[251] Barnard would go on to define this new form of college curricula and its relation to mental culture in his 1866 Convocation address, which was reprinted as a large volume of writings on modern life and the claims of science education: Frederick A. P. Barnard, "On Early Mental Training and the Studies Best Fitted for It" in *The Culture Demanded by Modern Life; A Series of Addresses and Arguments on the Claims of Scientific Education* ed. E. L. Youmans (New York: D. Appleton & Co., 1867), 309-344. Included in this volume were address by John Tyndall, William Whewell, T. H. Huxley, and many other prominent scientists.

[252] Barnard, "Proceedings at the Inauguration," 48.

[253] Barnard, "Proceedings at the Inauguration," 48.

By creating and investing in the school of mines, Columbia College found a way to reform the college curriculum and advance science with its practical benefits to not only the students who studied within the school, but to the whole nation and to industrial enterprises. With this statement, he aligned the future science instruction with practical applications and with both national and industrial interests.

In terms of the school of mines, board treasurer William Betts developed an agreement that Egleston and any other hires would be compensated through student fees and not from the college's budget. This was comparable to how the law school operated. After October 24, 1863, George Templeton Strong sought individuals who would be willing to help fund the $20,000 amount needed to get the main school started.[254] When he approached William E. Dodge, Strong learned that potential contributors would not support the school of mines unless they saw that the board was willing to provide some form of financial stability to the school. By the end of 1863, Egleston was professor of mineralogy and metallurgy. On his recommendation, the trustees announced the appointment of Francis L. Vinton, a West Point graduate and student at the *Ècole des Mines*, with Egleston as professor of mining on October 5, 1864. Three weeks earlier Egleston offered a position to the then professor of chemistry at Union College, Charles F. Chandler. As it turned out, all three men were Episcopalians.

On November 15, 1864, the School of Mines of Columbia College officially opened its doors in a rented building on the corner of Madison Avenue and 49th Street.

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[254] McCaughey, *A Lever Long Enough*, 25

The school opened with fifteen students and by Christmas day the population numbered thirty-three. Strong wrote in his diary on November 30, 1864, "If this school can be kept alive for the winter, it will succeed. In two years hence, its supply of educated metallurgists and engineers will begin to add millions to our national resources for the payment of a national debt."[255]

For Egleston and Columbia, the timing of this opening coincided with the newly organized engineering industry, as in some types of mining, lone miners and small partnerships began to give way to larger conglomerates and businesses.[256] Corporate finances increasingly funded this new industry, which mined areas of the country that the lone miner could not afford to mine. This change in funding, mining material, and techniques sparked the need for a school of mines and the engineering and scientific knowledge it provided its students.[257]

As President, Barnard worked with professors Thomas Egleston, Brigadier-General Francis L. Vinton, and Charles F. Chandler to transform Columbia School of Mines into a reputable and model American school. Chandler, Egleston and Vinton, as well as a few others, began to use their own educational backgrounds to formally develop

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[255] George Templeton Strong, *The Diary of George Templeton Strong*, Allan Nevins and Milton Halsey Thomas, eds., 4 volumes (New York: Macmillan, 1952), 3:524, 543.
[256]Kathleen H. Ochs, "The Rise of American Mining Engineers: A Case Study of the Colorado School of Mines." *Technology and Culture 33*, no. 2 (1992): 279.
[257] Bruce, *Launching*, 331-332; Fulton, *Memoirs*, 334-335; and Matthews, *History*, 355-356. See also LeCain "Moving Mountains," 127-20; Read, Thomas Thornton. *The Development of Mineral Industry Education in the United States* (New York: The American Institute of Mining and Metallurgical Engineers, 1941), 11-53; and Clark C. Spence, *Mining Engineers and the American West: The Lace-Boot Brigade, 1849-1933* (Moscow, ID: University of Idaho Press, 1993), 18-53, as they trace the beginnings of engineering education in American and the development of schools of mines.

a school of mines.[258] In doing so, according to historian Tim LeCain, they "deliberately attempted to become [an] American version of the prestigious European schools of engineering that had previously dominated."[259] They achieved this by incorporating aspects of their own education to form the curriculum and structure of the new school, especially in their attempt to find the balance between practical and theoretical education.[260]

Chandler, after graduating from the Sheffield School at Harvard, where he studied under Louis Agassiz, attended Göttingen in Saxony, from which he brought the German school's focus on thoroughness and scientific accuracy.[261] The German school also tended to favor a more practical education approach, in part due to its association with state mines. Chandler, who came to Columbia the same year as Barnard, accepted the position of Dean of the School of Mines and helped guide what historian Robert Bruce has called the "pioneer mining school" of America throughout the later part of the nineteenth century.[262] Egleston and Vinton both attended the *École des Mines* in Paris after their undergraduate studies. From this French school, they added the focus on logical arrangement and systematic development of subjects to Columbia School of Mines' theoretically focused curriculum.[263] Additionally, Vinton, a West Point graduate,

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[258] Matthews, *History,* 355-356; The other members who helped develop the Columbia School of Mines were Charles A. Joy, John S. Newberry, William G. Peck and J. Howard van Amringe.
[259] LeCain, "Moving Mountains," 135.
[260] LeCain, "Moving Mountains," 139.
[261] Matthews, *History,* 356.
[262] Bruce, *Launching,* 331-332; Fulton, *Memoirs,* 334-335; and Matthews, *History,* 354-356.
[263] Matthews, *History,* 356.

also added the focus on the mathematical foundation for engineering studies, a staple of the West Point curriculum. As a result of this unique combination of education and experience, especially from the *École des Mines*, the historian Tim LeCain argued that Columbia put "greater emphasis on theory over practical instruction."[264] These four men – Barnard, Chandler, Egleston, and Vinton – with the help of Columbia trustee, George Templeton Strong, created the Columbia School of Mines, which served as a model for other developing mining institutions.[265]

The Columbia School of Mines offered its students a rigorous period of training. Students could expect forty hours a week of lectures, labs and drawing with no break during the day for meals. However, by 1884, this schedule changed in that classes went from 9:00 am to 3:00 pm, Monday through Friday. Therefore, there was a reduction in hours, as well as some open hours, typically at the end of the day: however, there still was not a break for lunch.[266] In addition, Columbia maintained high admission standards, yet the enrollment continued to increase.[267] Between 1873 and 1888, the enrollment in the Columbia School of Mines exceeded that of Columbia College itself. As a result, the school added buildings, faculty, and courses to keep up with the demand. Initially, the school consisted of three years of study; however, by 1868, one year after the School awarded its first Engineer of Mines degree, the school lengthened the program to four

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[264] LeCain, "Moving Mountains," 139.
[265] Bruce, *Launching*, 332.
[266] Committee of Ten – Course Information for Report, 1884, "School of Mines, Columbia College, Scheme of Attendance," School of Mines Records, Box 4, Folder 7, Series II, Rare Book & Manuscript Library, Columbia University Library.
[266] Bruce, *Launching*, 332
[267] Bruce, *Launching*, 332; and Mathews, *History*, 355-380.

years, with the addition of a preparatory program. The school also offered degrees in Metallurgy, Geology, Natural History, Analytical Chemistry, and Applied Chemistry. The number of degrees increased with the addition of Civil Engineering in 1869, Architecture in 1881, and Electrical Engineering and Mechanical Engineering in 1889.[268]

The school, recognizing that a classroom-based, theoretical education might not meet all the needs of their students, also created opportunities for practical education. Professor Joy had his students reinforce their theoretical understanding through laboratory activities and instruction.[269] Additionally, since the school's inception, an expectation for the students was that they spend their summers travelling to mines and other works. In 1877, Professor Munroe took over this aspect of curriculum and formally created and organized a summer field program.[270] The first practical mining class travelled to the coal mining operations at Drifton and Hazleton, Pennsylvania, its collieries and other nearby works.[271] By 1883, another summer course focused on geodesy, a practice of surveying, met at Cooperstown, New York.[272] This program, eventually offered in the final two years of study, allowed students to gain practical experience in the field by spending several weeks at a field site, including an 1896 trip to Butte, Montana.[273] "Of the 871 mining degrees granted in the United States up to 1892,"

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[268] Matthews, *History,* 359-360.
[269] Finch, *School of Engineering*, 40-41.
[270] Finch, *School of* Engineering, 51; and Matthews, *History,* 369-370.
[271] Finch, *School of* Engineering, 51.
[272] Finch, *School of* Engineering, 51.
[273] Summer School, Butte, Montana, June 1896, Series I: Academics, Sub-Series I.4: Schools & Departments, Box OS 16, Historical Subject Files 1870s-2018, Rare Books & Manuscript Library, Columbia University in the City of New York.

wrote Bruce, "402 came from Columbia and 126 from MIT, with no other school accounting for as many as 60."[274] Therefore, Columbia and its School of Mines were the leaders of American mining education from its inception and into the 1890s.

This success came in the face of considerable pushback from "technology wary" trustees and non-scientific faculty. In the early 1870s, Barnard and Chandler would join forces to broadly expand the school's course offerings in engineering and the natural sciences. They also promoted graduate studies and attempted to appoint their own Ph.D. graduates to the faculty. On top of this, Chandler and Barnard fought for equal standing on campus for the Mines students.[275]

On March 3, 1874, members of the other contingents within the board of trustees began to push back against Strong and Barnard. It appears that some of the board wanted to limit the size and abilities of the school of mines. Some members even hinted at blaming the school of mines for the decline in college enrollments of the college proper. Barnard attributed this drop to the success of other institutions like Harvard and its elective course, in attracting New Yorkers who traditionally would have attended Columbia. More than two thirds of the students of the school of mines were nonresidents of New York and many were college graduates. Therefore, the students were in no way negatively affecting the enrollment of the college.[276]

In time, the trustees who supported the mines noticed an anti-mines and anti-science faction amongst the other members. Many of these held the view that the school

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[274] Bruce, *Launching*, 332.
[275] McCaughey, *Lever Long Enough*, 36.
[276] McCaughey, *Lever Long Enough*, 37

of mines might take over the college proper and change the scope of the college away from a more traditional, classical approach. In 1875, the school of mines lost their most ardent supporter on the board of trustees, with the death of George Templeton Strong. Soon thereafter, the anti-mine group, pushed through a mandate that all the school of mines curricula be increased from three to four years. The trustees made the optional preparatory year mandatory. One plausible reason for this mandate was that some of the trustees believed the three-year mines course gave it an advantage over the four-year college course.[277]

Barnard and other supporters of the school pointed out that those students entering the school of mines were on average two or more years older than those entering the college and were therefore more academically motivated to complete their program and get their careers underway. The addition of a fourth year had the potential of only impeding the program and the ability of students to gain the necessary education they needed to start their careers as soon as possible. In 1880, because of this change, registrations did not increase. However, the addition of architecture to the school of mines saw a return to the upward trend in enrollments.

Barnard, the State, and Coeducation

In 1879, Barnard began to focus on larger issues in higher education. In July, he spoke before the Regents of the University of the State of New York about the

[277] McCaughey, *Lever Long Enough*, 38.

relationship between education and the state.[278] In this address, he reminded the audience about the importance that the state of New York placed on education in the aftermath of the Revolution War. From this anecdote, Barnard stated his topic which "is the relation of the state to education — the obligation of the state to provide for the education of the citizens – the extent of the obligation — and the grounds on which it rests."[279]

Recognizing that there existed many perspectives on this topic, he suggested that:

> This great diversity of views indicates the absence of any general recognition of the fact that there are settled principles to which the question at issue may be referred, and by which the extent of the obligation of the government to maintain education may be ascertained. The discussions which take place upon the subject scarcely in the least involve those ultimate principles, but are almost exclusively concerned with the immediate effects of education is making the individual a better man, and therefore by inference a better citizen. In this form the argument is necessarily inconclusive, because it proves too much. It proves as well that we should have free national universities and free state colleges, as that we should have free common schools. Because the prosperity of the community is dependent on the general intelligence of its members, because educated men become naturally the leaders of society, because exclusion of the poor from the higher education handicaps them unfairly in the race of life, because a large as education really offered is the only means by which the genius lurking in the humbler ranks of society can surely be detected and developed and made serviceable — these are all apparently potent reasons why opportunities for the highest culture should be freely open to all.[280]

However, these reasons potentially applied to a whole host of schools and other institutions. Therefore, some clarity as to the function and role of the state needed further explanation.

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[278] Frederick A. P. Barnard, *Education and the State: An Address* (New York: The S. W. Green Typesetting Machines, 1879).
[279] Barnard, *Education and the State*, 7.
[280] Barnard, *Education and the State*, 9.

For Barnard, the functions and roles of government, or the state, were few and simple. They were:

1. To provide for the common defense.
2. To protect the citizen in his rights of person and property
3. To furnish him security in the peaceful prosecution of his chosen pursuit.
4. To institute tribunals for the administration of justice.
5. To treat with other governments, and to adjust questions which may arise with such, amicably or by force.[281]

This list was similar to the role and function of governments described by Wilhelm Humboldt in the late eighteenth and early nineteenth century, who likewise discussed the relationship between the state and education.[282] For Barnard, in order for the state to take a vested interest in the education of its peoples, it had to be shown that such interest helped the government achieve its purposes and functions listed above.[283] This was where a discussion of types of governments came into play as autocratic governments, may see education as a way to motivating self-preservation; where despotic systems, may use education as a way of "controlling sentiment, as well as of cultivating intelligence."[284] Under representative or democratic governments, there was a desire to have a citizenry

[281] Barnard, *Education and the State*, 10-11.
[282] See Chapter 1; Wilhelm von Humboldt, *The Sphere and Duties of Government*, trans. Joseph Coulthard (Bristol, England: Thoemmes Press, 1996), 65-70; Wilhelm von Humboldt, "On Germany's Educational System" in *The Rise of The Research University*, eds. Louis Menand, Paul Reitter, and Chad Wellmon (Chicago: The University of Chicago Press, 2017), trans. Paul Reitter and Chad Wellmon from Wilhelm von Humboldt, "Über die innere und äussere Organisation der höheren wissenschaftlichen Anstalten in Berlin" and "Antrag auf Erichtung der Universität Berlin, 12-14 Mai 1809," in *Wilhelm von Humboldts Gesammelte Schriften*, vol. 10, ed. Königlich Preussischen Akademie der Wissenschaften (Berlin: B. Behr, 1903).
[283] Barnard, *Education and the State*, 12.
[284] Barnard, *Education and the State*, 13-14.

with intelligence to make decisions with their votes. Therefore, according to Barnard, having an educated citizenry behooved the government to support some form of education.[285]

To this end, Barnard analyzed several arguments for and against the state's involvement in education. He stated:

> If individual effectiveness depends on individual intelligence, if the products of industry are better and more abundant in proportion as the judgment which guides its operations is more and more enlightened by cultivation, then it is plain that no limit ought to be placed on the extent to which the state should provide for the education of every citizen, but that which the nature of the problem itself imposes. By this I mean to say that we are not to discriminate between studies as in their own nature suitable or unsuitable to be taught in our schools. No kind of useful knowledge is unsuitable, if we have room for it… This is true because the benefits of mental culture increase in geometrical ratio, while the instrumentalities of such culture are increased only arithmetically; so that, as I've said before, if that were possible that a whole people could one and all receive the same high mental training which in the actual state of things falls to the lot of only the few, the advantage to the State would be beyond computation.[286]

He did clarify that there needed to be a core curriculum that existed for all students including reading, spelling, writing, and arithmetic, followed by geography, history, government and a study of the natural world – natural history, anatomy and physiology, physics, mechanics, and chemistry; and, lastly, vocal music and drawing.[287] Other forms of knowledge may be added, but only if time and need allowed for their addition.

Barnard concluded his address by warning against the multiplication of colleges without need. He was not against having a variety of colleges across the country, his

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[285] Barnard, *Education and the State*, 14.
[286] Barnard, *Education and the State*, 31-2.
[287] Barnard, *Education and the State*, 32-3.

worry was the type of education and the value of the degree that many institutions, claiming to be colleges, award. He spelled this out in more detail in 1880 and discussed why colleges began to include the name of the college on the degree.[288] Due to the "feebleness" of many institutions labeled as colleges, some degrees appeared to have not been worthy of the paper they were written on. Several colleges had tiny student populations, and some were no more than a secondary or preparatory school with a new name. In the end, he did find that in 1880, there were more colleges than the need really called for, but, again, his biggest complaint was the level and rigor of instruction found there.

Where his discussion on the relation between the state and education, especially the multiplication of colleges, brought him some critique, his next reform – opening higher education to women – lost him what little power he had with the Trustees of Columbia College. Between 1879 and 1882, Barnard published his annual *President's Reports*, all three of which focused on coeducation. In July of 1882, his paper "Should American Colleges Be Open to Women as well as to Men?" was read before the Convocation of University of the State of New York. In it, he argued that:

> For the proper function of a college is to deal with those capacities of men which the accidental conditions of human society have no power to control or influence. Its business is to develop and cultivate those intellectual faculties of the race which give to it its distinctive position as a race in organic nature. These faculties belong to the two sexes equally; it is equally important that they should be cultivated in both; and both sexes are therefore equally fit subjects for the culture which colleges are designed to give. Why

[288] Frederick A. P. Barnard, *Two Papers on Academic Degrees: I. On the Regulation and Control of the Degree-Conferring Power, II. On the Origin and Significancy of Academic Degrees* (New York: MacGowan & Slipper, 1880).

> then should women be excluded from the advantages which these institutions so freely extend to men?[289]

He laid out the common reasons given for the exclusion of women from higher education and the fallacious nature of these reasons. He also referenced the education and experiences of women at women's colleges, to which he applauded, but questioned why institutions specific to women had to continue when the same type of curricula and education may be received at historically male-only schools. Drawing on experiences of coeducation institutions in the New York, the West, and the South, he made a case for women to have access to the same form of education as men. As a result, in 1882, the board voted to limit the president's budget for printing as a way of censuring the publication of his ideas of reform in higher education.

For six more years, Barnard continued to publicly advocate for coeducation to no avail. In the process, he gave the board enough ammunition to begin to negatively affect the school of mines. In the final years of his presidency, the board often rejected his proposals concerning the school of mines for no other reason other than the fact that he proposed them. For example, in 1881, he proposed the introduction of electrical engineering into the school's curriculum based on the suggestion of Thomas A. Edison. The board denied the proposition claiming that the anticipated $10,000 was too expensive, even though Columbia enjoyed an excess revenue of a hundred thousand dollars a year from rental properties. A year later MIT and Cornell introduced electrical

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[289] Frederick A. P. Barnard, "Should American Colleges Be Open to Women as well as to Men?", 20th Annual Convocation of the University of the State of New York, at Albany, July 12, 1882, 141.

engineering. At Columbia, electrical engineering was approved in January 1889, at the second meeting after accepting Barnard's resignation.

Another example came from 1881 in which Barnard proposed a name change from the "School of Mines" to "the School of Applied Science."[290] This name change was due to the expanded range of degrees and instruction offered at the school that had surpassed the limitations of what a school of mines entailed. During its first decade, the school awarded most of its degrees in mining engineering. However, by the mid-1870s, the degree of Bachelor of Philosophy (Ph.B.) was awarded to those students majoring in applied chemistry and metallurgy. In 1880, the school would award its first civil engineering degree.[291]

Many graduates of the School of Mines stayed on to pursue graduate education. Beginning in 1871, with the support of President Barnard and the Board of Trustees, the School of Mines offered a graduate education, and eventually it awarded PhDs. The doctoral degree plan at the School of Mines was accepted by the board on June 2, 1873. This consisted of an additional two years of study beyond the baccalaureate, an examination, and a presentation of a thesis. In June 1875, the School of Mines awarded its first PhD to Elwyn Waller in analytic chemistry. This was the first PhD from Columbia, which was amongst a handful of universities that offered such a degree in America.[292]

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[290] McCaughey, *Lever Long Enough*, 41.
[291] McCaughey, *Lever Long Enough*, 42.
[292] The other schools included Yale, who began to offer the degree as early as 1861, Cornell (1873), and Harvard (1874). By 1882, Columbia's two-year old School of

Amongst the early PhDs awarded at the School of Mines was the first woman to graduate from Columbia. Winifred Edgerton earned this distinction in 1886, just four years after the trustees rejected Barnard's proposal to make Columbia College coeducational institution. Her enrollment at the School of Mines was quite unique.[293] After graduating from Wellesley in 1883, she completed a brief stint at the Harvard Observatory, before returning to New York. She approached President Barnard, who supported her application to Columbia. Professor of Astronomy John Krom Rees (EM 1878, PhD 1880) also supported her application.

However, the most influential supporter was Trinity Church's rector (the church where Edgerton's family attended) and Columbia board member, Reverend Morgan Dix. Dix secured Edgerton's admittance under the conditions that she work alone in the observatory and not attend class. These conditions, however, did not seem to have been followed to the letter of the law. In 1886, the School of Mines faculty unanimously voted to award the degree of PhD to Edgerton. After graduation, Edgerton considered taking a position at Smith College, but chose to forgo this position to marry James Merrill, an 1890 Columbia PhD in geology.[294]

Another obstacle for the school of mines and President Barnard came from within the faculty of the college— John W. Burgess. Burgess was a graduate of Amherst College and a student at both German and French universities before returning to

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Political Science offered its first PhD. However, by that time, the School of Mines had already awarded thirty-six.

[293] McCaughey, *Lever Long Enough*, 45.

[294] McCaughey, *Lever Long Enough*, 46.

Amherst as a professor. In 1876, he came to Columbia to establish a graduate school in political science. With the support of Trustee Samuel B. Ruggles and President Barnard, Burgess recruited more Amherst colleagues to establish the School of Political Science in 1880.[295]

In time, Barnard and Burgess disagreed over who should have access to education at Columbia. Whereas Barnard welcomed Jews, African Americans, and women to Columbia, Burgess and his followers systematically excluded them. In 1882, they permanently went their separate ways when Burgess successfully led an on-campus opposition to Barnard's coeducation movement. Following this move, in 1884, Burgess published his 22-page pamphlet *The American University —When Shall It Be? Where Shall It Be? What Shall it Be?*[296] In his pamphlet Burgess shamelessly praised the Board of Trustees of Columbia and predicted that the first American university would be private and in New York City.

After years of struggle with the Board of Trustees of Columbia College and some outspoken faculty, Frederick A. P. Barnard resigned after 25 years as president. Seth Low was then appointed as the next president, where he inherited a college organized into seven units.[297] Due to his inexperience in academic administration, Low looked to others for help. Unfortunately for the Columbia School of Mines, he found that help in the

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[295] Matthews, *History*, 269-70.
[296] McCaughey, *Lever Long Enough* 52.
[297] Matthew, *History*, 157-8. These units were: the college for men, the medical college, the law school, the engineering school (school of mines), a new graduate program in the social sciences, a graduate program taught by the college faculty, and a college course for women, in time replaced by Barnard College.

technology-averse John W. Burgess and his protégé, professor of philosophy, Nicholas Murray Butler (BA 1882, PhD 1884).

Barnard, as President of Columbia College, was instrumental in change at his own institution. He helped extend the elective system and increased the focus on graduate study and original research. During Barnard's tenure, student enrollment increased ten-fold, and the number of faculty also increased. However, for as much as he wanted to push Columbia forward, he had to work through an often-reluctant group of trustees.[298] An example of this reluctance came in Columbia's hesitancy to make the school coeducational, a goal that he pursued throughout his presidency. Instead, the trustees pushed for a women's college associated with Columbia. When the women's college opened in 1890, it bore the name of the man who pushed Columbia to include women – Barnard.[299]

American Higher Education into the Twentieth Century

During the 1850s, American higher education was in transition. By the end of the nineteenth century the landscape of American higher education looked nothing like it had in 1850, or even more so in 1800. Between 1850 and 1890, the old, classical college was under attack from a variety of different approaches to higher education. The inclusion of utilitarian schools, denominational colleges, European reforms, graduate education, access for more levels of society and women, federal government support, and the new

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[298] Brander Matthews, Chair, *A History of Columbia University, 1754-1904* (New York: The Columbia University Press, 1904), 247; and Veysey, *Emergence*, 99 -100;
[299] Mathews, *History*, 397.

elective system all signaled a change in what American higher education would be in the twentieth century.

According to more traditional interpretations, the classical college had been an obstacle to the modern system of higher education. Pointing to decisions made by the established elite schools such as Harvard and Yale, especially after the Yale Report of 1828, traditional historians developed four broad assumptions about higher education in the nineteenth century: elitism, irrelevance, denominationalism, and the dominance of the university after the Civil War.[300] Revisionist historians have aptly demonstrated that these assumptions were incorrect.[301] Although some of the early schools such as Harvard, Yale, and South Carolina State College, pulled heavily from the social elite, most of the other

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[300] See, Freeman Butts, *The College Charts Its Course* (New York: McGraw-Hill, 1939); Walter P. Metzger, *Academic Freedom in the Age of the University* (New York: Columbia University Press, 1961); Richard Hofstadter & Walter P. Metzger, *The Development of Academic Freedom in the United States*. (New York: Columbia University Press, 1955); Richard Hofstadter, *Academic Freedom in the Age of the College* (New York: Columbia University Press, 1961); Frederick Rudolph, *The American College and University: A History* (New York: Vintage Books, 1962), and; John S. Brubacher and Willis Rudy, *Higher Education in Transition: A History of American Colleges and Universities, 1636-1956* (New York: Harper, 1958).

[301] Roger L. Geiger, "Introduction" in Roger L. Geiger, ed., *The American College in the Nineteenth Century* (Nashville: Vanderbilt University Press, 2000), 3-8. Geiger systematically presents each assumption, their traditional backers, and the revisionist responses; Bruce Kimball, "Writing the History of Universities: A New Approach?" *Minerva* (1986): 375-89, provides insight into the historians of this movement and the inconsistencies therein; James McLachlan, "The American College in the Nineteenth Century: Toward a Reappraisal," *Teachers College Record* 80, 2 (1978): 287-306; James Axtell, "The Death of the Liberal Arts College," *History of Education Quarterly* 11, no. 4 (1971): 339-352; Hugh Hawkins, "The University-Builders Observe the Colleges," *History of Education Quarterly* 11, no. 4 (1971): 353-362; Potts, "American Colleges," 363-380, and; David F. Allmendinger, Jr., "New England Students and the Revolution in Higher Education, 1800-1900," *History of Education Quarterly* 11, no. 4 (1971): 381-389.

schools drew from other levels of society. As for the irrelevance, revisionists have shown that colleges with the classical curriculum made attempts to include other forms of study including science, and the Yale Report of 1828, often cited as a conservative throwback to previous approaches, was a reformation of earlier forms of the curriculum. In terms of denominationalism, revisionist scholars like Colin Burke and David Potts demonstrated that instead of overpopulating the country with religiously, primarily Protestant, oriented schools, which were in constant conflict with each other resulting in many shuttering their doors by the early decades of the twentieth century, denominations were more concerned with caring for their own flock instead of fighting with another church. Additionally, the attrition rates, were nowhere near those first reported by more traditional scholars. Finally, it was not 1865 that signaled the doom for the classical college giving rise to the university for the rest of the nineteenth century. Instead, 1890 is a more appropriate year for the rise and dominance of the university over the classical approach. Through these revisionist studies, the history of higher education became more complete. Yet, the traditional narrative still lingers in recent scholarship, signaling the necessity for further work on nineteenth century higher education in the coming years. This also means rethinking how historians divide the century to account for the changes in higher education. For this reason, this chapter began with 1850 and then traced developments, using Frederick A. P. Barnard, that originated before this time and continued beyond it.

Frederick A. P. Barnard provides an interesting case study into nineteenth century higher education. His experiences and contribution to American higher education and

science have often been overlooked with a focus placed, and deservedly so, on his contemporaries such as Charles W. Eliot, Francis Wayland, Andrew Dickson White, and others. Nevertheless, as this chapter showed, Barnard provided insight and pursued the spread of both higher scientific education in regions of the country where these approaches were either new or in their earliest development. His focus on regionality, reforming curricula, the purpose of college, the role of the state in education, and coeducation, along with his support of the Columbia School of Mines provides clear evidence for his inclusion in the list of innovators and reformers of American higher education in the nineteenth century.

Conclusion: Barnard and Beyond

Frederick A. P. Barnard may no longer be as well known in American higher education circles as Harvard's president Charles W. Eliot or later educators like John Dewey. However, Barnard provided a bridge through the various changes in American higher education during the nineteenth century. He received his classical education at Yale, but studied under a prominent scientist, Silliman, Sr. After graduating he continued to teach at Yale, before accepting a position in New York. Due to his scientific work, he took a position in Alabama and then Mississippi, teaching and administering scientific thought in a new region of the country. Through his connections in the scientific world, he eventually became president of Columbia at a time when the school was trying to clarify its own future. His scientific background and willingness to reform, propelled

Columbia College towards the status of a university and helped its developing school of mines become a model for other American institutions to emulate.

Further, Barnard's successes in elevating Columbia's enrollment, developing and continuing the Columbia School of Mines, and creating graduate studies at Columbia set in motion the development and continued existence of science and engineering in Montana throughout the 1880s up to the present.[302] Amongst the number of graduates and attendees of Columbia and the Columbia School of Mines, reside at least four who shaped science and engineering education and practices in Montana – William A. Clark, who attended in 1872, Frank W. Traphagen, class of 1883, Augustus M. Ryon, class of 1888, and F. Augustus Heinze, class of 1889.[303] Clark and Heinze became two of the "Copper Kings" in Butte, Montana. Clark resided in Deer Lodge, Montana, before living in Butte, and helped start the College of Montana. This school brought the two other men, Traphagen and Ryon, to Montana. Of the four, Heinze appears to be the only one not associated in some form or another in the development of science and engineering education in Montana, though he did hire several mining engineers.

Combining the research and practical approaches of scientific education with select approaches and experiences from German schools, American higher education systems and their faculties created the first graduate school at Johns Hopkins. By the early 1890s, Chicago and Stanford would join the ranks of this new American University.

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[302] Daniel Bell, *The Reforming of General Education: The Columbia College Experience in its National Setting* (New York: Columbia University Press, 1966), 16-17.
[303] Frank Diehl Fackenthal, Chair, *Columbia University Alumni Register, 1754-1931: Compiled by the Committee on General Catalogue* (New York: Columbia University Press, 1932), 158, 163, 384, 758, 887.

As the American University emerged, it was a minority in the field of American higher education, within which most students, male and female, attended denominational and single sex colleges. By 1900, this was no longer the case.

At the turn of the century, American higher education consisted of universities, land grant schools, state colleges, denominational colleges, schools of mines, and a smattering of other public and private colleges with various purposes of existence. Over the next few decades, many of these colleges made the steps necessary to become universities. Others faded away or merged with other institutions. Instead of the classical curriculum that dominated higher education up through the majority of the nineteenth century, most of these institutions had a combination of utilitarian, liberal arts, and elective forms of education. Additionally, many of these institutions were coeducational and accessible to all levels of society.

Over the course of the twentieth century, higher education would encounter new calls for reform and questions about its role and purpose in society at large and within the communities where it resides. With the help of federal forms of support, such as the Morrill Act of 1862 and 1890, the Hatch Act of 1877, the Smith-Lever Act of 1914, the Servicemen's Readjustment Act of 1944, and the National Defense Education Act of 1958, higher education was available to more people than ever before. It was also open to more critique.

In time, two models, developed during the Civil War, drastically changed educational outlooks and became the subject of political and industrial influence throughout the nineteenth and twentieth century. The land grant school and school of

mines developing first in the eastern states directly influenced higher education in the American West and internationally in Japan. The result of which is the subject of the following chapters.

CHAPTER THREE

MONTANA'S "FOURTH DIVISION OF GOVERNMENT": EVOLUTION OF HIGHER EDUCATION IN THE AMERICAN WEST'S BIG SKY COUNTRY, 1868-1948

On October 27, 1939, Dean William Cobleigh spoke before a crowd gathered for the unveiling of the A. M. Ryon Engineering Laboratories on the Montana State College campus in Bozeman. In his speech, Cobleigh recounted the fifty-one-year history of engineering education in Montana. According to Cobleigh, during this period, there existed four degree-granting institutions that focused on engineering education – the College of Montana at Deer Lodge in 1888, Montana State College at Bozeman in 1893, the State School of Mines at Butte in 1895, and the State University at Missoula in 1910.[304] Two men were responsible for the development of two of these institutions – Frank W. Traphagen, the first professor of chemistry at, what is now, Montana State University-Bozeman whose name adorns the chemistry building, and Augustus M. Ryon, the first President of Montana State University and professor of engineering.

These two Columbia School of Mines graduates transplanted a version of the curriculum and practices of Columbia into, first, the Montana School of Mines in 1888, and, then, to the newly established land-grant school in Bozeman in 1893. By using the term "version" I want to make clear that this new program was not a carbon-copy of

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[304] William M. Cobleigh, "51 Years of Engineering Training in Montana," 27 October 1939. Bozeman Faculty Biographies: A. M. Ryon, Accession 03001:6, Montana State University Archives (hereafter cited as Cobleigh, "51").

