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North Dakota's New Frontier: Unmanned Aircraft

Matthew D. Dunlevy

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NORTH DAKOTA'S NEW FRONTIER: UNMANNED AIRCRAFT

by

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This thesis, submitted by Matthew D. Dunlevy in partial fulfillment of the requirements for the Degree of Master of Arts from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.



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Dr. Kimberly K. Porter



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This thesis is being submitted by the appointed advisory committee as having met all of the requirements of the School of Graduate Studies at the University of North Dakota and is hereby approved.



Dr. Chris Nelson,
Dean of the Graduate School

8/5/21

Date

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To Byron Dorgan and John D. Odegard, the father and godfather of North Dakota UAS

ABSTRACT

Unmanned Aircraft, or drones, represent a modern-day frontier, one that is, as yet, neither fully explored nor fully developed. The state of North Dakota has moved into the frontier and is deeply involved in its exploration and development. The state has invested tens of millions of dollars in the Unmanned Aircraft Systems (UAS) industry, an investment that has helped to attract tens of millions of additional dollars from military sources and from private business firms. The University of North Dakota's John D. Odegard School of Aerospace Sciences, long-recognized as among the leading aviation schools in the nation, is at the forefront of developing and applying Unmanned Aircraft Systems, and the school was the first to offer a university degree in UAS. Noting North Dakota's commanding position in the UAS industry, an article in the *New York Times* dated December 25, 2015, referred to the state as "the Silicon Valley of Drones."

This thesis will contribute to the scholarly treatment of the UAS industry by concentrating on its development and application in the state of North Dakota. It will do so by using frontiers as the historical backdrop.

Throughout the state's history, North Dakotans have been characterized by their ability and willingness to adapt to the hardships and challenges faced on the North Dakota frontiers. They have also been able and willing to adapt to opportunities, to prospects, and to advances in technology. This thesis treats how North Dakotans are once again adapting, this time to the opportunities, prospects, and challenges presented by yet another frontier- that of unmanned aircraft or drones.

CHAPTER I

INTRODUCTION

The premise of this thesis, consisting of five chapters, is that Unmanned Aircraft Systems (UAS), or drones, are North Dakota's new frontier. Chapter One, the Introduction, includes a discussion of sources on frontiers and UAS. Chapter Two, identifying varieties of frontiers, discusses the challenges they present and the characteristics of the people who faced the challenges. Chapter Three discusses North Dakota as a frontier, and Chapter Four treats Unmanned Aircraft Systems as North Dakota's new frontier. Chapter Five concludes the thesis.

The word frontier can be traced to classical Latin and the word could be associated with the Latin word "finis" meaning a border, "frons" meaning a front, or the Latin word "limes" meaning an uncharted geographical territory past a border.¹ The word evolved through old French to form the word "frountere," which was used in the fifteenth century and means the "front line of an army."² The word then evolved through old English to late-middle English to the spelling "frontier" and it lends itself to many definitions in the present day.³

Several dictionaries offer definitions of a frontier. Webster's Dictionary, for example, defines a frontier as a region forming the margin of settled or developed

¹ Andrea Mura, "National Finitude and the Paranoid Style of the One," *Contemporary Political Theory* 15, no. 1 (April 2015): 61.

² Etymology Online, etymology of "frontier," accessed February 23, 2020, <https://www.etymonline.com/search?q=frontier>.

³Oxford Dictionary, definition of "frontier," accessed February 23, 2020, <https://www.lexico.com/en/definition/frontier>.

territory or unexplored ground.⁴ On the other hand, www.yourdictionary.com stated that, “When there is a new scientific theory that has not yet been explored, this is an example of a new frontier,” and “any new field of learning, thought, etc. or any part of a field that is still incompletely investigated.” That dictionary also referred to a frontier as, “an undeveloped area or field for discovery or research.”⁵

Scholars have also offered definitions of frontiers. A frontier, as defined by Fredrick Jackson Turner, for example, was an area with a population density of 2.1 persons per square mile. L. W. Lyde noted that a “frontier, in its earliest unconscious conception, seems to have been the extreme limit of the area from which the people living within it could obtain the necessary supplies of food. In what may be called its ideal illustration, on the steppe, survival of the unit depended on an adequate minimum of area.”⁶ Another scholar, Francesco Schiavone, wrote in 2008, “the frontier is here described by Turner as a state of mind rather than a legal, material and institutional concept: ‘It is not so much a line where one stops, but rather an area that works as an invitation to access.’”⁷ Walter Rundell Jr., an historian at Texas Women’s University, wrote, “the frontier was the line of most rapid and effective Americanization.”⁸ He also noted that the frontier was the “outer edge of a human wave continually surging across the American continent.”⁹ An historian at Loyola University, Michael Khordarkovsky,

⁴ Webster’s Dictionary definition of “frontier,” accessed February 23, 2020. <https://www.webster-dictionary.org/definition/frontier>.

⁵ Definition of “frontier,” accessed February 20, 2020, www.yourdictionary.com/frontier.

⁶ L. W. Lyde, “Types of Political Frontiers in Europe,” *The Geographical Journal* 45, no. 2 (February 1915): 126. Accessed February 23, 2020. doi:10.2307/1780250.

⁷ Mura, “National Finitude and the Paranoid Style of the One,” 78.

⁸ Walter Rundell Jr., “Concepts of ‘Frontier’ and ‘West,’” *Journal of the Southwest* 1, no. 1 (Spring 1959): 15.

⁹ Ibid.

defined a frontier as, “a politicogeographical *area* lying beyond the integrated region of the political unit.”¹⁰

Given these definitions and the etymology of the word, a frontier could refer to something military as part of an army, buffer space, or no man’s land. Most frequently a frontier is geographical, as a line, boundary, area, wilderness, limit, unsettled swath of land, or a territory. Lastly, and in a more modern sense, a frontier could be considered intellectual in nature as a field of study, limit of knowledge, state of mind, a process, a vocabulary, an uncertainty, production possibility, or something unexplored.¹¹

When the word frontier is used with intellectual fields, it is in a more metaphorical sense.¹² The newest fields themselves can be considered frontiers, but, by definition, and according to www.frontiersin.org, any “Cutting Edge Research” within a field is also a frontier.¹³ These intellectual frontiers are not only a concept, but also that they are frontiers is essential to the understanding of frontiers and the generation of new ideas.¹⁴ “Something unexplored” is perhaps the definition best pertaining to all fields,

¹⁰ Michael Khodarkovsky “From Frontier to Empire: The Concept of the Frontier in Russia, Sixteenth-Eighteenth Centuries” *Russian History* 19, nos. 1-4 (1992): 117.

¹¹ Definition of a “Production Possibility Frontier,” accessed Feb 23, 2020, <https://economictimes.indiatimes.com/definition/production-possibility-frontier>; Walter Pauk et al. *How to Study in College*, accessed February 23, 2020, https://books.google.com/books?id=KKzbabqaVvQC&pg=PA143&lpg=PA143&dq=definition+of+frontier+field+of+study&source=bl&ots=Mb8H9wdO3O&sig=ACfU3U0mktMmwWiakTZca7aqtru1U-blKA&hl=en&sa=X&ved=2ahUKEwiKk4LT9ejnAhUIvp4KHS_fCr44ChDoATABegQICBAB#v=onepage&q=definition%20of%20frontier%20field%20of%20study&f=false.

¹² Lisa Messeri, “Why We Need to Stop Talking About Space as a Frontier,” *Slate Magazine*, accessed February 23, 2020, <https://slate.com/technology/2017/03/why-we-need-to-stop-talking-about-space-as-a-frontier.html>.

¹³ Research topics for “FrontiersIn,” accessed February 23, 2020, <https://www.frontiersin.org/about/research-topics>.

¹⁴ Alessandro Iaria et al., “The Importance of Frontier Knowledge for the Generation of Ideas,” *Vox* (January 2018), accessed February 23, 2020, <https://voxeu.org/article/importance-frontier-knowledge-generation-ideas>.

both geographical and intellectual, and it is used in this thesis. Applying the term “prism” to the conceptualization of a “frontier” is a useful vehicle with which to understand other intellectual fields that are frontiers. Using the definition of frontier as a “prism” is nothing new, however.¹⁵ Regarding the history of the term “frontier,” the “figurative stretching of the word ‘frontier,’” Leah Ceccarelli wrote,

from meaning an unexplored geographical territory to denoting the extreme limits of knowledge, or *intellectual* territory, is a relatively new development in the English language, as evidenced by the first appearances of this meaning in dictionaries in the mid-twentieth century. The earliest instance I could find of this figurative meaning for the term “frontier” in a dictionary was in the fifth edition of *Webster’s Collegiate Dictionary* in 1941 where one definition was “an advance or not fully explored region, as of thought, sentiment, etc.” This meaning for the term was not present in the fourth edition of the same dictionary, published in 1934, suggesting that it was sometime between these two dates that the figure of an intellectual frontier became common enough for these lexicographers to include it in their publication.¹⁶

Because the word frontier lends itself to many definitions and to many applications, this thesis is based largely on secondary sources, that is, on the works of those who have studied frontiers and have published their findings.¹⁷ For the discussion on what may be

¹⁵ “Ideas about American life today are inseparable from the prism of the frontier.” Matti Johansen Richoux, “Frontiers in the American Mind: How Ideas About the Past, the Present and the Future in America are Dominated by Hollywood Frontier Narratives” (MA thesis, University of Oslo, Oslo, 2012), iii.

¹⁶ Leah Ceccarelli, *On the Frontier of Science: An American Rhetoric of Exploration and Exploitation* (Michigan, 2013), 32.

¹⁷ “Looming large upon the American historical horizon has always been the subject of frontiers.” Jack D. Forbes, “Frontiers in American History and the Role of the Frontier Historian,” *Ethnohistory* 15, no. 2 (1968): 203; “There is a considerable amount of scholarly treatment of the frontier.” John Whitehead, “How Have American Historians Viewed the Frontier?,” presentation to the “Meeting of Frontiers Conference,” University of Georgia, 2001, accessed February 12, 2017, <https://www.loc.gov/rr/european/mofc/whitehead.html>; see JSTOR, “American Frontier,” accessed February 19, 2017, <https://www.jstor.org/action/doBasicSearch?Query=american+frontier&prq=frontier&hp=25&fc=off&acc=on&wc=on&so=rel>; Robertson Allen, “Games without Tears, Wars without Frontiers,” *War, Technology, Anthropology* (Berghahn Books, 2012), 83; Lloyd C. Gardner, “Korean Borderlands: Imaginary Frontiers of the Cold War.” *The Korean War in World History* (University Press of Kentucky: 2004), 126; Richard Aquila, “The Searchers: Cowboys and Containment on the Cold War Frontier,” *The Sagebrush Trail: Western Movies and Twentieth-Century America* (University of Arizona Press, 2015), 131.

the most familiar use of the word frontier, this thesis uses the works of major scholars who have published on them, including Frederick Jackson Turner's *The Significance of the Frontier in American History*, Walter Prescott Webb's *The Great Plains*, and Elwyn B. Robinson's *History of North Dakota*.

Frederick Jackson Turner, the preeminent historian of the American frontier, identified multiple frontiers, but differentiated the American frontier from others in his landmark essay first published in 1893 and again in 1920, *The Frontier in American History*. “. . . [T]he frontier,” he wrote,

is the outer edge of the wave—the meeting point between savagery and civilization. Much has been written about the frontier from the point of view of border warfare and the chase, but as a field for the serious study of the economist and the historian it has been neglected.

The American frontier is sharply distinguished from the European frontier—a fortified boundary line running through dense populations. The most significant thing about the American frontier is, that it lies at the hither edge of free land. In the census reports it is treated as the margin of that settlement which has a density of two or more to the square mile. The term is an elastic one, and for our purposes does not need sharp definition.¹⁸

Turner brought the frontier to the forefront of historical scholarship, and he also demonstrated that to study the frontier is to study rural America and the Great Plains, subjects that have received a great deal of professional historical treatment.

A professor at the University of Wisconsin from 1890 to 1910, Turner became dissatisfied with the school and with his position. He believed that he was not receiving enough recognition as a researcher, for example, and, as a vain individual, Turner believed that he could make more of a name for himself on the east coast. An ostensible

¹⁸ Frederick Jackson Turner, *The Significance of the Frontier in American History* (New York: Henry Holt and Company, 1920), 3.

reason for his leaving Wisconsin was the school's support of the football team and the student body's caring more about extracurriculars than about scholarship.¹⁹ Leaving Wisconsin in 1910 for a professorship at Harvard, he became recognized as a leading historian, having posited in his "frontier thesis" that without the American frontier there would be no American democracy. "American democracy," he believed, "was born of no theorist's dream; it was not carried in the *Susan Constant* to Virginia, nor in the *Mayflower* to Plymouth. It came out of the American forest, and gained new strength each time it touched a new frontier."²⁰

In 1893, at the American Historical Association Convention meeting in Chicago, Turner was the third of five professors to deliver lectures on the program which would mark the beginning of an "epoch" of the historical profession in the twentieth century.²¹ Turner's paper on the frontier thesis, presented under the title, *The Significance of the American Frontier in History*, may still be the single best explanation of American growth.²² "The settlement of the problems that arose at one frontier," Turner stated in his presentation,

served as guides for the next frontier — for example, in matters relating to land policy and the Indians. There are various kinds of frontiers which passed westward in successive waves — for example, the Indian's frontier, the trader's frontier, the miner's or rancher's frontier, and the farmer's frontier. The methods of advance and the characteristics of each were traced, showing how the Indian was

¹⁹ Allan G. Bogue, "'Not by Bread Alone': The Emergence of the Wisconsin Idea and the Departure of Frederick Jackson Turner." *The Wisconsin Magazine of History* 86, no. 1 (2002): 10, accessed March 1, 2020, <http://www.jstor.org/stable/4637012>.