Columbia nestled in the mountainous valleys of Montana. Instead, these men tried to recreate their own educational experiences from a metropolitan-based college in the American West, with all its geographic limitations and proximity to actual sites of mineral extraction. William Cobleigh joined them as a student at the College of Montana in the Montana School of Mines, before rejoining them in Bozeman in 1894. In time, Cobleigh also studied at the Columbia School of Mines before returning to eventually become Dean of Engineering and have an engineering building neighboring his mentor Ryon's on the Montana State University campus. Montana State University memorialized these three men for their service to the campus, the state, and the fields of science and engineering to which they collaboratively and individually dedicated their lives. By bringing science and engineering education to Montana, these men continued the work of Columbia's Frederick A. P. Barnard in opening new geographical regions to science and engineering, as well as decentralizing these fields and their institutions through both privately and publicly-supported schools, such as the land grant school in Bozeman.

On May 26, 1864, Abraham Lincoln signed into law an Act of Congress that created the Montana territory out of the large Idaho territory. Soon after, the Organic Act of the Territory clearly defined the boundaries and set up the government. Lincoln did not live long enough to either set foot in Montana or see it become a state in 1889. However, his signature on another act of congress ensured that institutions like Montana State University received funding, developed, and supplied an academic space for the "Benefit

of Agriculture and the Mechanic Arts."[305] On July 2, 1862, Lincoln signed into law the Morrill Land Grant Act, in which each state:

> May take and claim the benefit of the act, to the endowment, support, and maintenance of at least one college where the leading object shall be without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life.[306]

Through a focus on the "liberal and practical" education of the "industrial classes" in agriculture and the mechanic arts, this act, and Lincoln's role in its approval, changed both the academic and physical landscape of every state in the country. As the political and social influence of the country spilled into western territories and what the act refers to as states in a "condition of rebellion or insurrection," inclusions of this act expanded with it.

As models of American higher education appeared in eastern states and schools, the American West served as a laboratory for individuals, religious organizations, industries, and the government to conquer, colonize, and assimilate land, its extractive resources, the people living and settling there, and the knowledge and practices these people had about their environment. Through a scientifically focused mission for agriculture and engineering, federal and state governments offered land-grants and money to create practical schools for young men and women. Industries and businesses funded schools, such as a school of mines, to develop and indoctrinate future mining

[305] Morrill Act 1862.
[306] Morrill Act 1862, sec. 4.

specialists and engineers with knowledge specific to industrial applications and the mining regions close to home. Beginning in 1868, Montana's territorial government began to think about the purpose and future of higher education within its borders.

In 1872, William A. Clark, a businessman and soon-to-be "Copper King," left Montana to attend the Columbia School of Mines.[307] With this education, Clark returned to Montana and was integral in setting up the first institution of higher education – the College of Montana. Ten years later, in 1888, as a College of Montana Board Member, this "Copper King" supported the establishment of the state's first school of mines and its connection with the Columbia School of Mines. Another "Copper King" studied and graduated from the Columbia School of Mines in 1889.[308] F. Augustus Heinze earned his master's in engineering degree from Columbia and traveled to Butte to apply his education in the copper mines. Two of the three "Copper Kings" studied at the Columbia School of Mines. The third "King," Marcus Daly, was a practically-trained miner, but he recognized the increasing importance of formal technical education and consistently employed graduates of Columbia as engineers in his company.[309]

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[307] Frank Diehl Fackenthal, Chair, *Columbia University Alumni Register, 1754-1931: Compiled by the Committee on General Catalogue* (New York: Columbia University Press, 1932), 158.
[308] Fackenthal, *Columbia University Alumni* Register, 384.
[309] Brander Matthews, Chair, *A History of Columbia University, 1754-1904* (New York: The Columbia University Press, 1904), 380. Upon his death, Daly left a scholarship fund for Montana students with either an interest in mining or family experience to attend Columbia. Through this scholarship fund, the movement of men studying science and engineering echoed early nineteenth century scientists and engineers who travelled east to Europe.

Then, on February 16, 1893, Governor John E. Rickards designated Bozeman as the site of Montana's College of Agriculture and Mechanical Arts. By this time, most states and territories of the United States had set up a land-grant college and begun instruction. Montana was the last of the 48 contiguous states to formally apply and form such an institution under the Morrill Act of 1862.[310] In time, these land-grant and schools of mines models directly shaped the educational, scientific, and technological knowledge creation and application practices, as professionalization became more closely tied to institutions of higher education, not only in the American West, but globally.

As professionalization blossomed in land-grant colleges, recent scholarship has begun to unravel the entangled pasts of these institutions and their affiliated lands.[311] In

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[310] In 1907, Hawaii chose Honolulu as the site of its land grant school. Alaska followed in 1917 by selecting Fairbanks as the site of their own school. Additionally, the Morrill Act of 1890 called for education for all races, which led to the designation of 19 colleges more formally known as the Council of 1890s Institutions. The Improving American Schools Act of 1994 reauthorized the Elementary and Secondary Education Act of 1965 and designated 29 tribal colleges and universities as land grant universities (This number has since increased to 31). These institutions reside mostly in the American West with schools as far east as Michigan and west as Alaska. However, in 2019, Montana is home to eight land grant universities, the largest number of land grant universities in a single state. This includes Montana State University in Bozeman as the 1862 Morrill Act university and seven tribal colleges and universities – Blackfeet Community College, Salish Kootenai College, Stone Child College, Aaniih Nakoda College, Little Big Horn College, Chief Dull Knife College, and Fort Peck Community College. In terms of region, the American East house fifty-seven land grant universities in thirty-one states, while the American West holds forty-nine in nineteen states, and the American Territories have six. For these numbers, the American West is defined as the states to the west of the Mississippi, along the 99th Meridian from North Dakota in the north to Texas in the South, including Hawaii and Alaska as the western most inclusions in this definition. The American territories that have land grant universities include American Samoa, Northern Marianas, Guam, the Federal States of Micronesia, Puerto Rico, and U.S. Virgin Islands.

[311] Margaret A. Nash, "Entangled Pasts: Land-Grant Colleges and American Indian Dispossession," *History of Education Quarterly* 59, no. 4 (Nov. 2019): 437-467. See also

analyzing the role of accumulation and conquest and its ties to settler colonialism, Sharon Stein has provided an avenue to dissect the colonial histories of land-grants schools.[312] For Stein, "the US federal government's vigorous efforts to accumulate Indigenous lands in the 19th century provided the conditions of possibility for the Morrill Act in 1862. Further, rather than view colonization as an isolated historical event," she asks how "colonial processes continue to shape contemporary higher education."[313] Historian Margaret Nash added to Stein's work by analyzing the "civilizing" influence of education through land-grant institutions along with other "civilizing" Acts of Congress, which built the American West on lands of dispossessed American Indians.[314] Robert Lee, Tristan Ahtone, and their colleagues at *High Country News* created a database that identifies the lands, the Indigenous inhabitants, and the land-grant schools that benefitted by these dispossessed lands.[315] This data and research firmly establish the relationship between land-grant institutions and settler colonial practices in the past, and asks questions about what these schools will do with this troubling history in the future.

Robert Lee and Tristan Ahtone, "Land-grab Universities," *High Country News*, March 30, 2020, https://www.hcn.org/issues/52.4/indigenous-affairs-education-land-grab-universities.

[312] Sharon Stein, "A Colonial History of the Higher Education Present: Rethinking Land-Grant Institutions through Processes of Accumulation and Relations of Conquest," *Critical Studies in Education* (Dec. 2017), 1-17.

[313] Stein, "A Colonial History," 2.

[314] In the same year that Congress passed Justin Morrill's "civilizing" Act, they also passed the Homestead Act and the Pacific Railroad Act. I would add the General Mining Act of 1872, as another influential piece of legislation that, as these other Acts, benefited from a state-sponsored system of Native dispossession. Additionally, the Act favored industry over the individual.

[315] See Robert Lee, "Morrill Act of 1862 Indigenous Land Parcels Database," *High Country* News, March 2020, https://www.landgrabu.org/.

This chapter traces the history of higher education in the American West, using Montana as a case study.[316] The history of higher education in Montana is not as familiar as other western states' systems, such as California. The bulk of the scholarship on Montana comes from individual institutional histories or in a few pages in larger tomes on the history of the state.[317] In using Montana, this study adds to earlier scholarship by analyzing statewide discussions about higher education from its first mentioning in the 1860s to just after World War II. Over this period, institutional development followed similar patterns found throughout the American West, including religious and civic support for schools, the rise and fall of institutions based on funding, regional support, and location, questions of decentralization, access, purpose, and the role of the state and federal organizations and funding. By 1932, the Chancellor of the University of Montana, Dr. Melvin A. Brannon, claimed that Montana had set itself apart from other western

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[316] For our purposes, seeing that this study primarily focuses on institutions of higher education, I define the American West based on an organization of 15 states in a compact created in 1951 known as the Western Interstate Commission for Higher Education (WICHE). This designation does exclude Oklahoma and Texas, two states traditionally included in other definitions of the American West, such as the "99th Meridian." This commission includes the following states: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, and Wyoming.

[317] Michael Malone, *Montana: A History of Two Centuries*, Revised Edition (Seattle: University of Washington Press, 1991); Merrill G. Burlingame, *A History of Montana* (New York: Lewis Historical Pub. Co., 1957), Merrill G. Burlingame, *A History: Montana State University Bozeman, Montana* (Bozeman, MT: Office of Information Publication, 1968), Louis W. and Antoinette R. Hagener, *A Northern Reflection* (Havre, MT: Northern Alumni Association, 2001), Robert Rydell, Jeffrey Safford, and Pierce Mullen, *In the People's Interest: A Centennial History of Montana State University* (Bozeman, MT: Montana State University Foundation, 1993), *University of Montana 75th Anniversary, 1893-1968* (Missoula, MT: Information Services Publication, 1968).

states and their higher education systems.[318] Unfortunately, for Brannon, both he and the system fell to economic and political pressures, brought on, in part, by the depression of the 1930s.

Beginning with a general overview of higher education in the American West, this chapter discusses the patterns of higher education development based on religious and civic responses to colonizing the American West. One of these responses comes from William A. Clark, who helped organize and develop Montana's first institution of higher education and supplied the means to create the state's first school mines based on the Columbia School of Mines. The history of Montana State University is the focus of the next section and draws on the connections between Montana and eastern institutions, primarily Columbia University. The chapter then discusses Dr. Melvin A. Brannon and his definition of the "fourth division of government" to retell the history of higher education in Montana and the successes, failures, and issues individual institutions and the collective system met up to 1920.[319] This discussion then leads the reader to Montana's evolving higher education system in the interwar years. Finally, the chapter concludes with a discussion on the role of institutions of higher education in the conquest and colonization of the American West and the long-term issues and educational contradictions, first seen in the early decades of Montana's institutions that continue to plague higher education to the present day.

[318] Brannon, "The Montana System of Administering Higher Education," 273.
[319] Brannon, "The Montana System Administering Higher Education," 270.

Through scientists and engineers like Traphagen, Ryon, and Cobleigh, as well as industrialists like Clark, Heinze, and Daly, historians can trace the role of the state and industry on education and knowledge production. These men connect Montana, through its institutions of higher education, to Columbia College in New York and to European institutions, such as Göttingen. Additionally, state-level debates on the centralization or decentralization of schools, the distribution of the types of knowledge taught at each school, funding, access, and the role of education in society exemplify the complexities of creating and supporting a functioning system of higher education in the American West. Whether it is as four disparate and competing state-supported institutions, a collection of religiously supported colleges, or a single, umbrella-like university system, the various institutions of higher education and their administration details the evolution of higher education from the nineteenth into the twentieth century.

Higher Education and the American West

Drawing on historical geographer D. W. Meinig's *The Shaping of America*, a study of the development of higher education in the American West relates directly to the patterns of migration and settlement of various groups. Specifically, three geographic patterns of migration appear – the development of St. Louis, a southern migration to Arkansas and Louisiana in 1834, and, finally, an eastern, interior migration from the Pacific coast in Washington, Oregon, and California.[320] Each of these migration patterns

[320] Lester F. Goodchild and David M. Wrobel, "Western College Expansion: Churches and Evangelization, States and Boosterism, 1818 – 1945," in *Higher Education in the American West: Regional History and State Contexts*, Lester F. Goodchild, Richard W.

help explain the colonial expansion and settlement into the western interior using trails and rivers. With this expansion and settlement came elements of eastern American society and civilization, including the desire for and organization of higher education.

The development of St. Louis, the "gateway to the West," provided the opportunity for various groups to seek new enterprises in the recently acquired lands of the Louisiana Purchase. In terms of education, the first school began in 1818, providing forms of education for those individuals desiring to head west. The trailheads of the Lewis and Clark, Oregon, California, and Mormon, as well as the Santa Fe and Old Spanish Trails originated in Missouri, advancing the development of institutions of education for new people in the region.[321] Likewise, rivers such as the Mississippi, Missouri, and Columbia, provided the transportation networks for the founding of towns, schools, and colleges. As settlers used trails and waterways to pierce into the western interior, schools of higher education gradually followed.

The pattern of higher education in the American West, followed similar patterns of development as in the American East. These institutions typically originated by either religious or ethnic pioneer groups or through forms of civic boosterism. As discussed in an earlier chapter, initially American higher education imitated that of England. Based on the examples of Oxford and Cambridge, the founders of Harvard and Yale centered the institutions along religious practices and education. In the American West, both Catholic and Protestant missionaries tried to Christianize the various indigenous groups such as

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Jonsen, Patty Limerick, and David A. Longanecker, eds. (New York: Palgrave Macmillan, 2014), 4.

[321] Goodchild and Wrobel, "Western College Expansion," 4.

the Pawnee, Shawnee, and Kansa, as well as the forcibly displaced Cherokee.[322] These missions eventually led to the development of schools. These schools, in turn, attracted the children of new emigrants into the West. However, religious groups were not the only initiators of higher education in the region.

As western populations grew, communities began to develop and with it, institutions found in established parts of the American East, including colleges, prisons, and territorial or state capitals developed as well. Coinciding with the development of religious institution of higher education, civic boosters founded and funded private and public institutions to educate the youth of nearby settlers and as a draw for other potentially interested settlers to move into the region.[323] This form of civic boosterism echoed earlier calls for the expansion and development of higher education in the American East.

These three geographical migrations started the development of higher education in the American West, which eventually expanded with the creation of the transcontinental railroads and availability of federal funding. In the early decades of the nineteenth century, the role of religious and civic boosterism within these migrations created a distinctive pattern of higher education development. For example, the Catholic community of St. Louis founded St. Louis University in 1818. The public University of Missouri followed by order of state mandate in 1839. In Oregon, the Methodist

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[322] Goodchild and Wrobel, "Western College Expansion," 4 and Robert V. Hine and John Mack Faragher, *The American West: A New Interpretive History* (New Haven: Yale University Press, 2000), 174-179.
[323] Goodchild and Wrobel, "Western College Expansion," 4-5.

community founded Willamette College in 1842, while Oregon State University opened in 1868.[324] In Montana, members of the Deer Lodge community founded the Collegiate Institute of Montana in 1878, before the Presbyterian church assumed control and changed its name to the College of Montana in 1883. The state of Montana did not create a public school until 1893 with what is Montana State University – Bozeman today. In each of these examples, a religious or civic organization set up a mature institution of higher education before a public choice was available. It was also in the West, that coeducation found a home, beginning with the University of Iowa in 1855 and spreading to the other western states and territories.

As mentioned earlier, the development of higher education in the American West was like that of the American East. As historian Arthur M. Cohen says, "the major influence on early institution development in the West was imitation."[325] This "imitation" included not only those who formed these institutions, but also their placement in relation to populated areas and their curricular organization. Cohen describes how the:

> Initial model included the isolated campus built away from the city and its temptations; often a preparatory school as a feeder for the college, the four-year baccalaureate degree; a curriculum centering on the liberal arts; the lay governing board; and a pattern of student residence designed as much for character formation as for instruction.[326]

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[324] Goodchild and Wrobel, "Western College Expansion," 7-8.
[325] Arthur M. Cohen, "The Evolution of Institutions in the Westward Expansion," in in *Higher Education in the American West: Regional History and State Contexts*, Lester F. Goodchild, Richard W. Jonsen, Patty Limerick, and David A. Longanecker, eds. (New York: Palgrave Macmillan, 2014), 39.
[326] Cohen, "The Evolution of Institutions in the Westward Expansion," 39.

States and territories in the American West replicated this model over and over as new institutions of higher education grew with migration and settlement practices. These practices, which dramatically increased the Euro-American population in the western region also coincided with the steady expansion of years of schooling for most of the population throughout the country. This expansion made it necessary for the college campus to initially have preparatory programs until independent public high schools were able to fill the gap between elementary and college education. The increasing population and expanding educational system, along with boosterism and religious organization, especially the various sects of Protestants, who each wished to have their own colleges to "perpetuate the faith by passing on its tenets through education" gave the impetus for the founding of more institutions of higher education in the American West.[327] Of most importance to this study is the state of Montana and its history of higher education and an unlikely supporter, a "Copper King" named William A. Clark.

William A. Clark and the American West

During the latter half of the nineteenth century, mining and its associated industries developed in the western states and territories. In 1863, the Montana territory became the location of the latest "gold rush."[328] Thousands of miners traveled to the Montana territory and set up claims. William A. Clark was one such miner, who influenced the direction of industry, politics, and education in Montana.

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[327] Cohen, "The Evolution of Institutions in the Westward Expansion," 40.
[328] Merrill G. Burlingame, *Montana State College, 1893-1919: A Preliminary Sketch* (Bozeman, MT: Montana State College, 1943) 1.

Born in Pennsylvania in 1839, William Andrews Clark attended public school until age 14 and then went to an academy. In 1856, he moved to Iowa with his parents and worked on a farm. In Iowa, he attended Iowa Wesleyan College, taught school, and studied law. In 1862, he moved west as he drove a team across the plains to Colorado, where he worked in the mines one winter. The following year, he drove an ox-team to Bannack, where he arrived on July 7. After his arrival, Clark worked a placer claim.[329]

By winter of 1863, Clark had $1000 and decided to expand his business ventures beyond mining. Clark bought a mule-team and transported merchandise to Bannack from Salt Lake City, which he sold for a large profit. The following year, he returned to his placer mine in the summer months, but continued his trading business by going to Boise, buying tobacco, and selling to miners at a considerable profit. At this point, Clark's business moved to trade only.[330]

As Clark's trading business expanded, he added a mail contract and a wholesale mercantile business. Clark also developed business connections with men in New York, including forming a partnership with R. W. Donnell and S. E. Larabie. Deer Lodge became the headquarters of this business, where these men had their own private bank. In 1872, the bank received a charter to become a national bank, but in 1878, it reverted to a private one. Additionally, in the early 1870s Clark began to invest in nearby mines. During this time, he also used his connections to receive positions of public recognition, including his appointment as the Montana orator at the Centennial Exposition at

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[329] James McClellan Hamilton, *History of Montana: From Wilderness to Statehood* (Portland, OR: Binfords & Mort, 1970), 270.
[330] Hamilton, *History of Montana*, 270.

Philadelphia. He was also a grandmaster of the Montana Masons in 1877 and both a member and chairman of the constitutional conventions assembled in Helena in 1884 and 1889, which wrote Montana's Constitution.[331]

In 1872, Clark enrolled in Columbia School of Mines, in New York. While enrolled, he studied metallurgy and assaying to help him with his new mining interests.[332] When he returned to Montana, it still did not have an institution of higher education. The call for higher education took many years to become a reality. In 1868, the Acting Territorial Governor James Tufts recommended the incorporation of the University of Montana but recognized that it might take years to create. He also thought that the acceptance of gifts or endowments for higher education needed to occur in the Montana Territory.[333] In 1881, the Montana Territorial Congress "granted to each state and territory seventy-two sections of land as endowment for a university."[334] However, the Montana Territorial Congress took no steps to use the endowment. Later, during the 16th Legislative Assembly Governor Preston Leslie pushed for the establishment of an agricultural and mechanical arts college under the provision of the Morrill Act of 1862. He suggested using the abandoned Fort Ellis, outside of Bozeman, for this institution; however, the legislature did not take any action on this recommendation.

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[331] Hamilton, *History of Montana,* 271.
[332] Richard H. Peterson, "William Andrews Clark," *American National Biography, Volume 4*, eds. John A. Garraty and Mark C. Carnes (New York: Oxford University Press, 1999), 955.
[333] Hamilton, *History of Montana,* 502.
[334] Hamilton, *History of Montana,* 502.

In 1878, the citizens of Deer Lodge took it upon themselves to create the first institution of higher education in Montana. As vice-president of the newly created board of trustees, William A. Clark helped fund and direct this institution. Originally named the Montana Collegiate Institute, due to financial hardships and the eventual takeover by the Montana Presbytery, in 1883 the name changed to the College of Montana.[335] Under the direction of new president, Reverend D. J. McMillan, the College of Montana offered a two-year preparatory program and four-year scientific and classical courses.[336] The College provided the youth of the Montana territory an opportunity to obtain a higher education in five departments: The Academy, The College, The School of Mines, The Conservatory of Music and Art, and Stenography and Typewriting.[337] McMillan's presidency lasted until 1889, but during his tenure, he was responsible for bringing the scientific and engineering world of Columbia to Montana, along with the help of a former student from Columbia, Clark.

In the mid-1880s, the mining and smelting industries in Montana controlled much of the economic and political climate of the territory. Up to this point, according to Kathleen Ochs, all along the "American mining frontiers, individual miners and small groups using relatively simple mining techniques (pans, rockers, sluices) quickly gave

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[335] Burlingame, *History*, 2; and Burlingame, *Montana*, 2.
[336] *First Annual Catalogue of The College of Montana, Deer Lodge, Montana: For the Academic Year, 1883-1884. (*Deer Lodge, MT: The New North-West, 1884), 4, 9-11.
[337] William M Cobleigh to Rev. William and Julia Cobleigh, 26 June 1891. William Merriam Cobleigh Papers, 1891-1929, Collection 2124:1, fol. 1, Montana State University Archives (hereafter cited as Cobleigh MSS).

way to groups using more capital-intensive methods."[338] During this initial wave of industrialization, "college-educated mining engineers gradually took over control of production, automated tools were introduced, and business organization began to change."[339] This was the case in Montana where many mining and smelting executives decided that Montana needed to offer more education and training for these fields, specifically in mining engineering and metallurgy. Clark and other leaders of these industries supplied a generous sum of money to the College of Montana for the purchase of scientific and mining equipment, as well as for the salaries of new faculty. Through this financing, Frank W. Traphagen first arrived in 1887 after spending his time after Columbia teaching in Virginia.[340] Traphagen acquired a position teaching chemistry and metallurgy in The School of Mines at the College of Montana. He was instrumental in recruiting Augustus M. Ryon to Montana as a professor of engineering, who worked as a mining and city engineer in New York after graduating from Columbia School of Mines in 1886.[341] Together they formed the first School of Mines in Montana in 1888 and became pioneers in their fields of education in the state.

In his address dedicating the A. M. Ryon Laboratories on October 27, 1939, William M. Cobleigh described the origins and continual evolution of engineering education and practices in Montana directly influenced by Montana State College and its faculty. In the address, Cobleigh related the origins of engineering education in Montana,

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[338] Kathleen H. Ochs, "The Rise of American Mining Engineers: A Case Study of the Colorado School of Mines." *Technology and Culture 33*, no. 2 (1992): 279.
[339] Ochs, "American Mining Engineers," 282.
[340] Hamilton, *History of Montana,* 504.
[341] Cobleigh, "51".

which began at the College of Montana with Ryon and Traphagen. Traphagen and Ryon grew up in New York together and were boyhood friends. Although older than Ryon, Traphagen remembered his friend when a vacancy occurred at the College of Montana and helped his fellow Columbia graduate get the job. In 1893, when Ryon accepted the Presidency of Montana Agricultural College, the College of Montana replaced him with E. H. McDonald, a graduate of the Michigan College of Mines, who went on to be the chief geologists for Northern Pacific in Billings. When Traphagen followed Ryon to Bozeman, the College of Montana replaced him with a Mr. King, who graduated from Case School of Applied Science. When the Montana School of Mines in Butte opened in the late 1890s, it added both McDonald and King into its first faculty.[342]

In Montana, Traphagen and Ryon transplanted the curriculum and practices of Columbia into their newly developed School of Mines. In 1889, Traphagen wrote to Columbia describing the recently created School of Mines at the College of Montana. Traphagen stated, "The object of the school is to fill a place which we believe is not occupied by any western institution."[343] He goes on to say that, he and Ryon modeled their School of Mines after Columbia as they "aim to copy it as far as practicable."[344] In essence, in a report to the Montana Association of Civil Engineers in January 1893, Ryon stated, "in point of ability we find that our average students differs but little from those found in eastern institutions, but owing to our small classes we are able to give them

[342] Cobleigh, "51".
[343] F.W. Traphagen, "The Montana School of Mines." *The School of Mines Quarterly, A Journal of Applied Science XI,* no. 1 (1889): 40.
[344] Traphagen, "Montana," 40.

more personal attention than is possible in the case of larger institutions so that the quality of work done will compare favorably with that of any of the engineering institutions."[345] However, there were some differences between the two schools of mines.

In particular, while Columbia offered several courses related to engineering, Montana only offered mining engineering.[346] Traphagen also pointed out that his school has "special advantages for field-work in surveying," for their proximity to large fields meant that the students "lose no time in getting to our work."[347] He also noted that the school was in the "midst of a mining district, and can give our men practice in mine location, mineral surveying, etc." and that their "nearness to the large mines of the territory give us very great advantage for teaching practical mining, timbering, etc."[348] Traphagen also provided a list of mining sites near the campus, including being able to see "the smoke from the smelters at Anaconda, and can readily reach the Pioneer placers, the silver-lead furnaces at Glendale, the copper plant of the Parrot Company, and the many silver mills in Butte and on every side of us."[349] Therefore, the location of the School of Mines at the College of Montana necessitated a more practical education focus than the curriculum of Columbia, which was more theoretical with a focus on practical education relegated to the summer field schools. Columbia like other engineering

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[345] Montana Society of Engineers Records, 1887-1975. "Technical Education in Montana." Montana State University Archives, 5. Later, Ryon states that he and the other instructors keep samples of work for anyone who liked to inspect them.
[346] *Sixth Annual Catalogue of the College of Montana, Deer Lodge, Montana: For the Academic Year, 1888-9.* (Butte City, MT: Inter Mountain Publishing Company, 1889), 23.
[347] Traphagen, "Montana," 40.
[348] Traphagen, "Montana," 40.
[349] Traphagen, "Montana," 40.

colleges developed in eastern states, excelled in theoretical training, which included a strong mathematical and science-based curriculum echoed, in part, from schools found in Europe.[350] Schools in the West, like the one in Montana, excelled in practical education owing to their proximity to the unique geographical resources and population conditions of the region. Furthermore, many of these western schools functioned to meet the demands of local mining industries, which was Clark's intention. Additionally, the Montana School of Mines, unlike Columbia, provided specific dedication to the mineral sources of one region.[351] During their tenures at the College of Montana, their "high-grade school of mines" received praise from the mining industry.[352] However, within a decade these instructors and the bulk of the school of mines program moved to different institutions – the Montana School of Mines in Butte and the Montana Agriculture College, which became Montana State University.

Before Traphagen, Ryon, and the School of Mines moved, these two men instructed another important man of science and engineering education in Montana, William M. Cobleigh. In 1891, Cobleigh, who was instrumental in continuing science and engineering education in Montana through the 1940s, enrolled as a student at the College of Montana and studied under Ryon and Traphagen.[353] Cobleigh boasted that at

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[350] Timothy J. LeCain, "Moving Mountains: Technology and the Environment in Western Copper Mining." (Ph.D. diss. University of Delaware, 1998), 127-206.
[351] LeCain, "Moving Mountains," 152.
[352] Hamilton, *History of Montana*, 504.
[353] In discussing science and engineering education, it is important to note the evolution of these two fields in the nineteenth and early twentieth centuries. As was discussed in chapters 1 and 2, theoretical approaches to these fields dominated the curricula that began to add in practical approaches in the latter half of the nineteenth century. In western schools like those in Montana, theoretical approaches still held sway over the curricula,

the time of his enrollment, the College of Montana had "Thirteen Professors and Teachers."[354] After his graduation from the College of Montana, Cobleigh followed his mentors to another institution.

Through William A. Clark, the Columbia School of Mines made it to Montana and supplied a way for locals to experience new ways of understanding the mines and the mining industry that drove much of the economy in Montana. Through the work of Traphagen and Ryon, we see how much the Montana School of Mines resembled Columbia. However, due to its proximity to the mines, the Montana School offered experiences that were more practical for its students. When this school migrated again, this time to Butte, the new metropole of industrialized science and engineering found a permanent home.

Montana State University, The Early Years.

Although William A. Clark's involvement in education and the School of Mines model seems to dissipate after his first influence in the 1880s, his own political and mining career supplied the means for economic development and influenced educational interests. In time, the second model – the Land Grant College – came to Montana. Montana State University's story began on February 16, 1893, when Montana Governor John E. Rickards signed a bill setting up Bozeman as the location of the Agricultural

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but science faculty and their students routinely invested time into practical approaches in mining, agriculture, and other scientifically related fields.

[354] William M. Cobleigh to Rev. William and Julia Cobleigh, 19 April 1891. Cobleigh MSS.

College of the State of Montana.[355] The land-grant school also supplied a more reliable career outlook for many collegiate instructors. Over the next week, Governor Rickards and the legislative assembly chartered the School of Mines at Butte, the University at Missoula, and the Normal College at Dillon.[356]After the signature came the daunting task of executing the provisions in the bill and meeting the expectations of the Morrill Act.

As discussed earlier, the College Land Grant Act, better known as the Morrill Act of 1862, created the opportunity for each state to establish and support at least one college of agriculture and mechanical arts, or engineering.[357] Through the selling of public lands, states developed colleges meant not for the elite but for average citizens.[358] Additionally, the course work of this college focused on practical studies. In these agricultural colleges, farmers "could learn the capability of soils and the benefits of various fertilizers, which grasses produced the best livestock and the most milk, deep plowing and drainage methods, remedies for crop diseases, and how to control

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[355] Burlingame, *History*, 1; Burlingame, *Montana*, 11; Robert Rydell, Jeffrey Safford, and Pierce Mullen, *In the People's Interest: A Centennial History of Montana State University* (Bozeman, MT: Montana State University Foundation, 1992), 9.
[356] Rydell, Safford, and Mullen, *People's*, 1. A Normal College refers to an institution that primarily focused on training teachers in pedagogy and education.
[357] Coy F. Cross II, *Justin Smith Morrill: Father of the Land-Grant Colleges*. (East Lansing, MI: Michigan State University Press, 1999), 83-86; Scott Key, "Economics or Education: The Establishment of American Land-Grant Universities." *The Journal of Higher Education 67*, no. 2 (1996): 198; "Morrill Act of 1862." *Morrill Act Of 1862* (January 7, 2009): 1. *Academic Search Complete*, EBSCO*host* (accessed March 27, 2014). http://search.ebscohost.com.proxybz.lib.montana.edu/login.aspx?direct=tru&db=a9h&AN=21213196&login.asp&site=ehost-live; Allan Nevis, *The Origins of the Land=Grant Colleges and State Universities: A Brief Account of the Morrill Act of 1862 and Its Results*. (Washington, D.C.: Civil War Centennial Commission, 1962), 1; and Veysey, *Emergence*, 15.
[358] Key, "Economics or Education," 198.

insects."[359] These new schools also provided the opportunity for engineering studies, the mechanical arts, including a growing interest in mining engineering and metallurgy.[360] The Second Land Grant Act of 1890 mandated that instruction must begin by July 1, 1893, or the state forfeited $33,000 in funds.[361] As part of this act, there was an added emphasis on agriculture with agricultural experiment stations being integral to the new school's focus. Additionally, the state outlined that the designation of a school site must occur within ninety days of the bill's passing.[362] The national economic crisis of 1893 only further hampered this process, as the state refused to appropriate funds for operating and building costs.

To meet the deadlines and form the college, Governor Rickards appointed the college's governing body, known as the Local Executive Board of Education.[363] This board had complete control of the college and answered only to the State Board of Education. The appointed members of the local board included Bozeman citizens Walter Cooper, Peter Koch, and Lester S. Willson, as well as Livingston banker E. H. Talcott and Manhattan malting executive George Kinkel, Jr. An advisory committee aided the

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[359] Cross, *Morrill*, 81.
[360] LeCain, "Moving Mountains," 149; Read, Thomas Thornton. *The Development of Mineral Industry Education in the United States* (New York: The American Institute of Mining and Metallurgical Engineers, 1941), 32.
[361] Rydell, Safford, and Mullen, *People's*, 9.
[362] Rydell, Safford, and Mullen, *People's*, 9.
[363] Burlingame, *History*, 9; Burlingame, *Montana*, 12-13; and Rydell, Safford, and Mullen, *People's*, 9.

board. This committee consisted of Nelson Story of Bozeman, Henry J. Haskell of Dawson County, and Robert G. Young of Butte.[364]

On March 28, 1893, the board met for the first time and elected its first officers. They chose Willson as the President, Kinkel as Vice President, and Koch as Secretary.[365] By the end of June, Koch also became the Treasurer.[366] The board also determined that they organized a school that ran for three months, beginning on April 17, 1893. The board appointed Professor Luther Foster as its first instructor and asked him to organize the school that admitted no pupil under the age of fourteen years.[367] The members of the Local Executive Board also received permission from the local public school board to rent rooms for three months in what became the Bozeman Academy, which was critical since they were not able to purchase any land or construct a building with the Land Grant Act monies. Before this meeting, the board selected a 40-acre plot south of Bozeman as an ideal location for the college. Originally chosen as a location of the capital, the plot resided next to the 160-acre poor farm. With time running short and minimal funds available due to the current economic crisis, Nelson Story bought the lands for $1,500 and donated it to the college.[368]

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[364] Burlingame, *History*, 9; Burlingame, *Montana*, 12-13; and Rydell, Safford, and Mullen, *People's*, 9.
[365] Minutes of the Montana State University Local Executive Board, 28 March 1893. Montana State University Local Executive Board Minutes, 1893-1970, Acc. 87032, Box 1, Vol. 1, Montana State University Archives (hereafter cited as Minutes, Executive Board).
[366] Minutes, 28 March 1893, Executive Board.
[367]Minutes, 18 June 1893, Executive Board.
[368] Rydell, Safford, and Mullen, *People's*, 9-11.

In March of 1893, the Local Executive Board selected the first faculty of the new college. In science and engineering, the board hired two faculty members from the College of Montana.[369] Augustus M. Ryon became the professor of mineralogy and mining engineering and Frank W. Traphagen became the professor of chemistry and natural science. As stated earlier, both men were graduates of Columbia College and the Columbia School of Mines. The Board also hired R. E. Chandler, a graduate of Stevens Institute of Technology, to teach mechanical engineering and mathematics.[370] At the Local Executive Board's second meeting, on April 4, 1893, they unanimously offered the presidency of the college to Ryon.[371]

Under the guidance of Ryon and Traphagen, Montana Agricultural College developed a strong engineering and mining curriculum. The early catalogues listed the official name of the school as the Montana College of Agriculture and Mechanic Arts, noting the importance of engineering practices within the school's overall focus.[372]

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[369] Burlingame, *History*, 15-16; Burlingame, *Montana*, 15-16; Minutes, 4 April and 18 June 1893, Executive Board; and Rydell, Safford, and Mullen, *People's,* 11.
[370] Burlingame, *History*, 15-16; Burlingame, *Montana*, 15-16; Minutes, 4 April and 18 June 1893, Executive Board; and Rydell, Safford, and Mullen, *People's,* 12.
[371] Minutes, 4 April and 18 June 1893, Executive Board.
[372] *First Annual Catalogue of the Montana College of Agriculture and Mechanic Arts, Bozeman, Montana: For the Academic Year 1893-94* (Bozeman, MT: The Avant Courier, 1893), 1; *Second Annual Catalogue of the Montana College of Agriculture and Mechanic Arts, Bozeman Montana: For the Academic Year 1894-95.* Bozeman, MT: Chronicle 1894), 1; *Third Annual Catalogue of the Montana College of Agriculture and Mechanic Arts, Bozeman Montana: For the Academic Year 1894-95 and Announcements for 1895-96* (Bozeman, MT: Chronicle Print, 1895), 1; *Fourth Annual Catalogue of the Montana College of Agriculture and Mechanic Arts, Bozeman Montana: For the Academic Year 1895-96 and Announcements for 1896-97* (Helena, MT: State Publishing Company, State Printers and Binders, 1896), 1; *Fifth Annual Catalogue Montana College of Agriculture and Mechanic Arts, Bozeman Montana: For the Academic Year 1896=97 and Announcements for 1897=98* (Bozeman, MT: Bozeman Chronicle, 1897), 1; *Sixth*

Although Traphagen and Ryon were unable to offer the many specialized courses dedicated to science and engineering that they took at Columbia due to lack of the amount of specialized equipment and staff, they were able to provide rigorous and practical generalized courses.[373]

Annual Catalogue Montana College of Agriculture and Mechanic Arts, Bozeman Montana: For the Academic Year 1897=98 and Announcements for 1898=99 (Bozeman, MT: Bozeman Chronicle, 1898), 1; *Seventh Annual Catalog Montana College of Agriculture and Mechanic Arts, Bozeman Montana: For the Academic Year 1898=99 and Announcements for 1899=1900* (Bozeman, MT: Bozeman Chronicle, 1899), 1; *Eighth Annual Catalog Montana College of Agriculture and Mechanic Arts, Bozeman Montana: For the Academic Year 1899=1900 and Announcements for 1900=1901* (Bozeman, MT: Bozeman Chronicle, 1900), 1; *Ninth Annual Catalog Montana College of Agriculture and Mechanic Arts, Bozeman Montana: For the Academic Year 1900-1901 and Announcements for 1901-1902* (Bozeman, MT: Bozeman Chronicle, 1901), 1; *Tenth Annual Catalog Montana College of Agriculture and Mechanic Arts, Bozeman Montana: For the Academic Year 1901-1902 and Announcements for 1902-1903* (Bozeman, MT: Bozeman Chronicle, 1902), 1; and *Eleventh Annual Catalog Montana College of Agriculture and Mechanic Arts, Bozeman Montana: For the Academic Year 1902-1903 and Announcements for 1903-1904* (Bozeman, MT: Bozeman Chronicle, 1903), 1.

[373] See the *First Annual Catalogue of the Montana College of Agriculture and Mechanical Arts, 1893-1894*, 12-14, in which is listed all the administration and faculty and their duties, along with detailed descriptions of the courses that MAC taught. The Catalogue outlined three courses: Agriculture, Domestic Economy, and Applied Science. The Course in Applied Science lasted four years and consisted of "Class-Room Studies" and "Practical Work." For admission to this course, a student had to have a "thorough knowledge of Arithmetic, Algebra, Geometry, Elementary Chemistry and Physics, United States History and English Grammar." The school made a conditional requirement if an admitted student was not proficient in one or more of these courses: in order to move on to the second year, the student had to pass an exam in the deficient subject. From the 1895-96 to the 1903-1904 school years, the science and engineering programs became more specialized, adding a focus in Chemistry (Analytical), General Science, Biology, Botany, Physics, Zoology, Mechanical Engineering, Electrical Engineering and Civil Engineering, see *Fourth Annual*, 18-19, 22-25; *Fifth Annual*, 21-24, 47-50, 59-62, 70-71; *Sixth Annual*, 20-23, 54-57, 68-71, 79-80; *Seventh Annual*, 21-24, 44-46, 51-53, 63-66, 74-75; *Eighth Annual*, 23-26, 46-48, 53-56, 70-71, 82-83, 88-89; *Ninth Annual*, 24-26, 48-50, 55-58, 72-76, 84-85, 90-91; *Tenth Annual*, 23-27, 55-59, 67-68, 73-74; and *Eleventh Annual*, 26-29, 60-64, 72-73, 78-79.

As president, Ryon viewed the college as the training ground for expert engineers. Historians Robert Rydell, Jeffrey Safford, and Pierce Mullen suggest that Ryon hoped to align "the future of the state with the future of engineering."[374] This view led Ryon and his faculty to develop a solid curriculum that focused on engineering, especially mining engineering. Ryon's work helped lead the way for the school to begin to focus on irrigation engineering in 1895.[375] On June 7, 1897, Montana Agricultural College designated $2,500 for apparatus for electrical engineering, thus beginning the electrical engineering program.[376] In December of that same year, the college asked the State Board of Education for an additional $1,200 a year for an assistant in the engineering department.[377] This appointment allowed the school to develop specialized courses in engineering. Six years after its establishment, in June of 1899, the College graduated its first students with a Bachelor of Sciences in Mechanical Engineering.[378] During this time, Traphagen and the other science professors and instructors continued to expand the sciences as well. Examples of this were in the inclusion of chemistry (analytical), general science, biology, botany, physics, and zoology.[379]

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[374] Rydell, Safford, and Mullen, *People's*, 13
[375] Cobleigh, "51".
[376] Merrill G. Burlingame. "Early Catalog Notes", Annual MSC Course Catalog, Merrill G. Burlingame Research Files on MSU History, 1895-1968. Accession 84014, Box 1:14, Montana State University Archive (hereafter cited as Burlingame, "Early").
[377] Burlingame, "Early".
[378] Cobleigh, "51".
[379] *Fourth Annual*, 18-19, 22-25; *Fifth Annual*, 21-24, 47-50, 59-62, 70-71; *Sixth Annual*, 20-23, 54-57, 68-71, 79-80; *Seventh Annual*, 21-24, 44-46, 51-53, 63-66, 74-75; *Eighth Annual*, 23-26, 46-48, 53-56, 70-71, 82-83, 88-89; *Ninth Annual*, 24-26, 48-50, 55-58, 72-76, 84-85, 90-91; *Tenth Annual*, 23-27, 55-59, 67-68, 73-74; and *Eleventh Annual*, 26-29, 60-64, 72-73, 78-79.

By 1894, Ryon resigned as President, which passed to another College of Montana faculty member, James Reid.[380] Reid presided over the college from 1894 to 1904 and saw the school develop into a more robust college. Upon his resignation in 1904, the college housed 356 students and boasted a faculty of 32.[381] The curriculum of the school showed this growth as well. In 1904, there existed a four-year course in civil engineering.[382] Additionally, the college further specialized biology into zoology and botany.[383] Although Ryon resigned his position, he retained his professorship, but within three years, he lost this position as well.[384] His replacement and a growing number of science professors came to Montana from eastern schools like Harvard, M.I.T., and the Stevens Institute of Technology.[385] A few of the engineering faculty also came from other land-grant schools in Wisconsin and Kansas.[386] These professors continued the westward migration of science and engineering into Montana.

In ten years, Montana Agriculture College grew from an idea on paper to a thriving institution of higher education. By 1904, the last remnants of the original faculty exited the college for other duties.[387] The last to do so was Frank W. Traphagen, who in

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[380] Burlingame, *History*, 24, 29-30; Burlingame, *Montana*, 23-25; Minutes, 31 May 1894, Executive Board; and Rydell, Safford, and Mullen, *People's*, 14.
[381] Rydell, Safford, and Mullen, *People's,* 21.
[382] *Eleventh Annual*, 78-79.
[383] *Eleventh Annual*, 26-29.
[384] Rydell, Safford, and Mullen, *People's,* 19-20. His initial resignation and eventual leave from the school is directly related to souring relationships with the Local Executive Board. Ryon appears to have made an enemy out of Koch during his year as President, due, in part, to a disagreement in the direction of the school and role of engineering.
[385] *Sixth Annual*, 5.
[386] *Sixth Annual*, 5.
[387] *Eleventh Annual*, 6.

1904 moved his family from Bozeman to Denver, as he became the Professor of Chemistry of the Colorado School of Mines in Golden, a short distance outside Denver.[388] In 1918, Traphagen made his way to Rapid City, SD, to teach at the South Dakota School of Mines, only to return to the Colorado School of Mines a few years later.[389] By 1940, Traphagen, then a retired professor, lived with his daughter Gertrude in Chicago until his death in 1941.[390]

After his resignation from Montana Agriculture College, Augustus M. Ryon made his way back to New York.[391] Ryon then went on to work in the coal business in Flushing, NY, until his death in 1949.[392] Before his death, Ryon visited the college that he helped create as they honored him with the dedication of the physics laboratories in his name. His former student and colleague, William M. Cobleigh, presided over the event.[393]

In 1898, two men affiliated with Montana Agricultural College, decided to reverse the western migration, and enrolled in Columbia University – William M. Cobleigh and Montana Agricultural College graduate Reno H. Sales. At Columbia, both men studied and earned their master's degree. Sales returned to Montana and worked

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[388] "Dr. Frank W. Traphagen: Chemist and Metallurgist, Once a Teacher, Dies in Chicago," *New York Times*, January 22, 1941.
[389] "Dr. Frank W. Traphagen"
[390] "Dr. Frank W. Traphagen"
[391] Rydell, Safford, and Mullen, *People's*, 13-20.
[392] "Augustus M. Ryon, Educator, 87, Dies: Found of the School of Mines at Montana College in 1888 Was Queens Coal Dealer," *New York Times*, June 10, 1949.
[393] Cobleigh, "51".

with the Anaconda Mining Company in Butte, which led to a successful career in the mining industry and his inclusion in the "Mining Hall of Fame."[394]

William Cobleigh was not a member of the first faculty at Montana Agriculture College, but he arrived in 1894 when Reid accepted the vacated presidency.[395] After graduating from the College of Montana in 1894, Cobleigh accepted the position of instructor of physics and chemistry. He was also the assistant of Traphagen, whom he studied under at the College of Montana.[396] Cobleigh eventually travelled east and earned his master's degree from Columbia University. He also studied at Harvard, the University of Chicago, and the Massachusetts Institute of Technology. He distinguished himself by his induction into the American Academy of Sciences.[397] He also earned the position of head of the chemistry department and Dean of Engineering at what is now Montana State University. During the first years of World War II, he served as the interim president, until Dr. R. R. Renne accepted the presidency in 1943. Cobleigh died in 1951, almost ten years to the day after his former instructor and colleague Frank W. Traphagen.[398]

During his tenure at Columbia University, Cobleigh wrote a letter to the students of Montana Agriculture College (MAC).[399] The purpose of this letter was to compare

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[394] "Mining Hall of Fame Inductees Database: Sales, Reno H.," National Mining Hall of Fame and Museum, Last modified December 16, 2004. http://www.mininghalloffame.org/inductee.asp?i=61&b=inductees.asp&t=n&p=S&s=
[395] Rydell, Safford, and Mullen, *People's*, 39.
[396] Rydell, Safford, and Mullen, *People's*, 29.
[397] Rydell, Safford, and Mullen, *People's*, 29.
[398] "William Cobleigh Dies last Night of Heart Attack," *Bozeman Chronicle*, January 16, 1951.
[399] Cobleigh, "Comparison of Columbia and MAC, 1900," Cobleigh MSS, 2124, Box 2, fol. 11

Columbia University and MAC in 1900. This letter described the differences in weather, school size, location, and facilities. In his comparison of the science courses, he said that, "It will not be the detriment of your college then, to say that Columbia offers more advantages in organic, industrial, & physical chemistry. I shall have to claim equality in the analytical sides of the subject from every standpoint via equipment, conveniences in the laboratory and methods of instruction."[400] He later encouraged students at Montana Agricultural College to attend Columbia when they graduate, concluding, "the experience will be beneficial. You can learn something here even after obtaining your B.S. from [MAC]."[401] In this letter, he was trying to sell the idea that the education received in Montana was like that which was experienced at Columbia, but in chemistry, Columbia had the edge. He was also imploring these western students to seek out graduate educational experiences, which Montana was unable to offer due to population, funding, and need. This letter was, in a way, similar to James M. Hart's 1874 book discussing the experiences of an education at Göttingen.[402] Both Cobleigh and Hart act as examples for their fellow students, Hart for those interested in advanced forms of education not available in the United States at the time, and Cobleigh for those Montana and western students not able to gain an advanced form of education in the West.

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[400] Cobleigh, "Comparison of Columbia and MAC, 1900," 12 and 14.
[401] Cobleigh, "Comparison of Columbia and MAC, 1900," 18.
[402] James Morgan Hart, *German Universities: A Narrative of Personal Experience, Together with Recent Statistical Information, Practical Suggestions, and a Comparison of the German, English and American Systems of Higher Education.* (New York, G. P. Putnam's Sons, 1874).

Montana Agriculture College, now Montana State University, honored each of these three scientists – Ryon, Traphagen and Cobleigh – with buildings dedicated with their names. Presently, two of these buildings still exist on campus, lasting reminders of their influence on the institution they helped to build. Though hidden from view, retrieved only through syllabi in dusty archives, these buildings also honor the distant school that first trained them and allowed them to continue their education in science and engineering. These three men brought science and engineering to Montana from New York and Columbia, and using the environmental constraints and potentials, crafted a way to learn and practice science and engineering in the American West. In doing so, they continued the work of Columbia's Frederick A. P. Barnard, decentralizing science and engineering, and furthered his dream of coeducation in higher education and in science.

Higher Education in Montana

By the 1930s, the purpose and function of higher education in Montana began to become an integral part of the social framework in the state. In his assessment of higher education in Montana, University of Montana Chancellor Melvin Brannon described education as being "intimately related to the interests of the home, in the training and development of the child."[403] So important was education and its role in Montana, that Brannon described it as the "fourth division of government" along with the executive,

[403] Melvin A. Brannon, "The Montana System Administering Higher Education," *School & Society* 35, no. 896 (February 27, 1932): 270.

judicial, and legislative.[404] In his overview of higher education in Montana, Brannon described the state of higher education in other regions of the country. According to Brannon, "Institutions are divided and multiplied and that their location and sites are determined by political expediency and not solely in relation to needs and opportunities of a long-time program of efficient and economical educational state service" which can lead to "wasteful and unnecessary duplication of work."[405] However, in his article, Brannon provided Montana as an example of how an higher education did not have to be consolidated to be effective.

The idea of a consolidated system of higher education had been discussed in Montana before the 1930s. In 1892, before Rickard signed into law the four original state supported schools, the legislature discussed the idea of a single university. Paris Gibson, founder of Great Falls, supported the idea of a single university for Montana, like the state's southern neighbor, Wyoming. Gibson pushed to get the land-grant school and all other forms of higher education to exist in Great Falls. He offered the state "a grant of land and a sizable cash endowment if it would locate a single-unit state university in his city."[406] However, prominent men in other parts of the state pushed back. The idea of the agricultural college residing in Great Falls did not make much sense, especially when Bozeman and the surrounding Gallatin Valley were the most developed lands for agriculture in the state. Further, placing the state school of mines any place other than

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[404] Brannon, "The Montana System Administering Higher Education," 270.
[405] Brannon, "The Montana System Administering Higher Education," 270.
[406] Michael Malone, Richard B. Roeder, and William L. Lang, *Montana: A History of Two Centuries*, Revised Edition (Seattle: University of Washington Press, 1991), 362.

Butte, the most active and productive mining area, seemed unreasonable. Additionally, the argument that "a decentralized system would bring higher education within easy travel of any family" proved too much for the legislature to ignore.[407] Unfortunately for Gibson, the legislature decided to turn down his idea and the thousands of dollars with it. As a result, in February 1893, Montana located the Agricultural College in Bozeman, the State University in Missoula, the Normal College in Dillon, and the School of Mines in Butte.

Over the next twenty years, the campuses grew slowly as the need for education grew and the fight for students and funding escalated.[408] In 1891, the report to the Federal Bureau of Education listed seven high schools in Montana; however, this came with a note stating the "high schools in this state were not standardized and the figures could not be regarded as dependable."[409] The apparent lack of high school level education led the campuses to develop "preparatory departments" to help students prepare for college level course work. The College of Montana had previously developed a similar system to help its own student body. According to W. F. Brewer, "about the only persons who finished high school in Montana were those who intended to go outside the state to attend college."[410] This changed in 1899, when the state legislature passed the county high

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[407] Malone, et al., *Montana*, 363.
[408] This fight for students and funding continues to plague Montana's institutions of higher education.
[409] W. F. Brewer, "Higher Education in Montana" April 9, 1946, Merrill G. Burlingame Papers, 1880-1990, Collection 2245, Box 41, Folder 6, Montana State University Archives, 2-3.
[410] Brewer, "Higher Education in Montana," 3.

school law, which led to the establishment of more standardized high schools.[411] Around the same time Brewer, a professor at Montana Agricultural College, shared his hope that at some point in time the ratio of collegiate students to sub-freshman students needed to reverse. According to Brewer, the ratio was "about seven or eight sub-freshmen students to one collegiate student."[412] In his speech to the faculty of Montana State College in 1946, Brewer related his conversation about this ratio with Peter Koch, one of the promoters and founders of the college, and James M. Hamilton, who was Superintendent of Schools at Missoula, Vice President of the State University, from 1898-1904, President of Montana State College from 1904-1919, and Dean of Men from 1919 until his death in 1940. According to Brewer, Koch replied in a patronizing tone, "Not in your time!"[413] Twenty years after this conversation, Brewer reminded Koch of this response and they "laughed together over his ineptitude" and went on to explain that "no one then dreamed of the rapid development of high school and college education in the country which had taken place up to 1913."[414] Brewer also related that Mr. Hamilton said that "when the institutions were founded in 1893, no one ever dreamed that the state would develop so extensive a demand for higher education or be willing to spend a fraction of the money then being spent for that development."[415] Both Koch and Hamilton were unable to forecast the rapid development and spread of education in Montana in its first few decades of statehood. Nor did they have "the remotest conception for the economic

[411] Brewer, "Higher Education in Montana," 3.
[412] Brewer, "Higher Education in Montana," 3.
[413] Brewer, "Higher Education in Montana," 3.
[414] Brewer, "Higher Education in Montana," 3.
[415] Brewer, "Higher Education in Montana," 4.

importance which the education institutions later assumed in the communities where they are located."[416] The purpose of these four state colleges was providing opportunities for a higher level of learning to the sons and daughters of Bozeman, Missoula, Dillon, Butte, and surrounding areas. In terms of economic interests, these institutions paled in comparison to Deer Lodge's acquisition of the state penitentiary, Helena's designation as the capital, or Miles City's securing of the State Reform School. For many, the schools, at first, were a consolation prize economically, but that changed as these institutions began to fight for students and funding before eventually becoming economic powerhouses in the twentieth and twenty-first centuries.

Around twenty years after the development of these institutions of higher education, the legislature, again, discussed the necessity of having four schools instead of a single, consolidated one. Since their development, the schools fought against each other for students, professors, and funding. Some viewed this competition between schools to be a great service to the institutions, and both its faculties and students. According to Brewer, the fact that there were English Departments in Missoula, Dillon, and Butte, as well as Bozeman, served as "a definite inducement to me to try to make my department give at least as good service to the state in our special functions as the English Departments in the other schools did with theirs."[417] This competition raised the level of teaching and provided the students with a "quality of service" necessary at this level of education.[418] Others described this period of competition as something comparable to

[416] Brewer, "Higher Education in Montana," 4.
[417] Brewer, "Higher Education in Montana," 9.
[418] Brewer, "Higher Education in Montana," 3.

guerrilla warfare, which was both expensive and wasteful.[419] This attitude led members of the legislature to consider consolidating the four schools into a single campus. The result meant closing campuses and, politically, that was detrimental, not only in 1913, but later to those who pushed for consolidation. Therefore, the legislature developed an alternative solution.

Instead of physically consolidating the four schools, the legislature focused on reducing duplications of courses and developed a single university system, comprised of each of the schools under the head of a chancellor. Dr. John H. Durston, editor of the Anaconda Standard, "devised a cosmopolitan plan for the control of institutions of higher education" based on his experiences in business and academia worldwide.[420] According to Brannon, Dr. Durston,

> Had observed that large business organizations operating plants in widely separated areas of the country, and even operating in different countries, had devised efficient coordinating agencies located in remote cities, New York, London or Paris, with the result that high efficiency and economy replaced the inefficiency and wastefulness of separated organizations.[421]

Durston then suggested the application of this model to higher education in Montana, with the creation of a central executive. This executive lived in the state capital and, under the name of Chancellor, handled the prevention of:

> Unnecessary duplications of courses of instruction in the various education institutions composing the University of Montana; to investigate carefully the needs of each of said institutions with reference of buildings, equipment and instruction; to estimate the necessary appropriations required for such

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[419] Malone, et al., *Montana*, 363.
[420] Brannon, "The Montana System Administering Higher Education," 270.
[421] Brannon, "The Montana System Administering Higher Education," 271.

> needs and to make recommendations to the legislative Assembly accordingly.[422]

The Board of Education supported this measure, but some community and institutional interests opposed the measure for fear that "outside and dictatorial control would be imposed upon the institutions composing the University of Montana."[423] In 1915, the legislature repealed the act, but Governor S. V. Stewart, who was the chairman of the state board of education, vetoed the repeal as he saw that it had merit. Then, in the same year, the state board of education appointed Dr. Edward C. Elliott as the first chancellor of the University of Montana.[424]

As chancellor, Elliot's first task was to reorganize higher education in Montana. Under the new law, each of the four institutions of higher education existed under the umbrella of the University of Montana. This reorganization retitled Missoula as the State University of the University of Montana, a wordy and unfortunate title. The other institutions kept their earlier names; however, the reorganization did affect every school's curriculum. In removing any "unnecessary duplications" programs went through a consolidation process which removed some fields from schools in favor of others.[425] For example, the State University transferred all work in engineering to Bozeman, the College of Agriculture and Mechanical Arts. Along with the transfer of work, came the

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[422] Brannon, "The Montana System Administering Higher Education," 272
[423] Brannon, "The Montana System Administering Higher Education," 272
[424] Brewer, "Higher Education in Montana," 13-14; Brannon, "The Montana System of Administering Higher Education," 272.
[425] Brannon, "The Montana System of Administering Higher Education," 271.

movement and addition of the State University's engineering faculty to Bozeman's faculty.[426]

At the same time, both established and new programs moved from the College of Agriculture and Mechanical Arts in Bozeman to the State University in Missoula. Due to the development of a large National Forest Service district office in Missoula, all forestry work moved to the State University. The advantages offered by the proximity to local experts in the National Forest Service helped to justify this move.[427] Additionally the school of pharmacy in Bozeman moved to the State University. The Board of Education had decided that if a school of medicine were to ever open in Montana, that the State University was the logical place for it. Therefore, it was also logical to place the school of pharmacy within the same institution that held the school of medicine.[428] Although, both examples have logical reasons for their movement, a simpler explanation may be that the movement was a way of balancing the two institutions in terms of the major high profile disciplines emerging at the time – engineering in one school balanced by forestry and pharmacy in the other.

As the executive officer, Elliot had to find ways to oversee each of the institutions, while keeping the structures of authority within each. Brannon described his predecessor's role as having "the policy of keeping authority and responsibility in even and judicial balance" while "administering this exceedingly interesting educational

[426] Brewer, "Higher Education in Montana," 13.
[427] Brewer, "Higher Education in Montana," 13.
[428] Brewer, "Higher Education in Montana," 13.

experiment of coordinating separated institutions into one integrated university."[429] In his six and a half years as Chancellor, Elliot found a way to coordinate economic and academic issues in the four institutions situated hundreds of miles apart. In doing so, Elliot created the University Council, which included the presidents of the four state schools, along with one or more deans from the two larger institutions.[430] Before his arrival, Montana had four separate, competing institutions, with varying approaches to budgeting and accounting, and each encroaching on the work of the other. However, when Dr. Elliot left in 1922, Montana's higher education system was a:

> Coordinated university composed of four units, with business offices thoroughly modernized and operating with budgets; with vital, experimental and enterprising faculties; with duplication of courses minimized and eliminated and with a consuming desire to give higher educational service to students and to improve steadily in all public service relations.[431]

In his stead, the Board of Education elected Dr. Melvin A. Brannon to the position of Chancellor of the University of Montana, a system he described as "unique in America" and having "no precedents to study or follow."[432]

In the early decades of the twentieth century, Montana's population blossomed because of the homestead movement, bringing people from all over the world to the

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[429] Brannon, "The Montana System of Administering Higher Education," 273.
[430] Brannon, "The Montana System of Administering Higher Education," 273.
[431] Brannon, "The Montana System of Administering Higher Education," 273.Although each school retained some crossover of general courses, such as English or Math, the degrees and programs offered by these institutions changed to reflect the desire to efficiently clear up any overlap.
[432] Brannon, "The Montana System of Administering Higher Education," 273.; Brannon "had been a member of the faculty of the University of North Dakota, President of the University of Idaho, and President of Beloit College." Brewer, "Higher Education in Montana;" 15.

eastern and northern parts of the state. This influx of people began to affect discussions about higher education across the state. Instead of consolidation, the popular topic for the previous thirty years, accessibility again became a point of discussion. As Brannon described, "It was easier in 1922 for students in northern and eastern Montana to travel to the University of Minnesota, six hundred miles to the east, than it was to reach the nearest unit of the University of Montana."[433] In an attempt to resolve these issues, the legislature offered to refund any railroad fares in excess of ten dollars.[434] Unfortunately, this often did not compensate the student for the inconvenience and time it took to travel from eastern and northern Montana to any institution of the University of Montana. As a result, under Brannon's Chancellorship, the legislature authorized the creation of two more teaching institutions of the University of Montana – the Eastern Montana Normal School at Billings and the Northern Montana College at Havre.[435]

By the end of the 1920s, the University of Montana had six units spread throughout the state; however, these were not the only institutions of higher education.

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[433] Brannon, "The Montana System of Administering Higher Education," 273.
[434] Brannon, "The Montana System of Administering Higher Education," 273.
[435] Brannon, "The Montana System of Administering Higher Education", 273, and; Malone, et al., *Montana,* 363. The Eastern Montana Normal School at Billings opened in 1927. It is now known as Montana State University – Billings. The Northern Montana College at Havre opened in 1929 and is now Montana State University – Northern. Even though homesteading was responsible for the creation of both of these institutions, by the time of their formation, homesteading the economics behind it were in decline. Additionally, Montana and the rest of the country entered an economic depression – The Great Depression – by the end of 1929. This left a heavy financial burden on the citizens of the state, who now had six institutions of higher education to fund. It is also important to note that in 1913, the legislature designated Fort Assiniboine as the site of the Northern Montana Agricultural and Manual Training School; however, funding for the school was never approved, and this designation eventually became Northern Montana College at Havre, sixteen years later.

As previously mentioned, although discussions of a public institution of higher education began in the 1860s, it was a private school, the College of Montana that was the state's first school. However, it was not the only private school to develop in Montana, but it became the first religiously affiliated institution of higher education in Montana, though not the last.

In 1889, the same year that Montana became the forty-first state in the union, Methodists in Prickly Pear Valley, north of Helena, created an educational institution. They named this new school, Montana University. This name became an issue when in 1893 the state legislature created the public university system. Therefore, in 1893, Montana University became Montana Wesleyan University, then Montana Wesleyan College. In 1898, Montana Wesleyan moved from the Prickly Pear Valley to Helena. Then, in 1923, Montana Wesleyan and the defunct College of Montana merged under the name of Intermountain Union College.[436] This was an interfaith institution, which operated in Helena until a 6.2 earthquake damaged the campus in 1935. The college found new life when it merged with Billings Polytechnic Institute in 1947 to form Rocky Mountain College in Billings, where it runs to this day and continues not only its historical affiliation with the Presbyterian and Methodist churches, but with the United Church of Christ, as well.[437]

Although Protestant churches were the first to create institutions of higher education in Montana, they were not the only faith to do so. In 1909, the Catholic Bishop

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[436] Malone, et al., *Montana*, 362.
[437] Lewis Eaton, a former president of the College of Montana, opened Billings Polytechnic Institute in 1908.

John P. Carroll opened Mount St. Charles College in Helena. This was a school for boys supported by the Diocese of Western Montana at Helena.[438] In 1932, Mount St. Charles College became Carroll College in honor of its founder. In 1946, the boys' school became coeducational.[439]

In the same year that Mount St. Charles College changed its name, the Diocese of Eastern Montana opened the Great Falls Junior College as a girls' school. In 1939, it changed its name to the College of Great Falls and became a four-year school. Additionally, it became coeducational in 1937. In time, this institution underwent several name changes, most recently changing from the University of Great Falls to the University of Providence.

By the end of 1948, Montana had six state and three private institutions of higher education. However, with the evolution of state, national, and global interests, this number drastically increased. In the coming decades, community colleges and American Indian colleges and universities developed throughout the state. Additionally, more private, and religiously affiliated schools appeared including both for- and non-profit schools. Whereas Montana was the last state (not including Hawaii and Alaska) to name a land-grant school within its borders, it now boasts eight.[440]

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[438] Malone, et al., *Montana*, 362.
[439] Malone, et al., *Montana*, 362.
[440] This is the result of the 1994 expansion of the Land Grant status to American Indian Colleges and Universities.

In sum, by the beginning of the 1920s, Ryon and Traphagen were no longer in Montana. The state had four public institutions of higher education in place, which meant finding a way to financially support each one. In 1920, with voter approval, the state used special mill levies to compensate for the heavy property tax load paid by the citizens.[441] In 1930, with six state institutions, voters renewed the one-and-a-half-mill levy from 1920, and in 1940 this increased to three and one-half mills. At the end of World War II, the federally funded GI Bill led to an influx of veterans into the university system in Montana, and elsewhere. This rapid increase in student population put financial and physical strains on Montana campuses. As a result, the 1947 legislature, referred two referenda to the people. The first raised the university levy to six mills, and the second created a five million dollar building bond. The voters approved both measures in the 1948 election.[442] As a result, all six schools were able to expand their campuses with new buildings and faculty, a departure from earlier decades of political and financial instability.