²⁰ Turner, *The Frontier in American History*, 293.

²¹ "Annual Report of the American Historical Association: 1893," accessed March 1, 2020, http://www.archive.org/stream/1893annualreport00ameruoft/1893annualreport00ameruoft_djvu.txt.

²² Gene Gressley, "The Turner Thesis: A Problem in Historiography," *Agricultural History* 32, no. 4 (October 1958): 227.

pushed back and how each frontier affected its successor. It was found that the successive frontiers revealed the progress of society.²³

His presentation was aptly timed. The American Historical Association Convention was held in conjunction with the World's Columbian Exposition, or "World Fair," held in Chicago, which was a celebration of the exceptional growth of America in the four hundred years since the discovery of the "new world."²⁴

Although the best-known and most-influential historian on the American Frontier, Turner is joined by other scholars, including Walter Prescott Webb, Robert Mondy, Ernest Wallace, Ray Allen Billington and Herbert Eugene Bolton.²⁵ Mondy, Billington, and Bolton, as well as others who agree with Turner in their scholarly work, are referred to as "Turnerian."

Walter Prescott Webb, Texas's best-known historian, published *The Great Plains* in 1931 and, narrowly missing being awarded a Pulitzer, won a Loubat Prize from Columbia University.²⁶ A study on the geography and people living in states of the Great Plains, Webb's work is one of the most influential monographs of American frontier historiography.²⁷ "On a rainy night in the winter of 1922," Webb wrote when discussing the inspiration for the work,

²³ "Annual Report of the American Historical Association: 1893."

²⁴ Richard Kluger, "The Old Frontiers: Seizing Destiny: How America Grew from Sea to Shining Sea," *The New Republic*, May 6, 2008, accessed March 1, 2020, <https://newrepublic.com/article/63196/the-old-frontiers>.

²⁵ Some of these authors gave the study "great impetus." Jack D Forbes, "Frontiers in American History and the Role of the Frontier Historian," *Ethnohistory* 15, no. 2 (1968): 203, accessed March 12, 2017, doi:10.2307/480557.

²⁶ George Wolfskill, "Walter Prescott Webb and the Great Plains: Then and Now," *Reviews in American History* 12, no. 2 (1984): 296.

²⁷ L. Patrick Hughes, "Walter Prescott Webb's Great Plains Thesis," *History 1302: U.S. History Since 1877*, lecture, <http://www2.austincc.edu/lpatrick/his1302/webb.html>, accessed March 12, 2017.

I read *The Way to the West*, wherein Emerson Hough pointed out that the American ax, rifle, boat, and horse were the instruments and agencies with which the pioneers conquered the frontier. The list did not seem so wholly satisfactory in that it did not apply to the Plains so aptly as it did to the timbered region. Then I saw for the first time the place of the revolver, that its popularity among the horsemen of the plains was no accident; and, in justice, I thought it deserved a place among those things with which the frontier of at least half the country had been subdued.²⁸

When Webb wrote about the revolver elsewhere in the book, he mentioned that it helped the people to settle in places where they had not been before. Webb is also remembered for emphasizing the other technologies that were important to the frontier and the Great Plains, such as windmills and barbed wire.²⁹ Barbed wire served to control cattle and windmills drew water from wells. Webb wrote about the harsh environment of the Great Plains and the institutions found there, and he believed that Americans, accustomed to conditions in Europe and the East, had to adapt to the new environments and institutions.

Webb published *The Great Frontier* in 1951 in which he contrasted the frontier with the developed world. “I have undertaken,” he wrote,

to look at the whole frontier rather than a part of it, and to determine its relation to and influence on that part of western civilization which was not frontier, to be specific western European civilization. It was necessary to create two names for these two gigantic forces with which I am concerned: the Great Frontier and the Metropolis. The Great Frontier includes all the new lands discovered by Columbus and his associates around the opening of the sixteenth century, three new continents and a large part of a fourth, Africa.³⁰

A major point of Webb’s work was that there was no longer a “Great Frontier” and he wanted the time after Columbus’ discoveries to be known as the “Age of the Great

²⁸ Walter Prescott Webb, *The Great Plains*, 2nd ed. (Boston: Ginn and Company, 1959), v.

²⁹ “A Guide to the Walter Prescott Webb Papers, 1857-1966,” accessed March 7, 2020, <https://legacy.lib.utexas.edu/taro/utcah/00344/cah-00344.html>; George Wolfskill, “Walter Prescott Webb and the Great Plains: Then and Now,” *Reviews in American History* 12, no. 2 (June 1984), 302.

³⁰ Walter Prescott Webb, *The Great Frontier* (University of Texas Press, 1951), 17.

Frontier.” Webb also noted in the book that three types of frontiers exist on the “fringe:” geographic, socio-economic-political, and scientific.³¹ With the physical frontier disappearing, Webb argued, the last frontier was that of the sciences, though these sciences of the Metropolis accelerated the depletion of the physical frontier.³² Webb believed that “today, new frontiers are being conjured up in every direction” and that it was important always to compare them with the “real thing.”³³ He wrote that a characteristic of frontiers was that what they touch is often wide ranging. Webb believed that the Great Frontier had a tremendous influence on sciences such as astronomy, on the humanities, literature, art, education, and, perhaps most of all, on history. *The Great Frontier* became a classic piece of historical literature and, having written many other works on American history and the frontier, Webb attracted a following of students who went on to distinguish themselves in the field of history.

Robert Mondy studied under Walter Prescott Webb and completed a dissertation titled *Jesse Mercer: A Study in Frontier Religion*. The biography discussed an influential Baptist minister who eventually had a university named after him. Mondy’s study was an example that religion was a prominent and important feature on the frontier.

“Protestantism,” for example, Webb wrote in *The Great Frontier*,

was one institution whose authority the frontier did not have to break, for that authority came *broken* and in denominational fragments. There was complete harmony between the man who stood naked in the presence of nature and the man who stood naked in the presence of God. In the forests of the frontier the same man stood naked in the presence of both.³⁴

³¹ Webb, *The Great Frontier*, 284.

³² Walter Rundell Jr., “Walter Prescott Webb: Product of Environment,” *Arizona and the West* 5, no. 1 (Spring 1963): 12.

³³ Webb, *The Great Frontier*, 280.

³⁴ *Ibid.*, 90.

Such writing certainly had an influence on Mondy. In 1980, he published his most significant work titled *Pioneers and Preachers: Stories on the Old Frontier* to a favorable reception among scholars. The book treated how weather, farmland, and demographics affected the lives of people on the frontier.

Ernest Wallace was another prolific author and a professor of history at Texas Tech. His best-known work was *Texas' Last Frontier: Fort Stockton and the Trans-Pecos*. This work illustrated the hardships that “sturdy pioneers” and Native Americans endured on the frontier. As the pioneers and Native Americans regularly fought with each other, Wallace showed how the concept of personal safety was an issue on the frontier. Wallace’s historical writing was so vivid as to have one reviewer comment that Texas at the time, as Wallace wrote it, “epitomizes the frontier.”³⁵

Ray Allen Billington, among the most outspoken writers supporting Frederick Jackson Turner’s frontier thesis, published such works as *Western Expansion: A History of the American Frontier* in 1949. This book “evidenced great diligence” and aimed to tell a story similar to Turner’s thesis, but seemingly in a more organized and condensed way.³⁶ Billington’s *The Far Western Frontier*, published in 1956, discussed the frontier as “life in the raw.” Much of the book treated how the people of the American frontier were in a constant struggle with nature, though tools such as those Webb identified

³⁵ C. L. Sonnichsen, “Review of Texas’ Last Frontier: Fort Stockton and the Trans-Pecos, 1861-1895, by Clayton W. Williams and Ernest Wallace,” *Western Historical Quarterly* 14, no. 4 (October 1983): 477.

³⁶ Homer C. Hockett, “Review of Western Expansion, A History of the American Frontier, by Ray Allen Billington,” *Journal of American History* 36, no. 3 (December 1949): 551.

helped settle the Far West.³⁷ In 1963, Billington published *America's Frontier Heritage*, aiming to broaden the understanding of how the West was won. He wrote to show that “frontier types could not be so exactly designated, for the pioneering process required a complex variety of skills that defied any simple definition. The West was won not only by hunters and herdsman and farmers, but also by miners, explorers, soldiers, lumbermen, land spectators, missionaries, and lawyers.”³⁸ His work *The Frontier Thesis: Valid Interpretation of American History?* was published in 1966, and, as the title suggested, held Turner's thesis as integral to the study of history in the United States.³⁹ *The Genesis of The Frontier Thesis* was well received by critics when Billington published it in 1971, mainly as a biography of Turner.⁴⁰ His last work, *Land of Savagery, Land of Promise: The European Image of the American Frontier in the Nineteenth Century*, published in 1981, tied together his previous ideas and demonstrated that, although the frontier was a difficult time and place of which to be part, it was still seen as a “wave of the future swept across the Atlantic.”⁴¹ Billington's publications, similarly to Turner's, consider the American frontier as integral to the history of the United States and contributing to the development the country's culture, individualism, and future. They also romanticize the concept of a frontier.

³⁷ Oscar Osburn Winther, “Review of The Far Western Frontier, 1830-1860, by Ray Allen Billington,” *The American Historical Review* 62, no. 3 (April 1957): 638.

³⁸ Arrell M Gibson, “America's Frontier Heritage: A Review Essay,” *Civil War History* 14, no. 3 (September 1968): 250.

³⁹ Robert F. Berkhofer, “Review of Ray Allen Billington's The Frontier Thesis: Valid Interpretation of American History?,” *Agricultural History* 41, no. 3 (July 1967): 313.

⁴⁰ Masaharu Watanabe, “Review of The Genesis of The Frontier Thesis: A Study in Historical Creativity,” *Western Historical Quarterly* 3, no. 4 (October 1972): 421.

⁴¹ Klaus J. Hansen, “Review of Land of Savagery, Land of Promise: The European Image of the American Frontier in the Nineteenth Century,” *Journal of American History* 69, no. 1 (June 1982): 120.

Herbert Bolton, Frederick Jackson Turner's student, also studied and published on the frontier. His *The Spanish Borderlands: A Chronicle of Old Florida and the Southwest*, published in 1921, held that Turner's frontier thesis needed to be applied in the light of all of North America's frontiers instead of only those of the United States. Much of the territory he discussed was from Florida to California and south of the Rio Grande, an area Turner neglected to treat as much as he did the rest of the northern parts of the United States.

Although Turner, Webb, and others made significant contributions to the study of frontiers, their works have been criticized in recent years as being overly triumphalist and sensationalist. For example, Webb wrote, "This was indeed a heroic period, heroic for the individuals and the nations involved. People love their heroic periods, make legends about them, and vaguely hope that they will come again."⁴² These authors often wrote of "the Golden West" and they used adjectives that might be frowned upon in historical writing. They wrote of "great striding pioneers moving ever westward" and the legends that followed them. The Turner Thesis in particular has been debated by those who disagree with Turner on many points.

Four historians, Patricia Nelson Limerick, Richard White, Donald Worster, and William Cronon, make up the major critics of Turner's essay *The Significance of the Frontier in American History*. Described as, "The Gang of Four," they express what have become known as AntiTurnerian views of the American frontier.

⁴² Webb, *The Great Frontier*, 280.

Limerick was a Marxist historian and became skeptical of materialism and social class under historian C. Vann Woodward at Johns Hopkins University. As an historian, she is best known for her criticism of Turner and she asserted in her 1987 publication *The Legacy of Conquest: The Unbroken Past of the American West* that when Turner referred to the frontier as a process he set “arbitrary limits that excluded more than they contained.”⁴³ She believed that Turner was drawn to the frontier as a place of failure the same way that historians are drawn to the moral failure of the southern United States in the American Civil War.⁴⁴ She believed that the people of the frontier raped the environment of the western United States and that Turner should have seen this as a stain on our nation’s history rather than as something to glorify. When she used “conquest” in the title of her work, Limerick was, in part, referring to the way Europeans treated the Native Americans. She believed that the “discrimination, greed, intolerance, deceit, and violence in these western states” were actually demonstrating that the West was where the “white man destroys his own world”⁴⁵

Turner claimed that the frontier shaped American democracy, but Limerick rejected this because the injustices of race on the frontier were contrary to America’s democratic values. She was also critical of the word frontier being put to purposes by “politicians, pundits and product pitchmen.”⁴⁶ Limerick’s dissatisfaction with Turner made apparent an important aspect of frontiers: ethics. Such topics as racial inequality

⁴³ Patricia Nelson Limerick, *The Legacy of Conquest: The Unbroken Past of the American West* (New York: W. W. Norton, 1987), 21.

⁴⁴ Donald Worster et al., “The Legacy of Conquest by Patricia Nelson Limerick: A Panel of Appraisal,” *Western Historical Quarterly* 20, no. 3 (Aug 1989): 303.

⁴⁵ Ibid.

⁴⁶ Stephen Aron, “Reviewed Work: The Frontier in American Culture: Essays by Richard White and Patricia Nelson Limerick,” *The Register of the Kentucky Historical Society* 93, no. 3 (Summer 1995): 343.

and environmental destruction have ethical aspects to them, and Richard White, her contemporary, was concerned with many of the same issues that Limerick raised against Turner.