Whereas politics played a role in the placement and continuation of separate state institutions of higher education, this does not appear to be the case for the Eastern Montana Normal School. In 1925, the legislature created a commission of educational experts tasked with surveying the several cities vying for the new school. According to

[441] A mill levy is special property tax based on the assessed value of said property. One mill is equal to $1000 of assessed value.
[442] Malone, et al., *Montana*, 364. It is important to note that this levy was renewed in 1958 and again every ten years and was included in the 2018 ballot.

Brannon, this commission "investigated the educational, the economic, the social, the sanitary, the recreational, and other factors" of each of these potential locations.[443] This approach appears to have been the first of its kind in the United States, in which the state made a decision by a "strictly scientific decision on the education merits of the case."[444] In the end, this "scientific decision" of the commission placed the new school in Billings, where it resides to this day.

The apparent apolitical decision to place the new institution in Billings was a symptom of many factors that existed in the relationship amongst the people, the legislature, and the institutions themselves. The success of Dr. Durston's idea of a consolidated university system with distinct units of higher education rested on the idea of a healthy relationship between the government and the institutions of higher education. Each member of this relationship had to know its own role. For example, the legislature had to recognize that its "field of action was legislation and not administration," and unless this was understood "conflicts with university administration would unquestionably result."[445] To their credit, the subsequent legislatures in the late 1910s to early 1930s, appear to have followed this line of thought. In reinforcing his point that

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[443] Brannon, "The Montana System of Administering Higher Education", 274.
[444] Brewer, "Higher Education in Montana", 15; In his article, Brannon included a letter from Dr. John J. Tigert, then U.S. Commissioner of Education: "The step which Montana has taken to insure the establishment of a higher educational institution in allocation to secure the best results interests me very much. This is the first instance of the kind that has come to my attention. I think the State is to be congratulated on the wisdom it as shown in going about the matter in this scientific way. It has set an example which other states might well follow in establishing new institutions," Brannon, "The Montana System of Administering Higher Education", 274.
[445] Brannon, "The Montana System of Administering Higher Education," 274.

education is the fourth branch of government, Brannon wrote "there must be no conflict among the legislative, executive, judicial and educational divisions."[446] If a conflict arose and representatives of one branch invaded another, it had the potential to seriously impair the efficiency of the invaded branch.

However, Brannon was also critical of the role that institutions of higher education played in the relationship, especially in how higher education administered itself. Brannon suggested that the administering of higher education may fail if "the governing board of education did not discriminate sharply between responsibilities concerned on the one hand with financing higher educational units and on the other hand with administering expertly and effectively educational policies."[447] In terms of Montana's administering of higher education, it appears that the system was working from its establishment in 1915 to the early 1930s. The Montana state board of education balanced delegation and administration with the six units of higher education. If this had not been the case, and the state board of education did not delegate authority to trained administrative officers and students of education and research, then "mediocrity of performance and almost certain failure in higher education would result."[448]

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[446] Brannon, "The Montana System of Administering Higher Education," 274.
[447] Brannon, "The Montana System of Administering Higher Education," 274
[448] Brannon, "The Montana System of Administering Higher Education," 274. Although it appears that faculty did not have any influence on these decisions, according to Brannon, "for the success of the Montana system the state board of education has uniformly recognized the wisdom of delegating the formulation and administration of educational policies to faculties and administrative officers." Therefore, while the administrative officers appear to have a larger role in these decisions, the faculties do have a voice in directing the outcomes of these "key decisions". I also believe that that "students of education and research" is Brannon's description of faculty.

The success of the Montana system in its early years was not only due to a hands-off approach by the legislature and a system of delegation of authority to education experts by the state board of education, it was also the role of individual people. Brannon highlighted the role of both faculties and presidents of the schools in engaging with students, alumni, and citizens of communities concerning educational experiments and in the development of cooperation amongst all parties.[449] Through an executive council, comprised of the presidents and specific directors and deans from the six units, the chancellor and the executive secretary of the university, this body provided a forum for thorough discussions of budgets, educational experiments, and research. As a result, the highly competitive and political maneuvering that plagued the efficiency and effectiveness of higher education in Montana in the preceding decades and reinforced discussions of consolidation in the legislature subsided, at least for a brief time.

The Montana system did not only address efficiency, it also tried to reduce the financial burden on its students and the state's citizens. The legislature created the Montana system in 1915. During the 1915-1916 school year, the four institutions had a joint student population of 2,133 students. At the same time, the legislature appropriated an operating and maintenance budget of $520,182 of state money. Therefore, the per capita cost was $243.87. In comparison, in 1930-1931, there were 4,909 students in the six institutions. The state appropriated $1,035,000, a per capita cost of $210.83. This equates out to a savings of $33.04 per student, or "a reduction in the appropriation of state money of over 13 per cent per student in the fifteen years that the present system has

[449] Brannon, "The Montana System of Administering Higher Education," 275.

been in operation."[450] These figures become more useful when compared with university systems of other states in the region.

In 1928, and again in 1931, twelve states gave their figures on state expenditures for maintenance and material resources in higher education. These twelve states included Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, and Wyoming.[451] Of these states, only Nevada and Wyoming had a centralized, one campus university system. In the 1928 survey, Montana ranked eighth in maintenance expenditures from state revenues. According to the report, "Montana's expenditures represent 5.5 per cent. of the total for twelve states, where as she has 7 per cent. of the population and approximately 8 ½ per cent. of the resources."[452] In terms of material resources, Montana's expenditures averaged more than thirty percent less than other states. Later, in 1931, with six institutions, Montana's expenditures were 19.9 per cent lower, per capita, then the average of the twelve states.[453] This, then, suggests that the financial burden placed on students and the state is comparably less than

[450] Brannon, "The Montana System of Administering Higher Education," 275-276; Brannon goes on to qualify these figures by recognizing that the "per capita cost of education is a very unscientific and unsatisfactory unit of measurement" and "allowance for the variable purchasing power of the dollar and for the respective offerings in the departments and in professional schools during each of the collegiate years considered must have proper evaluation."

[451] These twelve states made up part of the fifteen state Western Interstate Commission of Higher Education. California, Hawaii, and Alaska are missing in these surveys, the latter two were not states at this time. As for California, it may have been excluded based on the parameters of survey focusing on the northwest Rocky Mountain states.

[452] Brannon, "The Montana System of Administering Higher Education," 276.

[453] Brannon, "The Montana System of Administering Higher Education," 276.

those of higher educational systems in regionally similar states.[454] However, this lower burden did not satisfy the entirety of the legislature, especially when the country began to reel from an economic depression.

At the height of the Great Depression, Montana legislatures, to provide their constituents with tax relief, targeted the Montana system of higher education. During the 1933 session, this body had two options: close the new institutions in Havre and Billings, or "make wholesale cuts throughout the system."[455] Now, the legislature has the responsibility to the state to adjust budgets to deal with deficits. However, the legislature dealt with the Montana system by adding a clause to the appropriations bill that forbade a salary for the chancellorship. Chancellor Brannon had the choice of continuing in his position without pay but chose to resign instead. Without a chancellor, the legislature was free to issue severe budget cuts across all the institutions, nearly ending the entire system. In his 1935 report to the State Board of Education, President Alfred Atkinson of Montana State College at Bozeman said that the college had lost 25 faculty members since 1933.[456] Similarly, the other five units of higher education had to run on minimal budgets. It was not until the 1940s that higher education in Montana saw a turnaround in finances.

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[454] Brannon does present a caveat with these statistics, stating that using per capita costs can be problematic due to institutional objectives and differences in educational accounting. However, he relies on two outside accounting and administrative experts to support his claims. For him, the state is spending considerably less on their students than many of the surrounding states, and the success of this is due to the organizational structure of the system he is the chancellor of. However, Brannon does not discuss variations in tuitions in his analysis of per capita expenditures. See Brannon, "The Montana System of Administering Higher Education," 276-277.

[455] Malone, et al., *Montana*, 364.

[456] These faculty received an aggregate pay increase of 47.2 percent in their new positions, Malone, et al., *Montana*, 364.

As the 1930s transitioned into the early 1940s and the country was pulled into World War II, the university system continued to be underfunded and lack a chancellor. In 1940, without the chancellor, Montana State College's William Brewer reported to the legislative education committees conveying the lack of unity within the university system. He implored the committees to reestablish the chancellorship, now vacant for seven years, to curb the institutional rivalries that once again were plaguing the schools.[457] The lower house of the legislature removed the clause forbidding a salary to the chancellor from the appropriations bill, soon thereafter. However, the senate restored the clause on the session's final night, thereby prohibiting the chancellorship to exist.

During the 1943 session, Governor Sam Ford championed the reinstitution of the chancellorship. This time the legislature passed the appropriation measure with funding for a chancellor.[458] The State Board of Education then selected Dr. Ernest O. Melby, President of the State University at Missoula as the new chancellor. Unfortunately for the Montana system, this only made things worse. Melby accepted the position with the stipulation that the office of the chancellor move from Helena to Missoula. Whereas the originators of the chancellorship sought to make the position impartial and place it outside the purviews of any of the state institutions of higher education, Melby centered his administration and aligned his intentions around what was best for Missoula. This led the other institutions to criticize Melby of bias.[459] In time, the legislature lost confidence in Melby for this and other reasons.

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[457] Brewer, "Higher Education in Montana," 18.
[458] Brewer, "Higher Education in Montana," 18 and Malone et al., *Montana*, 364.
[459] Brewer, "Higher Education in Montana," 18-19 and Malone et al., *Montana*, 364.

In a controversial position, Dr. Melby continued to make decisions in the best interest of the State University in Missoula. He and the State Board of Education tried to tighten their control of the six units of higher education. First, Dr. Melby pushed forward the idea of converting the Dillon campus from a teaching college into a vocational school. He then pushed to make Havre and Billings into junior colleges. In both cases, the legislature rejected these changes.[460] Within a year, Dr. Melby offered his resignation, "alleging that the office had no power to carry out its responsibilities and that the functions could just as well be performed by the President of the State University at less expense."[461] The State Board of Education accepted this resignation, restored Dr. Melby as the State University's president and appointed him as the executive officer of the State Board of Education. Unfortunately, this new position had no legal precedent and lacked a clear description of its role. Regardless, Dr. Melby and the State Board of Education put forth new policy measures that dismayed many legislators, as well as the other institutions of higher education. Dr. Melby vehemently supported this new policy, and when the legislature only supported some minor points, rejecting most of the major ones, he resigned his position. Later, the State Board of Education, now free of Dr. Melby's influence, withdrew its statement of policy.[462] The result of Dr. Melby's tenure was that the legislature passed a law, which directed the State Board of Education to employ a chancellor who was not a president of any of the units within the system.

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[460] Malone et al., *Montana*, 364.
[461] Brewer, "Higher Education in Montana," 19.
[462] Brewer, "Higher Education in Montana," 19.

In April 1946, the State Board of Education abided by this new law as it went to Minnesota to find its new chancellor, Dr. George A. Selke. Dr. Selke had been the President of St. Cloud Teacher's College and was a strong advocate of education at all levels.[463] During his tenure, the Montana system saw an increase in enrollment, due in large part to veterans using the GI Bill to help pay for school. The system also received an increase in funding with the 1948 building bond and increased mill levy.[464] However, in 1951, Dr. Selke was called back to military service in Germany, where he served as Deputy Chief of the Education and Cultural Relations Division of the Allied High Commission for Germany (HICOG).[465] After his departure, the State Board of Education abandoned the chancellorship, and within the next few decades, the organization of higher education in Montana endured several drastic changes regarding its institutions, support, and programs.

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[463] Dr. Selke was an educator, superintendent of schools and director of Elementary and High School in Minnesota before serving as President of St. Cloud Teacher's College in 1926. In 1943, Selke took a leave of absence to join the war effort and was stationed in London, Italy, and Austria. In November 1945, he was the Acting Chief of the Education and Religion Office for Land Salzburg, where worked with "Monuments Men" Capt. Charles R. Statgast and Lt. Col. Ernest T. Dewald to "facilitate the recovery and return of works of art and other cultural objects looted by the Nazis and stored within the jurisdiction of the United States Forces, Austria (USFA);" "George Albert Selke (1888-1970)," Monuments Men Foundation, Accessed April 3, 2020, https://www.monumentsmenfoundation.org/selke-maj-george-a.

[464] Malone et al., *Montana*, 364.

[465] "George Albert Selke."

Conquest, Colonization, and Continuation with Higher Education

In sum, the history of higher education in Montana is a microcosm of the history of higher education in the American West and the United States, more generally. Institutions of higher education accompanied settler groups as they conquered new lands; made them legible with maps, laws, and communities; and sought to set up organizations and institutions of life from which they left. The origins of these institutions came from either religious or civic boosterism, or in the case of Montana, first civic then religious.

With the establishment of the Collegiate Institute of Montana (College of Montana), civic boosters looked to create an institution that drew young students to Montana, in a region that was beginning to rapidly grow due to the mining industry in nearby Butte and Anaconda. William A. Clark was instrumental in setting up this school at Deer Lodge and directing aspects of its growth even after the Presbyterian church took it over. In terms of access and regionality, Clark and other industrial parties realized that it was in their best interests to create a school of mines nearby, instead of continually sending students to previously established schools in other states and on the east coast.

In a way, Clark, by bringing Traphagen and Ryon from the East, at the Columbia School of Mines, to Montana, pushed for the idea of decentralization. Through the creation of the Montana School of Mines, which mimicked Columbia, these men created a school on the periphery whose primary focus was to serve the periphery. Traphagen and Ryon taught what they learned at Columbia but focused more on the practical approaches to the curricula due to their direct access to mines and field studies that the instructors and students, nestled in New York City, might only imagine, or briefly experience in

summer sessions at Camp Columbia. In this way, the school of mines served the interests of Montana (and their eastern financial backers) by providing industries and mines with educated mining engineers experienced with Montana's geography, geology, and mines. Therefore, this school, like many schools of mines in the American West, became a site of colonization. The industries affiliated with extractive resource acquisition, developed an institution modeled after Columbia School of Mines, but centered on the importance of local knowledge and experience that comes with a decentralized educational system. Further, as discussed earlier, graduates of this and other scientific and technological programs had the option to travel to the more established schools in the East to gain higher levels of education, typically more theoretical, until similar programs developed in the peripheral schools, as was the case with William Cobleigh and Reno H. Sales, who returned to Montana with their advanced degrees.

In Montana, it is easy to see the early connections between higher education and industrial interests, but also with state and federal interests. Montana was the last state (excluding Alaska and Hawaii) to establish a land-grant school based on the Morrill Acts of 1862 and 1890. These forms of legislation married the future of higher education of the United States to both federal and state interests. In terms of federal interests, the Morrill Act was a federal decision backed with federal funding. As for state interests, the distribution and direction of each land-grant school was left to the discretion of state legislation. These utilitarian schools changed the landscape of higher education, as well as the landscape itself, with its interest in agricultural and engineering knowledge and practices.

The marriage between state/federal interests and higher education grew stronger over the years, first with the Hatch Act of 1887, which set up a research paradigm for these institutions with the creation of experimental stations. This agricultural research changed the way local and regional farmers practiced their craft. Then, in 1914, the Smith-Level Act strengthened the ties between land-grant schools and local farmers with the cooperative extension program. This program provided a vehicle for agricultural experiment station research and applications to be distributed to farmers throughout the state. In this way, these schools perpetuated the colonization efforts within these newly acquired territories and states through the development and dissemination of agricultural knowledge and practices to the western landscapes and incoming settlers, and in so doing, bolstered the college's own rosters.

This relationship between the federal government and higher education continued throughout the twentieth century, but state interests in higher education fluctuated dramatically. In Montana, legislatures once again began to question the decision of a decentralized system of higher education, the model chosen by earlier legislatures when the public college system was created. Four institutions competing against each other and other out-of-state institutions was too difficult to control and appeared to be inefficient. However, as William Brewer indicated, as had his predecessors, the competition was healthy as it challenged his own educational practices and forced him to not be complacent. But the issues of control and funding provided the incentive to change the status quo and created a new system under the direction of Edward Elliot, as chancellor.

Throughout the 1920s, this system, first under Elliot and then Melvin Brannon, appeared to be working. A system of control was in place, where the heads of each institution reported to the chancellor and the legislatures were mostly hands-off. By the 1930s, the Montana system of higher education had expanded and become a target for legislators frustrated with the amount of state monies heading its way. For these legislators, the Great Depression, as discussed earlier, gave them a way to remove the chancellor and opened the door to financially handicap the growth of the Montana system. Temporary leadership fixes (Dr. Melby) only made things worse, and it was not until the 1940s, that public higher education in Montana began to regain its footing. First, the state supplied new sources of funding. Second, the federal government, through the GI-Bill and other educational initiatives tied to scientific research and national defense, pumped new forms of funding and an increased number of students into these colleges.

By 1950, Montana's higher education system was still in a process of evolution and its schools, such as Montana State College, with its foundation in practical, utilitarian knowledge and scientific research, was poised to capitalize on geopolitical events that influenced federal, state, and industrial funding. In the process, these institutions continued to dictate the kind and direction of knowledge production and its application through established experiment stations, emerging research laboratories, the extension program, and in the education of undergraduate and graduate students. Brannon's "Fourth Division of Government" directly influenced the evolution of Montana – politically, scientifically, industrially, agriculturally, and socially.

This “Fourth Division” served as a site of colonization where settlers, industrialists, and politicians created institutions that mimicked those in the established east but were uniquely focused on the local environment. The American West served as a site of settler colonialism and through institutions of higher education like the College of Montana or the land grant school in Bozeman, shaped the local knowledge production and development in this region. These institutions borrowed from the American East but found that the West offered new challenges to these borrowed approaches. Therefore, early pioneers in higher education had to find ways to adapt what they knew to the environment in which they worked. Some, like William Cobleigh, except for some years of continuing and advanced education, stayed in the West for the entirety of his career. Others, like Traphagen moved around in the American West establishing and revising institutions of higher education. And, finally, some, like Ryon, stayed in the West for a brief time only to return to the comforts and opportunities he had left behind in the East. All three of these men helped build the idea of a higher education system in the American West that was influenced by both industrial and state interests. In terms of Montana State University, this all began with a signature of a president who never set foot in Montana, but who has a statue of his likeness outside the Student Union Building of Montana’s land-grant school — Abraham Lincoln.

CHAPTER FOUR

"BOYS, BE AMBITIOUS": JAPANESE HIGHER EDUCATION AND THE UNITED STATES

On May 18, 1973, a small crowd gathered at the Triangle Street Cemetery in Amherst, Massachusetts. Gilbert E. Mottla stood before the crowd recalling an event during the previous summer when the Women's Garden Club of Amherst and a group of Japanese officials had reported their concern about a dead umbrella tree on William Smith Clark's gravesite. The Garden Club offered to buy a replacement, and the Japanese officials offered to send a cherry tree from Japan. Unfortunately, the Plant Quarantine Division of the U.S. Department of Agriculture banned its importation. At this time, a professor at the University of Massachusetts, Dr. Colby, donated a tree, a descendant of a Japanese cherry tree Professor William Penn Brooks, one of Clark's faculty, brought to Amherst from his tenure in Japan in 1880.

Among the crowd of people were several important faculty members, city officials, and a dignitary from Japan. The Director of International Programs at the University of Massachusetts in Amherst, Dr. Barbara Burn, spoke about William Clark's mission in Japan – the establishment of what became Hokkaido University. She then related the continued relationship between their two universities, the faculty and scholar exchanges of the 1950s and 60s, and the recent exchanges with President Niwa. Dr. Burn then introduced Mr. Masao Tsukamoto, Deputy Consul General of Japan.

Mr. Tsukamoto spoke about William Clark and the impression he left on Japan. Reminding the crowd that Clark went to Japan in 1876 to be a headmaster at the Sapporo College, he recalled Clark's parting speech, "Boys, be ambitious!" According to Tsukamoto, this sentence is amongst the first taught in English classes in Japan. The message behind these words provided a model for Mr. Tsukamoto to live his life. "Should I be more ambitious in my boyhood following the teachings of Dr. Clark," he claimed, "I would have been more successful in my life."[466]

Although William Smith Clark's tenure in Japan lasted less than a year, he left an enduring impression on the educational and cultural future of the country, especially Hokkaido. Throughout the 19th century, imperial-minded Western nations had imposed their form of educational practices on African and Asian peoples. Japan, however, was different. They sought out knowledge and practices from Western nations, paid for experts to come and instruct their people, adopted and adapted this expertise, and then removed the Western experts without being physically colonized. They then used this Western knowledge and practices to set up their own empire that ended after World War II. During this time, individual American scientists, engineers, and educators made an impression on agricultural, engineering, and education practices in Japan, especially in Hokkaido, that continues to this day.

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[466] Masao Tsukamoto, "Remarks delivered by Mr. Masao Tsukamoto at tree planting ceremony, held at gravesite of President William S. Clark on May 18, 1973." Series: 1, Subseries 3, Box 3 Folder 27, William Smith Clark Papers (RG 003/1-1867). Special Collections and University Archives, University of Massachusetts Amherst Libraries. [Hereafter as: Clark Papers].

This chapter discusses the relationship between Japan and the United States and the responsibility that American educators and agricultural, scientific, and technological experts had on Japanese colonial and educational practices. Beginning with the Meiji Restoration of 1868, I will briefly note the state of Japan leading up to this political and resulting social change. Then I will highlight the role that Yukichi Fukuzawa, the Iwakura Mission, and Kiyotaka Kuroda played in the establishment of the new government and in the colonial offices of the Kaitakushi. Following the Kaitakushi, I will explain the function that American experts had in disseminating modernity through models of colonization. This will lead to a lengthy discussion about William Smith Clark and the development of Massachusetts Agricultural College. Then, I will address the purpose of education in colonization and the development and continuation of Sapporo Agricultural College under the direction of Clark and other American educators. I will conclude with a discussion of this school's evolution to an imperial college, the reestablishment of relations with the University of Massachusetts-Amherst, and the lasting effects of Clark and his statement, "Boys, Be Ambitious!"

Through educators, engineers, and government officials, this chapter will highlight the use of higher education as a tool of the state. Specifically, the college developed at Sapporo became a school of colonization as it educated young men to transform the landscape, its flora, fauna, and people into territory workable and legible to the Meiji government. We see the influence of scientific education through agricultural and engineering practice, and in the continuation of this form of education, for some students, in countries with more established universities and graduate programs.

Questions of access also play a role as Japan adopted and adapted educational practices and approaches in shaping their country and its citizenry into the twentieth century. Before the arrival of the United States in the 1850s, it is important to note that Japan had a thriving education system.[467] However, with the arrival of the United States and the resulting Western influences, educational reform drastically shaped Japan, specifically Hokkaido, for generations to come.

Meiji Restoration, Colonization, and the Iwakura Mission

In 1868, the Tokugawa Era ended with the Meiji Restoration.[468] The arrival of Commodore Matthew C. Perry and the letter from President Millard Fillmore in 1853, drastically complicated Japan's domestic and international policies.[469] The resulting political turmoil and treaties undermined the Edo *bakufu* and provided designs for future reforms.[470] Additionally, the Edo *bakufu* had long dealt with different forms of education

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[467] See R.P. Dore, *Education in Tokugawa Japan* (Ann Arbor: Center for Japanese Studies, 1984).

[468] From 1603 to 1868, the Edo *bakufu*, established by Tokugawa Ieyasu (1542-1616), controlled Japan. Tokugawa Ieyasu and his successors set up Edo as the capital of his power and systematically went about domineering all domains, See Conrad Totman, *Early Modern Japan*, (Berkeley: University of California Press, 1993) and Brett L. Walker, *A Concise History of Japan*, (Cambridge: Cambridge University Press, 2015), 124-158.

[469] "From Millard Fillmore, President of the United States of America, to His Imperial Majesty, the Emperor of Japan, November 13, 1852," Accessed February 1, 2020, http://afe.easia.columbia.edu/ps/japan/fillmore_perry_letters.pdf.

[470] See Conrad Totman, *The Collapse of the Tokugawa Bakufu, 1862-1868*, (Honolulu: The University Press of Hawaii, 1980) and H. D. Harootunian, *Toward Restoration: The Growth of Political Consciousness in Tokugawa Japan*, (Berkeley: University of California Press, 1970). For treaties, see "Amity and Commerce," entered into force July 4, 1859, *Treaty Series* 185, 362-372, https://www.loc.gov/law/help/us-treaties/bevans/b-jp-ust000009-0362.pdf. Article X of this treaty gave Japan the right "to engage in the

that rivaled the Neo-Confucian orthodoxy.[471] Among these other forms of education was an external source, referred to as "Dutch learning," which provided a more scientifically oriented perspective to life and the human body.[472] In the last decades of the Edo *bakufu*, these political, ideological, and cultural conflicts signaled a need for change, which led to the restoration of the emperor.[473]

A few months into the new government, a document, issued in the name of the young Emperor Meiji, appeared at a time when uncertainty in the direction of this government existed. *The Charter Oath (of the Meiji Restoration)* spelled out the five aims of the new government. These included:

1. Deliberative assemblies shall be widely established, and all matters decided by public discussion.
2. All classes, high and low, shall unite in vigorously carrying out the administration of affairs of state.

United States scientific, naval and military men, artizans of all kinds, and mariners to enter into its service. All purchases made for the government of Japan may be exported from the United States, and all persons engaged for its service may freely depart the United States" ("Amity and Commerce," 367), this provided an opportunity for Japan to hire American experts in the final decades of the nineteenth century.

[471] See Masao Maruyama, *Studies in the Intellectual History of Tokugawa* Japan, trans. Mikiso Hane (Tokyo: University of Tokyo Press, 1974). On Neo-Confucian orthodoxy see Herman Ooms, *Tokugawa Ideology: Early Constructs, 1570-1680*, (Ann Arbor, MI: Center for Japanese Studies University of Michigan, 1998). On merchant education see Tetsuo Najita, *Visions of Virtue in Tokugawa Japan: The Kaitokudō Merchant Academy of Osaka*, (Chicago: The University of Chicago Press, 1987).

[472] See Donald Keene, *The Japanese Discovery of Europe, 1720-1830*, (Stanford: Stanford University Press, 1969) and Genpaku Sugita, *Dawn of Western Science in Japan: Rangaku Kotohajime*, trans. Ryōzō Matsumoto (Tokyo, The Hokuseido Press, 1969).

[473] On this ideological conflict see Tetsuo Najita, *The Intellectual Foundations of Modern Japanese Politics*, (Chicago: The University of Chicago Press, 1980), Bob Tadashi Wakabayashi, *Anti-Foreignisms and Western Learning in Early-Modern Japan: The* New Theses *of 1825*, (Cambridge: Harvard University Press, 1986), and George M. Wilson, *Patriots and Redeemers in Japan: Motives in the Meiji Restoration*, (Chicago: The University of Chicago Press, 1992).

3. The common people, no less than the civil and military officials, shall each be allowed to pursue his own calling so there may be no discontent.
4. Evil customs of the past shall be broken off and everything based upon the just laws of Nature.
5. Knowledge shall be sought throughout the world so as to strengthen the foundations of imperial rule.[474]

Whereas each of these points signaled a change of direction for the Japanese government and its peoples, the fifth point is the most pertinent to this dissertation.[475] Through the fifth point, the Meiji government sent dignitaries, scholars, and students across the globe to gather information, practices, materials, and people to help them better acclimate to the modern world and to find ways to both secure and expand their boundaries.

Colonization and international diplomacy were not foreign concepts to Japan. According to Inazo Nitobe, "For some years preceding the Restoration (1868) foreign relations had been forced upon Japan; and the contact with Russian diplomacy brought vividly to mind the fact that the northern extremity of our Empire touched one end of the Czar's vast dominion."[476] The northern extremity referred to the islands north of Japan inhabited by those who many had accepted as "a barbarian folk known as the Ainu" and the islands were "a dreary waste of snow and ice, altogether unfit for inhabitation by a

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[474] "The Charter Oath (of the Meiji Restoration), 1868," accessed February 14, 2020, http://afe.easia.columbia.edu/ps/japan/charter_oath_1868.pdf.
[475] The other points of *The Charter Oath* changed traditional ideas and definitions of what it meant to Japanese. Part of these changes included the elimination of status divisions, conscription of an army, and focus on Western approaches various aspects of life. See David L. Howell, *Geographies of Identity in Nineteenth-Century Japan* (Berkeley: University of California Press, 2005) and Irokawa Daikichi, *The Culture of the Meiji Period*, trans. Marius B. Jansen (Princeton: Princeton University Press, 1985).
[476] Inazo Nitobe, *The Imperial Agricultural College of Sapporo, Japan* (Sapporo: The Imperial College of Agriculture, 1893): 1.

race of higher culture."[477] However, the government began to see the potential of the islands, for they held abundant natural resources and lacked what they considered a "civilized" human population.[478] In the words of Nitobe, the government began seeking ways to "extend its fostering care" to the lands, its flora, fauna, and people.[479] For example, historian Brett Walker analyzed the role the Tokugawa *bakufu* had in administering vaccinations to the Ainu in the years preceding the Meiji Restoration.[480] By this time, the Japanese had conquered the island, its peoples, and were setting it up as a colony. According to Howell, "After 1868 the Meiji state treated Hokkaido as a colony and implemented policies of development to ensure that the Western powers respected its claims to the island."[481] The policies reflected ideas found within *The Charter Oath* and from men like Fukuzawa.

In 1885, Fukuzawa authored an essay "Datsu-a Ron" (On Saying Good-bye to Asia) that urged his fellow countrymen to remove themselves from East Asian traditions. Beginning with an analysis of the convenience of transportation and its relationship to the

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[477] Nitobe, *The Imperial Agricultural College of Sapporo, Japan*, 1.
[478] Brett L. Walker, *The Conquest of Ainu Lands: Ecology and Culture in Japanese Expansion, 1590-1800* (Berkeley: University of California Press, 2001), provides a detailed account of Japan's early pursuits of conquering Ezo (Hokkaido) and the interactions between Japanese and Ainu peoples. Kayano Shigeru, *Our Land Was a Forest: An Ainu Memoir* trans. Kyoko Seldan and Lili Seldan (Boulder, CO: Westview Press, 1994), provides an Ainu perspective of the conquest and colonization of the Ainu peoples during and after the Meiji Era. See also David L. Howell, *Capitalism from Within: Economy, Society, and the State in Japanese Fishery* (Berkeley: University of California Press, 1995) and Richard Siddle, *Race, Resistance and the Ainu of Japan* (London: Routledge, 1996).
[479] Nitobe, *Imperial Agriculture College*, 1-2.
[480] Brett Walker, "The Early Modern Japanese State and Ainu Vaccinations: Redefining the Japanese Body Politic, 1799-1868" *Past and Present* 163 (May 1999): 121-60.
[481] Howell, *Capitalism from Within*, 19.

movement of Western civilization to the East, he stated: "If one observes carefully what is going on in today's world one knows the futility of trying to prevent the onslaught of Western civilization."[482] He continued by recounting the effects of Western civilization on the Meiji Restoration and that if the government and its people had not changed their isolationism, the result was a loss of national independence. He went on to say "public and private sectors alike, everyone in our country accepted the modern Western civilization. Not only were we able to cast aside Japan's old conventions, but we also succeeded in creating a new axle toward progress in Asia. Our basic assumptions could be summarized in two words: 'Good-bye Asia *(Datsu-a)*'."[483] In this statement, and throughout the whole essay, Fukuzawa outlined the reasons for empire creation and how this empire might deal with its nearest neighbors:

> It is better for us to leave the ranks of Asian nations and cast our lot with civilized nations of the West. As for the way of dealing with China and Korea, no special treatment is necessary just because they happen to be our neighbors. We simply follow the manner of the Westerners in knowing how to treat them. Any person who cherishes a bad friend cannot escape his bad notoriety. We simply erase from our minds our bad friends in Asia.[484]

Through empire creation, Japan followed the goals and methods of Western civilizations, which made colonizing and knowing, first Hokkaido, then other nearby territories, of utmost importance to the young Meiji government.

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[482] Yukichi Fukuzawa, "Good-bye Asia (Datsu-a), 1885" in David J. Lu, *Japan: A Documentary History, Volume II The Late Tokugawa Period to the Present* (Armonk, NY: An East Gate Book, 1997), 351.
[483] Fukuzawa, "Good-bye Asia," 352.
[484] Fukuzawa, "Good-bye Asia," 353.

The imperial government created the colonial office to develop the resources of the northern islands and defend it from any foreign power. Organized on August 16, 1869, the Kaitakushi dominated the direction of the island's resources, inhabitants, and external influences. Under the direction of Vice-Governor General Kiyotaka Kuroda, the Kaitakushi expanded the imperial government's presence in Hokkaido. Kuroda took office the summer of 1870 and soon thereafter, in a reply to the Emperor's question about colonial policy, he responded that education was the most important factor in expanding the Imperial interests in Hokkaido.[485] His pursuit of focusing on education in Hokkaido eventually led to the government sending men abroad for the preparation of the civil service and pioneering labor needed to conform Hokkaido to the wishes of the government.

In the early years of the Meiji government, political dignitaries, scholars, and students traveled abroad to set up diplomatic relations and to acquire knowledge for the empire. The most important of these missions was the Iwakura Mission (Embassy) of 1871-1873. This mission first traveled through the United States then toured several European nations before cutting the mission short due to political unrest concerning Korea.[486]

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[485] Nitobe, *Imperial Agriculture College,* 2; David Forsyth Anthony, "The Administration of Hokkaido under Kuroda Kiyotaka 1870-1882: An Early Example of Japanese-American Cooperation" (Ph.D. dissertation, Yale University, 1951), 1; Fujita, *American Pioneers and the Japanese Frontier,* x. Kuroda Kiyotaka administered the Kaitakushi until its abolishment in 1882.

[486] Kume Kunitake, *The Iwakura Embassy, 1871-1873: A True Account of the Ambassador Extraordinary & Plenipotentiary's Journey of Observation Through the United States of America and Europe, vol. I-V,* trans. Martin Collcutt (Chiba: The Japan Documents, 2002).

As the embassy traveled across the western half of the United States towards the capital, Kume Kunitake supplied a general summary of the country, its institutions, climate, and peoples. He wrote detailed accounts of daily activities from the embassy's tour of an armory in Springfield, Massachusetts to the dinners in Washington D.C. Throughout the tour of the United States, the embassy paid close attention to institutions of education and to agriculture. For example, in Oakland, California, the embassy observed several different educational institutions from elementary to higher education and military schools to those focused on the deaf and blind.[487] The embassy, especially the detachment from the Ministry of Education, took special note of practices and structures of these institutions.[488]In regards to agriculture and its education, Kume does make a note about the Morrill Land Grant Act of 1862 and its effects on the country.[489] He continued by discussing agriculture more generally and the role it played in the United States. For example:

> America possesses the prime requirements for agriculture: good climate and vast lands. No other country can compare with it in utilising the energy of people from Europe and other continents and using machines to enhance the power and accumulate an astonishing national wealth… *the sagacious men who led the country displayed a strikingly independent spirit and emphasised practical learning in the arts and sciences.*[490]

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[487] Kume Kunitake, *The Iwakura Embassy, 1871-1873: A True Account of the Ambassador Extraordinary & Plenipotentiary's Journey of Observation Through the United States of America and Europe, vol. I*, trans. Martin Collcutt (Chiba: The Japan Documents, 2002), 86-88.
[488] The members of the Education branch of the Iwakura Mission included: Tanaka Fujimaro, Nagayo Sensai, Nahajima Nagamoto, Kondo Masatsuna (Chinzō), Imamura Kazuo (Warō), and Uchimura Kimihira (Ryōzō), Kume, *The Iwakura Embassy*, 403-404.
[489] Kume, *The Iwakura Embassy*, 247-248.
[490] Kume, *The Iwakura Embassy*, 250.

Kume's attention to the "practical learning in the arts and sciences" provided a foreshadowing of what the Japanese government emphasized in the colonization of Hokkaido and other territories. Through education, especially in agriculture, Japan reshaped the land to their needs. According to Nitobe, "Japan had long since forgotten the art of breaking up new land; agricultural systems too intensive to be applied to a newly-opened country; her mining operations were too primitive to be followed on an extensive scale."[491] In order to make up for these shortcomings, and in the creation of new settlements dealing with indigenous peoples, General Kuroda set his sights on the knowledge discussed by Kume during the Iwakura Mission, and by other scholars, found within the United States.

American Influences

In the fall of 1870, General Kuroda traveled to the United States to study its colonization of the American West. However, simply borrowing the techniques and approaches the Americans used without proper guidance and training was not ideal. Therefore, General Kuroda strengthened his attention on education, and upon his return in July 1871, he reported to the government about his findings. According to Nitobe, pioneering,

> Was not confined to the opening of rivers and mountains, nor even to the augmenting of population, but that it must take cognizance of the all-important labor of fostering human talents, of training youthful minds— in one word, that the first great aim never to be lost sight of in founding a new

[491] Nitobe, *The Imperial Agricultural College*, 2.

> colony, must be to provide itself with men and women, properly equipped to become the leaders of a pioneering population.[492]

At the end of his report he asked that young women be sent abroad as well as young men to become fathers and mothers of this fledgling new colony. In total, the Kaitakushi dispatched twenty-eight students to the United States, France, and Russia, including five women in 1871.[493]

In terms of education, General Kuroda planted the seed of developing schools throughout Japan in June 1872, and under the patronage of the Kaitakushi, the school in Tokyo opened offering a general and a special course.[494] The latter focused on rudimentary forms of knowledge where the former included departments of mechanics, physics, mining, geology, architecture, surveying, chemistry, botany, zoology, and agriculture.[495] The instructors were foreign specialists. Amongst these foreign specialists who influenced Japanese education was a professor of biology, Edward Morse. His accounts in *Japan Day by Day*, offer an insight to Japanese culture and education during the late 1870s and early 1880s, including a brief trip to Hokkaido and the Sapporo Agricultural College.[496] However, the comprehensive scheme of scientific education was not carried out. Only in 1874 was agriculture added to the curriculum. As to the other

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[492] Nitobe, *The Imperial Agricultural College*, 3.
[493] Hokkaido Prefectural Government, ed. *Foreign Pioneers: A Short History of the Contribution of Foreigners to the Development of Hokkaido.* (Sapporo: Hokkaido Prefectural Government, 1968), 25.
[494] Hokkaido Prefectural Government, *Foreign Pioneers,* 25.
[495] Nitobe, *The Imperial Agricultural College of Sapporo, Japan*, 4.
[496] Edward S. Morse, *Japan Day by Day 1877, 178-79, 1882-83, vol 1 & 2* (Boston: Houghton Mifflin Company, 1917). For an account of Sapporo Agricultural College see Volume II, 8-12.

scientific fields, the pursuit of creating specific curriculum for each was never fully realized. This was in part due to the shortcomings as instructors of those men and women sent abroad, which reinforced the idea of bringing in foreign experts.

In 1872, Yukichi Fukuzawa, after several years teaching western knowledge in his school, published a brief essay – "Encouragement of Learning."[497] Before this essay, Fukuzawa had authored several books on the West; however, the essay provided the foundation for what he wrote about for the rest of his life. Like other educational thinkers, such as Frederick A. P. Barnard and Wilhelm von Humboldt, Fukuzawa was concerned about the usefulness of knowledge. Fukuzawa also addressed why he chose Western approaches over the Chinese classic education. In his *Autobiography*, he compares Occidental and Oriental education and how they develop a people's character:

> From my own observations in both Occidental and Oriental civilizations, I find that each has certain strong points and weak points bound up in its moral teachings and scientific theories. But when I compare the two in a general way as to wealth, armament, and the greatest happiness for the greatest number, I have to put the Orient below the Occident… In the education of the East, so often saturated with Confucian teaching, I find two things lacking; that is to say, a lack of studies in number and reason in material culture, and a lack of the idea of independence in spiritual culture. But in the West I think I see why their statesmen are successful in managing their national affairs, and the business people in theirs and the people generally ardent in their patriotism and happy in their family circles.[498]

Fukuzawa added to these ideas through his "Encouragement of Learning" by suggesting that the Classical Chinese education:

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[497] Yukichi Fukuzawa, "Encouragement of Learning: the first essay, 1872", appendix II in *The Autobiography of Yukichi Fukuzawa*, trans. Eiichi Kiyooka (New York: Columbia University Press, 2007).

[498] Yukichi Fukuzawa, *The Autobiography of Yukichi Fukuzawa*, trans. Eiichi Kiyooka (New York: Columbia University Press, 2007), 214-215.

> Without real use should be left to other days and one's best efforts should be given to real learning that is near to men's everyday use — for instance, the 47 letters of the alphabet, the composition of letters, bookkeeping, the abacus, and the use of scales. Advancing farther, there will be many subjects to be taken up: geography is a sort of story of and guide to Japan and all the countries of the world; natural philosophy is a study of the nature and the function of all things under the heavens; history is a detailed chronology and studies the conditions of every country in the world, past and present; economics explains the management of a household and other country and of the world; ethics gives the natural principles for a man's conduct of himself and with his fellow man and shows how we should behave in society.[499]

To achieve this goal, Fukuzawa recommended students study Western books and learn the "letters written sideways."[500] Further, he stressed how important the focus on scientific learning was for all levels of society.[501] For Fukuzawa:

> Learning in the broad sense can be divided into immaterial and material aspects. The former includes such subjects as ethics, theology, and metaphysics; the latter, such subjects as astronomy, geography, physics, and chemistry. Each branch of learning broadens the range of one's knowledge and experience, gives one discernment into the principles of things, and understanding of one's duties a man. In order to widen one's knowledge and experience, one must listen to the words of others, read books, and form one's own ideas.[502]

In adhering to this advice, he believed that one achieved personal independence and "thereby enrich and strengthen the nation."[503] For a country can only obtain national independence once its people achieved personal independence.[504]

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[499] Fukuzawa, "Encouragement of Learning: the first essay," 450-1.
[500] Fukuzawa, "Encouragement of Learning: the first essay," 451.
[501] Fukuzawa, "Encouragement of Learning: the first essay,"
[502] Yukichi Fukuzawa, *An Encouragement of Learning*, trans. David A. Dilworth and Umeyo Hirano (Tokyo: Sophia University, 1969), 9.
[503] Fukuzawa, *Encouragement*, 16.
[504] Fukuzawa, *Encouragement,* 16.

Regarding the government, Fukuzawa implored people to pursue learning to avoid tyranny.[505] He viewed education as paramount to the success of the nation and identified "ignorance and illiteracy of the people" as the main obstacles for governments.[506] Fukuzawa called for all nations to teach each other and learn together.[507] In so doing, Japan may learn all that they can from the world and vice versa. He found that:

> Japanese civilization will advance only after we sweep away the old spirit that permeates the minds of the people. But it cannot be swept away by neither government degree nor private admonition. Some persons must take the initiative in doing things in order to show the people where their aims should lie. We cannot look to the farmers, the merchants, or scholars of Japanese or Chinese learning to personify these aims. The scholars of Western learning must fill this role. But they are not entirely measuring up to this assignment. Their numbers have increased of late, and they are giving instruction in Western texts or reading translations. They seem to be making every effort, but in fact there are not a few about whose doings I have some misgivings. For many are reading the words without understanding, or understand but do not have the sincerity to put the meanings into practice. I have more than a few doubts about their actual behavior, because such scholars and gentlemen are aware of the existence of official posts but unaware of the existence of their private selves; they know how to stand above the government but not how to be under it. They have ultimately not been able to shake off the bad habits of the scholars of Chinese learning. They have Chinese bodies dressed up in Western clothes.[508]

In other words, Fukuzawa saw the need for Western approaches to education using Western scholars. However, he identified some students of these Western scholars as being more interested in obtaining governmental positions rather than bettering

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[505] Fukuzawa, *Encouragement,* 14.
[506] Fukuzawa, *Encouragement,* 22.
[507] Fukuzawa, "Encouragement of Learning: the first essay," 452-5.
[508] Fukuzawa, *Encouragement,* 24.

themselves. He saw the importance of education and learning but was leery of the motivations of the individual and the role of the government.

In the procurement of knowledge, Fukuzawa saw the benefits for the individual and the eventual positives for the community and nation. The West provided a better form of education that allowed the Japanese people to be more adept to modern practices and knowledge. The alternative, the Classical Chinese education, did not meet this new form of material and modern knowledge. However, while he recognized the importance of the government in pursuing this new form of knowledge, he also saw potential problems with the role of government, especially when one pursued the Western approaches at a superficial level. In his comparison of his contemporary government with that of the past, he concluded:

> The governments of the past used force, but the present regime uses both force and intelligence. In contrast to the former, the latter is rich in techniques of controlling the people. Past governments deprived the people of power; the present regime robs them of their minds. Past governments controlled men externally, the present regime controls their interior as well. The former was a devil to the people, the latter is now a god. Fear has given place to blind worship.[509]

This conclusion paints a stark portrait of knowledge and who controls it, especially concerning the depth of knowledge. Fukuzawa clearly admired ideas and knowledge from the West, but he also saw that it had its own issues. In other words, one needed to study the West in depth, beyond the superficiality that the West, in all things, was superior. One can see the idea of blind worship he used above. He instead called on scholars to develop a discerning mind, one that critiqued the past and the present, and

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[509] Fukuzawa, *Encouragement,* 31.

analyzed traditional practices against modern ones. Therefore, Fukuzawa called on scholars of his day to move beyond the superficiality and to focus on the problems Japan needed to solve.[510] This process led to changing Eastern approaches as well as adopting Western approaches. The focus on learning, and especially the attention paid to Western approaches, became even more obvious in the call to colonize and control Hokkaido.

The placement of schools on Hokkaido was important for the Kaitakushi to get correct. Hakodate, the port city on the southern edge of Hokkaido, had been the center of activity for the government on the island. By 1875, Sapporo, a town with a population of around 8,000 people designed in American fashion with squares, became the capital of the island.[511] Therefore, Sapporo became the ideal site for the creation of schools that General Kuroda thought necessary for the colonization of Hokkaido. According to Nitobe, "Mother Nature here is well calculated to nurture youthful souls, and to imbue them with the love of study and the love of work."[512]

The imperial government had given General Kuroda direct authority to negotiate with the American government for the services and employment of anyone who might fulfill the needs of the Kaitakushi in Hokkaido. Between 1870 and 1882, the Kaitakushi employed fifty Americans, seventeen Europeans and thirteen Chinese. According to Fumiko Fujita, in terms of development, the Kaitakushi "left a distinctively American imprint on the history of Hokkaido."[513] Through the Kaitakushi and its administrator,

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[510] Fukuzawa, *Encouragement,* 99-100.
[511] Nitobe, *The Imperial Agricultural College,* 5.
[512] Nitobe, *The Imperial Agricultural College,* 5
[513] Fujita, *American Pioneers and the Japanese Frontier*, x.

Kiyotaka Kuroda, American experts began to arrive in Japan and Hokkaido, bringing with them their Western education, practices, and ideas about science, engineering, and colonization.

Kiyotaka Kuroda became the figurehead of the Kaitakushi and interacted with the American experts. According to Fujita, "Kuroda recommended not only a sharp increase in the annual budget for the Kaitakushi but also the employment of foreign experts, as well as sending Japanese students abroad to learn Western technology."[514] As to the reason why the number of American experts vastly outweighed any other country, Fujita states, "Kuroda therefore preferred the United States because the Japanese viewed the United States as a country with more experience in the successful development of a new land than any other country."[515] Additionally, the terrain and climate of Hokkaido was similar to select portions of the United States. To get American experts, Kuroda worked with the Japanese Charge d'Affaires in Washington DC, Mori Arinori, and began their search for ideal experts.[516]

American Experts in Japan

In his search for American experts, Kuroda met with President Ulysses S. Grant, who recommended Horace Capron, the Commissioner of Agriculture. General Horace Capron, having served in the American Civil War, parlayed his military career into one in

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[514] Fujita, *American Pioneers and the Japanese Frontier,* 4.
[515] Fujita, *American Pioneers and the Japanese Frontier,* 7.
[516] Fujita, *American Pioneers and the Japanese Frontier,* 10; Hokkaido Prefectural Government, 28. For more on Mori Arinori and his views of the United States, see Arinori Mori, *Life and Resources in America* (Washington, DC, 1871).

the government. Named the Commissioner of Agriculture in 1867, he held the position until enticed to be an adviser of agriculture for Japan. On April 6, 1871, Capron received a letter of introduction for Arinori Mori.[517] The letter stated that "his government desires to secure the services of a competent civil engineer and of a competent agriculturalist" for the development of the "northern islands of the empire."[518] The letter described the islands as "uncultivated and sparsely populated," "wooded, and as probably fitted for cereal."[519] On April 17, 1871, Capron accepted the position and the accompanying $10,000 annual salary, becoming the commissioner from May 1871 to May 1875.[520] Capron thereby became the first of many American experts to be employed by the Kaitakushi and bring an American style of colonization to Japan.[521] This appointment led to the introduction of American crops, animals, machines, and methods used on Hokkaido.

In May of 1871, Capron began to inquire about institutions and individuals to recommend to Mori. On May 9, 1871, Capron wrote a letter to William Smith Clark, the

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[517] H. Brown to Capron, April 6, 1871, Box 2, Correspondence Jan-May 1871, Horace Capron Papers, Manuscript Division, Library of Congress, Washington DC. [Hereafter as: Capron Papers].
[518] H. Brown to Capron, Capron Papers.
[519] H. Brown to Capron, Capron Papers.
[520] Contract as Commissioner of Agriculture for Japan, April 17, 1871, Box 2, Correspondence Jan-May 1871, Capron Papers; Fujita, *American Pioneers and the Japanese Frontier*, 10. In terms of salaries, it is interesting to point out that as Secretary of Agriculture, Capron made $3000 a year. His staff, Thomas Antisell and Stuart Eldridge made $2500 and $1800, respectively. However, in Japan, they made $4000 and $2000 respectively.
[521] For a biography on Horace Capron, see Harold S. Russell, *Time to Become Barbarian: The Extraordinary Life of General Horace Capron* (Lanham, MD, University Press of America, 2007).

President of Massachusetts Agricultural College in Amherst.[522] After a brief introduction, Capron informed Clark that he had recommended his school as "the best educational institution for a Japanese youth of high rank."[523] Capron went on to say of Mori:

> The young gentleman is bright, intelligent, understands English; and has a fair Japanese education; is nineteen years of age. Mr. Mori expresses some fears that, you may have no preparatory course in which to prepare him for the regular Curriculum. It has occurred to me that, perhaps in a case so peculiar, one even of National importance, and which might also prove of prospective advantage to your institution, you might relax something of the stringence of your regulations for admission; or at least manage to take charge of the preparation instructions of this youth. I shall esteem it a personal favor if you can accommodate the views of Mr. Mori.[524]

The student was not the last Japanese students to request enrollment at Massachusetts Agricultural College. In September of 1871, Charles Wolcott Brooks, the Japanese consul in San Francisco wrote a similar letter to Clark on behalf a Mr. Iwayama, who focused on studying stock and all affiliated branches.[525] This infusion of Japanese students into American colleges continued, many enrolling at Massachusetts Agricultural College.

To fulfill his duties as the new Commissioner, Capron began to seek out engineers and agriculturalists. Through his connections with Joseph Henry at the Smithsonian Institute and other well-connected scientists, Capron sent several inquiries. One engineer that came highly recommended was Benjamin Smith Lyman, but unfortunately the

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[522] Horace Capron to William Smith Clark, May 9, 1871, Box 2, Correspondence Jan-May 1871, Capron Papers.
[523] Capron to Clark, Capron Papers.
[524] Capron to Clark, Capron Papers.
[525] Charles Wolcott Brooks to Capron, Japanese consul in San Francisco re: admitting a Japanese student, September 1, 1871, Series 2, Box 4, Folder 6, Clark Papers.

compensation promised was "insufficient."[526] However, within a few years, Lyman joined Capron in Japan and was a critical figure in the surveying of Hokkaido's geology and discovery of its coal and other resource deposits.

After Lyman's initial refusal, Capron brought Thomas Antisell, A. G. Warfield, and Stuart Eldridge with him as experts in their own fields. At first, the working relationship between the Americans and the Kaitakushi progressed well; however, in time, the rigidity of the Kaitakushi and the expectations of the Americans caused some conflict. According to Fujita, "cooperation was often accompanied by friction."[527] This friction led to the changes in the organization of American experts and to the redistribution or loss of positions. During such time, Benjamin Smith Lyman and his assistant Henry Smith Munroe replaced Thomas Antisell who briefly took a position at the Kaitakushi School in Tokyo, the progenitor of the Sapporo Agriculture College.[528]

Edwin Dun was an agriculturalist who helped to drastically change agricultural approaches on Hokkaido. In 1873, Dun met with Albert B. Capron, Horace's second son, and they discussed ranching and livestock.[529] This meeting led to his appointment to the Kaitakushi, where he managed the government farm in Aoyama, Nanae, and Sapporo.[530] He was responsible for the horse breeding at Niikappu, the dairy farm at Makomanai and

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[526] Benjamin Smith Lyman to Joseph Henry, June 9, 1871, Box 3, Folder 6: Misc. Correspondence, C-P, Capron Papers.
[527] Fujita, *American Pioneers and the Japanese Frontier*, x,
[528] Fujita, *American Pioneers and the Japanese Frontier*, 12.
[529] Hokkaido Prefectural Government, *Foreign Pioneers*, 43; Brett L. Walker, *The Lost Wolves of Japan* (Seattle, WA: The University of Washington Press, 2005), 140.
[530] Hokkaido Prefectural Government, *Foreign Pioneers*, 47-49.

in other farms in Hokkaido.[531] He continued to live and work in Japan after the abolishment of the Kaitakushi in 1882 through his positions as the second Secretary of the American Legation in Japan (1884) and as Minister to Japan (1893-1897).[532] Dun also worked with professors, such as William Penn Brooks at Sapporo Agricultural College's Farm.[533] Due to his agricultural efforts in Hokkaido, Dun earned the moniker "Father of Hokkaido Agriculture."[534]

As an engineer, Benjamin Smith Lyman proved himself invaluable to the Kaitakushi through his topographical and mining surveys of Hokkaido and other areas of Japan.[535] Lyman studied at Harvard before completing his education in geology at the Ecole Impérial des Mines in Paris for two years and at the Royal Academy of Mines in Freiberg for one year.[536] After completing his studies in the early 1860s, Lyman surveyed the petroleum fields in the Punjab, India for the British Government from 1869 to 1870.[537] After returning to America, Lyman received word of a position in Japan, which

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[531] Hokkaido Prefectural Government, *Foreign Pioneers,* 49; Walker, *Lost Wolves*, 142-146.
[532] Hokkaido Prefectural Government, *Foreign Pioneers,* 53-54.
[533] Hokkaido Prefectural Government, *Foreign Pioneers,* 50.
[534] Hokkaido Prefectural Government, *Foreign Pioneers,* 53.
[535] See Benjamin Smith Lyman, *Geological Survey of Yesso: A General Report on the Geology* (Tokei: Kaitakushi, 1877); Benjamin Smith Lyman, *Geological Survey of Hokkaido: Report of Progress of the Yesso Geological Surveys, for 1875, and Seven Coal Survey Reports* (Tokei: Kaitakushi, 1877); and Lyman made a number reports about Hokkaido and individual site studies for resources in Horace Capron, *Reports and Official Letters to the Kaitakushi* (Tokei: Kaitakushi, 1875).
[536] Fujita, *American Pioneers and the Japanese Frontier*, 44; Hokkaido Prefectural Government, *Foreign Pioneers,* 56.
[537] Fujita, *American Pioneers and the Japanese Frontier*, 45; Hokkaido Prefectural Government, *Foreign Pioneers,* 57.

he accepted in October 1872, with a start date of December 1872.[538] During his tenure with the Kaitakushi, Lyman had an American assistant, Henry Smith Munroe.[539] Lyman and Munroe trained thirteen Japanese assistants, who were the first students to receive regular training in geology and mineralogy in Japan.[540] Lyman is responsible for surveying the Makubutsu, Naie, Bibai, Horonai, and Kayanuma mines and creating Japan's first geological map.[541] From 1876-79, Lyman surveyed oil fields in the Niigata and Shizuoka prefecture and created geological maps for Tohuku, Hokuiriku, Chogoku, Kyushu and Shikoku districts.[542] These surveys provided detailed maps and locations of resources, including the viability and potential industrial benefits of each. The coal beds in Hokkaido provided the impetus to mine and use coal to help drive the colonization in Hokkaido and provide fuel for other government and industrial opportunities throughout the empire. The oil field surveys resulted in a similar outcome and provided a potential fuel source for the industrialization of Japan. In the handwritten document entitled "The Petroleum Industries of Japan," Lyman traced the history and location of petroleum in Japan.[543] He reported a rapid increase of barrels produced from 10,000 in 1879 to

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[538] Fujita, *American Pioneers and the Japanese Frontier*, 45; Hokkaido Prefectural Government, *Foreign Pioneers,* 57.
[539] Henry Smith Munroe eventually took a position in the Columbia School of Mines in New York City, where he taught engineering throughout the 1880s and 1890s.
[540] Hokkaido Prefectural Government, *Foreign Pioneers,* 63. These assistants include: Tokusaburo Yamauchi, Yoshimaru Akiyama, Tomoaki Kuwata, Shigo Misawa, Jozo Takahashi, Teiichi Kada, Taro Sakaich, who in 1888 surveyed the Oyubari coal bed, Takeji Saito,Ju-ichi Shimada and Eigo Yamagiwa, who both went back to Hokkaido and surveyed the Ikushun betsu, Seimei Maeda, and Shogo Nishiyama.
[541] Hokkaido Prefectural Government, *Foreign Pioneers,* 61-62.
[542] Hokkaido Prefectural Government, *Foreign Pioneers,* 67.
[543] Benjamin Smith Lyman, "The Petroleum Industries of Japan," c. 1896, Series 3. Writings, Box 26, Benjamin Smith Lyman Papers (MS 190). Special Collections and

180,000 in 1895.[544] His surveys and information concerning the geological resources around Japan provided the government and industries with direct information about the value of land not only on but also below the surface.

In addition to his perspectives on engineering and geology, Lyman held strong positions on how to colonize Hokkaido.[545] Included in his ideas for colonization, Lyman suggested specific social arrangements for colonization and provisions for receiving settlers. He thought that roads were the first step to the colonizing process and that houses needed to be widely spaced apart for further development. Additionally, he thought that a tax on size and quality of land was a necessity. Further, he suggested that the government sell horses to settlers, as they will take better care of what they buy. His final recommendation was that the people, not the government, own the mines.[546] Lyman also shared his opinions about the placement of the Sapporo Agricultural School, when the Kaitakushi moved it from Tokyo to Sapporo in 1875.[547]

Colonization through Education

Shortly after his arrival on January 2, 1872, General Capron suggested the establishment of an agricultural college in Sapporo. Specifically, he said:

> It should be the endeavor of this government to establish by every possible effort, scientific, systematic and practical agriculture. In no way can this be done more effectively or economically than by connecting with the gardens

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University Archives, University of Massachusetts Amherst Libraries [Hereafter as: Lyman Papers].
[544] Lyman, "The Petroleum Industries of Japan," 4, Lyman Papers.
[545] Hokkaido Prefectural Government, *Foreign Pioneers,* 65.
[546] Hokkaido Prefectural Government, *Foreign Pioneers,* 65.
[547] Hokkaido Prefectural Government, *Foreign Pioneers*, 66-67.

> at this place (Tokyo) and also with the farm at Sapporo, institutions at which shall be taught all the different branches of agricultural science. These institutions should have well appointed laboratories, and should be supplied with professors of acknowledged ability and their several specialties.[548]

This recommendation matched General Kuroda's own interest in establishing educational centers in Hokkaido, and he tried to make this recommendation a reality as quickly as possible.

The Sapporo Agricultural School, or College, addressed both the agricultural and engineering expectations of the Kaitakushi. By July 1875, the transition of the school from Tokyo to Sapporo was complete; however, Principal Hirotake Zusho (Zushio) needed to hire a faculty.[549] The faculty consisted of three foreign teachers, the curriculum resembled Massachusetts Agriculture College and the students graduated within four years. With these goals in mind, Kuroda asked Kiyonari Yoshida to find suitable candidates.

To create an effective college of agriculture that met the needs and desires of the Kaitakushi and the imperial government of Japan, General Kuroda instructed the Japanese minister in Washington to find the ideal candidate to lead the new agricultural college in Hokkaido. At this time, the state agricultural college at Amherst Massachusetts was an exemplary institution where the tenants of the Morrill Act of 1862, specifically in terms of agricultural education, had been carried out exceedingly well. Its president, William Smith Clark, was then nominated to organize the sister institution in Sapporo.

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[548] Nitobe, *The Imperial Agricultural College,* 5-6.
[549] Hokkaido Prefectural Government, *Foreign Pioneers,* 101.

Massachusetts Agricultural College and William Smith Clark

The early history of Massachusetts Agriculture College revolves around a select group of men, with William Smith Clark at its center. Clark, in many ways, handled the placement and direction of the primarily agricultural side of Massachusetts' land grant school. He used his educational experience at Amherst College and in Germany, coupled with his teaching experience at Amherst College and his time in the Civil War to shape not one, but two land grant schools.

Born in Ashfield, Massachusetts on July 31, 1826, William Smith Clark was the first son of Dr. Atherton Clark and his second wife, Harriet Smith Clark.[550] At the age of fifteen, Clark enrolled at Williston Seminary and graduated in 1844 at the age of 18.[551] In the fall of 1844, he enrolled in nearby Amherst College and began to develop an interest in botany and other sciences. Upon his graduation in 1848, he returned to Williston Seminary and taught chemistry and natural sciences for two years.[552] He then enrolled in the Georgia Augusta University in Göttingen.[553]

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[550] Family Record, Series 1: Biographical Materials, Box 1, Folder 1, Clark Papers; Hokkaido Prefectural Government, *Foreign Pioneers*, 98; John Maki, *A Yankee in Hokkaido: The Life of William Smith Clark* (Lanham, MD: Lexington Books, 2002), 1.
[551] WSC's biographical data for AC alumni Records, Series 1: Biographical Materials, Box 1, Folder 1, Clark Papers; Hokkaido Prefectural Government, *Foreign Pioneers*, 99; Maki, *A Yankee in Hokkaido*, 17-18.
[552] Hokkaido Prefectural Government, *Foreign Pioneers,* 99; Maki, *A Yankee in Hokkaido*, 34.
[553] Hokkaido Prefectural Government, *Foreign Pioneers,* 99; Maki, *A Yankee in Hokkaido*, 34-38.

At Göttingen, Clark studied under Friedrich Wöhler, who was famous for his synthesis of urea in 1828.[554] Accompanying Clark on this educational journey was his close friend Newton C. Manross.[555] Clark and Manross were Wöhler's first American students at Göttingen and began a lengthy list of Americans who studied under Wöhler and other scientists after him. In 1852, Clark completed his Doctoral degree with a paper that focused on the chemical composition of meteoric iron.[556] He then returned to Amherst and became a Professor of Chemistry at Amherst College.[557] He continued in this role up to 1867, when he became the President of the newly formed Massachusetts Agricultural College.[558]

Before his presidency, Clark actively took part in the American Civil War. He later served in the Massachusetts legislature and was instrumental in Amherst's acquisition of the Agricultural Colleges as defined under the Morrill Act of 1862.[559] Therefore, Clark's first act with the land grant model was in his role in bringing it to Amherst and as president when it first opened its doors to students in 1867. In 1868, Clark hired a fellow student of Wöhler, Charles Anthony Goessman, as professor of

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[554] Hokkaido Prefectural Government, *Foreign Pioneers,* 100; Maki, *A Yankee in Hokkaido,* 39.
[555] Maki, *A Yankee in Hokkaido*, 38. Clark met Manross while attending Amherst College. They remained close friends until Manross's death in the Civil War.
[556] Hokkaido Prefectural Government, *Foreign Pioneers,* 100.
[557] Hokkaido Prefectural Government, *Foreign Pioneers,* 100.
[558] Maki, *A Yankee in Hokkaido*, 85-86. Before his election as president, Clark was originally going to be professor of horticulture and botany. However, due to the unexpected resignation of Paul A. Chadbourne, the trustees voted Clark into the presidency.
[559] Hokkaido Prefectural Government, *Foreign Pioneers,* 100; Maki, *A Yankee in Hokkaido,* 57-84.

Chemistry.[560] Later, in the many letters between Wöhler and Goessman, Wöhler recalled that Clark was "one of my lovable pupils" and that he had heard Clark was going to Japan.[561] These experiences helped prepare Clark for his role in the internationalization of the land grant mission in Japan.

William Smith Clark rose to the top of Kaitakushi's list of candidates due to his educational theories and his work as president of Massachusetts Agriculture College. Earlier in this chapter, Clark and the College had been singled out by Capron and Brooks as an ideal place for Japanese students. On February 3, 1872, Mori wrote to Clark about his thoughts concerning education. Specifically, Mori asked for advice on education to "assist my countrymen in their efforts to become instrumental in advancing civilization in the East."[562] He continued by asking for Clark's perspectives on the effects of education on "the material prosperity of a country," its "Commerce," its "Agricultural and Industrial interests," "the social, moral and physical condition of the people," and its "influences upon the laws and government."[563] Unfortunately, the reply to this request was not preserved in Clark's papers; however, his actions during his short tenure in Japan demonstrated his perspectives.

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[560] Frederick Tuckerman, Joseph B. Lindsey, and Charles Wellington, *Charles Anthony Goessman* (Cambridge, MA: The Riverside Press, 1917), 28.
[561] Friedrich Wöhler, Letter to Gössman, 25 February 1876, from "Letters of Friedrich Wöhler" in Tuckerman, et al. *Charles Anthony Goessman*, 134-5.
[562] Mori Arinori to Clark, Japanese minister to the US re: info and advice on development of education in Japan, February 3, 1872, Series 2, Box 4, Folder 6, Clark Papers.
[563] Mori Arinori to Clark, Clark Paper.