Richard White is probably best known for his work, *Railroaded: The Transcontinentals and the Making of Modern America*. Although romanticizing the time of the frontier, his central argument was that, “transcontinental railroads were a Gilded Age extravagance that rent holes in the political, social and environmental fabric of the nation, and they were as mismanaged and corrupt as they were long.” White disagreed with Turner’s sentiment of the west in this work and disagreed again with Turner’s thesis in his *The Frontier in American Culture: An Exhibition at the Newberry Library* in 1994. In this work, he acknowledged Turner as doing the field of history a service by highlighting the frontier, but he attempted to instruct readers that the frontier should be seen more from an academic and less from an entertaining viewpoint. This contrast is also seen in the irony of Turner’s presenting his landmark thesis across the city from Buffalo Bill, an entertainer associated with the American West, in Chicago in 1893.⁴⁷

Donald Worster, a former Hall Distinguished Professor of American History at the University of Kansas, wrote *Rivers of Empire: Water, Aridity and the Growth of the American West* in 1985. In the work, he linked Henry David Thoreau’s portrayal of survivalism and freedom to Turner, and he emphasized that natural resources were key to the frontier, particularly the control of water.⁴⁸ This was drawn parallel to Webb’s

⁴⁷ M. Guy Bishop, “Reviewed Work: The Frontier in American Culture: An Exhibition at the Newberry Library, August 26, 1994-January 7, 1995,” *Illinois Historical Journal* 88, no. 4 (Winter 1995): 291.

⁴⁸ M. Catherine Miller, “Reviewed Work: Rivers of Empire: Water, Aridity, and the Growth of the American West,” *Agricultural History* 60, no. 4 (Autumn 1986): 122.

argument that windmills were important, though Worster went further and stated that water on the frontier could “determine social order, manner of government and economic development.”⁴⁹ He also wrote *Dust Bowl: The Southern Plains in the 1930s* in 1979 for which he won a Bancroft Prize. In *Dust Bowl*, Worster contributed to the study of frontiers by portraying the difficulty of farmers trying to farm on the frontier similarly to the way they farmed in Ohio. Attempting to farm undeveloped, treeless land during the Dust Bowl, where no one had farmed before, proved to be a disaster when the rains stopped. The book’s thesis is that nature prescribes limits in some places with which humankind is unable to cope, and this was especially obvious on the American frontier during the Dust Bowl.⁵⁰ He wrote that the frontier and the Great Plains were caused great harm by pioneer farmers with “great phalanxes of clanking, smoking machines remaking the face of the earth and grinding under its rural culture in the process.”⁵¹ Harming the environment, according to Worster and in contrast to Turner, harmed frontier culture and contributed to the severity of the Dust Bowl.

William Cronon, the Frederick Jackson Turner and Vilas Research Professor of History at the University of Wisconsin-Madison, disagreed with the man after whom his professorship is named in his book *Nature’s Metropolis: Chicago and the Great West* in 1991. The book was reviewed positively and won the Bancroft Prize and then became a finalist for the Pulitzer. The book’s thesis is that one cannot understand the city of

⁴⁹ Martin Reuss, “Reviewed Work: Rivers of Empire: Water, Aridity, and the Growth of the American West,” 10, no. 1 (Winter, 1988): 75.

⁵⁰ Gould P. Coleman, “Reviewed Work: Dust Bowl: The Southern Plains in the 1930s,” *Agricultural History* 54, no. 2 (April 1980): 366.

⁵¹ Donald Worster, *Dust Bowl: The Southern Plains in the 1930s* (New York: Oxford University Press, 1979), 58.

Chicago without a grasp of the frontier surrounding it, and vice versa.⁵² He wrote in a way that suggested that the destruction of the frontier around the city of Chicago turned Chicago into the “Great White City” of 1893, where Turner was able to first posit his frontier thesis. He also identified Chicago as the “beginning” of the American frontier, whereas Turner described Chicago as the “end” of the frontier.

Aiding Turner’s critics are the new methods they are using to study the frontier and the time that has passed since Turner first published his seminal works on the frontier. Although some of Turner’s disciples, “rigidly confine their essays to frontier/settlement chronologies,” modern historians have the luxury of being able to “pursue their themes far into the twentieth century.”⁵³ Other scholars, such as the “Gang of Four,” use different definitions of the frontier or they consider the study of the frontier in the overall theme of history, rather than in the themes of American politics, democracy, and development as Turner did. These new methods, such as regression analysis, big data, digital population census reports, and use of technologies such as computers, smartphones, and the internet assist them in ways that their predecessors could never equal.

If it is a given that *The Significance of the Frontier in American History* is the most significant work of frontier history of any historian noted in this thesis, then one aspect of frontier historiography that can be surmised from the two camps, the authors, their historical schools, their arguments, and their publications, is that there was a frontier

⁵² Stephen H. Cutcliffe, “Reviewed Work: Nature’s Metropolis: Chicago and the Great West,” *Technology and Culture* 51, no. 3 (July 2010): 728.

⁵³ Michael P. Malone, “American Frontier and Western Issues: A Historiographical Review,” *The Journal of American History* 74, no. 3 (1987): 1039, doi:10.2307/1902166.

and that it has many interpretations. The frontier, therefore, is a cognitive tool with a history of its own to correlate with different definitions for the easier conceptualization of the unknown. The debate on frontiers itself is a vehicle for the understanding of the new ventures of humanity, especially in intellectual fields. To that end, the definitions of frontiers, utilized to no end and conveniently for perhaps selfish purposes by the aforementioned historians, are appropriately associated elsewhere.

Scholarly journals on intellectual fields are conduits for the study of the “unknown,” the same “unknown” used in defining a frontier. Just as settlers pushed westward to settle unknown geographical territory, scholars use journals to push the boundaries of the known limits of human knowledge. Scientific journals, therefore, become necessary sources of study in order to demonstrate whether or not a scientific field fits the definition of a frontier. Several scientific fields are underdeveloped or on the “fringe” of human knowledge, and publications devoted to them are explored in this section of the chapter. These fields are those of medicine, space, artificial intelligence, social media, and drones.

Medicine, though practiced in various forms across millennia, could be considered a frontier of multiple new frontiers because so much of it is undeveloped. Gene editing, a wholly new phenomenon, confounds a generation of doctors across the world. Additionally, new viruses such as the Coronavirus (COVID-19) of 2020 require responses that have been unexplored. The last example of medicine as a frontier, as seen through published sources, will be in nootropics, or brain-enhancing drugs, as recent developments in the world of medicine.

The Journal of Molecular Biology in June 2018 contained an article titled “CRISPR Ethics: Moral Considerations for Applications of a Powerful Tool” by Carolyn Brokowski and Mazhar Adli.⁵⁴ CRISPR is an acronym for Clustered Regularly Interspaced Short Palindromic Repeats. Two years later, a Chinese scientist, He Jiankui, was criticized for creating the world’s first genetically edited babies using CRISPR, an apparatus for editing human genes.⁵⁵

As with any frontier, there are unexplored ethical considerations in medicine. Genome editing could be used to breed super soldiers by nation states or non-state actors, which also could compromise the birth of a baby. These possibilities stand against many religious principles and are questionable from a legal perspective in many countries. The doctor, in his defense, published an article titled: “The Roadmap towards Developing Standards for Safety and Efficacy for Human Germline Gene Editing and Moral Principles.”⁵⁶

The New England Journal of Medicine has by far the most material on gene editing and CRISPR and the journal’s authors are generally more favorable towards the new technology. For example, M. H. Porteus’ 2019 article “Frontiers in Medicine: A New Class of Medicines through DNA Editing” referred to the technology as the “holy grail” because it “represents a transformative means of generating medicines and gives

⁵⁴ Carolyn Brokowski and Mazhar Adli, “CRISPR Ethics: Moral Considerations for Applications of a Powerful Tool,” *The Journal of Molecular Biology* 431, no. 1 (June 2018): 88-101.

⁵⁵ Pam Belluck, “Chinese Scientist Who Says He Edited Babies’ Genes Defends His Work,” *The New York Times*, November 28, 2018, accessed April 3, 2019, <https://www.nytimes.com/2018/11/28/world/asia/gene-editing-babies-he-jiankui.html>.

⁵⁶ *Ibid.*

the engineering of the genome a precision that has not previously been possible.”⁵⁷ In “The Future of Gene Editing—Toward Scientific and Social Consensus,” Lisa Rosenbaum commented on those who believe individuals such as He Jiankui are monstrous, although there is “a potential future role for gene editing in providing opportunities for happier, healthier lives.”⁵⁸ In “A CRISPR Way to Restore Hearing,” Wade W. Chien discussed how a method of using CRISPR dubbed “Beethoven” can restore the sense of hearing to babies born deaf.⁵⁹

The International Journal of Medical Sciences also covers gene editing from multiple points of view. Yan He wrote “While it is Not Deliberate, Much of Today’s Biomedical Research Contains Logical and Technical Flaws, Showing a Need for Corrective Action.”⁶⁰ Regarding CRISPR, the author discussed how previously proven medical techniques and processes are bypassed using CRISPR. This casts doubt on the technology’s safety because CRISPR disregards the proven history of such processes. Safety is often jeopardized by the nature of frontiers, and change occurs often on frontiers sometimes in the form of mutation. Genes, even without CRISPR, are subject to change or mutation, and viruses at the similar molecular level do also. One that has recently mutated into another frontier for medicine is the Novel Coronavirus, medically referred to as COVID-19.

⁵⁷ Matthew Porteus, “Frontiers in Medicine: A New Class of Medicines through DNA Editing,” *The New England Journal of Medicine* 40, no. 380 (March 2019), 947.

⁵⁸ Lisa Rosenbaum, “The Future of Gene Editing—Toward Scientific and Social Consensus,” *The New England Journal of Medicine* 380, no. 10 (March 2019): 971, doi: 10.1056/NEJMms1817082.

⁵⁹ Wade W. Chien, “A CRISPR Way to Restore Hearing,” *The New England Journal of Medicine* 378, no. 13 (March 2018): 1255-6.

⁶⁰ Yan He et al., “While it is Not Deliberate, Much of Today’s Biomedical Research Contains Logical and Technical Flaws, Showing a Need for Corrective Action,” *The International Journal of Medical Sciences* 15, no. 4 (January 2018): 309-22.

Some undeveloped areas of medicine fit the definition of a frontier as the front line of battle. Sources, such as journal articles and professional studies, need to be developed in short order to prevent calamity and technologies needed to be developed to tame the environment of a frontier. These sources have indeed found their way to publication with regard to the coronavirus or COVID-19.

In February 2020, Ying Liu wrote “The Reproductive Number of COVID-19 is Higher Compared to SARS Coronavirus” in the *Journal of Travel Medicine* only two months after the initial outbreak of COVID-19 in Wuhan, China.⁶¹ He found that the World Health Organization’s estimate of how fast the virus can spread is lower than reality. The article used previous studies on similar viruses, was short in length, and included a sample study of only one month. This shows the lengths scholars must go to, the hardships, and the lack of resources they would have on such a scientific frontier in the modern day.

An unexpected and unseen concept unique to the COVID-19 virus is seen in Huijun Chen’s “Clinical Characteristics and Intrauterine Vertical Transmission Potential of COVID-19 Infection in Nine Pregnant Women: A Retrospective Review of Medical Records” published in *The Lancet* on March 7, 2020.⁶² This article was published three months after the first cases of the outbreak were reported in China. Looking to see how the children the expectant mothers were carrying would react to the virus, he expected

⁶¹ Ying Liu et al., “The Reproductive Number of COVID-19 is Higher Compared to SARS Coronavirus,” *Journal of Travel Medicine* 27, no. 2 (March 2020): 1-4.

⁶² Huijun Chen et al., “Clinical Characteristics and Intrauterine Vertical Transmission Potential of COVID-19 Infection in Nine Pregnant Women: A Retrospective Review of Medical Records,” *The Lancet* 395, no. 10226 (March 2020): 809-15.

still births, but all nine babies were born healthy, though unique to this virus in a way unknown, all nine mothers needed a C-section. The author had not seen this in a virus before, and he is still trying to figure out why, demonstrating the uncertainty, surprises, and challenges consistent with a scientific frontier.

Danger is also present on scientific frontiers, as seen in an article published by Feng Pan et al in *Radiology* titled “Time Course of Lung Changes on Chest CT During Recovery from 2019 Novel Coronavirus (COVID-19) Pneumonia” on February 13, 2020. The researchers were exposed to twenty-one carriers of the virus in order to determine whether the change in their breathing over the course of their infection with the virus affected the transmission of the virus to others and how the virus affected their hearts. They found that healthy patients usually recovered fully, though they experienced issues with their breathing and heartbeat patterns, with greatest severity “10 days after initial onset of symptoms.”⁶³ The researchers contributed to the frontier of what is known about the virus while exposing themselves to the potential harm of a virus that is unknown in comparison to other strains.

It should be noted that the authors of these articles come from the same geographical regions where the viral outbreak occurred. These studies show that such sources on frontier topics must draw upon previous sources, such as studies on the SARS virus. They also show that some frontiers require more immediate resources than others, and that the generation of sources treating frontiers is usually beneficial to those on the frontiers and elsewhere in society.

⁶³ Feng Pan et al., “Time Course of Lung Changes on Chest CT During Recovery from 2019 Novel Coronavirus (COVID-19) Pneumonia,” *Radiology* 295, no. 3 (February 2020): 715-21.

Among the more interesting medical frontiers is that of prescription and non-prescription drugs, particularly the kinds that improve cognitive functions. These are known as nootropics, and they pose the dangers of the unknown along with ethical issues as can be seen in publications dealing with them.