When initially asked to come to Japan, Clark stated, "I cannot be away more than one year, but I hope to accomplish a two-year job in one."[564] On March 3, 1876, Clark signed a contract having procured a leave of absence two months earlier.[565] The trustees of the college in Massachusetts consented to the loan of its President for the period of one year. On May 20, 1876, he left for the post with David Pearce Penhallow, and William Wheeler. On his way to Japan, Clark stopped in Honolulu and visited with his wife's family, who were missionaries in Hawaii. This visit solidified his resolve to teach the *Bible* as part of his curriculum for a moral education.[566]

Clark in Hokkaido

The Sapporo Agricultural College opened on August 14, 1876, with twenty-four students representing all the main islands of Japan. The faculty consisted of the Honorable Hirotake Zusho (Zushio) as Director, of William S. Clark, Ph.D. LL.D., as President of the College and soon-to-be Director of the College Farm, William Wheeler, C.E., as Professor of Mathematics and Civil Engineering, David P. Penhallow, B.S., as Professor of Botany and Chemistry, Seitaro Hori, Secretary and Interpreter, and of K. Yoshida as Farm Overseer. William Penn Brooks, B.S., Professor of Agriculture, and successor to Dr. Clark as president, arrived soon thereafter.[567]

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[564] Hokkaido Prefectural Government, *Foreign Pioneers,* 103.
[565] Request to Board of Trustees for official leave to go to Hokkaido, January 12, 1876, Series 2, Box 4, Folder 7, Clark Papers; Japanese and English versions of contract, March 3, 1876, Series 2, Box 4, Folder 7, Clark Papers.
[566] Hokkaido Prefectural Government, *Foreign Pioneers,* 104.
[567] Nitobe, *The Imperial Agricultural College*, 6-7.

Over the course of the next few months, Clark, Wheeler, and Penhallow began to set up and revise the curriculum of the school and raised its level to that of an "average American college."[568] On September 2, 1876, Clark and the faculty published the Sapporo Agricultural College Plan of Organization and Regulations, which included the purpose of the college as an institution of the Kaitakushi for the "education and practical training of young men who are expected to become its employēs after graduation and to serve under the direction of the department for the term of five years."[569] These rules and regulations set up a college and provided a clear idea of the expectation of the school and its students. This plan continued to go through revisions as was needed.

Within a week of establishing the expectations for the school, Clark wrote to Kuroda with general improvements for the Kaitakushi. First, Clark believed that a "well-equipped farm" fell under the purview of a "foreign Professor of Agriculture, who shall be under the direction and authority of the President of the College."[570] At this farm, students will experience "theoretical and practical" instruction and there will be "Experiments with new crops, fertilizer and machines, as well as with manufactures such as silk, sugar, beer, vinegar, &c."[571] Additionally, Clark called for a transition from hand implements to machines.

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[568] Nitobe, *The Imperial Agricultural College*, 6; It was also during this time that Clark began to make plans and requests for the construction of the chemistry lab, see Clark to Hori Motoi: re Chemistry lab plans, August 29th, 1876, Series 2, Box 4, Folder 8, Clark Papers.
[569] SAC Plan of Organization and Regulations, September 2, 1876, Series 2, Box 4, Folder 9, Clark Papers.
[570] Clark to Kuroda in Tokyo re: improvement of Kaitakushi's work, September 8, 1876, Series 2, Box 4, Folder 9, Clark Papers.
[571] Clark to Kuroda, September 8, 1876, Clark Papers.

Second, Clark thought the buildings of Hokkaido needed modifications. This included raising the building to two feet above the ground and creating a cellar for storage. He also suggested the addition of brick or stone chimneys along with glass windows, instead of paper. All these suggestions helped the people colonizing Hokkaido endure the climate and the hazards associated with it.[572]

Third, Clark also had opinions on both the food and clothing of Hokkaido's inhabitants. For example, Clark said, "In regard to the food and clothing of the people some change seems indispensable. That clothing of wool, boots and shoes of leather, and a considerable amount of animal food…necessary in this climate…"[573] He also called for the introduction of grasses, corn, swine, sheep, and cattle. For Clark, all of these "improvements" were the necessary next steps for the Japan's colonization plan.

It was also in the early part of September 1876, that Clark sought the approval to engage William P. Brooks as another professor and eventual replacement for Clark. Accompanying Brooks was a large seed and grain supply needed to plant the fields around the school farm.[574] The following day, Kuroda wrote to Clark about the plans for the farm and named him as its director. According to Kuroda:

> The Sapporo government farm was established for the purpose of furnishing the people a model in Agriculture. After consultation with Gen. Horace Capron some years ago, sufficient experiments in producing various crops, raising livestock and general farm management, have been made to demonstrate the adaption of these things is the climate and soil of Hokkaido.

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[572] Clark to Kuroda, September 8, 1876, Clark Papers.
[573] Clark to Kuroda, September 8, 1876, Clark Papers.
[574] Zushio to Clark re: approval of Brooks' appointment, September 11, 1876, Series 2, Box 4, Folder 9, Clark Papers.

> As, however, the customs and ideas of the older time are yet prevalent, the general introduction of new methods is difficult.[575]

Kuroda viewed the farm as an example for other farms to follow but he also accepted that new ideas will be difficult to introduce due to the presence of the older ones. However, he felt it was best to substitute the new, foreign ways for the older, Japanese ways. The college's purpose was to introduce new methods over the old Japanese ways.

Clark, on the heels of his letter on improvements for the Kaitakushi, wrote to Kuroda with a plan for an American colony in Hokkaido. During a recent excursion to the Sorate Coal beds, the idea of an American colony became a matter of discussion. After thinking on the subject for a time, Clark posited four inquiries:

> First. Would the Japanese government receive such immigrants upon the condition that they should abuse their American citizenship and become subjects of this Imperial government?
> Second. In case such a colony of not less than thirty young men, skilled in agriculture or some one of the mechanic arts with their families should be organized for settlement in the valley of the Ishkari, would the government make them a grant of land in such place as the might select one the public domain?
> Third. In consideration of the educating influence of such a colony of active, enterprising and intelligent persons, and the probability that other parties might follow them, would the government provide them a free passage from San Francisco to Sapporo and erect from the suitable cheap houses, for which they should pay a moderate rent?
> Fourth. Would such persons be permitted to engage in trade, manufactures, fishing and mining, &c, will all the rights and privileges of other Japanese citizens in all parts of the empire?[576]

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[575] Kuroda to Clark re: transfer of farm to SAC ad WSC's appointment as director, September 12, 1876, Series 2, Box 4, Folder 9, Clark Papers.
[576] Clark to Kuroda re: scheme for an American colony in Hokkaido, September 12, 1876, Series 2, Box 4, Folder 9, Clark Papers.

Accompanying these inquiries, Clark discussed what the community might look like and the amount of material goods needed for the colony. Clark was adamant that such a colony might benefit not only Hokkaido, but all of Japan. He believed that the colony might serve as a template for the Japanese to copy. Although this idea never came to fruition, that an American educator was proposing another, foreign, colonization movement, when he was already part of the Japanese colonization approach to Hokkaido, is jarring.

Every American involved with Sapporo Agricultural College had specific expectations of their role. However, these expectations did not stop them from seeking opportunities outside their contracts. Where Clark was thinking of colonies, William Wheeler was busy building a weather station in Hokkaido.[577] In time, Clark used his position to change the direction of religion in Hokkaido as well.

Clark was an influential figure for the students of Sapporo Agriculture. In the first year of the school, students organized a Literary Club with Clark's help.[578] Not only did his students adhere to the expectations of the land grant model he used in Massachusetts, but they also experienced Clark's focus on Protestant Christianity.[579] During his short tenure, Clark wrote two documents: "The Pledge of Abstinence from liquor and tobacco" and *The Covenant of Believers in Jesus*.[580] All the students and faculty signed these

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[577] Correspondence to Kuroda Kiyotaka, September 2, 1876, Series 2, Box 4, Folder 9, Clark Papers.
[578] WSC's endorsement of student plan for literary society, November 1, 1876, Series 2, Box 4, Folder 9, Clark Papers.
[579] Mori Arinori, *Life and Resources in America* (Washington D.C., 1871), 246-247.
[580] Hokkaido Prefectural Government, *Foreign Pioneers,* 107-108; See also Copy of *Covenant of Believers in Jesus,* 1877, Series 3, Box 6, Folder 15, Clark Papers.

documents which helped root Christian morality into the culture of Hokkaido. After his departure from Japan, Clark wrote to a Mr. Dodge:

> You will be delighted to learn that, in August last, Rev. M.C. Harris, an American missionary, at my request, visited Sapporo and baptized the entire sophomore class in the name of the Father, and of the Son, and of the Holy Ghost. Who can foretell what these sixteen young officers may accomplish for the evangelization of their countrymen! Pray for them.[581]

From these sixteen initial converts, Christianity took hold in Hokkaido and continued to thrive up to the present day. Amongst these converts were Jhon K. Ito, leader of the temperate movement and Father of Fisheries in Hokkaido; K. Uchida, pioneer and leader of rice planting in Hokkaido; M. Oshima, Dr. L., Philologist, former Head of Sapporo Agricultural College, and nominated pastor of Sapporo Independent Christian Church over 15 years; Dr. Kingo Miyabe, a famous botanist; M. Adachi, authority on sericulture; I. Hiroi, Dr. in engineering, Emeritus Professor of Civil Engineering, Tokyo University; Kanzo Uchimura, an evangelist; and Dr. Inazo Nitobe, a Quaker and pacifist.[582] Each of these men came to Sapporo to meet the call of the government, but they left with an additional religious focus to their lives.

Several factors limited student enrollment in the school. First, due to the finite appropriations made by the government the school was only able to educate a maximum of fifty students. All successful candidates to the school received their education at the government's expense, including board, room, clothing, and any other materials needed

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[581] Correspondence to Mr. Dodge re: baptism of 1st class at SAC (original on opposite side of item in folder 15, from Tanouchi, copied by WSC, October 25, 1876), October 31, 1877, Series 2, Box 4, Folder 6, Clark Papers.
[582] Copy of *Covenant of Believers*, Clark Papers.

at the school. This was necessary due to the state of Hokkaido, in which the potential for life and work was limited in comparison to other parts of Japan because the island was in the process of being colonized. Therefore, the government supported the education of the successful candidates on certain conditions. Specifically, all successful candidates were required to sign an agreement with the authorities to serve in the Kaitakushi for five years after graduation. This also meant that the students had to move their household to Hokkaido. The course of study lasted four years and focused on the branches of knowledge that the Kaitakushi and faculty thought "necessary to make efficient officials and exemplary pioneers."[583] As described in the plan of organization,

> It was the aim of the college to qualify its students for intelligent and effective work in the administration of business, and those departments of industry and technical science pertaining to agriculture and the development of natural resources, manufacturers, and the maintenance of an advanced civilization; also, to promote conceptions of the relations to the state into society and of self-culture befitting their perspective stations.[584]

Therefore, the aim of this school was not only centered on agriculture. Instead, as Nitobe describes it, the focus was "much broader and approached in fact to a school of cameralistic science, which was so eagerly pursued in Germany" in the eighteenth and nineteenth centuries.[585] General Kuroda sought the creation of an institution to prepare officials for development and shepherding of a public economy in Hokkaido. Like the schools in Germany which pursued the cameralistic sciences, Sapporo concentrated it in agriculture. As Nitobe states, "the main aim and value of the cameralistic science was

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[583] Nitobe, *The Imperial Agricultural College,* 7.
[584] Nitobe, *The Imperial Agricultural College* 7-8.
[585] Nitobe, *The Imperial Agricultural College*., 8.

essentially of practical character, and what must be practical has widely different interests from what is to be scientific."[586] He continued, "An education, in order to be of practical use in a new country, must needs be more comprehensive than profound: it can afford to become special only as the country grows older."[587] Therefore, the initial focus and direction of this school was tied to imperial goals.

Unfortunately, the number of potential students prepared for the rigors of collegiate life at the Sapporo Agricultural College were in short supply. Like newly formed colleges in the United States, the Sapporo Agricultural College established a preparatory department. In the nineteenth century, especially, preparatory departments were necessary to fill the gap between the elementary education of interested students and the expectations of collegiate curricula. Until the development of more standardized high school systems, the preparatory department provided the means to ready any potential student. At the Sapporo Agricultural College, boys over the age of twelve enrolled in the program, which prepared them for the expectations of the collegiate course.[588] However, not all students enrolled in the preparatory program were ready to continue to the college.[589]

William Smith Clark, his fellow American educators, and the Kaitakushi based the Sapporo Agricultural College on the Morrill Land Grant college model. In doing so, the college focused on agricultural and mechanical arts education. Clark, Penhallow,

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[586] Nitobe, *The Imperial Agricultural College* 8-9.
[587] Nitobe, *The Imperial Agricultural College*, 9.
[588] Nitobe, *The Imperial Agricultural* College, 9.
[589] Correspondence to Kuroda Kiyotaka, September 2, 1876, Series 2, Box 4, Folder 9, Clark Papers

Brooks, and Wheeler developed and taught a curriculum that mirrored Massachusetts Agriculture College and American approaches to agriculture and engineering. According to the Hokkaido Prefectural Government, "The teachers took leadership in the farming as well as in the classroom and they proved to be 'the brains' of the colonization of Hokkaido."[590]Additionally, the college relied on governmental funding and land to establish the college and all residual operations.

In terms of Sapporo, the government granted two hundred and fifty acres to the college, half of which had been cleared before the opening of the school.[591] The purpose of this land was for any experimentation in agricultural and scientific practices that may benefit the students and the college. President Clark saw to the erection of a model barn on this land, not only the first of its kind in Hokkaido, but in the entirety of Japan.[592] The barn served two purposes. The first was to be a source of imitation for present and future farmers on Hokkaido. The second was to increase the development of husbandry programs for cattle, horses, and other stock animals. Soon after its construction, native horses, and cattle, as well as several Shorthorn cows filled the ground floor. Additionally, the college ordered farm vehicles, machines, tools, and varieties of both grass and corn

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[590] Hokkaido Prefectural Government, *Foreign Pioneers*, 26.
[591] Nitobe, *The Imperial Agricultural College of Sapporo, Japan*, 9.
[592] The barn consisted of an oak and elm foundation. These trees were plentiful in the area and the timbers were seasoned for construction. Spruce was what they used to construct the building. In terms of dimensions, the ground floor was 100 x 50 feet, with the height of posts from ground to eaves set at 25 feet. The barn consisted of three levels – the cellar, the ground floor for cattle and horses, and the upper floor for storage of hay. The design of the barn resembled a traditional New England barn, and was quite similar to the barn associated with the State College of Agriculture at Amherst.

seed from America to bolster the effectiveness of not only the model barn, but also of the farm and agricultural curriculum based on it.[593]

With the erection of the school barn and the creation of the first agricultural college in East Asia, Clark left Sapporo in spring of 1877 to resume his position at Massachusetts Agricultural College in Amherst. Having only been in Japan for less than a year, President Clark left a legacy that continues to this day. Three words, those he spoke to his students and staff as he left, are known throughout Japan — "Boys, be ambitious!".[594] Inazo Nitobe described Clark's legacy with his students as: "Of lasting benefit to those, who came in close personal contact with him, was that invincible energy, which was his — and without which, it is said, neither circumstances nor talents can ever make of a two-legged creature a man."[595]

In his brief time in Japan, Clark shaped the direction of education in Hokkaido. He also changed the cultural outlook through his focus on a Protestant Christian way of life. Back in the United States, Clark lectured on Japanese agriculture and planted several Japanese trees and plants around Amherst. In the fall of 1878, Clark sought a second leave of absence to become the president of a Floating College. The trustees denied this request, which prompted Clark to resign in 1879. Clark then tried his hand at mining, but due to dishonest conduct on the part of his business partners, and issues with mining, this

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[593] Nitobe, *The Imperial Agricultural College of Sapporo, Japan*, 10.
[594] Hokkaido Prefectural Government, *Foreign Pioneers,* 109-110.
[595] Nitobe, *The Imperial Agricultural College of Sapporo, Japan*, 110.

venture forced him into bankruptcy.[596] Clark eventually died on March 9, 1886 and was buried in Amherst.[597]

Sapporo Agricultural College after Clark

Although Clark's physical presence was no longer at Sapporo, his spirit, assistants, and fellow educators continued to shape the direction of the college. Professor Wheeler took on the role of president in the absence of Clark.[598] He also continued to serve the college and the Kaitakushi in the fields of surveying and engineering. Professor Penhallow was influential in the study of textile fibers produced in Hokkaido as well as studying and improving tanning processes. William Penn Brooks, who had taken over the college farm from Clark, continued to make regular improvements to the scope and functionality of the farm. Additionally, in the second academic year, the college completed the construction of a chemical laboratory, the plant house, a corn barn, and the beginnings of a museum of Natural History.[599] Each of these improvements elevated the

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[596] Hokkaido Prefectural Government, *Foreign Pioneers,* 110-111.
[597] J.K. Uchimura, "The Missionary Work of William S. Clark, Ph.D., LL.D." Christian Union, April 2, 1886, Series 1, Box 1, Folder 2, Clark Papers.
[598] Correspondence to Mother, April 22, 1877, Folder 4, William Wheeler Papers (RG 002/3 W54). Special Collections and University Archives, University of Massachusetts Amherst.
[599] Nitobe, *The Imperial Agricultural College of Sapporo, Japan*, 11 and 20. Over the next couple decades, the College continued to add new buildings and features to the campus including a military hall, museums, and additional farming lands and buildings. In 1882, a two-story framed building was erected to house a museum separate from the College Museum. The college added this building to its holdings in 1885. It was the repository of Benjamin S. Lyman's mineralogical collection, Ainu relics and tools, and several stuffed animals representing the fauna of Hokkaido. Additionally, the college added a Botanical Gardens the same year. Set in the western part of Sapporo, the grounds were ideally cultivated to preserve some specimens of the forests that once covered the

ability of what the faculty taught and what the students learned.[600] In the words of President Wheeler, these additions were proof that "the material needs of the College for carrying out the routine of study in training, prescribed under the present system, have been, in the main, provided for. The institution had passed the formative stage and was now possessed of all the important requisites for its legitimate work."[601]

During the 1879-1880 school year, the College reformed its regulations regarding its student population. The reform lifted the limitation of student numbers and made students responsible for their own education. However, the government still provided some measure of financial support for those men of limited means, who they considered worthy. The condition was that these men repaid the debt after graduation in regular installments.[602] Although this reform opened the door for more students, the physical limitations of the buildings and classrooms kept the numbers closer to what had been previously established. Further, the first graduating class of the college (1880) had begun with twenty-four students, but at the time of graduation had been reduced to thirteen. Each of these men earned the degree of "*Nôgakushi*" or "Bachelor of Agriculture" and

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island and provided the public with examples of the different flora Hokkaido. Further, the college added two hundred and twenty-five acres, including what had been a government seed farm

[600] By 1880, the faculty grew with the addition of John C. Cutter, M. D., as Professor of physiology and Comparative Anatomy, Cecil H. Peabody, B.S., as Professor of Mathematics and Mechanics, Lieutenant Kato as Military Instructor, and of Michimasa Miyasaki, B.S., as Chemical Assistant. Additionally, the faculty continued to revise the curriculum to meet the needs of the students, conform to the plan for colonial efforts, and to align more closely to the requirements for agricultural and engineering education.

[601] Nitobe citing President William Wheeler, Nitobe, *The Imperial Agricultural College of Sapporo, Japan*, 12.

[602] Nitobe, *The Imperial Agricultural College of Sapporo, Japan*,14.

received employment from the Kaitakushi in a field connected with agriculture, engineering, or education.[603] The following year, the college graduated another ten students, who all went into civil service.[604]

After more than a decade, the Meiji government decided that that Kaitakushi was unprofitable and decided to end it. Unfortunately, many of these decisionmakers were unaware of what the Kaitakushi had done on Hokkaido and the effects pioneering had on people, organizations, and finances. The ending of the Kaitakushi in February of 1882 might have been disastrous for the school had it not been for its adoption by the Department of Agriculture and Commerce.[605] The ending of the Kaitakushi also meant that students no longer were required to commit to government service post-graduation.[606]

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[603] Nitobe, *The Imperial Agricultural College of Sapporo, Japan*,14.

[604] It was also in 1881 that Genzo Mori became the Director of the college with the resignation of Hn. Dsusho. Mori held this position until 1886. Additionally, the presidency transferred from Wheeler to Penhallow and Brooks. Brooks held the position from August 1880 to 1886, when the Director absorbed the position.

[605] The Department of Agriculture and Commerce resided in Tokyo and were in charge of the agricultural interests of the island. However, the actual administration of these interests were the responsibility of the three prefectures established in Sapporo, Hakodate, and Nemuro. A year later, this department created a subdivision – the Kanri-Kyoku (Bureau of Supervision) – to mind the college. This arrangement lasted until 1886 when a new administrative body, the Hokkaido Cho was established. Then, in December 1886, an Imperial ordinance placed the college under the joint jurisdiction of two authorities: the governor of Hokkaido, who directed the business side of the institution, while everything relating to faculty and instruction fell to the supervision of the Department of Public Instruction, Nitobe, *The Imperial Agricultural College of Sapporo, Japan*, 15-16.

[606] Those students who had previously obtained their education through government assistance, still had to repay their government through some form of service.

In March 1887, with the external administration of the college on firmer footing, the college had to make internal administrative adjustments. Recently appointed Professor Shosuke Sato became Acting Director. Sato was a graduate of the college's first class and had continued his education in agrarian studies at Johns Hopkins University in the United States. Under his administration the college continued to evolve.[607] The scope of instruction increased in size to allow for new courses and distinct levels of agricultural study. Agriculture and civil engineering were the two main courses or departments of the college.[608] The preparatory course continued to function, but with a more comprehensive and elevated curriculum. Additionally, the college created a practical course in agriculture to train younger farmers in the use of machines, care of livestock, and rudimentary agricultural sciences.[609]

Many graduates of the College continued their education and some, like Sato, returned to be faculty or administrators. By 1886, two of the college's graduates — Kingo Miyabe ('81) and Sho Watase ('84) — had both studied at the Imperial University in Tokyo in the natural sciences. Miyabe then studied Botany at Harvard, while Watase completed his zoological studies at Johns Hopkins then became an Assistant at Chicago University. In 1887, the college appointed two of its graduates as professors, Isami Hiroi and Inazo Nitobe, both graduates of the class of 1881, and both were in America at the

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[607] In 1888, Dr. Sato was released from the Acting Director position with the appointment of Hokkaido Governmental official, Bunzo Hashiguchi, Nitobe, *The Imperial Agricultural College of Sapporo, Japan*, 21.
[608] At the end of these courses, students received the degree of Nogakushi (Bachelor of Agriculture) or Kogakushi (Bachelor of Engineering).
[609] Nitobe, *The Imperial Agricultural College of Sapporo, Japan*, 17.

time of their appointment.[610] However, neither candidate was ready to take on the positions immediately. Therefore, in the spring of 1887, Giyemon Sudo, a graduate in Veterinary Medicine from the Komaba Agricultural College, filled the chair vacated by Dr. Cutter's return to America.[611] Additionally, Horace E. Stockbridge, Ph. D., Professor of Chemistry and Geology, renewed his expiring contract for another fifteen months.[612] In 1888, the college lost Professor Brooks after a decade of service.[613] Then, in 1889, when Stockbridge left for America, Toyozo Yoshii, a graduate of the Komaba Agricultural College in Agricultural Chemistry, replaced him.[614]

In 1889, Hiroi and Miyabe returned to Sapporo Agricultural College as it continued to expand and add new lands and departments. Hiroi had to cut short his

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[610] Hiroi had been an engineer with the Mississippi River Commission in St. Louis and the Iron Bridge Works at Edge Moore, Delaware. As part of his appointment as associate professor of the college, Hiroi had to complete his engineering studies in Germany, where he studied at the Royal Polytechnic Institutes of Karlsruhe and Stuttgart. Inazo Nitobe, had been studying at the Imperial University and then Johns Hopkins in History and Economics. Upon receiving the appointment, Nitobe devoted three years to study of Agricultural Economics and Administration in Germany at Bonn, Berlin, and Halle, Nitobe, *The Imperial Agricultural College of Sapporo, Japan*, 18-19.
[611] Nitobe, *The Imperial Agricultural College of Sapporo, Japan*, 19.
[612] Nitobe, *The Imperial Agricultural College of Sapporo, Japan*, 20.
[613] Brooks returned to his alma mater as Professor of Agriculture, but his service and time in Sapporo was held in high esteem. His replacement, Professor Arthur A. Brigham, was also a graduate of Massachusetts Agricultural College, and began his work in 1889. Brigham was a practical farmer, who had divided his time between farming and being a member of the state legislature. His contract ended in 1891, but it was renewed, and he was still teaching at Sapporo in 1893.
[614] Nitobe, *The Imperial Agricultural College of Sapporo, Japan*, 21. Upon his return to the United States, Stockbridge became the Director of the Experimental Station at Purdue University. The following year, he was elected as the President of North Dakota Agricultural College, a position he held until 1893, see "President Horace Stockbridge, North Dakota Agricultural College," Accessed on February 25, 2020, http://www.digitalhorizonsonline.org/digital/collection/ndsu-bolley/id/325/.

studies in Europe to take charge of the Engineering Department, which was in desperate need of instructors. He reorganized the department and added Cornell University graduate, Bunzo Sugi, C.E., the following year. The College also established the Military Department, which then helped the colonial militia headquartered in Sapporo. Further, the College added some 3,273 acres of government forest in Yubari to its holdings.[615] By 1890, all teachers were Japanese and carried on "the Clark Tradition."[616]

In 1890, the Imperial Parliament, the Diet, began to review and dispense with institutions and funds that were no longer needed. At this time, many alumni authored a resolution to counteract the possible reduction in funds or other possible negative effects on the College. The resolution stated:

> We believe that our alma mater is an institution essential not only for the Hokkaido but for Japan at large, filling a unique position in the educational system of the Empire. It stands for the upholding of higher technical and practical education. It aims to train men for developing the physical resources of the country. In an age like this when people only talk, and politics and law engrossed the attention of the rising generation, in a land like this (meaning the Hokkaido), which hides within its bosom inexhaustible treasures, technical education is of an estimable value; and an institution equipped for this special purpose, must either be created a new or, better still, maintained if happily one already exists. Should, however, the public, — more especially the Parliament — fail to recognize the worth of our alma mater, and make any encroachment upon its appropriations, we must have whereupon to fall back for the source of its revenue.[617]

At the same time, a policy within the Hokkaido government provided the opportunity for individuals to possess through a loan or as a gift, factories or farms originally started and

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[615] Nitobe, *The Imperial Agricultural College of Sapporo, Japan*, 22.
[616] Hokkaido Prefectural Government, *Foreign Pioneers,* 26.
[617] Nitobe, *The Imperial Agricultural College of Sapporo, Japan*, 22-23.

controlled by the government.[618] The purpose of this policy was to encourage individual and private enterprise in Hokkaido. Seeing the potential of this opportunity and the unknowns surrounding the decisions of the Parliament, the Alumni Association of Sapporo Agricultural College applied for the College Farm and additional lands.[619] With their application accepted, the Alumni Association became an important part of the College.[620]

In understanding the role of the college, one might ask, *to what extent has it justified its own existence* and for Inazo Nitobe and other individuals in higher education, a quick response was, *look at what our graduates have done*. As stated previously, the first two graduating classes of Sapporo Agricultural College went into civil service with the Kaitakushi. However, when the third class graduated the Kaitakushi was no more. The prefectures, at the time, did not have the wherewithal to pay many of these graduates. Therefore, only a few of this class remained in Hokkaido, the rest found work in other parts of Japan. The fourth class of graduates was the first to not be supported by the government. Therefore, these graduates had no responsibility to the administration of Hokkaido and had the option to go wherever they desired.[621]

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[618] Nitobe, *The Imperial Agricultural College of Sapporo, Japan*, 23.

[619] When Dr. Sato returned from America in 1886, he organized the Alumni Association. At first it was an informal a company of young graduates who occasionally got together for social meetings and remembrances of their time in college.

[620] The Association's possession of the land came with some contingencies. The college's farm held the model barn which included stock, machines, and other apparatus needed to keep the farm functioning effectively. Therefore, the Association had to provide the upkeep to the farm, so that its status as a model farm continued. The Association was also responsible for the upkeep and maintenance of other lands in Sapporo.

[621] Their own education at Sapporo gave them a solid foundation to do whatever they wanted to do in their own lives. Of use was their knowledge of English, which allowed

However, while many students traveled to other parts of Japan, the largest concentration of graduates resided in Sapporo. In the early 1890s, around one-third of all alumni of the departments of agriculture and engineering worked in various branches of the administration of Hokkaido.[622]

As is the case with many institutions of higher education, Sapporo Agricultural College has had to work through the tenuous relationship between science and practice. As Nitobe suggested, "between the profit-seeking Practice and the truth-seeking Science there lies a wide gulf in interests."[623] Therefore, the demands of the *practice* and *science* of agriculture do not always harmonize. This lack of harmony has and will shape institutions of higher education that focus on agriculture and agricultural science education. In time, this will lead to each agricultural institution developing its own individual character in how it manages and instructs this relationship. Inevitably, as Nitobe describes, "An organization no less than an organism, can not last long without adapting to its environment."[624] This process is slow and must not be pressured from

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many graduates to gain positions in educational fields, in business, and in government. Several graduates also become writers covering topics and fields such as botany, agriculture, chemistry, physics, history, engineering, zoology, travels, literature, economics, fishery, and geography, Nitobe, *The Imperial Agricultural College of Sapporo, Japan*, 29-30.

[622] This included agriculture, colonization, education, engineering, forestry, fishery, and geological surveying. Additionally, graduates of the college filled out the rosters and or active members of several intellectual and social organizations such as the Society for the Advancement of Agriculture, the National Science Society, the Fishery Association, the Young Men's Christian Association, the Temperance Society, the Silk Culture Association, and many others, Nitobe, *The Imperial Agricultural College of Sapporo, Japan*, 30.

[623] Nitobe, *The Imperial Agricultural College of Sapporo, Japan*, 32.

[624] Nitobe, *The Imperial Agricultural College of Sapporo, Japan*, 33.

external forces. “Politics must never meddle with an educational institution,” Nitobe declares, “for the kingdom of Science must never tolerate the rule of politics or pander to the fickle wants of public opinion.”[625] These ideas echo those of Wilhelm von Humboldt. Sapporo Agricultural College, at least in its first twenty years of existence, adopted the Morrill Land Grant Model instituted at Massachusetts Agricultural College in Amherst, along with its governmental ties, colonial aspirations, and scientific foundations. This college had a lasting effect on the shape and direction of Japanese colonization efforts in Hokkaido, the use of its resources, and the development of knowledge within its people. This included the impression of the Clark’s influence on Christianity in Hokkaido through his students like Nitobe, Miyabe, and others. In the end, the Sapporo Agricultural College helped establish new ways of using the land on Hokkaido and provide a model for further imperial conquests for Japan.

Hokkaido University and Empire

As time moved into the twentieth century, the lessons learned from the colonization efforts on Hokkaido prepared Japan to expand its empire little by little. Through international conflict and regional wars, Japan began to increase the size of its influence: first on Hokkaido (1868), then Taiwan (1895), Manchuria (1905), Korea (1910), then all of Manchuria (1931), China proper (1937), French Indo-China (1941), British Burma (1941), British Borneo (1942), and the Dutch East Indies (1942) –

[625] Nitobe, *The Imperial Agricultural College of Sapporo, Japan*, 33.

everywhere, they used Western notions of modernity and science and engineering to do so.

Yukichi Fukuzawa, Kiyotaka Kuroda, Mori Arinori, the Iwakura Mission all embraced the five points of *The Charter Oath*, especially the last one: "Knowledge shall be sought throughout the world so as to strengthen the foundations of imperial rule."[626] In the United States, Japan saw a country that had just conquered its western lands through force and colonized it, in part, through education. Using the land grant model of education, states were able to provide opportunities of knowledge acquisition through the agriculture and the mechanical arts. This model was exactly what Japan needed to fully colonize Hokkaido. Through scientific surveys, education, and practice, Japanese colonizers, through the help of American scientists, engineers, and educators, reshaped Hokkaido both above and below the surface of the land.

Fukuzawa called for education for personal independence, which in turn ensured national independence. He also called for his countrymen to throw off the traditional ways of Chinese education and embrace Western approaches. In his famous "Datsu-a ron", when talking about Japan's neighbors – China and Korea – he stated: "We simply follow the manner of the Westerners in knowing how to treat them … We simply erase from our minds our bad friends in Asia." [627] Through the efforts established during the early years of Meiji, the government quickly sought to become modern and ramped up its industrialization. They sought Western ideas and approaches but did not heed the words

[626] "The Charter Oath (of the Meiji Restoration), 1868."
[627] Fukuzawa, "Good-bye Asia," 353.

of caution from Fukuzawa's *An Encouragement of Learning*, where he warned about the superficiality of the motives of learning. He said, "One must have insight into when to believe and when to remain skeptical."[628] In a desire to quickly change a civilization to embrace a Western approach, Fukuzawa observed, that "the focus of past beliefs has only been redirected toward the modern West, but we have no guarantee that a truly critical choice has been made concerning present beliefs and doubts."[629] This idea of "erasing from our minds" the friends of Asia appears to have been a driving force of the government in the last decade of the nineteenth century and the first few decades of the twentieth. But was this a "truly critical choice" or was it a superficial understanding of the modern West?