In a monograph published by the University of Minnesota Press in 1995, *On Drugs*, David Lenson stated that new, untested drugs are still being mass produced and becoming available on the commercial market. The newness presents as many difficulties as it could present benefits, and nootropics are no exception. The book noted that the question remains whether a nootropic is “salutary because it mimics the disinterestedness of logic, permitting intellectual activity with a minimum of distraction” or whether “at small doses they appear to aid logical thought, but they tend to make labor too interesting in and of itself.”⁶⁴

Cesare Mondadori discussed the frontier of nootropics in “Delayed Emergence of Effects of Memory-Enhancing Drugs: Implications for the Dynamics of Long-Term Memory” published in *Proceedings of the National Academy of Sciences of the United States of America*.⁶⁵ The article noted that the use of memory enhancing substances, an underexplored field, has not been shown to produce the desired results, in either the short or the long term. V. Cakic also wrote on the topic in “Smart Drugs for Cognitive Enhancement: Ethical and Pragmatic Considerations in the Era of Cosmetic Neurology,” published in the *Journal of Medical Ethics*. In this article, the author wrote that the

⁶⁴ David Lenson, *On Drugs* (Minnesota: 1995) 79.

⁶⁵ Cesare Mondadori et al., “Delayed Emergence of Effects of Memory-Enhancing Drugs: Implications for the Dynamics of Long-Term Memory,” *Proceedings of the National Academy of Sciences of the United States of America* 91, no. 6 (March 1994): 2041-5.

effects of nootropics are marginal, but that there will soon be nootropics that greatly enhance cognitive performance and that they will be distributed and used in unregulated and dubious ways. This will also create an “uneven playing field” between those with nootropics and those without.⁶⁶ Ingrid Walker included a chapter in her book *High: Drugs Desire and a Nation of Users* titled “Why We Use: The Pleasure and Eros of Drugs” and commented on the addictive nature of nootropics.⁶⁷ People could become addicted to the desire to have their cognition increased, in addition to the physical addiction of their body requiring the drug. This new dilemma would pose a problem of extremely intelligent people using their brains in any way possible to obtain more of the drug, which could lead to a major disruption in human interaction and society. Walker also wrote that although nootropics improve the limits of consciousness, “consciousness is precisely the frontier where our materialistic understanding of the brain stops.”⁶⁸

Outer space fits the definition of a frontier as a place “where no one else has been.”⁶⁹ This frontier is inherently unsafe because of radioactivity, cold temperatures, and the absence of oxygen. Outer space, fittingly, intersects with medicine as a frontier, as is apparent in astronauts returning from space and finding that their brains are functioning differently because their bodies were designed to be conditioned to Earth’s gravity. *Space Science Reviews* is a peer-reviewed journal with articles highlighting concerns of safety in outer space. In “Cosmic Ray Implications for Human Health,” M.

⁶⁶ V. Cakic, “Smart Drugs for Cognitive Enhancement: Ethical and Pragmatic Considerations in the Era of Cosmetic Neurology,” *Journal of Medical Ethics* 35, no. 10 (October 2009): 611.

⁶⁷ Ingrid Walker, *High: Drugs Desire, and a Nation of Users* (University of Washington Press: 2017), 131.

⁶⁸ *Ibid.*, 141.

⁶⁹ As can be seen in the title of the history of a Apollo Project: “Where No Man Has Gone Before: A History of Apollo Lunar Exploration Missions” accessed February 22, 2020, <https://www.hq.nasa.gov/office/pao/History/SP-4214/contents.html>.

A. Shea and D. F. Smart wrote that humans have not yet perfected mitigations to cosmic radiation exposure for astronauts.⁷⁰ The caution is echoed in “Man in Space.

Bioastronautics: Yesterday, Today, Tomorrow” by O. G. Gzenko in the same journal.⁷¹

Safety for astronauts will also be a concern when Mars is colonized, as described in

“Selection of the Mars Science Laboratory Landing Site” by M. Golombek.⁷²

The journal *Advances in Space Research* considers other issues encountered on the space frontier. Safety in space is the primary concern in V. M. Petrov’s “Problems and Conception of Ensuring Radiation Safety During Mars Missions,” and also in “An Alternative Approach to Solar System Exploration Providing Safety of Human Mission to Mars” by J. I. Gitelson.⁷³ In “The European Space Debris Safety and Mitigation Standard,” F. Alby considered safety regarding materials entering, and already within, Earth’s orbit.⁷⁴

Planetary and Space Science publishes on safety factors in the field of space studies. For example, the article “Next-Generation of Robotic Planetary Reconnaissance Missions: A Paradigm Shift” by Wolfgang Fink, showed how space-based drones are mapping the earth more safely than manned missions.⁷⁵ The need for safety, other than

⁷⁰ M. A. Shea and D. F. Smart, “Cosmic Ray Implications for Human Health,” *Space Science Reviews* 93 (July 2000): 187-205.

⁷¹ O. G. Gzenko, “Man in Space. Bioastronautics: Yesterday, Today, Tomorrow,” *Space Science Reviews* 50, no. 3 (August 1989): 500-2.

⁷² M. Golombek et al., “Selection of the Mars Science Laboratory Landing Site,” *Space Science Reviews* 170 (July 2012): 641-737.

⁷³ V. M. Petrov, “Problems and Conception of Ensuring Radiation Safety During Mars Missions,” *Advances in Space Research* 34, no. 6 (May 2004): 1451-1454; J. I. Gitelson et al., “An Alternative Approach to Solar System Exploration Providing Safety of Human Mission to Mars,” *Advances in Space Research* 31, no. 1 (January 2003): 17-24.

⁷⁴ F. Alby et al., “The European Space Debris Safety and Mitigation Standard,” *Advances in Space Research* 24, no. 5 (April 2004): 1260-63.

⁷⁵ Wolfgang Fink et al., “Next-Generation of Robotic Planetary Reconnaissance Missions: A Paradigm Shift,” *Planetary and Space Science* 53, no. 14 (December 2005): 1419-26.

for human life, exists for unmanned assets, according to Joseph A. Burns' and Brett J. Gladman's "Dynamically Depleted Zones for Cassini's Safe Passage Beyond Saturn's Rings," published in the same journal.⁷⁶

Safety was a common concern for people on frontiers, and *Astrophysics and Space Science* demonstrates how the safety of the human race could be in jeopardy from celestial bodies in outer space. Martin Beech's "The Past, Present, and Future Supernova Threat to Earth's Biosphere" described how the human species is one large gamma ray burst, from the sun or nearby star, away from mass extinction.⁷⁷ Space, in this respect, fits the definition of a frontier in the sense that unexpected events could alter the lives of people on the frontiers at an instant. The sun's position in the corotational circle of the Milky Way Galaxy is one that actually provides Earth, and Earth's solar system, with relative safety from intruding celestial bodies, as outlined in L. S. Marochnik's "On the Origin of the Solar System and the Exceptional Position of the Sun in the Galaxy."⁷⁸ Wars and technologies employed in waging wars were commonplace on the frontier, and Shannon Orr, in an article published in *Peace Studies* and titled "Peace and Conflict in Outer Space," discussed how the technologies employed in space travel are also used in war.⁷⁹

Artificial intelligence (AI), fitting the description of a frontier in that it is an unexplored and undeveloped area, is among the most important fields of study ever

⁷⁶ Joseph A. Burns and Brett J. Gladman, "Dynamically Depleted Zones for Cassini's Safe Passage Beyond Saturn's Rings," *Planetary and Space Science* 46, no. 9 (October 1998): 1401-7.

⁷⁷ Martin Beech, "The Past, Present, and Future Supernova Threat to Earth's Biosphere," *Astrophysics and Space Science* 336 (October 2011): 287-302.

⁷⁸ L. S. Marochnik, "On the Origin of the Solar System and the Exceptional Position of the Sun in the Galaxy," *Astrophysics and Space Science* 89 (January 1983): 61-75.

⁷⁹ Shannon Orr, "Peace and Conflict in Outer Space," *Peace Studies* 30, no. 1 (February 1998): 52.

ventured into by humans. It pertains to computers that have become so powerful as to be able to make intelligent decisions on their own through functions programmed into them. Researchers have only recently begun to appreciate the possibilities and the potential perils of what AI could mean for society, which is consistent with both the romantic ideals and with the questions of safety seen on other frontiers.

War and ethics are predominant themes in journals pertaining to the frontier of artificial intelligence. As outlined in the *International Journal of Artificial Intelligence and Soft Computing*, AI is expected to revolutionize many aspects of humanity. Such articles as “Predicting Financial Time Series Data Using Artificial Immune System-Inspired Neural Networks” by Haya Al-Askar demonstrate this.⁸⁰ This was also seen in *Frontiers in Artificial Intelligence* in such articles as “Pancreatic Cancer Prediction Through an Artificial Neural Network” by Wazir Muhammad.⁸¹

The *International Journal of Advanced Computer Science and Applications* contained an article titled “Design of an Intelligent Combat Robot for War Fields” by S. Bhargavi.⁸² This article considered artificial intelligence in a robot as a tool for rescuing wounded friendly soldiers more safely and killing enemy soldiers with as little cost as possible to the side possessing artificial intelligence capabilities. An article by Peter Simon Sapaty titled “Military Robotics: Latest Trends and Spatial Grasp Solutions,” in

⁸⁰ Haya Al-Askar et al., “Predicting Financial Time Series Data Using Artificial Immune System-Inspired Neural Networks,” *International Journal of Artificial Intelligence and Soft Computing* 5, no. 1 (November 2015): 45-68.

⁸¹ Wazir Muhammed et al., “Pancreatic Cancer Prediction Through an Artificial Neural Network,” *Frontiers in Artificial Intelligence* (May 2019).

⁸² S. Bhargavi et al., “Design of an Intelligent Combat Robot for War Fields,” *International Journal of Advanced Computer Science and Applications* 2, no. 8 (January 2011): 64-70.

the *International Journal of Advanced Research in Artificial Intelligence*, discussed how artificial intelligence is a useful tool for Explosive Ordnance Disposal (EOD).⁸³

The *Journal of Artificial Intelligence Research* contains an article titled “Obtaining Reliable Feedback for Sanctioning Reputation Mechanisms” by Radu Jurca and Boi Faltings that discussed the application of ethics to artificial intelligence.⁸⁴ Ethics are also central to the journal *Artificial Intelligence*. This is seen in articles in the journal such as “Robot Ethics: Mapping the Issues for a Mechanized World” by Patrick Lin; “Robotics: State of the Art and Future Challenges” by Christopher Stanton and Mary-Anne Williams; and “Ethical Guidelines for a Superintelligence” by Ernest Davis.⁸⁵

In a computing realm similar to artificial intelligence, social media is a new scientific frontier. Social media includes online networking sites such as Facebook and Twitter, which are ways for people to communicate on a mass scale. The benefits of new forms of communications, along with the drawback of the sacrifice of personal privacy, are consistent with the risk and rewards balances on frontiers. The first people to venture into the online portals of social media were entering into an unexplored and undeveloped space, that is, into a frontier in the scientific sense.

Social media is discussed in journals such as the *Journal of Medical Internet Research* and *Business Law Today* and is highlighted in such articles as “Attitudes

⁸³ Peter Simon Sapaty, “Military Robotics: Latest Trends and Spatial Grasp Solutions,” *International Journal of Advanced Research in Artificial Intelligence* 4, no. 4 (April 2015): 9-18.

⁸⁴ Radu Jurca and Boi Faltings, “Obtaining Reliable Feedback for Sanctioning Reputation Mechanisms,” *Journal of Artificial Intelligence Research* 29 (August 2007): 391-419.

⁸⁵ Patrick Lin et al., “Robot Ethics: Mapping the Issues for a Mechanized World,” *Artificial Intelligence* 175, no. 5 (April 2011): 942-9; Christopher Stanton and Mary-Anne Williams, “Robotics: State of the Art and Future Challenges,” *Artificial Intelligence* 172 (2008): 1967-72; Ernest Davis, “Ethical Guidelines for a Superintelligence,” *Artificial Intelligence* 220, (March 2015): 121-4.

Toward the Ethics of Research Using Social Media: A Systematic Review,” by Su Golder.⁸⁶ The title of the article suggests a link to frontiers, in which ethics play a defining role. Theodore Claypoole wrote, in an article titled “Privacy and Social Media Today” and published in *Business Law Today*, that among the reasons social media is accepted by the general populace is that it is so new, although it is “anathema” to privacy.⁸⁷

The frontier, as noted earlier in this chapter, changed American politics, and politics were a major component of the American frontier. That politics are a major aspect of social media is noted in articles in *The Journal of Social Media in Society* and in such articles as “#TrumpStyle: The Political Frames and Twitter Attacks of Donald Trump” by Eric Dunning, and “Social Networking Site as a Political Filtering Machine: Predicting the Act of Political Unfriending and Hiding on Social Networking Sites” by Joseph Yoo.⁸⁸

A psychological aspect of social media is discussed in Elliot Panek’s “It’s All About Me (or Us): Facebook Post Frequency & Focus as Related to Narcissism.” Psychology is also a concept rooted in other frontiers.⁸⁹ The journal *Social Media + Society* further elaborates on morality, politics, and psychology in social media in articles such as “Social Media for Social Good or Evil: An Introduction,” by Jeff Hemsley; “The

⁸⁶ Su Golder, “Attitudes Toward the Ethics of Research Using Social Media: A Systematic Review,” *The Journal of Medical Internet Research* 19, no. 6 (June 2007).

⁸⁷ Theodore Claypoole, “Privacy and Social Media,” *Business Law Today* (January 2014): 4.

⁸⁸ E. Dunning, “#TrumpStyle: The Political Frames and Twitter Attacks of Donald Trump,” *The Journal of Social Media in Society* 7, no. 2 (2018): 205-31; Joseph Yoo et al., “Social Networking Site as a Political Filtering Machine: Predicting the Act of Political Unfriending and Hiding on Social Networking Sites,” *The Journal of Social Media in Society* 7, no. 2 (2018): 92-119.

⁸⁹ Elliot Panek et al., “It’s All About Me (or Us): Facebook Post Frequency & Focus as Related to Narcissism,” *The Journal of Social Media in Society* 7, no. 2 (September 2018): 1-17.

Clickwrap: A Political Economic Mechanism for Manufacturing Consent on Social Media” by Jonathan Obar and Anne Oeldorf-Hirsch; and “Selfies, Policies, or Votes?: Political Party Use of Instagram in the 2015 and 2016 Spanish General Elections” by Stuart J. Turnbull-Dugarte.⁹⁰ The psychological aspect of social media is examined in the journal through “Anger, Fear, and Echo Chambers: The Emotional Basis for Online Behavior” by Da Wollebaek.⁹¹ Morality and ethics are issues on the frontier of social media, just as they are on other frontiers.

There are, however, positive aspects to the frontier of social media, as discussed in *The Journal of Social Media in Society*’s “Social Media for Good? A Survey on Millennials’ Inspirational Social Media Use” by Sophie Hela Janicke.⁹² The content of this article runs parallel to the thought that there are many positive aspects of social media, such as rewards, just as there were on other frontiers.

Online Social Networks and Media publishes more articles on privacy in social media than others, as seen in Imrul Kayes’ and Adriana Iamnitchi’s “Privacy and Security in Online Social Networks: A Survey” and “Decentralizing Privacy Preserving Services for Online Social Networks” by Leila Bahri.⁹³ Privacy as an issue is also central

⁹⁰ Jeff Hemsley et al., “Social Media for Social Good or Evil: An Introduction,” *Social Media + Society* (July 2018): 1-5; Jonathan Obar and Anne Oeldorf-Hirsch, “The Clickwrap: A Political Economic Mechanism for Manufacturing Consent on Social Media,” *Social Media + Society* (August 2018): 1-14; Stuart J. Turnbull-Dugarte, “Selfies, Policies, or Votes?: Political Party Use of Instagram in the 2015 and 2016 Spanish General Elections,” *Social Media + Society* (April 2019): 1-15.

⁹¹ Dag Wollebaek et al., “Anger, Fear, and Echo Chambers: The Emotional Basis for Online Behavior,” *Social Media + Society* (June 2019): 1-14.

⁹² Sophi Helga Janicke et al., “Social Media for Good? A Survey on Millennials’ Inspirational Social Media Use,” *The Journal of Social Media in Society* 7, no. 2 (September 2018): 120-40.

⁹³ Imrul Kayes and Adriana Iamnitchi, “Privacy and Security in Online Social Networks: A Survey,” *Online Social Networks and Media* 3, no. 4 (2017): 1-21; Leila Bahri et al., “Decentralizing Privacy Preserving Services for Online Social Networks,” *Online Social Networks and Media* 6 (June 2018): 18-25.

to “OOSSINT – Open Source Social Network Intelligence: An Efficient and Effective Way to Uncover “Private” Information in OSN Profiles” by Giuseppe Cascavilla.⁹⁴

Privacy, together with openness, individualism, and sometimes lawlessness, are issues on the social media frontier, just as they were, and are, on other frontiers.

Medicine, outer space, artificial intelligence, and social media can all be classified as frontiers because they exhibit the characteristics of frontiers, those of being unexplored, undeveloped, unsafe, riven with ethical issues, laden with value, and associated with politics. These characteristics also apply to the frontier of Unmanned Aircraft Systems (UAS) or drones.

Secondary sources on drones include articles from the *Journal of Unmanned Aerial Systems*, a journal new to the academic scene and the only journal dedicated to the topic of UAS. The absence of other journals suggests that the scholarly study of UAS is not only new, it is underdeveloped. Other sources such as “What Type of Person Supports 24/7 Police Drones Over Neighborhoods?: A Regression Analysis” by Daniel A. Marte, reveal the ethical issues involved when drones invade personal privacy or restrict individualism.⁹⁵ Sources also include business and technology publications and materials used in aviation classes at the University of North Dakota in Grand Forks.

Because drones are a new frontier and becoming a new field of study, those writing on

⁹⁴ Giuseppe Cascavilla et al., “OOSSINT – Open Source Social Network Intelligence: An Efficient and Effective Way to Uncover “Private” Information in OSN Profiles,” *Online Social Networks and Media* (2016): 1-21.

⁹⁵ Daniel A. Marte et al., “What Type of Person Supports 24/7 Police Drones Over Neighborhoods?: A Regression Analysis,” *Journal of Unmanned Aerial Systems* 4, no. 1 (December 2018): 61-70.

them must draw from other fields of study, just as those on medical frontiers must draw from other fields of study when they encounter a new disease.

Primary sources pertaining to UAS include state ledgers, police records, legal documents such as regulation exemption petitions, Certificates of Authorization for flights, flight manuals, FAA Advisory Circulars, Congressional documents, Charters such as from the UAS Research Ethics and Privacy Committee at the University of North Dakota, and UAS advertisements from newspapers, including the *Grand Forks Herald*, *The Bismarck Tribune*, and *New York Times*. That the UAS Research Ethics and Privacy Committee at UND exists is a reminder that UAS share the definition of a frontier with respect to ethics.

Few monograph-length scholarly works treat the history of UAS, and almost every monograph or article that contains UAS as a topic has a short history section, from which much of any historiography would need to be drawn. Unfortunately, most of these historical treatments disagree on what the first UAS was, what the definition of a UAS is, and what the milestones are in its evolution. These disagreements and arguments share a common spirit with the disagreements that the Gang of Four have with Turner and his disciples.

Numerous books and articles on drones have been published. Some are in the form of an interactive website, though most are outdated. Most books about drones are drone pilot logbooks or manuals on do-it-yourself (DIY) drone kits. Many offer advice on how to fly drones or they are thriller novels featuring drones in a fantastic fictional story. The most comprehensive histories of UAS are Greg Goebel's "Unmanned Aerial

Vehicles,” Laurence Newcombe’s *Unmanned Aviation: A Brief History of Unmanned Aerial Vehicles*, Steven Zaloga’s *Unmanned Aerial Vehicles: Robotic Air Warfare 1917-2007*, and Brendan Gogarty’s *Unmanned Vehicles: A (Rebooted) History, Background, and Current State of the Art*.⁹⁶

Goebel’s well-illustrated work is a collection of narrated primary sources dating to the first unmanned aircraft used for target practice. Although Goebel does not write as an academic, the numerous specification charts for the unmanned aircraft he discussed are comprehensive and are a credit to his work. He traced his history of UAS to the first “important use” of UAS being target drones in World War II. This work shows a scholar attempting to shed light on an undeveloped topic, that of UAS, as other scholars have done in other unexplored areas.

Laurence Newcombe’s *Unmanned Aviation: A Brief History of Unmanned Aerial Vehicles* is an important work and perhaps the only monograph that could pass muster for use in history courses on UAS in higher education. Although not an historian, Newcombe has done more research and writing than anyone else on UAS history, including what must have been tedious design-work on the history of “names applied to unmanned aircraft” such as “Aerial Torpedoes,” “Pilotless Aircraft,” and “Drones.”⁹⁷ One of Newcombe’s most important contributions to UAS history is his contention that all previous pilotless aircraft converge into the modern conception of a cruise missile, and that all present-day drones trace their lineage to the cruise missile. This argument could

⁹⁶ Greg Goebel, accessed April 21, 2019, <http://craymond.no-ip.info/awk/twuav1.html#m1>; Brendan Gogarty, accessed April 21, 2019, https://issuu.com/brendangogarty/docs/jlis_21.1.drones.

⁹⁷ Delmar Fahrney, *The History of Pilotless Aircraft and Guided Missiles* (Washington: Department of Defense, 1958), 125.

be seen as being akin to Turner's tracing American democracy's lineage to the American frontier, demonstrating that all frontiers have their scholars and scholarly arguments.

No one has yet studied UAS in North Dakota to any degree except anthropologist Marcel LaFlamme of Rice University who wrote a dissertation on UAS in North Dakota to show that UAS is an evolution from manned aircraft. "The maturation and proliferation of unmanned aircraft, or drones," he wrote,

is reconfiguring the media technologies, infrastructures, and practices on which pilots have previously relied. Drawing on ethnographic fieldwork with both manned and unmanned pilots in North Dakota, a state that has courted the unmanned aircraft industry in a bid for economic diversification, [there is] emergence of a new regime of aviation communication organized around the obligation to transmit continuously.⁹⁸

This quote shows an unexplored change in the way pilots are going to need to operate in response to the effect of UAS. That no one else has studied UAS in North Dakota also suggests that the topic of UAS is underdeveloped, reminiscent of the definition of a frontier.

A North Dakotan, Doug Marshall, wrote *Introduction to UAS* in 2012, though it is not focused on North Dakota in particular.⁹⁹ That an introduction to the topic of UAS was first published in 2012 shows how undeveloped the topic of UAS is and suggests how UAS are a scientific frontier. Only a few University of North Dakota professors have published scholarly articles on UAS and some of the articles were published in the *Journal of Unmanned Aerial Systems*. Given that UAS are growing in influence and that North Dakota is a hub of UAS, one could reasonably expect more scholarship published

⁹⁸ Marcel LaFlamme, "A Sky Full of Signal: Aviation Media in the Age of the Drone," *The Journal of Media, Culture, and Society* 40, no. 5 (October 2017): 689.

⁹⁹ See Appendix K.

from North Dakota on UAS. This, again, shows that the topic is underdeveloped, similarly to other scientific frontiers. The last major North Dakota UAS primary source used in this thesis is a professional study done by the Grand Forks Region Economic Development Corporation and its partners in May 2007. The document discusses some of the history of UAS in North Dakota, and includes the statement that,

unmanned aviation dawned on the Grand Forks horizon when the Defense Department's 2005 Base Closure and Realignment Commission (BRAC) announced Grand Forks Air Force Base, with its 3000 employees, was on its list. The region immediately set to work along two vectors, to reverse the BRAC decision and to identify and attract new businesses to compensate for the loss of the base if unsuccessful. For the former, they were partially successful in that the departure of the manned aircraft was somewhat offset by plans to base unmanned aircraft at the base that would be controlled from Hector Air National Guard Base in Fargo.¹⁰⁰

This passage shows that an unmanned aircraft mission could be the reward seen often on frontiers.

The sources presented here represent the extent of professional writing or scholarship on UAS or that written on the topic of UAS in North Dakota. Though few, the sources suggest that UAS are a frontier, and that they are, as yet, an undeveloped scholarly topic. UAS, as can be discerned from the sources, have their seminal scholars, disputes, dangers, safety aspects, ethical issues, hazards, and potential rewards. If the application of the term "frontier" to UAS is not the best way to conceptualize the new phenomenon of drones, the sources suggest that it is at least one that helps someone unfamiliar with the technology understand it better. The rest of this thesis seeks to fill a

¹⁰⁰ MTSI Grand Forks Unmanned Aviation Business Development Roadmap, May 31, 2007. Also see appendices C and F.

void by being the first scholarly study on UAS, especially UAS as a North Dakota frontier.

CHAPTER II
FRONTIERS AND THOSE WHO CONFRONTED THE CHALLENGES THEY
PRESENTED

People have been drawn to frontiers throughout history, but all frontiers present challenges and ethical issues to those who dare to breach them. Frontiers also involve taking risks such as ridicule, ruin, failure, rejection, humiliation, ostracism, and death. If “economic theory presents people as substantially risk averse, rationally avoiding uncertainty,” as Robert Shiller suggested, the individuals who assume the risks involved with breaching frontiers must share certain character traits that enable them to confront the challenges, the ethical issues, and the risks. This chapter identifies, describes, and discusses these individuals and the character traits they shared.¹⁰¹

Numerous scholars have written about the traits of those who breach frontiers. Frederick Jackson Turner, for example, wrote,

To the frontier the American intellect owes its striking characteristics. That coarseness and strength combined with acuteness and inquisitiveness; that practical inventive turn of mind, quick to find expedience; that masterful grasp of material things, lacking in the artistic but powerful to effect great ends; that restless, nervous energy; that dominant individualism, working for good and for evil, and withal that buoyancy and exuberance which comes with freedom—these are the traits of the frontier, or traits called out elsewhere because of the existence of the frontier.¹⁰²

Of those breaching other than physical frontiers, authors note similar traits. These include the characteristics of “inventiveness, practicality, inquisitiveness, restlessness,

¹⁰¹ Robert J. Shiller, *Finance and the Good Society* (Princeton University Press, 2012), 139.

¹⁰² Turner, *The Significance of the Frontier in American History*, 37.

and optimism.”¹⁰³ Indeed, Leah Ceccarelli, an author mentioned in the previous chapter wrote, “it would not take much to see these characteristics in the eccentric, resourceful, and energetic scientists who were soon to be imagined as striking out across the metaphorical frontiers of science.”¹⁰⁴ Four of the most defining traits those breaching frontiers share are independence, courage, resoluteness, and adaptability. These are the character traits covered in the next section of the thesis.