The Meiji Restoration continued the efforts to colonize and secure the northern island of Hokkaido against the influence of Russia and other possible foreign bodies. They adopted Western approaches to managing land through engineering and agriculture and people through education. The school established in Sapporo became Hokkaido Imperial University in 1918. In 1919, the Agricultural College became the Faculty of Agriculture, and the School of Medicine was also established. Over the next thirty years, the Faculty of Engineering, Science, Law, and Literature were added to the institution. In 1947, Hokkaido Imperial University became Hokkaido University and in 1953, it created the Graduate School. As this school, which provided a model and center for colonizing Hokkaido and expanding Japan's empire evolved to Hokkaido University, Japan's empire

[628] Fukuzawa, *An Encouragement of Learning*, 94.
[629] Fukuzawa, *An Encouragement of Learning*, 95.

peaked, the country went to war in WWII, the empire crumbled, and the Cold War started.

In the 1950s, faculty from Hokkaido University and the University of Massachusetts – Amherst (UMass) began a dialogue with each other. Over the next few decades faculty from both institutions were part of a series of exchanges. These exchanges opened new lines and access to research and materials concerning both schools and their individual and collective history. John Maki, a historian at UMass, contributed to these exchanges, which in turn provided the necessary materials to conduct research on William Smith Clark and the Massachusetts connection with Hokkaido.

In 1876, William Smith Clark traveled across the country and across the Pacific Ocean to Japan. In doing so, Clark internationalized the land grant mission and became a part of a larger colonizing mission to modernize Hokkaido. Although Clark's physical presence in Japan lasted less than a year, his influence continues to this day and can be seen in memorial statues or in popular culture, such as the plush Pokémon representation of Clark as a large Pikachu statue pointing, with a Pikachu child imitating him.

Clark and his fellow American educators and experts imported American approaches to education, science, technology, and agriculture that had a lasting effect on the land and peoples of Hokkaido and Japan. These men effectively turned a school, modeled after a land grant school in Massachusetts, into a school of empire and colonization. Whether it was through scientific and agricultural thought and practice, or through Clark's religious missionizing, Hokkaido, the Japanese colonizers, and the indigenous Ainu populations were forever changed. In the end, Clark's final words to his

students, “Boys, Be Ambitious!” became a life lesson, not only for those men on that road in 1877, but for Japanese students up to the present day.

CHAPTER FIVE

"NEW FRONTIERS OF THE MIND ARE BEFORE US": HIGHER EDUCATION AFTER WORLD WAR II

In February 2018, select members of Montana State University's (MSU) administration and CEOs from several industries ceremonially broke ground on the new Applied Research Lab in the MSU Innovation Campus.[630] Included in the groundbreaking were Waded Cruzado, President of MSU; Kris Merkel, CEO of S2 Corporation; Wesley Kremer, President of Raytheon Integrated Defense Systems; Lieutenant Governor of Montana, Mike Cooney, Renee Reijo Pera, MSU Vice-President of Research and Economic Development; and Joe Shaw, Professor of optical sciences at MSU and Director of the Optical Technology Center. This Lab will provide a space with the proper security clearance for MSU to conduct research for the Departments of Defense and Energy. This multimillion-dollar investment from both the university and outside grants will provide research opportunities and new sources of funding for the university.

Opening in 2020, much of what occurs in this 20,000 square foot building will be unknown to the public due its sensitive nature.[631] However, this was not the first time

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[630] Tracy Ellig, "Montana State Breaks Ground on Applied Research Lab" MSU News Service, February 21, 2018, http://www.montana.edu/news/17465/montana-state-breaks-ground-on-applied-research-lab. The new building will house six laboratories for advanced classified research.

[631] Schontzler, Gail. "MSU's Spy-proof Research Lab Nearly Complete." *Bozeman Daily Chronicle*, January 18, 2020: 01. *NewsBank: Access World News*. https://infoweb-

sensitive and secretive research had been conducted at Montana State University, nor was it the first time that federal departments and those affiliated with military applications supplied funding and material for research. This working relationship has had its ebbs and flows for several decades, as scientific and technological research projects and laboratories developed, especially after the end of World War II. As a result, universities across the United States, and specifically in Bozeman, Montana, became active participants in the Academic-Military-Industrial Complex. The study of the Academic-Military-Industrial Complex and its role in shaping higher education in Montana is the focus of this chapter.

This chapter argues that as colleges and land-grant schools redefined themselves as universities and some schools of mines renamed themselves as tech schools, global politics, and international cooperation created a more connected world. Institutions of higher education, especially those associated with state and industrial interests, became new sites of colonization and conquest, and reinforced imperial thinking as government and military contracts funded the development of specialized research projects that continue to shape the direction of science and technological knowledge development.

Where Wilhelm von Humboldt, in 1809, called for state support with freedom and autonomy for university professors, twentieth and twenty-first century schools became the site of practical knowledge development and applications for the state or other external interests. In the process, institutions of higher education became bureaucratic

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newsbankcom.proxybz.lib.montana.edu/apps/news/document-view?p=AWNB&docref=news/1788C122A44195F0.

organizations haggling with political and industrial funding agencies who viewed universities as their own producer of practical knowledge. However, these institutions house faculty who must find ways to balance this expectation with a desire for theoretical knowledge production and their role as educators — a more Humboldtian ideal. This response has irked some members of these agencies who are ignorant of the original idea of the university, its place in society, and its relationship to the state. As a result, politicians question the purpose in funding institutions that do not produce entirely "useful" knowledge for the benefit of the state.[632] Instead, these politicians seek to limit or defund institutions, and focus their funding on institutions that will align with the state or provide more practical, job-oriented educational opportunities, or have a long history of strong research programs, perhaps with ivy league roots.

Beginning with a discussion on President Dwight D. Eisenhower and his description of the Academic-Military-Industrial Complex (AMIC), this chapter will focus on the Electronics Research Laboratory (ERL), its history and its faculty, staff, and students, to analyze Montana State University's relationship with the AMIC in the 1950s through the end of the century. Stanford University, and the creation of the Stanford Research Institute, plays a key role in the development of ERL, as MSU had been a satellite site for an SRI study. This study laid the foundations for ERL and the resulting years of research and development. The role of research, its effects on educational opportunities, and the people involved in ERL are of utmost importance to longevity of

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[632] Derek Thompson, "The Republican War on College" *The Atlantic* November 20, 2017 https://www.theatlantic.com/business/archive/2017/11/republican-college/546308/.

the program and the spinoff companies it inspired. Ultimately, ERL, as an entity appeared to fade away but the people who were integral parts of the laboratory and the continued focus on engineering research and development define the legacy of ERL. Finally, we will conclude with a discussion about the Academic-Military-Industrial Complex and the state of higher education today.

Eisenhower and the Academic-Military-Industrial Complex

On January 17, 1961, speaking to the country for the final time, President Dwight D. Eisenhower laid out a cautionary tale of the country's relationship with what he called the military-industrial complex. In this speech, Eisenhower stated, "in the councils of government, we must guard against the acquisition of unwarranted influence, whether sought or unsought, by the military-industrial complex."[633] He warned that the potential of "the disastrous rise of misplaced power exists and will persist."[634] This power and its relationship to how it could direct the government for good or ill provided a sense of foreboding to the end of Eisenhower's tenure as President.

As he continued with the speech, Eisenhower identified the function of the university and its relationship to the government. He described the "free university" as historically being the "fountainhead of free ideas and scientific discovery," and that it "has experienced a revolution in the conduct of research."[635] The rise of the research

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[633] Dwight D. Eisenhower, "Farewell Address: Reading Copy" January 17, 1961, 15. https://www.eisenhower.archives.gov/research/online_documents/farewell_address/Reading_Copy.pdf
[634] Eisenhower, "Farewell Address," 15.
[635] Eisenhower, "Farewell Address," 17-18.

university has been documented throughout this dissertation beginning with Wilhelm von Humboldt. Humboldt saw the need to limit the role of the state, whose "action should be confined to the protection of the citizen within is frontiers and against attacks from outside."[636] Overall, Humboldt "was afraid that State influence on education would 'always favour one particular form'; this was particularly deleterious if it 'relates to man as a moral being […] and ceases altogether to have any beneficial action if the individual is sacrificed to the citizen.'"[637] He later went on to argue that the "sole purpose of education must be to shape man himself" and the state's role must be reversed: "Education of the individual must everywhere be as free as possible, taking the least possible account of civic circumstances. Man educated in that way must then join the State and, as it were, test the Constitution of the State against his individuality."[638] Therefore, man was a subject who helped shape society and not an object of the state.

Humboldt envisioned a university that united teaching and research. In his own words, this new system had "a special feature of the higher scientific establishments that they treated science as a problem that is never completely solved and therefore engaged in constant research."[639] Two themes of higher education originate with Humboldt: the university as an extension of the state but free to pursue its own interests and connecting

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[636] Gerd Hohendorf, "Wilhelm von Humboldt," *Prospects* 23, no. 3–4 (September 1, 1993): 668.
[637] Wilhelm von Humboldt, *Gesammelte Schriften: Ausgabe der Preussischen Akademie der Wissenschaften* [Collected Writings: Prussian Academy of Sciences Edition], 17 vols., (Berlin, 1903-1936): I, 143, as cited in Gerd Hohendorf, "Wilhelm von Humboldt," *Prospects* 23, no. 3–4 (September 1, 1993): 668.
[638] von Humboldt, *Gesammelte Schriften*, I, 144-145, cited in Hohendorf, 668.
[639] von Humboldt, *Gesammelte Schriften*, X, 251, cited in Hohendorf, 673.

teaching and research. The twin pillars of a Humboldtian university are the freedom of science and the autonomy of the teaching staff. These two premises allowed science and research to be conducted without the interference of political or external entities. This was because Humboldt did not want politics to misuse science. However, this autonomy and freedom was not an attempt to lock university teachers away from society. This was in direct opposition of his views of education and its key role in society.

This role in society and the free pursuit of research without interference from the state or any of its entities was not the reality for Eisenhower. Instead he saw that universities were beholden to external entities:

> Partly because of the huge costs involved, a government contract becomes virtually a substitute for intellectual curiosity. For every old blackboard there are now hundreds of new electronic computers…The prospect of domination of the nation's scholars by Federal employment, project allocations, and the power of money is ever present and is gravely to be regarded. Yet, in holding scientific research and discovery in respect, as we should, we must also be alert to the equal and opposite danger that public policy could itself become the captive of a scientific-technological elite.[640]

At different points in his speech, Eisenhower discussed the importance of balance and its place in the maintenance and well-being of the country. He then cautioned the public about the potential of the military-industrial complex to distort the balance of power, not only in terms of politics, but also in academics. For this reason, scholars have referred to it as the Academic-Military-Industrial complex (AMIC), as the academic world is often the site of research and development within the larger complex.[641] This connection

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[640] Eisenhower, "Farewell Address," 17-18.

[641] See Jonathan Feldman, *Universities in the Business of Repression: Academic-Military-Industrial Complex and Central America* (Boston: South End Press, 1989); Stuart W. Leslie, *The Cold War and American Science: The Military-Industrial-*

between the three fields was integral to Senator J. William Fulbright's "The War and its Effects" speech before the Senate on December 13, 1967.[642] Fulbright echoed Eisenhower's concerns over the complex, but went further to explain how Eisenhower's warnings came to fruition in how professors shifted from teaching their students to doing the will of their government. The balance described by Humboldt between teaching and research, if this complex is left unchecked, becomes skewed to the side of research, and the teaching role suffers. Additionally, the type of direction of research itself becomes misaligned away from pure research and towards practical, externally driven research.

This misalignment continued and was reinforced through Vannevar Bush and the creation of the National Science Foundation in 1950, which provided an avenue for institutions of higher education to gain access to funding to pursue scientific and technological research, specifically for non-Defense related pure research.[643] Similarly, due to the launch of *Sputnik*, the United States government passed the National Defense Education Act of 1958.[644] This Act legitimized federal funding of higher education. In doing so, the Act made funds available for low-cost student loans. Additionally, although this act was intended to support science, mathematics, and foreign languages, it also

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Academic Complex at MIT and Stanford (New York: Columbia University Press, 1993), and; Henry A. Giroux, *The University in Chains: Confronting the Military-Industrial-Academic Complex* (Boulder: Paradigm Publishers, 2007)

[642] Senator J. William Fulbright "The War and Its Effects – II," on December 13, 1967, 90th Cong., 1st sess., Congressional Record 113, pt. 27:2279.

[643] Vannevar Bush, *Science the Endless Frontier: A Report to the President on a Program for Postwar Scientific Research.* (Washington DC: National Science Foundation, [1945] reprinted 1960).

[644] United States Senate, "Sputnik Spurs Passage of the National Defense Education Act" https://www.senate.gov/artandhistory/history/minute/Sputnik_Spurs_Passage_of_National_Defense_Education_Act.htm

expanded libraries and a variety of other services for students.[645] These federal developments changed higher education through new sources of funding, new directions for research, and an expansion of opportunities for a larger number of students.

Stanford, the Stanford Research Institute, and Montana

The story begins with Stanford University and the Stanford Research Institute. The idea for the Stanford Research Institute first emerged in 1925 in the mind of Stanford professor of chemistry, Dr. Robert E. Swain.[646] He wanted to create a research institution dedicated to chemistry, physics, and biology. He shared this idea with his friend and Stanford alumnus, Herbert Hoover, in 1926/7, who agreed with the prospect of a research institute and pushed for its development. Hoover had previously helped fund the Stanford Graduate School of Business and discussed the idea of the "Stanford family of institutions."[647] The president of Stanford Dr. Ray Lyman Wilbur was receptive to this idea. Unfortunately for Swain, several exogenous events prevented the manifestation of this idea until much later. Beginning with the economic crisis that led to the Great Depression, Stanford was not in a secure place to support the development of this program. Additionally, across the country there were concerns about the nature of

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[645] US Senate, "Sputnik".
[646] Weldon B. Gibson, *SRI the Founding Years: A Significant State at the Golden Time* (Los Altos, CA: Publishing Service Center, 1980), 5; Donald L. Nielson, *A Heritage of Innovation: SRI's First Half Century* (Menlo Park, CA: SRI International, 2006), B-1.
[647] Gibson, *SRI*, 5.

research institutes and the competition they posed to academics and basic research programs. Finally, World War II prohibited the creation of said institute until later.[648]

In 1946, Stanford Research Institute formally opened its doors on the Stanford Campus.[649] Over the next several decades the Institute evolved and worked with a variety of military and industrial organizations, which led to it divorcing itself from the University in 1970, over outcries of its close connection with the military.[650] But before leaving Stanford University, SRI set up remote links on other campuses. During 1955 and 1956, SRI had a contract with the Air Force Cambridge Research Center that focused on the development and demonstration of an experimental meteor burst communication system.[651] In the course of this study, Bozeman, Montana was selected as a suitable remote link.

Electrical engineering was not a new field at Montana State College. On June 7, 1897, Montana Agricultural College designated $2,500 for electrical engineering apparatus, thus beginning the electrical engineering program.[652] Between 1897 and the 1950s, the engineering departments grew and had a variety of success. In the 1920s, the

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[648] See Gibson, *SRI,* 6-17, This provides a detailed account of the ebbs and flows that Swain and Stanford went through as they sought to create this new institution.
[649] Gibson, *SRI,* 1.
[650] Weldon B. Gibson, *SRI the Take-Off Days: The Right Moves at the Right Times* (Los Altos, CA: Publishing Service Center, 1986), vii.
[651] Nielson, *Heritage of Innovation*, 9-12-9-17. Nielson does an excellent job describing the intent and process behind meteor burst communication technology. *Electronics Research Laboratory,* (Bozeman, MT: Endowment and Research Foundation, 1963), 71-72.
[652] Merrill G. Burlingame. “Early Catalog Notes”, Annual MSC Course Catalog, Merrill G. Burlingame Research Files on MSU History, 1895-1968. Accession 84014, Box 1:14, Montana State University Archive (hereafter cited as Burlingame, “Early”).

college joined other land-grant schools in opening an engineering experiment station to conduct research similarly to the previously established agricultural experiment station.[653] However, by 1954 it appears that only Chemical Engineering had a research program attached to its graduate program. The Dean of Engineering, Dr. E. W. Shilling, met with Dr. Donald K. Weaver, Jr., Senior Research Engineer at Stanford Research Institute in 1952 about the possibility of creating an Electrical Engineering Research Laboratory at Montana State College (MSC).[654] Subsequent discussions between Dean Schilling and Weaver indicated a willingness to consider a research and a graduate program at MSC. In 1955, SRI sent Weaver to conduct a survey about the advantages and problems with this idea. The survey indicated several "advantages of a research program and its effect not only on the college but on the development of opportunities in Montana for the state's own technically trained youth."[655]

In June of 1956, SRI subcontracted responsibility to the endowment and research foundation at MSC and to Dr. Weaver, who joined the staff at MSC. SRI agreed to loan a "considerable amount of capital equipment to MSC and also to supply the necessary government-furnished equipment required by remote stations."[656] Thus, the Electronics Research Laboratory at MSC was born.

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[653] Montana shows up in 1924, showing the formation of its station on April 18, 1924; History of Engineering Experiment Stations, 1916-1926, Box 1, Folder 5, Office of Education: Records of the Office of the Assistant Commissioner, Division of Higher Education, Record Group 12; National Archives at College Park, College Park, MD.
[654] *Electronics Research Laboratory*, 68; D. K. Weaver Jr., "Engineering Research Possibilities at Montana State College", 1956.
[655] *Electronics Research Laboratory*, 68; Weaver, "Engineering Research Possibilities."
[656] *Electronics Research Laboratory*, 68-9.

Electronics Research Laboratory

During its first two years, ERL relied on SRI for research contracts. However, due to the recession in the fall of 1957, SRI had to pull their financial support leaving ERL on its own. It has been suggested that the launch of Sputnik may have saved ERL from a sudden death.[657] Soon after Sputnik's launch, ERL began to obtain several research projects from Rixon Electronics, Hoffman Electronics, Rome Air Development Center, and the Technical Material Corporation, to name a few.[658] In other words, the United States thoroughly felt the pressure of the Soviet Union launching Sputnik. At this time, established research laboratories, even ERL, one in its infancy, became active sites for new forms of research, often with international implications.

Between 1958 and 1961, ERL grew rapidly, doubling its research income each year. By 1963, the annual income was around $460,000. From an original staff of three, ERL had grown to a staff of fifty by 1961. Additionally, the number of graduate students grew from an average of one per year before 1956 to more than twenty by 1961.[659]

In 1960, Dr. Byron J. Bennett joined the faculty of Montana State College as head of Electrical Engineering Department; eventually he became Dean of Engineering.[660] At around the same time, Robert Leo arrived from Arizona and began working on developing the area of computer techniques and digital circuit techniques at MSC. He was recruited to Montana while working in Arizona after completing his master's in

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[657] *Electronics Research Laboratory*, 68-9.
[658] *Electronics Research Laboratory*, 69.
[659] *Electronics Research Laboratory*, 69.
[660] *Electronics Research Laboratory*, 70.

electrical engineering at Stanford.[661] In time, he became the second and final director of ERL, as he helmed the program throughout the latter part of the 1960s and into the 1970s.[662] In 1971, when asked about what ERL did, Leo pointed out that "some of the work is theoretical and some has practical applications, many directly affecting Montana."[663] At the time, the Montana Crime Control Commission was one of the largest sponsors of ERL, as it worked to improve communication between law enforcement in Montana with other authorities.[664]

During the 1960s, the ERL was granted secret clearance by the United States military. This allowed ERL to develop projects for different branches of the U.S. military and its affiliated companies. For example, when the Minuteman Missile Weapon system was being installed in Montana it opened the door for a long relationship between ERL and the Boeing Company.[665] In time, this security clearance and ERL's work with international agencies provided the opportunities for ERL staff and products to travel overseas to places like Thailand and South East Asia.[666] Some ERL staff members, who eventually departed to form Montronics, a spinoff company, returned to ERL and were involved in designing equipment for the Atomic test series in the Pacific in 1962.[667]

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[661] Personal Interview, Robert Leo, August 12, 2014.
[662] Personal Interview, Robert Leo, August 12, 2014.
[663] Bill Young, "ERL: From Meteor Tails to Christmas Cards" *Bozeman Daily Chronicle* (July 11, 1971): 6.
[664] Young, "ERL," 6.
[665] *Electronics Laboratory*, 70. See also, Robert E. Leo, "Technical Note: Signal Attenuation in Minuteman Cable" Electronic Research Laboratory (March 5, 1962), ERL Archival Materials.
[666] Personal Interview, Robert Leo and Nick Shrauger, August 12, 2014.
[667] Personal Interview, Ron Callantine, August 13, 2015.

In 1966, Leo invited Montana State University's President Leon Johnson, the vice presidents, and deans to tour the ERL facilities and listen to presentations from its eight divisions. According a memo to the ERL Group Supervisors, they were expected to provide a "five minute dissertation on his group and their activities," which included the major function of the group, definition and description of present projects, future efforts and aims, and a closing.[668] The eight groups included: Communications, headed by John Duncan; Electronics, headed by Dr. Paul Uhlrich; Environmental Engineering, headed by Dr. Donald K. Weaver; Signal Analysis, headed by Dr. Norman Shyne; Radio Sciences, headed by Daniel March; Instrumentation, headed by John Rompel; Facilities, headed by Robert Rickabaugh; and Processes, headed by Ron Callantine.[669] Leo provided the "five minute dissertation" from the Communications group as an example for the other groups.

The Communication Group report laid out the focus of the group and detailed the projects it had been working on over the past few years. Headed by Duncan, this group "engaged in investigations of the fundamentals of efficient and reliable information, transmission, retrieval, and processing and their application" using advanced techniques,

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[668] Memorandum to ERL Group Supervisors from R.E. Leo, November 28, 1966, ERL Archival Materials.

[669] Memorandum to ERL Group Supervisors from R.E. Leo, ERL Archival Materials. These are the projects listed for each group: Communications – FM Study, Navy Southern Cross, and Data Systems; Electronics – RC Active Networks, Magnet, Control Systems; Environmental Engineering – Data Center and Bridger Instrumentation; Signal Analysis – Signal Analysis and Synthesizer; Radio Sciences – Frequency Standards, Microwaves, Satellite, Radio Noise, and Meteor Burst; and Instrumentation – Digital Pressure Transducers, Rossi, Data Transmitters, Receivers. Both Facilities and Processes did not have specific items to discuss.

and modern designs and theories. [670] The first project this group discussed dealt with their relationship with the Navy Electronics Laboratory of San Diego (NEL). ERL served as consultants for NEL for two years doing everything from providing advice to actual designs for the lab. Twice a week, ERL talked with the Navy through an SSB radio channel and developed several prototypes for Navy communication systems.[671] The goal was to develop Navy's Project Southern Cross, which was the new tactical communication system planned for 1970.[672]

From an earlier contract with NASA, this group continued to study how they could improve the efficiency of the reception of FM data. The results of this study led to a patent application centered on using lower power transmitters, which would reduce the size and weight of space and satellite communication systems. Additionally, these results led to a contract with the US Army Electronics Command at Fort Monmouth, New Jersey that culminated in the use of Frequency Tracking Filters in the Army.[673]

As for digital data, the Communications Group discussed how they developed systems and equipment to retrieve "vast amounts of field data from many sources and processing this data so it may be presented in its most digestible and useful form."[674] For hydrometeorological data, this group devised analog-to-digital converters that take analog

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[670] Memorandum to ERL Group Supervisors from R.E. Leo, "Communications Group," November 28,1966, ERL Archival Materials.
[671] SSB refers to single side band, which was a long-range radio signal used to transmit information. See Gil McElroy, VE3PKD, "Amateur Radio and the Rise of SSB" *QST* January 2003, http://www.arrl.org/files/file/Technology/pdf/McElroy.pdf.
[672] "Communications Group," ERL Archival Materials.
[673] "Communications Group," ERL Archival Materials.
[674] "Communications Group," ERL Archival Materials.

measurements from transducers at thermistors, anemometers, and wind direction instruments, and converts them into digital data. This data was then transmitted to a data acquisition center, which punched an IBM card for processing in the IBM 1620 computer. The group noted that "a unit is presently under development which will eliminate the tape to card conversion step and will read the tapes directly into the computer."[675] This new unit sped up the process and reduced the materials needed for the cards.

As the Communications Group concluded their presentation, they described how both the Army and Navy were in negotiations with them. These negotiations focused on additional research and development for the future. As the group added more manpower and space to their operations, they suggested that these relationships would expand.[676]

Unfortunately, Leo did not include the other groups' dissertations in his memorandum; however, he provided some other details about ERL and what it resembled in 1966. Included were a list of twenty-nine sponsors and the financial information from July 1, 1965 – June 30, 1966.

[675] "Communications Group," ERL Archival Materials.
[676] "Communications Group," ERL Archival Materials.

Table 2. Sponsors of ERL reported in 1966.[677]

Sponsors of ERL, 1966	
Aero-Service Co.	Montronics, Incorporated
Air Force Cambridge Research Center	National Aeronautics & Space Administration
Autonetics	National Science Foundation
AVCO Corporation	Navel Electronics Laboratory
The Boeing Company	Permian Corporation
Bonneville Power Administration	Rixon, Incorporated
Deaconess Hospital	Rome Air Development Center
Granger Associates	Soil Conservation Service (Dept. of Ag.)
Hoffman Electronics	Stanford Research Institute
Hughes Aircraft Corporation	Stanford University
International Business Machines	Technical Material Corporation
Lawrence Radiation Laboratory	University of Saskatchewan
Montana Power Company	US Army Electronics Laboratory
Montana State University	US Forest Service
Water Resources Research, Dept. of Interior	

In terms of financial information, Leo listed the total income as $427,523.96. He then broke down the "Contracts and Grants Only" to:

Salaries	$178,982.57 on projects alone
Materials	$121,649.89
Travel	$ 21,010.51
Program Development	$ 14,043.66
Facilities	$ 27,992.32
Business Admin & Payroll Reserve	$ 34,855.62
Fees Earned	$ 9,847.35[678]
Total	$408,381,92

The "Contracts and Grants Only" numbers were $19,142.04 less than the overall income reported above. This suggested that there were other sources of income for ERL outside the contracts and grants line items listed above. This difference also demonstrated how reliant ERL was on external contracts and grants for their operations to continue.

[677] Memorandum to ERL Group Supervisors from R.E. Leo, ERL Archival Materials.
[678] Memorandum to ERL Group Supervisors from R.E. Leo, ERL Archival Materials.

The Electronics Research Laboratory resided on the MSC campus in Ryon Labs. Graduate students and some staff had offices in the upper level of the building named for the first president of MSC, which was demolished in the 1990s and replaced by Barnard Hall.[679] The professors, who were also ERL staff members, had offices in Roberts Hall. In time, this separation of offices was partially resolved with the building of Cobleigh Hall between the two buildings.

In Ryon labs, ERL divided the space between the different research groups in and with other engineering departments. ERL also had a field site called the "log cabin."[680] This building was near the football stadium and was a location for many communication-based projects. The physical arrangements suited ERL and other departments of engineering throughout the 1960s, but at the close of the decade space began to diminish.

At the end of the 1960s, ERL and the Endowment and Research Foundation developed the idea of a research park. This park allowed fledgling businesses, some of which spun out of ERL, an opportunity to have the necessary laboratory space and offices to develop their business. In 1968, Robert Leo wrote to Dr. Roy Huffman about the research park. The new building shared spaces with ERL, TAP and Summit Engineering Corp. These organizations requested a building with 10,000 ft^2 to provide enough space for offices and laboratories. An earlier proposed plan designated a lab area of

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[679] Personal Interview, Ron Callantine; Robert Leo, Nick Shrauger; Bob Foreman and Harley Leach, November 3, 2014; Norm Shyne, November 7, 2014; Don Pierre and Don Rudberg, November 17, 2014; John Hanton, November 21, 2014; and Lee Cannon, December 9, 2014. Many of these former ERL students, workers, and professors talked about the offices being up in the rafters including a section for graduate students.
[680] Personal Interview with Don Rudberg and Lee Cannon.

approximately 5,500 ft^2, which was smaller than desired.[681] It is now referred to as the Huffman building, and currently houses the MSU campus police.

ERL and Research

The primary focus of the Electronics Research Laboratories was research. This program provided opportunities for graduate students and professors to pursue both basic and applied research. Individuals involved with ERL also had opportunities to engage in engineering research and consultation projects outside the purview of the University. Through these forms of research, ERL designed and developed products, performed data acquisition and processing, and conducted environmental research and developed instrumentation. This included many local and international contracts. One such project occurred in the early 1970s with the Max Planck Institute in Germany. In 1974, the *Montana Collegian* reported that "A six-ton antenna" was "shipped to the MSU campus by air and truck from Germany."[682] The antenna was designed to help "scientists study the make-up and disturbances in the ionosphere."[683] This study was a joint project between the U.S. National Oceanographic and Atmospheric Administration, ERL, and the Max Planck Institute. Similar antennae were constructed in Dallas, Texas and Boulder, Colorado to receive the signals and detect disturbances.

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[681] Robert E. Leo, "Research Park Correspondences January 17, 24, and February 2, 1968." ERL Archival Materials.
[682] Keith A. Botterud, ed. "The Front Cover" *Montana Collegian* 50, no. 3 (Fall 1974).
[683] Botterud, "The Front Cover."

The Electronics Research Laboratory did not just focus on international research projects. It also worked with departments at Montana State College/University, including psychology, physics, and agriculture. In agriculture, ERL designed several products to collect data about livestock and crops. They also developed radio-controlled systems to help regulate the amount of irrigation a field received.[684] The K^{40} Lean-Fat Ratio detector enabled animal scientists to determine the amount of fat in cows, using radiation.[685] ERL also designed a pill that could be detected using a Rf system. Livestock swallowed the pill, then a rancher used an ERL-designed device to identify the animal. Additionally, in the 1970s, ERL developed a computing and timing system for use in rodeos.[686] This may have been one of the first computer-based timing systems used in rodeo and was operated by ERL students.

As mentioned earlier, throughout the 1970s, ERL worked with the Montana Board of Crime Control to improve the communication between law enforcement agencies throughout the state. This entailed developing a "Speech Scrambler" to prevent eavesdroppers from accessing sensitive radio broadcasts.[687] ERL also helped determine the proper radio equipment for the agencies to use and how to communicate with each other. More locally, ERL worked with Bridger Bowl to determine snow depth and other hydrometeorological readings from the slopes to MSU.[688]

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[684] Personal Interview Robert Leo, Nick Shrauger, and John Hanton.
[685] Personal Interview with Lee Cannon.
[686] Personal Interview with Nick Shrauger.
[687] Personal Interview with Robert Leo.
[688] Personal Interview with Robert Leo.

ERL also had a few projects involving forest fires. Early in ERL's history, lightning direction finders were developed as lightning was responsible for starting fires, especially in Alaska.[689] ERL students and staff also developed new fire training and detection systems that were used in Montana and in other states.

ERL and its Spinoffs

In 1960, a group of engineers and students spun off ERL and formed their own electronics company called Montronics. After two years, John Fluke Manufacturing Co., from Seattle, acquired this company.[690] At its peak, Montronics employed around 100 people, including many ERL graduates. However, Fluke eventually relocated production to Seattle. Some staff returned to MSU, working in the Electrical engineering department as professors, stockroom supervisors, and fabrication supervisors.

At the end of the 1960s, two more companies spun off ERL – Summit Engineering, Corp. and Western Telecomputing. At the beginning of the 1970s, another group spun off – Developing Technology Incorporated. Each of these companies inhabited the Huffman building for a time. Another company, Teletech also spun-off in the early 1970s. These companies had varying degrees of success but provided opportunities for the growth of the electronics industry in Bozeman. Other companies employed ERL staff in the role of consultant. This appears to be the case with Tetragenics, which started in 1972 and helped meet the needs of Montana Power

[689] Personal Interview with Harley Leach, Norm Shyne,
[690] Personal Interview with Norm Shyne, Nick Shrauger, and Ron Callantine.

Company, specifically in the use of digital computers to automate the Ryan Dam.[691] Each of these companies helped develop the electrical engineering industry in Bozeman. In time, this approach served as a model for other companies to spinoff and develop either in Bozeman or in other locations.