Those considering breaching a frontier must be willing to separate from, and therefore not be dependent on, their former surroundings. This shows independence, and they will either be independent, or learn how to be while on the frontier. “Independent” is defined by one dictionary as “not requiring or relying on something else,” and “not requiring or relying on others (as for care or livelihood).”¹⁰⁵ To breach frontiers, individuals could rely on neither the place they were in nor on those around them. Robert Wuthnow wrote,

independence in this sense is not rugged individualism. It does not imply going it alone, doing whatever one damn well pleases, come hell or high water. Being independent does not come at the expense of defaulting on one’s obligations. The personal freedom implied in being one’s own boss is compromised only when social obligations force one to do something inconsistent with this understanding of one’s true self.¹⁰⁶

¹⁰³ David J. Weber, “Turner, the Boltonians, and the Borderlands,” *The American Historical Review* 91, no. 1 (February 1986): 66.

¹⁰⁴ Ceccarelli, *On the Frontier of Science*, 37.

¹⁰⁵ Definition of “independent” <https://www.merriam-webster.com/dictionary/independent>, Accessed July 28th, 2020.

¹⁰⁶ From the chapter titled “Independence.” Robert Wuthnow, *In The Blood: Understanding America’s Farm Families* (Princeton University Press: 2015), 101.

This passage suggests that there are many ways to think of the term independence, and the trait can contradict how people think of themselves. Often, it took courage to come to, and act on, the realization that one was or could be independent.

The challenges that people face on frontiers certainly take courage to overcome. “Courage,” according to a dictionary definition, is the “mental or moral strength to venture, persevere, and withstand danger, fear, or difficulty.”¹⁰⁷ Numerous scholars have discussed the trait of courage. C. S. Lewis wrote, “courage is not simply one of the virtues, but the form of every virtue at the testing point, which means at the point of highest reality.”¹⁰⁸ Carl Von Clausewitz, the well-known Prussian war theorist and author of *On War*, wrote that along with temperament, courage is the second part of the highest form of genius.¹⁰⁹ Courage is perhaps the most important trait those breaching a frontier can possess, or acquire quickly, if they are to be successful on a frontier long enough to demonstrate resoluteness.

According to one dictionary, “resoluteness” can be defined as firmness of purpose, and “resolute” is defined as having a decided purpose; determined; resolved; fixed in a determination; hence, bold; firm; and steady.¹¹⁰ Vocabulary.com has it that a person with resoluteness is someone who wants to do something very much and will not

¹⁰⁷ Definition of “courage,” <https://www.merriam-webster.com/dictionary/courage#synonyms>, accessed July 28th, 2020.

¹⁰⁸ Quote on “courage” by C. S. Lewis, *Forbes*, <https://www.forbes.com/quotes/1350/>, accessed July 29, 2020.

¹⁰⁹ Carl von Clausewitz, *Vom Kriege* trans. Michael Howard, Peter Paret, and Bernard Brodie, 15th ed. (Princeton: 1984), 101.

¹¹⁰ Definition of “resoluteness,” <https://www.webster-dictionary.org/definition/Resolute>, accessed July 29th, 2020.

let anything get in the way.¹¹¹ Someone on, or breaching a frontier, will need resoluteness in order to face the challenges that could break the will to continue in an endeavor.

Lastly, a trait common among those on frontiers is that of being adaptable. Another dictionary holds that a person who is “adaptable” is “able to adjust oneself readily to different conditions.”¹¹² Conditions and circumstances on frontiers can and often do change, and this requires people to change in accordance with their new surroundings. If they do not, they risk succumbing to the ever-present challenges of a frontier. The trait of adaptation is also a concept touted by Dr. Elwyn B. Robinson as a theme of North Dakota history, a trait discussed in the next chapter.

The next section of this chapter is a discussion of six frontiers and those who breached them, the challenges they confronted, the ethical issues they faced, and the risks they assumed. The six frontiers, organized chronologically, are the Promised Land of Abraham, medicine, the Great Plains, space, social media, and artificial intelligence. These frontiers were breached by individuals who demonstrated the character traits of independence, courage, resoluteness, and adaptability.

The Book of Genesis recounts the story of Abraham and the Promised Land of Canaan. Abraham set out from Ur, an ancient Sumerian city on the Euphrates River in what is now Iraq, for the land of Canaan, which is present-day Israel and Palestine.¹¹³

¹¹¹ Vocabulary.com definition of “resolute,” <https://www.vocabulary.com/dictionary/resolute#:~:text=Definition%20%3A%20Vocabulary.com-,resolute,anything%20get%20in%20the%20way>, accessed July 29th, 2020.

¹¹² Dictionary.com definition of “adaptable,” <https://www.dictionary.com/browse/adaptable?s=t>, accessed July 29th 2020.

¹¹³ Claire Miller, “The Garden of Eden Fading Fast,” *Frontiers in Ecology and the Environment* 1, no. 4 (May 2003): 173.

Here, one finds the first reference of a frontier in the Bible in the passage: “The Canaanite frontier stretched from Sidon in the direction of Gerer and as far as Gaza.”¹¹⁴

Abraham, the son of Terah, is considered to be the father of three of the world’s great religions-Judaism, Islam, and Christianity.¹¹⁵ In the Bible, Abraham is introduced as Abram, and he set out for Canaan, for him, a frontier. God commanded him, “leave your country, your family and your father’s house, for the land I will show you. I will make you a great nation; I will bless you and make your name so famous that it will be used as a blessing.”¹¹⁶ The apostle Paul wrote in Hebrews 11:8, “By faith Abraham, when called to go to a place he would later receive as his inheritance, obeyed and went, even though he did not know where he was going. By faith he made his home in the promised land like a stranger in a foreign country.” By faith, Abraham obeyed God and left for an unknown country, for him, a frontier.

Abraham’s faith in God allowed him to appeal to God for assistance, for protection, and family. God offered the assistance of protection to Abraham promising, “Have no fear, Abraham, I am your shield.”¹¹⁷ Abraham wanted more, namely a family, when he replied, “My Lord Yahweh what do you intend to give me? I go childless.”¹¹⁸ Speaking to God in such a way would have required courage. Abraham tried to make good on God’s promise to him by bearing a child with Sarah, but, as she was unable to conceive, he made the questionable decision to impregnate Sarah’s handmaiden.

¹¹⁴ Gn 10:19.

¹¹⁵ Stanley Brice Frost, *Patriarchs and Prophets* (McGill-Queen’s University Press: 1963), 13.

¹¹⁶ Gn 12:1-2; A. H. Sayce, “The Age of Abraham,” *The Biblical World* 26, no. 4 (October 1905): 250.

¹¹⁷ Gn 15:1.

¹¹⁸ Gn 15.2-3.

God gave him his first son Ishmael, to be father of twelve princes, and then God gave him a son named Isaac. In a situation unlike anyone had ever experienced to that point, Abraham almost sacrificed Isaac to God, until God, convinced that Abraham was faithful, commanded him not to kill his son. This is one of the most controversial passages in the Bible because of the command that God gave to Abraham. Carol Bakhos wrote,

that God would test Abraham by commanding him to sacrifice the son of the covenant has troubled not only biblical scholars but also ethicists and moral philosophers such as Immanuel Kant, who rejects altogether the command as morally incongruous. Even for Soren Kierkegaard, who valorizes Abraham—he refers to him as the father of faith—the event is haunting: “The ethical expression for what Abraham did is that he was willing to murder Isaac; the religious expression is that he was willing to sacrifice Isaac, but in this anguish lies the contradiction that can indeed make one sleepless.”¹¹⁹

By being faithful and obedient to God, Abraham was successful on the frontier of Canaan, becoming a rich man with livestock, silver, and gold, and a beautiful wife named Sarah. On this frontier, Abraham and his nephew Lot quarreled about their livestock grazing on each other’s lands. They separated, and Abraham went to another new land to the south of Hebron, called Mamre. Abraham eventually traveled back to a part of Canaan in the land of the Philistines called Kadesh, the southern border of present-day Israel. Abraham found the land to be plentiful, as God had told him, a “Promised Land.”

Abraham was indeed successful on the frontier that for him and exiled people became a story of hope.¹²⁰ Abraham demonstrated independence from his people when

¹¹⁹ Carol Bakhos, *The Family of Abraham* (Harvard University Press: 2014), 191.

¹²⁰ “Caught in collective amnesia about their exilic present and past, these Judeans in Babylon focused instead on stories of ancient ancestors. They ‘looked to’ landless ancestors like Abraham and Sarah, related to their struggles, and found hope in their promise.” David M. Carr, *Holy Resilience: The Bible’s Traumatic Origins* (New Haven: Yale University Press, 2014), 96.

he set out for Canaan, courage when faced by God's commands, resoluteness with Sarah and his desire for a son, and adaptability to his surroundings. Abraham demonstrated to all posterity how to breach and survive a frontier.

The medical field, in contrast to Abraham's frontier, is an intellectual frontier, although dating to the time of Abraham, when humans were attempting to determine the cause and cure of diseases and plagues. This section will discuss medical frontiers, and, more specifically, those of preventing, treating, and curing diseases. The men discussed in this section are Dr. Edward Jenner, Louis Pasteur, Dr. Robert Koch, Dr. Walter Reed, and Major General William Gorgas.

Edward Jenner, one of the most celebrated physicians of all time, clearly demonstrated the traits of courage and adaptability while also dealing with ethical issues in his life. After being born to a pastor and his wife in England in 1749, Jenner studied to become a surgeon, and he did well by following another famous British doctor's advice. "Don't think;" William Harvey advised him, "try."¹²¹ Jenner's interests shifted towards inoculation and the development of immunity against disease, which, during his time was an emerging, albeit risky, practice.¹²² A major fear was that people who were vaccinated against a disease would have only the symptoms cease while they remained as carriers who could potentially infect those around them. At the time, one of the most deadly and rampant diseases was smallpox, acknowledged to be a scourge. Jenner discerned from milkmaids, seemingly immune to the disease, that someone who had been infected by

¹²¹ K. Loncarek, "Revolution or Reformation," *Croatian Medical Journal* 50, no. 2 (April 2009): 195.

¹²² Salah Zaimeche, Salim Al-Hassani, "Lady Montagu and the Introduction of Smallpox Inoculation to England," accessed July 31, 2020, <https://muslimheritage.com/lady-montagu-smallpox-inoculation-england/>.

cowpox became immune to smallpox. Jenner extracted the pus from the blistered palms of a milkmaid inflicted with cowpox and had the courage to inject that pus into an eight-year-old boy named James Phipps. Phipps developed an immunity to smallpox.

Other medical doctors at the time had discovered that cowpox could prevent smallpox, but Jenner was the man who brought the discovery to the consciousness of the world, after The Royal Society of London for Improving Natural Knowledge had accepted his discovery. Having courageously risked his own life by being frequently in close proximity to individuals infected with smallpox, he risked the life of a young boy by inoculating him, and proved that smallpox could be prevented and eradicated. George III, the King of England, gave Jenner funds with which to continue his work on vaccination, and Emperor Napoleon Bonaparte released two English prisoners of war to Jenner after he inoculated the entire Grande Armée against smallpox. Helping Napoleon was an ethically questionable proposition for an Englishman at the time, though ultimately, it was unquestionably done for the greater good of humanity. For his work, Jenner is referred to as the “father of immunology,” and it is said of him that his work “saved more lives than the work of any other human.”¹²³

Louis Pasteur, another credited with saving many lives, was born one month before Jenner died in December 1822. The medical frontier of microbiology was relatively undeveloped in the mid-1800’s, during Pasteur’s prime, and viruses and bacteria were indiscriminate of geographical location. Making a name for himself in the field of scientific research, Pasteur proved that light passing through crystals was bent,

¹²³ “How Did Edward Jenner Test His Smallpox Vaccine?” accessed August 1, 2020, <https://www.telegraph.co.uk/only-in-britain/edward-jenner-discovers-the-smallpox-vaccine/>.

not by the shape of the crystal, but by the internal arrangement of the crystal's molecules. As a member of the French intelligentsia, he also demonstrated that alcohol ferments from yeast instead of from decomposition. Pasteur had the courage to expose himself to germs as he breached the boundaries of human knowledge of microorganisms, sterilizing milk, for example, to make it safe to drink, thereby lending his name to the word "pasteurized."¹²⁴ This work led him to his magnum opus, curing rabies in 1885.

Pasteur took a risk when giving a boy the rabies vaccine he developed from tests on rabbits because, had the boy died, Pasteur, an unlicensed physician, would almost certainly have been sent to prison. It took courage for Pasteur to risk the boy's life, but, believing it was worth the risk to benefit mankind, he decided to inject an unproven substance into the boy. He also took the risk of collecting saliva from rabid dogs in order to study the virus and subsequently grow it in rabbits. These were among the ethical challenges Pasteur overcame.

Pasteur, displaying resoluteness, and knowing that he would be judged by doctors, hid his notes from the world. He was also extremely hard on his students, sometimes being "unfair, combative, arrogant, unattractive in attitude, inflexible and even dogmatic."¹²⁵ However, Axel Munthe noted, "Pasteur himself was fearless," and sure of himself.¹²⁶ With courage and resoluteness, the risks Pasteur took mostly paid off and he became known as the "Father of Microbiology."

¹²⁴ Stephen Feinstein, *Louis Pasteur: The Father of Microbiology* (New Jersey: Enslow Publishers, Inc., 2008), 11.

¹²⁵ Patrice Debre, *Louis Pasteur* (The Johns Hopkins University Press, 1998), xxiv.

¹²⁶ Axel Munthe, *The Story of San Michele* (New York: E. P. Dutton, 1945), 149.

Robert Koch, born in Germany in 1843, continued Pasteur's work in microbiology and, through adaptability and independence, became known as the "Father of Bacteriology." After working as a military surgeon in the Franco-Prussian War, he became a professor at Berlin University and conducted research on microorganisms. Inventing the process of growing bacteria with potato slices, gelatin, and agar, Koch risked his health, and that of his students and his patients, at the university hospital where he conducted his tests. The bacteria could have grown into a dangerous strain and spread in the building, had Koch not adapted safety precautions to his work spaces. In 1891, he left the university in a display of independence in order to focus exclusively on his research without spending time as an administrator or teacher.

Later, Koch was involved in a controversy when he erroneously claimed, to international fanfare, that his vaccine tuberculin would cure tuberculosis. His mistress was Hedwig Freiberg, and he risked her life when he tested it on her, ignoring her protests. Instead of being a cure, however, Koch's tuberculin proved to be the best way to diagnose tuberculosis. Koch experienced the ethical challenges and potential humiliation of the medical frontier firsthand, testing tuberculin on his mistress and making premature claims about its efficacy.

To Koch's credit, he had found the root cause of tuberculosis, and he was also the first to find the causes of cholera and anthrax. These accomplishments are on par with finding cures, as he was the first to show that anthrax, for example, remained dormant under specific conditions. He risked his health by activating the spores and demonstrating when the germ could be deadly. When he studied the origins of cholera in

Egypt and India in 1884, his work contributed to the Germ Theory of Disease, and it revealed that germs come from other organisms, not inanimate objects such as dead tree wood, as was once posited by Aristotle. Robert Koch received the Nobel Prize in Physiology in 1905. The Robert Koch Institute in Berlin is named for him, and his work led to a “golden era” of bacteriology.

Walter Reed was an American contemporary of Robert Koch on the frontier of disease, and, although Robert Koch is known as the “Father of Bacteriology,” Walter Reed is known as the first American bacteriologist. Graduating with an M.D. when seventeen years old from the University of Virginia, and with another M.D. at age nineteen from New York University, Reed joined the United States Army Medical Corps. Starting his career in bacteriology, he proved in 1896 that troops did not contract yellow fever as a result of drinking water from the Potomac River. Rather, they contracted it after walking through trails in swampy wooded areas at night.¹²⁷

After being assigned to Cuba to travel to numerous United States Army installations and research typhoid in 1898, Reed found that flies spread the disease. He used Pasteur’s germ theory of disease and Robert Koch’s suggestions of observing bacteria to prove to the United States Army Yellow Fever Commission in Cuba that mosquitoes transmitted the disease. Typhoid and yellow fever had previously been believed to spread through contact with fecal matter or fecal particles being carried by the air. Reed was exposed at times to the flies and mosquitos, a risk his assistant, Jesse William Lazear, succumbed to when he contracted yellow fever and died trying to find its

¹²⁷ Howard Kelly, *Walter Reed and Yellow Fever* (Baltimore, The Medical Standard Book Company: 1906), 80.

cause. Individuals such as Clara Maass, a nurse, allowed themselves to be infected by yellow fever. Clara eventually also died from yellow fever.

General Leonard Wood, United States military governor of Cuba, said of the discovery that mosquitos transmitted yellow fever that it was, “the greatest step forward made in medical science since Jenner’s discovery of the vaccination for smallpox.”

Walter Reed received honorary degrees from Harvard and the University of Michigan in recognition of his findings. A medal named the “Walter Reed Medal,” is awarded at the same level as a Congressional Gold Medal, and bears his name. Walter Reed hospital was named for him.

William Gorgas was also a physician in the United States Army, while Walter Reed was making his groundbreaking advancements in bacteriology, and he showed adaptation and independence in his life on the medical frontier. He joined the United States Medical Corps only a few years after Walter Reed did. When he contracted and recovered from yellow fever early in his career, Gorgas developed an interest in fighting it. In 1898, Gorgas was stationed in Cuba at the same time Walter Reed was. Instead of attempting to discover what caused the disease, he worked to eradicate it.

Gorgas used his position as chief sanitary officer at the Panama Canal to construct public water systems and drain ponds and swamps where mosquitoes that carry yellow fever bred. He also installed mosquito netting and fumigated areas near the Panama Canal so that workers were protected from mosquitos. Without this adaptation to conditions common to construction projects, it is unlikely that the Panama Canal could have been built. Many of Gorgas’ peers were skeptical that the measures he took would

have any effect on reducing the spread of yellow fever, but he was later credited with having saved thousands of lives. The French had attempted to build a canal in Panama in 1881, but had to abandon the effort as most of their workers died from yellow fever. Gorgas was well aware of the dangers, but he decided the construction of the Panama Canal was worth the risk, and he adapted new methods of disease prevention. Gorgas eventually rose to the rank of Major General, became president of the American Medical Association, served as Surgeon General of the Army, and was awarded the Public Welfare Medal.

Jenner, Pasteur, Koch, Reed, and Gorgas were pioneers on a frontier, that of medicine. They shared traits that allowed them to overcome great risks to their health and the health of those around them for the betterment of mankind. They all had detractors, and they all experienced setbacks, but they were all ultimately successful and remembered for their work and for the countless lives they saved. Around the time of their discoveries, another, perhaps stereotypical physical frontier, presented its own challenges in the United States, that of the Great Plains.

As the frontiersmen moved west across the United States, starting in the 1830's and intent on getting to the Willamette Valley in Oregon, the first leg of their venture through Kansas and Nebraska was treacherous in that there was nothing but grass in any direction as far as the eye could see. Considering the High Plains of the upper Missouri and West, in 1820 Major Stephen H. Long lobbied to "convince both Government and people that the way was blocked by a Great American Desert."¹²⁸ Long believed that the

¹²⁸ Richard H. Dillon, "Stephen Long's Great American Desert," *Proceedings of the American Philosophical Society* 111, no. 2 (April 1967): 93.

Great Plains, much of the Louisiana Purchase, was “wholly unfit for cultivation, and of course uninhabitable by a people depending upon agriculture for their subsistence.”¹²⁹

This section of the chapter is a discussion of those who cultivated and settled the area, the pioneers, homesteaders, farmers, herders, and ranchers.

The resolute American herders and farmers displayed courage when they moved to the plains. Many of them were strong and middle-aged, and, over the next few decades, they ultimately disproved Long’s claim that it is impossible to settle on the Great Plains.¹³⁰ They exhibited an eagerness to get to work on the “desert,” seeing the prospects of a new life regardless of the risks posed by the Great Plains.¹³¹ They struggled to grow wheat, and, with luck, there was good rainfall, but much of the risk was in the conception that the prairie was hazardous because trees did not grow there. This psychological misconception was not the only psychological risk, particularly among women.

In his book *Giants in the Earth: A Saga of the Prairie*, Ole Edvart Rølvaag, describing the hunger and hardships on the South Dakota prairie, wrote that one of the women, Beret, lost her mind because her son died. Another woman, Ola, also lost her mind because there was nowhere to hide on the silent, dark, and treeless plains.¹³²

¹²⁹ Ralph C. Morris, “The Notion of a Great American Desert East of the Rockies,” *The Mississippi Valley Historical Review* 13, no. 2 (September 1926): 193.

¹³⁰ “The ‘Great American Desert’” *The Scientific American* 58, no. 13 (March 1888): 198. Accessed April 5, 2020, <https://www.jstor.org/stable/10.2307/26093309>.

¹³¹ Merlin Paul Lawson, *The Climate of the Great American Desert: Reconstruction of the Climate of the Western Interior United States* (University of Nebraska Press: 1974), 54.

¹³² O. E. Rølevaag, *Giants in the Earth: A Saga of the Prairie* (1927; repr., New York: Harper Collins Publishing, Inc., 1991), 43.

Regarding pressures of death and different climates, Elwyn B. Robinson, the noted North Dakota historian, wrote that,

Under such pressures many women broke down and became old and stooped before their time. Guy Divet believed that the “crushing burdens of the prairie frontier” contributed to the early death of his mother, “a woman of considerable culture and pride.” He wrote that the prairies “devoured” women, that they, like his mother, were “a part of the grist of the frontier’s mill, taken for toll in the interest of generations to come.” Some even lost their minds.¹³³

In addition to the risk to the mental state of individuals, there was also the risk presented by the indigenous people, as Long noted that the “Great Desert is frequented by roving bands of Indians who have no fixed place of residence but roam from place to place in quest of game.”¹³⁴ The pioneers on the Great American Desert had a resoluteness of purpose, turning the sod on the same day that they needed to secure contracts to keep their farms in business, and then turn to refining their product as well.¹³⁵ The settlers turned the area into, “no longer a desert, dry, sterile, worthless, but the best portion of the continent.”¹³⁶

Among the best examples of those who endured different types of hardships were those of the West River in South Dakota, of whom Paula Nelson wrote. A telling passage from her work, *The Prairie Winnows Out Its Own*, summed up many of the components of frontier resoluteness in the person of George Reeves, a rancher in Meade County, South Dakota.

¹³³ Elwyn B. Robinson, *History of North Dakota* (Lincoln: University of Nebraska Press, 1966), 169.

¹³⁴ Robert R. Crifasi, *A Land Made from Water: Appropriation and the Evolution of Colorado’s Landscape, Ditches, and Water Institutions* (University Press of Colorado: 2015), 10.

¹³⁵ Everett Newton Dick, *Conquering the Great American Desert* (Lincoln: University of Nebraska Press, 1975), 159.

¹³⁶ “The Migration of The Great American Desert,” *The Scientific American* 42, no. 17 (April 1880): 256. Accessed April 5, 2020, <https://www.jstor.org/stable/10.2307/26073127>.

Government officials, planners, and anyone else who had never “looked up from his work with his eyes full of grit and dust to see the Devil standing there spraddle legged above the black clouds of a dust-storm” and yet had refused to give up were not worthy of Reeves’s respect. Reeves’s brand of west river ideology was tough and hard, self-righteous and stubborn, and guided by uncompromising self-interest. He shared none of the faith in the promise that helped many west river people stay afloat during hard times. The force he fought was blind and unfeeling; God may have been a source of consolation for Reeves, but the Devil was running the show.¹³⁷

Reeves is a good example of a person on the frontier confronting challenges and risks, while believing in a future, and he adapted to his surroundings. He was also aware of the process of people being winnowed out despite their best intentions. Paula Nelson also wrote that, “Reeves, like most of the ‘stickers’ who made it through the Depression, accepted federal help, eventually developed a successful ranching operation, and continued to rail against the federal government.”¹³⁸

David Danbom, an historian living in North Dakota, noted that pioneers on the Great Plains, such as Reeves, were, “proud of their efforts to tame the wilderness,” but they “were damned by the government for turning the soil and attempting to force wheat and corn into country that nature had designed for grazing animals”¹³⁹ This damnation in many ways was well deserved, because these individuals farmed and developed the land too extensively with deforestation, mines, buildings, and roads. Patricia Nelson Limerick put it this way, the pioneers “raped” the West.¹⁴⁰

¹³⁷ Paula M. Nelson, *The Prairie Winnows Out Its Own: The West River Country of South Dakota in the Years of Depression and Dust* (Iowa City: University of Iowa Press, 1996), 199-200.

¹³⁸ Nelson, *The Prairie Winnows Out Its Own*, 200.

¹³⁹ David Danbom, “Review of *The Prairie Winnows Out Its Own: The West River Country of South Dakota in the Years of Depression and Dust*, by Paula Nelson,” *The Journal of American History* 83, no. 4 (March 1997): 1454.

¹⁴⁰ Bradley J. Birzer, “Reflections on the New ‘Western History’ of the 1990s,” *The Imaginative Conservative*, accessed October 21, 2020, <https://theimaginativeconservative.org/2012/08/reflections-on-new-western-history-of.html>.

Frontiersmen, homesteaders, pioneers, ranchers, farmers, and others faced many hardships, those presented by topography, distance, weather, bureaucrats, government regulations, indigenous people, insanity, hunger, financial loss, and the realization that they had traded a good life in the East for a life of hardship. Eventually, however, they demonstrated that the Great Plains were a place that could be settled and made productive. They changed the land into the breadbasket of the country, paved the way for settlement in the fertile grounds of the west coast, and, in most cases, built comfortable lives for themselves on what was once described as a “great desert.”

Space, perhaps, is the last frontier known to mankind as a physical frontier. In popular culture, space is often referred to as “the final frontier.” In the physical and geographical sense, this is true, and it is not yet conquered by any means. Those who have dared, and continue to dare, to breach the outer layer of Earth’s atmosphere, as a prerequisite, have traits such as courage and adaptability. To astronauts in particular, these traits have been called “the right stuff.” When American astronauts started training to be the first of their countrymen in space as part of Project Mercury, they needed special, perhaps unique, qualities to help them get through the rigorous training. Tom Wolfe, described these intrepid fellows in his book *The Right Stuff* when he wrote,

herein the world was divided into those who had it and those who did not. This quality, this *it*, was never named, however, nor was it talked about in any way. As to what this quality was, well, it obviously included bravery. But it was not bravery in the simple sense of being willing to risk your life. The idea here (in the all-enclosing fraternity) seemed to be that a man should have the ability to go up in a hurtling piece of machinery and put his hide on the line and then have the moxie, the reflexes, the experience, the coolness, to pull it back in the last yawning moment—and then to go up again *the next day*, and the next day, and every next day, even if the series should prove infinite—and ultimately, in its best expression, do so in a cause that means something to thousands, to a people, a

nation, to humanity, to God. Nor was there *a test* to show whether or not a pilot had this righteous quality. There was, instead, a seemingly infinite series of tests. A career in flying was like climbing up one of those ancient Babylonian pyramids made up of a dizzy progression of steps and ledges, a ziggurat, a pyramid extraordinarily high and steep; and the idea was to prove at every foot of the way up that pyramid that you were one of the elected and anointed ones who had *the right stuff* and could move higher and higher and even—ultimately, God willing, one day—that you might be able to join that special few at the very top, that elite who had the capacity to bring tears to men’s eyes, the very Brotherhood of the Right Stuff itself.