Table 3. Selected Spinoff Companies Affiliated with Montana State University

Parent Organization / Department	Spinoff Company	Date
ERL	Montronics	1960
	Summit Engineering, Corp.	Late 1960s
	Western Telecomputing	Late 1960s
	Digital Technology Incorporated	1970
	Teletech	Early 1970s
Department of Physics Optical Technology Center[692]	Orionics	1980-85
	Big Sky Laster Technologies/Quantel USA	1981
	Optec	1995
	Spectrum Lab	1999
	Bridger Photonics	2006
	Montana Instruments	2008
	MT Photonics Industry Alliance	2013

A critical piece of ERL's success had to do with its students. ERL offered funding opportunities and real-world experiences that enabled students to obtain advanced degrees and positions with electronics companies in and out of state. This approach to student research experience continues to the present day with the Undergraduate Scholar Program, the McNair Scholars Program, The Research Experiences for Undergraduates

[691] Personal Interview with Nick Shrauger.
[692] As of 2017, there have been 45 companies that were either directly or indirectly associated with the Department of Physics or the Optical Technology Center at Montana State University. Figure 2 only lists a selected number of companies. For a full list see http://www.optec.montana.edu/.

(REU) and many other opportunities provided by the Office of Research and Economic Development and individual departments.[693] This stemmed from the legacy of programs like ERL.

When asked about the legacy of ERL, Nick Shrauger replied, "ERL marked the transfer of MSC from a small ag college…a "cow college" to technology."[694] Along with this technology came new opportunities for research and instruction. Some students earned positions at MSU and had successful careers as professors of electrical engineering. Others formed local electronics companies or worked within them. Additionally, some students returned home, to distant countries to work in companies or in higher education. The experiences they had with ERL and the EE department equipped them with the knowledge and ability to be highly competitive in the field.

The End of ERL

In time, ERL as an entity seemed to disappear. When asked about the end of ERL, I received multiple responses. Some pointed to the companies that emerged from ERL as the cause for the end of ERL.[695] A few mentioned the late-1970s and early-80s, as many of the ERL staff members from the early days began to retire and were not replaced.[696] Others pointed to the 1980s, suggesting that reports were still published under the ERL heading.[697] In some way, they are all correct. Each of these reasons contributed to the

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[693] See http://www.montana.edu/research/undergrad.html
[694] Personal Interview with Nick Shrauger.
[695] Personal Interview with Lee and Lynn Cannon.
[696] Personal Interview with Nick Shrauger and Bob Leo.
[697] Personal Interview with Don Pierre.

eventual disappearance of ERL. Another contributor, suggested by a few, was the change in funding that occurred in the late 1960s and early 1970s.[698] Before this change, the overhead money earned from the contracts was used to upgrade equipment, spur new research, fund graduate students, and hire new staff and faculty. Often this money was rolled over to other years. However, some suggested that parties within the MSU administration and the Montana Government saw a better use for this money and changed the funding model. This resulted in less funds for ERL. Additionally, others felt the sting of the "publish or perish" adage that accompanies higher education promotions. Unfortunately, projects classified as secret cannot be published in the same way as non-secret projects. A couple participants suggested that the focus of research then changed to meet the "publish or perish" requirement and thus limited what ERL could do.[699] Regardless of the exact reason for its disappearance, by the mid-1980s, ERL as an entity, either in name only or in practice, seems to have faded away.

ERL was a research and teaching program that offered students and instructors opportunities for actual, practical experience, which allowed all involved with opportunities for local, regional, national, and international contracts and research. However, due to changes within the university system coupled with opportunities to pursue research and applications outside academia, ERL as an entity gradually diminished; however, it provided a model that continued to inspire the continual development of the electrical engineering and electrical and computer engineering

[698] Personal Interview with Don Rudberg.
[699] Personal Interview with Ron Callantine.

programs at MSU. Further, the model for inspiring industrial spinoffs provided the opportunity for the construction of the industrial park and the active electrical engineering and technology industries in and around Bozeman today.

Electronics Research Laboratory may have faded away, but its legacy exists in how it helped bring Montana State University into the computer age and in turn laid the groundwork for numerous engineering and electronics industries in Bozeman and Montana. This legacy continued in President William Tietz's development of the Tech Park in the late 1980s.[700] This park was meant to insulate startup companies focused on aspects of scientific and technological research. The land for this park, on the west side of 19th between College and Garfield, is not owned by the university, but by the MSU Alumni Association. In 2016, MSU began to inquire about occupying some of this space for their own purposes. [701] The Tech Park, now known as MSU Innovation Campus has, for several years, attempted to expand and provide a space for companies to develop. However, due to restrictive tax designations, growth has been stagnant.

In the coming years, MSU will lease lab space for approximately $2 million a year. The Innovation Campus paid to construct a new Applied Research Laboratory building, paying for it with a loan from a group of local banks, according to MSU's proposal to the regents. "No state funds or tuition dollars will be used," MSU wrote.[702]

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[700] Robert Rydell, Jeffrey Safford, and Pierce Mullen, *In the People's Interest: A Centennial History of Montana State University* (Bozeman, MT: Montana State University Foundation, 1992), 176-177.
[701] Gail Schontzler, "MSU Eyes New Lab to Kick Off Tech Park Expansion" *Bozeman Daily Chronicle,* November 17, 2016, 1.
[702] Gail Schontzler, "MSU Eyes New Lab to Kick Off Tech Park Expansion" *Bozeman Daily Chronicle,* November 17, 2016, 1.

Instead, MSU paid for the lease and related costs using some of the overhead reimbursements ("facilities and administrative" money) it receives from research grants, which its scientists and professors win from federal agencies and other outside sources.

In July 2017, Montana State University won permission to move campus offices into the Nopper Building, despite protests from five small high-tech companies. These small companies that were getting kicked out of the Advanced Technology Park believed these actions might lead to the end of their business.[703] The Montana Board of Regents voted 7-0 to let the university lease space in the Nopper Building on West College Street, the Tech Park's original building.[704] It was built in the 1980s as the first step in then-MSU President Bill Tietz's dream of creating a high-tech incubator in Bozeman, where scientists who came up with new technologies could launch companies to boost the economy of Bozeman and Montana. In October 2018, the Bozeman Daily Chronicle, reported that this park was vying for two federal food and agriculture research offices tied to the USDA. If accepted, it could mean up to 600 jobs and more of a federal presence near campus.[705]

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[703] Gail Schontzler, "MSU Plan to Move into Tech Park Worries Startup Firms" *Bozeman Daily Chronicle* July 5, 2017, 1.
[704] In October 2018, faculty and staff were informed of University Communications' move to the Nopper Building.
[705] Katheryn Houghton, "MSU Tech Park Vies for Federal Research Facilities, Would Mean 600 Jobs to Bozeman," *Bozeman Daily Chronicle*, October 10, 2018, 1.

Future Relationships and the Role of the University

The university's move into the Innovation Campus and pursuit in developing federally-focused research continues the school's long history with the Academic-Military-Industrial-Complex. But it also reminds me of Eisenhower's warning: "Partly because of the huge costs involved, a government contract becomes virtually a substitute for intellectual curiosity," and "the prospect of domination of the nation's scholars by Federal employment, project allocations, and the power of money is ever present and is gravely to be regarded."[706] Humboldt perceived the university to be a place of teaching and research with a foundation on the freedom of science and the autonomy of the teaching staff. These premises allowed science and research to be conducted without the interference of political or external entities. This was because Humboldt did not want politics to misuse science. This autonomy and freedom was not an attempt to lock university teachers away from society in an ivory tower. This was in direct opposition of his views of education and its key role in society.

Instead, the university must consider its relationships with external entities. In the present social and political climate, higher education, and its ability to survive, depends on these external entities to provide the necessary funding to keep the institutions functioning. According to Henry A. Giroux, "both the Academy and democracy are in peril … A fundamental assault has been launched on the Academy's unfulfilled legacy of democratic education and its present and future role as a democratic sphere."[707] For

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[706] Eisenhower, "Farewell Address", 17-18.
[707] Giroux, *University in Chains*, 1.

Giroux, the state of higher education is troubling as many are "convinced that education is now about job training, competitive market advantage, patriotic correctness, and a steady supply of labor for the national security state."[708] This gets to a larger question about the purpose of higher education, educators and politicians have been trying to define for centuries.

For Montana, and its land-grant university, the purpose of education has had a turbulent history. This chapter demonstrated that federal involvement in higher education after World War II had major consequences. On the one hand, more students were able to access the possibility of higher education. To meet the demand of this increase in student populations, campuses had to expand. This expansion then put strains on the endowments and public financial support systems. As this strain grew, universities and their faculty had to find other ways to procure the necessary funds to fulfill their dual role of teacher and researcher, especially at a university. However, this money was often not freely given, and usually had some condition with it. For example, when the Electronics Research Lab received monies from the United States Navy for communication purposes, ERL was not able to use that for their agricultural studies. Therefore, as universities and professors continued to apply for and receive these funds, the direction and nature of their research practices changed.

Overtime, free-inquiry-based research will be compromised as industrial, military, and federal or state suitors provide specific sources of funding for specific types of research. Some universities may have the freedom to be selective about these

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[708] Giroux, *University in Chains*, 2.

opportunities as their financial existence may not be tied to collecting enough grants and other funding sources. However, public institutions of higher education may not have that luxury as state and federal legislatures dictate the type and amount of public funding schools receive. For Giroux, "as the 21st century unfolds, higher education faces both the legitimation crisis and the political crisis."[709]

This crisis provides a real threat to the idea of a university, its function, and role in society. For the men and women of the Electronics Research Laboratory at Montana State University, the Academic-Military-Industrial Complex provided real opportunities for education, practical experience, and research in a variety of fields. The projects they completed in Montana, across the United States, and abroad had larger implications beyond the laboratory or field site in which they were developed. As I sit in the second floor of a Bozeman golf course restaurant, listening to these, now retired, engineers, professors, and staff members reminiscing about their time with ERL and Montana State University, they talk of the people, the students, the connections, and the interesting projects they did. Occasionally there was a sour note about a company or a project that did not succeed in a way they expected, but they see the value of their time with ERL not as active members of the Academic-Military-Industrial Complex, but as "The catalyst … that opened the door to make [MSU] the modern research institution it is today."[710]

[709] Giroux, *University in Chains*, 6.
[710] Personal Interview Nick Shrauger.

EPILOGUE

A NINETEENTH CENTURY MODEL IN A TWENTY-FIRST CENTURY WORLD

On November 6, 2018, Montanans went to the polls to vote on local and state officials, referendums, and initiatives. One legislative referendum, LR-128 (SB 85), focused on financial compensation for Montana's public colleges and universities.[711] The referendum was "an act submitting a 6-Mill levy for continued support of the Montana University system," slated to begin January 1, 2019 and conclude December 31, 2028. Since 1948, this 6-Mill levy has been on the ballots every ten years.

As with all state and federal elections in Montana, the Secretary of State sent out a pamphlet providing information to the voters about the ballot measures. Accompanying the measures were arguments for and against, plus a rebuttal of each argument. The arguments for the 6-Mill levy began by referring to the tradition of this measure with its origin in 1948. The proponents for the measure argued that "Montanans then believed what we know to be true today: access to education is key to increased opportunities and greater productivity and success for our children, families, businesses, communities, and state." They stated that this was neither a new tax nor a tax increase, then followed with specific numbers of the measure, and a list of those who supported it. This argument concluded by arguing that "it helps keep the quality of educational programs up and the cost to students down … [it] was a good deal in 1948 and it's a good deal now." By

[711] See *Voter Information Pamphlet* (Montana Secretary of State 2018), 9-13 for any citations in the first four paragraphs.

supporting the measure, they argued, “we can continue an important Montana tradition and build a bright future for Montana’s students.”

The argument against this measure provided six reasons, including that it was an extra tax, the university system was too big, had rejected funding from a conservative foundation, and had spent their funds questionably, that university policies disarmed students, and accountability. The writers then proposed the idea of a “bottom-up” funding approach giving students “consumer power” and creating “healthy competition” to the current system. The writers also questioned the need to graduate students in fields that Montana did not need, such as teachers and social workers, instead of machinists and nurses. Their solution was a “market-oriented funding mechanism.”

In response to these claims, those in favor of the measure again restated their previous points, adding that “our farms, ranches, and businesses could lose out on important agricultural and technological research being done across the state.” Then, they concluded with a focus on accessibility and affordability. Those against the measure disagreed, arguing that colleges/universities had become billion-dollar empires of opulence. For those against the measure, there was a distrust with the university system and a call for spending to not discriminate against “conservative professors and students” as they fund “MUS’s liberal agenda.” The against position suggested that “perhaps a little belt-tightening is in order” for the Montana University System.

Beginning in the nineteenth century, Humboldtian and German ideas of higher education shaped its direction throughout the world. First, Humboldt described the state-funded institutions housing professors who had academic freedom and were not beholden

to state interests. Second, he defined the relationship between research and teaching where research informed teaching in a balanced alignment. Third, regarding scientific education, the development of the laboratory provided students with direct exposure to scientific practice and thought. In analyzing higher education, we can see these reforms reflected in practice and in questions we need to ask for the future.

Since its inception, the modern university has had to respond to questions about itself. The biggest question is: *What is the university for?* Over the last few decades, historians, educators, and politicians have tried to answer this question, especially in terms of the twentieth and twenty-first centuries. As detailed in earlier chapters, the question had been asked before, in the broader context of Humboldtian practices; science education, its access, its types of knowledge, and its applications; and relationships between institutions of higher education and the society, state, and military-industrial interests.

Over the past several decades this question has continued to have politicized responses, often falling into two categories: its utility and its tradition. In terms of utility, defenders and attackers of the university relied on economics, jobs, and competition. This fed into the idea of the corporatization of higher education and the negative consequences of this shift in higher education. For tradition, defenders look at the historical good of an institution and the technologies and ideas created that had short- or long-term effects from the local to international level. However, these approaches led to nostalgic ideas that conflated what *was* with what *will be*.

This concluding chapter will examine the changing role of the university and the legislatures that have begun to defund land-grant schools throughout the United States, such as in Oregon, Wisconsin, and to a lesser extent, Montana. Through this process, the focus on Humboldtian and German ideas of research has diminished, replaced instead by an emphasis on education that has the more practical goal of job placement, in some ways a reversal of tenets in the land-grant model and in others a reprisal. The role of nostalgia and its detrimental effects on current practice and legislation concerning higher education played a key role in this shift. Further, I will highlight the integration of global corporations and interests in education and land-grant schools and its relationship to how Humboldt's model of education and Vannever Bush's view of science came to fruition. Finally, I will conclude with a discussion of the purposes of higher education and its place in twenty-first century society.

Recent discussions of higher education propose the idea that there is something wrong. Issues of access to funding, the role of the state, and the type of curricula become snapshot headlines that inundate our consciousness. While there are some major concerns including the corporatization of higher education and its negative effects on academia, this dissertation has shown that similar issues plagued earlier versions of these schools, their students, faculty, and administrators. It is important to recognize the cracks in the nineteenth century models of education that dot the twenty-first century educational landscape, but it is equally vital to historicize these cracks and use history to better understand how they developed and where they might go.

Reforms and Funding

The history of American higher education is tumultuous. It is a series of ideas and reforms, theoretical and practical, private and public, funded and unfunded, and various amalgamations of each. In recent years, criticisms are louder, due in part to 24-hour media and the ubiquitous forms of social media. Historically, these criticisms signaled shifts in the higher educational landscape. For example, in reaction to the replacement of more traditional, classical forms of education, John Henry Newman pushed for a higher education system that focused on teaching without the research.[712] In the 1930s, Abraham Flexner criticized the modern American university, trumpeting the German approach as the ideal.[713] This came at the time when the German university system was under assault at home and out-of-sync with expectations and practice in the United States.

After World War II, federal initiatives such as the Servicemen's Readjustment Act of 1944, the National Defense Education Act of 1958, the creation of the National Science Foundation in 1950, and others provided the means for a sudden increase of students in higher education and new avenues of research funding. Like the nineteenth century initiatives that created the land-grant schools and increased agricultural research and exposure to local farmers, these twentieth century approaches also created the opportunity for new types of schools that could reach an even wider audience (For

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[712] See John Henry Newman, *The Idea of a University* Frank M. Turner, ed. (New Haven: Yale University Press, 1996; Jaroslav Pelikan, *The Idea of the University: A Reexamination* (New Haven: Yale University Press, 1992).
[713] Abraham Flexner, *Universities: American, English, German* (New Brunswick, NJ: Transaction Publishers, 1994).

example, community colleges, tribal colleges, and universities). As a result of these changes, Clark Kerr, in 1963, defined the resulting institution of higher education as the "multiversity."[714] The multiversity consists of several communities: the undergraduate and the graduate; the humanist, social scientist, and scientist; the professional schools; the non-academic personnel; and, administrators.[715] Flexner considered the university to be an organism, in which everything was bound together.[716] This was not the case with the multiversity. Instead, Kerr viewed the multiversity as "a mechanism held together by administrative rules and powered by money."[717]

By the 1980s, this mechanism became more bureaucratized and began to function more as a corporation. This corporatization was the natural next step after universities began to rely more on federal grants to direct research. It also became, along with militarization and right-wing, political fundamentalism, the most recent areas of higher education to critique. For example, in their advocation for the slow movement in higher education, professors Maggie Berg and Barbara K. Seeber described corporatization as "compromise[ing] academic life and [speeding] up the clock," and that "in the corporate university, power is transferred from faculty to managers, economic justifications dominate, and the familiar 'bottom line' eclipses pedagogical and intellectual concerns," to which they "advocate deliberation over acceleration."[718]

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[714] Clark Kerr, *The Uses of the University, fourth edition* (Cambridge, MA: Harvard University Press, 1995).
[715] Kerr, *The Uses of the University*, 14.
[716] Kerr, *The Uses of the University*, 15.
[717] Kerr, *The Uses of the University*, 15.
[718] Maggie Berg and Barbara K. Seeber, *The Slow Professor: Challenging the Culture of Speed in the Academy* (Toronto: University of Toronto Press, 2016), x.

This corporatization of higher education was also directly tied to funding changes at the state-level concerning public universities and institutions of education. In 2015, Governor Scott Walker released his new budget for Wisconsin, calling for a reduction of state funding to public institutions of higher education of $250 million for two years.[719] The result of this funding cut meant lost jobs, reduction in programs, and a negative impact on the state of higher education. At UW-Eau Claire, administrators reduced their workforce by 15 percent to make up for the loss of $7.7 million. A decline in enrollment also meant that this university lost an additional $1.5 million.[720]

On top of these financial changes one of Scott Walker's budget proposals included a shift in the mission of higher education in Wisconsin.[721] The mission of the University of Wisconsin was summed up in the *Wisconsin Idea*, and described the relationship between the university and the state.[722] The budget proposal removed the words directing the university to "search for truth" and "improve the human condition" and replaced them with "meet the state's workforce needs."[723] In response to public criticism, Walker claimed that it was a drafting error, and did not push for the change.

In 2017, as Wisconsin began to focus on the new biennial budget, academics were surprised that Walker pushed for increased funding and an eventual reduction in

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[719] Nico Savidge, "Across UW System, Campuses Reduce Courses, Advising and Jobs as Budget Cuts Take Hold," *Madison State Journal*, April 12, 2016.
[720] Savidge, "Across UW System".
[721] Valerie Strauss, "How Gov. Walker tried to quietly change the mission of the University of Wisconsin," *The Washington Post*, February 5, 2015.
[722] Charles McCarthy, *The Wisconsin Idea* (New York: The Macmillan Company, 1912).
[723] Strauss, "University of Wisconsin".

tuition.[724] As part of this increase in funding, Walker called for the introduction of performance metrics, the ability of students to opt out of some fees, and no funding for building and maintenance. This focus on metrics brings the fallacy of accountability. Stefan Collini defines this fallacy as "the belief that the process of reporting on an activity in the approved form provides some guarantee that something worthwhile has been properly done."[725] This was another example of the corporatization of higher education. In the end, some questioned the motivation behind this about face, especially with a re-election campaign on the horizon.

In a broader study, the Center on Budget and Policy Priorities reported in 2017 that state funding of public universities was well below historic levels.[726] For the school year ending in 2017, funding was almost $9 billion below those for 2008. States have reduced their funding resulting in schools raising their tuition rates. The result was that the higher price of higher education prohibited some students from affording to attend college, or students relied more on loans to make up the difference. The only states spending more than in 2008 were Indiana, Montana, Nebraska, North Dakota, and Wyoming. In states like Alabama, Arizona, Illinois, Louisiana, New Mexico, Oklahoma, Pennsylvania, and South Carolina, per-student funding fell over 30 percent between 2008 and 2017. This change in funding reduced schools' abilities to meet the needs of their

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[724] Rick Setzer, "Scott Walker Loosens the Purse Strings," *Inside Higher Ed*, March 1, 2017.
[725] Stefan Collini, *What Are Universities For?* (New York: Penguin Books, 2012), 108.
[726] Michael Mitchell, Michael Leachman, and Kathleen Masterson, "A Lost Decode in Higher Education Funding: State Cuts Have Driven Up Tuition and Reduced Quality," *Center on Budget and Policy Priorities*, August 23, 2017.

students and resulted in either increased tuition, reduction of programs, reduction in jobs, or a combination of all three. It also meant that these schools relied more heavily on grants and contracts from the academic-military-industrial complex. Senator Fulbright and, earlier, President Eisenhower had warned against this, arguing that, "partly because of the huge costs involved, a government contract becomes virtually a substitute for intellectual curiosity." [727] Intellectual pursuits ceased to be pure in nature, and instead were practically driven by external (military) entities.

Funding and Research

One Humboldtian ideal of higher education is the relationship between research and teaching. This relationship can be a contradictory one, especially if one task impedes on the other, but it can also be an enlightening one, in which one task elevates and drives the other. According to Berg and Seeber, "Because the corporate university has aggressively made research (of a certain kind) the top priority, it is in this area of our work that many of us are particularly vulnerable to the ways corporate language can, to borrow Collini's apt phrasing, 'colonize our minds.'"[728] This colonization changes the way academics and scholars view research. Instead of letting research take its time to gestate and develop in contemplative minds, there is a mad rush to publish quickly and quite often. This feeds into the "publish or perish" mantra that is drilled into any

[727] Dwight D. Eisenhower, "Farewell Address: Reading Copy" January 17, 1961, 17. https://www.eisenhower.archives.gov/research/online_documents/farewell_address/Reading_Copy.pdf
[728] Berg and Seeber, *Slow Professor,* 56; Collini, *What Are Universities For,* 95.

academic's head from the time they were in graduate school. In Collini's assessment of this approach to research, he believes it is:

> Making everyone so jittery that they suffer from *publication praecox* will no more improve the quality of our intellectual life than a faster 'rate of production' of ejaculations would necessarily improve our sexual lives. It will, for example, make it more difficult, especially for younger scholars, to think of undertaking a major project which might not yield any entries for the annual return for several years to come, but which might when completed be worth far more than a whole CVful of slight articles and premature 'syntheses'.[729]

The problem is the role of *output* and meeting certain measurements and standards in the corporate university. The result is a flood of research articles, blogs, and books that inundate academics with excessive amounts of reading to stay abreast of the recent discussions and trends in their field.

On top of this pressure comes the idea that the function of higher education is not for the investigation and production of new knowledge; instead, it is about job placement, or Walker's "workforce needs." The resulting shift in educational and research practices is detrimental to all fields of scholarship. Land-grant schools were born out of the utilitarian movement of higher education, but they also had research-based initiatives attached to them (The Hatch Act, for example, and the resulting agricultural experiment stations). These research sites did produce practical forms of knowledge, but they also used and produced theoretical knowledge. For Henry Giroux, "Higher education is about more than job preparation and consciousness raising; it is also about imagining different

[729] Collini, *What are Universities For*, 127.

futures and politics as a form of intervention into public life."[730] It is to these interventions that research, especially in the humanities, can provide new perspectives. It is also this perspective that can sometimes lead past and present faculty members to think fondly on the "way it was."

Higher Education and Nostalgia

When thinking about history, one must consider the social and cultural contexts that shaped the events, ideas, and people in and around institutions of higher education. For the last half of the nineteenth century, the American West, its conquest and colonization, was the setting for the Morrill Land Grant colleges and federal funding. At the same time, Meiji reforms used foreign experts and education to fully colonize Hokkaido, which provided a blueprint for further imperial expansion in late nineteenth and early twentieth centuries. During most of the last half of the twentieth century, the Cold War provided the impetus for increases in federal funding for higher education. When faculty members lament the current meagre offering of funding, according to Patricia Limerick, many will be unable to think historically and "to acknowledge how much the episodes of free-flowing federal support for higher education came out of the context of arms races in brinkmanship, Korea and Vietnam, and frightening face-offs between the Soviet Union and United States."[731] It was during these quests for

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[730] Henry A. Giroux, *The University in Chains: Confronting the Military-Industrial-Academic Complex* (Boulder: Paradigm Publishers, 2007), 1.
[731] Patty Limerick, "Forty-five Years in the Academic Saddle: The American West, Higher Education, and the Invitation to Innovation," in *Higher Education in the American West: Regional History and State Contexts* Lester F. Goodchild, Richard W.

international dominance that society mandated the investment in public resources. This may stave off the nostalgia, but it could also be a motivating factor for academics and society alike to consider if there are less nationalistic or militaristic reasons to encourage and increase federal support for higher education.

For now, we do not need to long for the past. As evidenced in Chapter Three, funding was always an issue in Montana, legislators often questioned the purpose and practice of higher education, and successes came in many forms and often with negative effects. Instead, we must analyze and learn from the past and determine what worked when it worked and why. We must seek out the motivations and climate that drove individuals, groups, and institutions to pursue the line of thought, research, and experimentations they chose to pursue. We need to freely decide on what we must measure ourselves by — is it a broad term of advancement shaped by academic pursuits in enlightenment or an empire, or is it something else, again shaped by enlightenment or empire?

The need for academics to pursue status, recognition, and its subsequent funding have shaped the course of higher education. Would it not also be a clever idea to forgo these outside entanglements, and, instead, focus on crafting new generations of critical thinkers, pursuing new lines of thought, in investigating, revising, or confirming older ideas and theories? Can one do this without the corporate, military, or federal funding? History will show that this form of inquiry can be difficult and potentially unprofitable

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Jonsen, Patty Limerick, and David A. Longanecker, eds. (New York: Palgrave Macmillon, 2014), 80-1.

financially, but what are the true pursuits of academia? Make money or expand knowledge? Once again, the realist and the idealist converge in their eternal struggle for control. Can one pursue funding without the strings of empire and dominance? Can one pursue enlightenment apart from empire? These may seem like intractable questions to ponder, but they get to the heart of the question about the purpose of higher education and what it might look like in the twenty-first century.

Twenty-first Century Higher Education

In recent years, educators, administrators, and external parties have all begun to provide ideas for higher education in the twenty-first century. Books with titles such as *Toward a More Perfect University*, *Our Underachieving Colleges*, and others provide solutions and processes to correct the course of higher education.[732] What this dissertation has demonstrated from Germany to New York, from Mississippi to Massachusetts, and from Montana to Japan, is that higher education has constantly questioned its own mission. It has always been gripped by larger cultural contexts of empire and control and it needs to reinvent itself each generation.

This dissertation began with a study of several nineteenth century approaches to higher education. In many ways these approaches were a reaction to methods from earlier centuries. Likewise, higher education in the twenty-first century carries the memories and

[732] Jonathan R. Cole, *Toward a More Perfect University* (New York: Public Affairs, 2016); Derek Bok, *Our Underachieving Colleges: A Candid Look at How Much Students Learn and Why they Should be Learning More* (Princeton: Princeton University Press, 2006).

scars of the nineteenth and twentieth centuries. For many authors who call for reforms of higher education, or even question its role, they focus on historical approaches or they may relate reforms in other fields into higher education.[733] For example, Kerr analyzed the evolution of higher education to the creation of the multiversity. Berg and Seeber used the approaches from the Slow Food movement and applied them to academia.

Whichever method of critique or reform mentioned, it is important to remember that models change as they move from one context to another. As we saw in Chapter One, for instance, there was no "German Model" of higher education. There were many models, some built off others, many focused on the two Humboldtian principles concerning the relationship between research and teaching, as well as academic freedom. When American faculty and administrators attempted to mimic or emulate German or other European schools, it was never an exact copy. Even when southern schools mimicked northern schools, they were never exact matches. The critical point to make here is that location matters, people matter, and function matters. A school of mines in New York City functions, looks, and educates its students differently than a school of mines in Montana or Colorado. Likewise, a land-grant school in Massachusetts will inherently be different than one in Montana or Japan. However, there is a shared history

[733] For example, Collini, *What Are Universities For?*; Giroux, *University in Chains*; Kerr, *Uses of the University*; Berg and Seeber, *The Slow Professor*; Lester F. Goodchild, Richard W. Jonson, Patty Limerick, & David A. Longanecker, eds., *Public Policy Challenges Facing Higher Education in the American West* (New York: Palgrave Macmillan, 2014; Derek Box, *The Struggle to Reform Our Colleges* (Princeton: Princeton University Press, 2017); Derek Bok, *Our Underachieving Colleges: A Candid Look at ow Much Students Learn and Why they Should be Learning More* (Princeton: Princeton University Press, 2006).

among these institutions, and they exemplify the importance of the decentralization of knowledge.

Additionally, reformers of higher education, regardless of their location often come to similar conclusions. For example, Wilhelm von Humboldt in 1809 demarcated the role of the state in relation to higher education. Similarly, in Chapter Two, Frederick A.P. Barnard defined this same relationship in the 1870s. Finally, in Chapter Four, Yukichi Fukuzawa and Kuroda Kiyotaka had similar discussions about this relationship. Humboldt saw a contradictory relationship of a supportive state that did not interfere. Barnard thought that the only reason a state should be invested in education is if it helped the state achieve its core functions. He also described how, depending on the form of government the state used, the role and relationship of education could be beneficial to the state but detrimental to the citizen. Fukuzawa saw the need for nations coming together to teach each other, while General Kuroda, as the director of the Kaitakushi, pursued the relationship that saw education as a driving force of colonization to meet the needs of the state. Everyone has a slightly different take, but all see some form of a relationship between the state and higher education, and in many cases, this relies on some form of funding.

In recent years, financial concerns about higher education have become a major point of discussion. Earlier, ideas and issues surrounding funding were discussed. As is evident from events surrounding the state of Wisconsin to the general degradation of state funding for schools over the last decade, the institutions of higher education have been struggling. President Eisenhower discussed this issue in 1961 when he introduced the

American public to the military-industrial complex. To make up the lost funds, schools either must increase their tuitions or rely on other sources. Through increased tuition, schools alienate certain portions of the population. However, if these same schools rely too much on external sources of income, then they run the risk of being controlled by the state, military, or industrial interests. This, in turn, could have drastic effects on the makeup of the university, the faculty, the research pursued, and the courses taught. Similarly, financial issues could lead to the reorganization of systems of higher education, as evidenced in Montana in Chapter Three and in Sapporo in Chapter Four. In both cases, the direction and approaches of these schools drastically affected the function of each. For Montana, financial issues, coupled with political strife, all but crippled the schools in the first half of the twentieth century. In Sapporo, the colonizing mission changed when the Kaitakushi was abolished and the school had to figure out how to administer itself.

The relevance of centralized or decentralized knowledge production has plagued higher education since its inception. However, as demonstrated in this dissertation, decentralization has been and continues to be beneficial. When the school of mines opened in Deer Lodge, Montana in 1888, it had certain advantages and disadvantages over the school at Columbia. However, the work, the learning, and the knowledge created and disseminated were important. When Stanford Research Institute (SRI) began conducting Meteor Burst Communication tests, they set up posts in a variety of locations. In this way SRI could gather data from many locations to analyze and form a more complete understanding of the system. When Massachusetts Agricultural College opened

its farm and later its experiment stations, or Montana, or Sapporo, each site was able to conduct tests for local, regional, national, and international purposes. This collected body of knowledge could then be shared through journals, public lectures, cooperative extension activities, or in the classroom. Therefore, a network of decentralized institutions is more advantageous than a single ivory tower isolated away from opportunities inherent in the various cultural, geographical, and political regions throughout the globe.

Whatever shape higher education takes in the twenty-first century, it must continue to be decentralized; focused on research; using research to inform the academy, the public, and the classroom; remaining accessible; and it must provide the time and space for contemplation, deep thought, and community. Without these basic goals, the core of the university — knowledge production and dissemination— is incomplete. The issues that haunt higher education today — state, federal, and industrial funding; research vs. teaching; practical education vs. creating citizens; corporatization, the high speed of academia —are not new. American colleges are built on nineteenth century models. The twentieth century provided the opportunity to align these schools with the research agenda and the Academic-Military-Industrial Complex, which, in turn provided new forms of technology and research for educational and industrial purposes. Now, in the twenty-first century, we still exist within nineteenth century models attempting to adapt to twentieth and twenty-first century demands and expectations. The adaptability of colleges and universities is the key to their success but has its share of potential pitfalls. This dissertation has shown that by understanding the history that connects Wilhelm von

Humboldt to the Applied Research Lab, academics, educators, and politicians can thoroughly evaluate, design, and transform the present and future of our institutions of higher education.

Regarding the ballot measure that introduced this epilogue, on November 6, 2018, Montanans voted 307,704 to 181,171 to support the measure and continue to fund higher education for another ten years.[734]

[734] *Official Election Results*, "Legislative Referendum No. 128 – 6 Mill Levy for Montana University System". http://mtelectionresults.gov/resultsSW.aspx?type=BQ&map=CTY

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