None of this was to be mentioned, and yet it was acted out in a way that a young man could not fail to understand. When a new flight (i.e., a class) of trainees arrived at Pensacola, they were brought into an auditorium for a little lecture. An officer would tell them: “Take a look at the man on either side of you. One of the three of you is not going to make it!” That was the opening theme, the *motif* of primary training. We already know that one-third of you do not have the right stuff.¹⁴¹

The first American to orbit the earth, John Glenn, and the first man to walk on the moon, Neil Armstrong, obviously had the right stuff. Even to make it to training, astronauts not only had to be jet pilots, they also had to have risked being shot down in a dogfight or potentially captured and tortured as a POW if they ejected over enemy territory. John Glenn returned from combat missions on multiple occasions in Korea with over 250 holes from enemy fire in his aircraft. Armstrong lost a wing of his jet fighter in Korea when he was under fire during a low bombing run and his plane caught a cable the enemy had set as a trap. He had to eject when he made it to friendly waters, to be rescued from the ocean by helicopter crews. This was the type of danger pilots were exposed to before they could qualify to be astronauts.

In Project Mercury, pilots often crashed and died in test flights. On January 27, 1967, astronauts who graduated from the Mercury Program to the Apollo Program were

¹⁴¹ Tom Wolfe, *The Right Stuff* (New York: Picador, 1979), 16-7.

killed in an electrical fire during a practice mission, revealing that danger was present even on the ground. Glenn, coming before Armstrong, had pioneered a new profession. Everything he did in training and then in space was something no one before him had experienced. One of the first to experience Extra-Vehicular Activity (EVA), or a spacewalk, Glenn risked the freezing temperatures, the vacuum, and the radiation of space- protected only by a space suit. The suits that the first astronauts wore were notorious for mechanical failures. Those wearing them died as a result.

Armstrong was warned that he had only fifty chances out of a hundred of landing on the moon safely and that the chances of his returning to Earth were even fewer. As he descended to the surface of the moon on July 20, 1969, he executed one of the most dangerous feats in human history. The computer alarms were blaring a few minutes from touchdown, and he had technicians from Launch Control distracting him and telling him that the alarms were not a problem. The rotation of the moon was faster than anticipated, and the landing location Armstrong had chosen appeared more and more unsafe as he approached. The crew, Armstrong and Buzz Aldrin, also believed that they were running short of fuel and they were preparing for a collision without the dampening effect of downward thrust. The ignition switch to return to Earth was broken in the descent, and the men's heart rates had increased to almost 150 beats per minute, which was problematic, just before they landed. They had no idea of what was on the moon's surface- other lifeforms, infections, or moon-borne diseases- but the men stepped onto the moon anyway. They had the right stuff.

On his return, Armstrong toured the world and was lauded for his accomplishment. Ticker tape parades were held in his honor, and President Richard Nixon invited him to the White House. President Ronald Reagan later requested Armstrong to publish a book with other astronauts titled *Pioneering the Space Frontier: The Report on the National Commission on Space*. Having received the Presidential Medal of Freedom and other awards, Armstrong is remembered in history as the greatest space hero.¹⁴²

John Glenn also received the Presidential Medal of Freedom, presented by President Barack Obama, along with numerous other accolades. He served honorably as a United States Senator, easily winning election in Ohio because of his fame. President Jimmy Carter considered him as a running mate when he ran for President of the United States in 1976. Glenn received honorary degrees, and he has had ships, rockets, and buildings named in his honor.

Astronauts were not the only ones breaching the space frontier. Entrepreneurs also set their sights on the stars in partnership with such entities as the National Aeronautics and Space Administration. The best-known space entrepreneur as of 2020 was Elon Musk, CEO of SpaceX.

Musk has been portrayed by numerous publications as a leader in business. He showed creativity from an early age as the co-founder of the multibillion-dollar company PayPal. Two of his companies, Tesla and SpaceX, were valued in the tens of billions of

¹⁴² “Space Foundation Survey Reveals Broad Range of Space Heroes; Early Astronauts Still the Most Inspirational,” October 27th, 2010, accessed August 2, 2020, <https://web.archive.org/web/20120723031011/http://www.spacefoundation.org/media/press-releases/space-foundation-survey-reveals-broad-range-space-heroes-early-astronauts-still?id=1038>.

dollars in 2020. To make a profitable venture out of a frontier so difficult to commercialize as space, Musk had to have developed a “scrappy ethos.”¹⁴³ Musk, as with others attempting to do business on the frontier of space, also had a “Grandiam Ferociter,” or a “step-by-step ferocity.”¹⁴⁴

Musk was both the instigator and the target of several high-profile lawsuits, a risk coming with his ambitious goals. He sued NASA and the United States Air Force when he believed that his organization was being unfairly excluded from bidding processes. Musk was sued by the United States Securities and Exchange Commission for asserting on social media that he could bypass the Commission’s regulations by taking a company private in 2018. Musk’s losing this case in mid-2019 was an example of the risks of the space frontier. Stock in his companies plummeted as a result of his action.

The risks to human life, in addition to business risk, are as real in Musk’s world as they were in that of the astronauts. One of Musk’s competitors on the space frontier, Richard Branson, lost a pilot in an October 2014 crash, testing an airframe that could carry a detachable rocket capable of launching private individuals into outer space. Musk and Branson, showing resoluteness, both believe that persevering in the ventures, as they do today, is worth the risk. Generally successful as a businessman, Musk, a controversial figure, was

a brutally demanding employer, he leaves scorched trails of former workers and partners. His unrealistic deadlines and obsessive attention to detail are legendary,

¹⁴³ Bhavya Lal, “Lords of the Universe, Review of *The Space Barons: Elon Musk, Jeff Bezos, and the Quest to Colonize the Cosmos* by Christian Davenport,” *Issues in Science and Technology* 35, no. 1 (Fall 2018): 94.

¹⁴⁴ Lal, “Lords of the Universe,” 94.

as are his seemingly ludicrous ambitions – colonizing Mars has long been a key objective.¹⁴⁵

Musk’s intelligence and drive overshadowed the risks he takes and the shortcomings in his character. Though he has only helped to begin the exploration of space from a commercial standpoint, a realm previously reserved for governments and militaries, he has stood the test of time to prevent his companies and himself from being winnowed away on the frontier of space. Musk is immortalized in popular culture, often being compared to the superheroes in movies and comic books.¹⁴⁶

Musk also encountered many of the dangers and ethical issues confronting those breaching the frontier of space, such as the ownership of space and the hazards associated with space exploration. Although many of these issues are not new in space, or for frontiers in general, they must be adapted to by individuals and societies alike. One of the adaptations is the improvement of safety features in the cockpits of spacecraft used by SpaceX.

Social media is another frontier with both new and old issues, such as cybersecurity and privacy. Social media platforms are computer-based portals by which people are enabled to communicate with each other and share ideas and photos. A veritable megatrend, the social media frontier has been neither fully developed nor fully explored, and it has one major patriarch: Mark Zuckerberg. Mark Zuckerberg, founder and CEO of Facebook, is a particularly intelligent and focused individual. Having

¹⁴⁵ Robin Tatu, “On the Shelf: Reach for the Stars, Review of Elon Musk: Tesla, SpaceX, and the Quest for a Fantastic Future by Ashlee Vance,” *American Society for Engineering Education Prism* 25, no. 1 (September 2015): 42.

¹⁴⁶ The Slate Group, “The Innovators,” *Foreign Policy* 23, Special Issue: The 100 Leading Global Thinkers of 2013 (December 2013): 97.

attended Harvard University to study computer science, he started the social networking website Facebook from his dorm room in 2004. He took a risk, because a failure would have resulted in ridicule. He developed the organization on the internet, an area itself still not fully developed nor understood, in an innovative fashion. He was labeled as one of the top thirty-five innovators in the world under the age of thirty-five three years later in the *MIT Technology Review*.¹⁴⁷ Three years after that, Zuckerberg was the *TIME* Person of the Year. Featured in the magazine's major article, he was referred to as the "presiding visionary."¹⁴⁸

Zuckerberg's meteoric rise on the internet frontier was born of controversy, with one of his Harvard classmates accusing him of stealing the social networking idea from him and his best friend accusing him of betraying him in business matters. Zuckerberg lost multimillion-dollar settlements on both of these occasions, and the website was accused by activist groups of stealing their personal data. Facebook was a major target of Hillary Clinton's ire in the 2016 general election for the President of the United States because of the impression that the social network was manipulated by the Russian Federation.¹⁴⁹

The United States Senate Committee on the Judiciary and Senate Committee on Science, and Transportation Commerce called Zuckerberg to appear for hearings regarding his company's lapses when handling private data, and he was asked how

¹⁴⁷ Kate Green, "Innovators Under 35," *MIT Technology Review*, June 2007, accessed April 7, 2020, <http://www2.technologyreview.com/tr35/profile.aspx?trid=635>.

¹⁴⁸ Lev Grossman, "Mark Zuckerberg - Person of the Year 2010," *TIME*, December 15, 2010.

¹⁴⁹ Brian Stelter, "Hillary Clinton Rails on Facebook for its Role in Spreading Russian Propaganda," *CNN Money*, September 15, 2017, accessed March 27, 2021, <https://money.cnn.com/2017/09/15/media/hillary-clinton-facebook-russian-meddling/index.html>.

Facebook was planning to deal with those and other lapses.¹⁵⁰ Some Senators charged that Facebook could be using the personal information people shared with Facebook to manipulate them. Some also charged that once the data breach of 87 million people's personal information came to light, Facebook had an ethical obligation to notify each one, something the company failed to do.

Having stood strong under fire at the U.S. Senate hearings, Zuckerberg, displaying resoluteness, moved his company past the debacle. Regardless of setbacks, Zuckerberg's was one of the most fascinating stories of an individual's meteoric rise to fame at a young age. The youngest self-made billionaire in history, he employed more than 27,000 workers in 2020, and he was ranked by *Forbes* in 2016 as the tenth most powerful person in the world.

Artificial intelligence (AI), although less developed than social media as a concept, is a frontier with far more potential. According to David Poole, artificial intelligence is a computer system that, "acts intelligently; it is flexible to changing environments and changing goals, it learns from its experience, and it makes appropriate choices given perceptual limitations and finite computation."¹⁵¹ AI was first introduced as an academic topic of study by John McCarthy, a computer scientist at Dartmouth College in 1955. The new field was initially met with much disappointment because of the seemingly insurmountable difficulties arising from the lack of computing power.

¹⁵⁰ "Facebook, Social Media Privacy, and the Use and Abuse of Data," April 10, 2018, Recording of the hearing, accessed August 2, 2020, <https://www.judiciary.senate.gov/meetings/facebook-social-media-privacy-and-the-use-and-abuse-of-data>.

¹⁵¹ David Poole, Alan Mackworth, Randy Goebel, *Computation Intelligence: A Logical Approach* (Oxford University Press: 1998), 1.

Those who studied artificial intelligence lost funding because of the government's perception that the field was too underdeveloped, and computer scientists had to adapt to find ways to develop the field. The pioneers of AI then, and now, are professors and academics. The difference is that, in 2021, the professionals at the forefront of AI development, in addition to being academics, also have positions in industry at companies such as Google and Facebook.

Dr. Geoffrey Hinton, the “Godfather of Deep Learning,” works at Google Brain and he is a Professor of Computer Science at the University of Toronto.¹⁵² Hinton outstripped IBM's Deep Blue program, which beat the chess grandmaster Garry Kasparov in 1996, by creating a computer to beat the best human player in the world at a more complex game: “go.” Creating the program for such a computer to win in 2016 would have been a grueling task fraught with deadlines, budgetary constraints, politics, and the possibility of failure.

Dr. Andrew Ng is Hinton's contemporary. He co-founded the Google Brain division of the Google Corporation where Hinton works, and he is also a Professor of Computer Science at Stanford University. Ng developed an artificial intelligence that could identify cats in real life, after having seen them only on YouTube videos. He has also been lauded for his work in getting speech recognition on smartphones to a level of accuracy high enough that it can be used by the general public. These breakthroughs represent new knowledge and tools for humanity, ones that have been unexplored and

¹⁵² Adrian Lee, “The Meaning of AlphaGo, the AI Program that Beat a Go Champ: A Q&A With Geoffrey Hinton, the Godfather of ‘Deep Learning’ – Which Helped Google's AlphaGo Beat a Grandmaster—on the Past, Present and Future of AI” *Macleans's*, March 18, 2016, accessed August 2, 2020, <https://www.macleans.ca/society/science/the-meaning-of-alphago-the-ai-program-that-beat-a-go-champ/>.

that come with their own difficulties. Ng wrote about the pressure he experienced to produce his work in ways that can be disseminated to hundreds of thousands of people.

Dr. Ray Kurzweil is perhaps the best-known subject matter expert in AI, and a man who has been awarded over twenty honorary doctorates from various universities around the world. Known as “Edison’s rightful heir,” he is a Director of Engineering at Google.¹⁵³ Kurzweil’s work on technological singularity, or AI accelerating so fast as to converge all other existing technologies into it, thereby creating a new state of existence for humans, has gained significant notoriety.

Kurzweil has also been known to make false predictions of the advancement of technology, such as the rate at which Ng’s speech recognition would gain mainstream acceptance. He has also been criticized for some of his writings by those who assert that his hypotheses are dark, far-fetched, and incorrectly projected. His contemporaries at Google and Facebook, however, still hold him in high regard.

Dr. Yann LeCun is the Silver Professor of the Courant Institute of Mathematical Sciences at New York University, and splits his time by also maintaining a position as Chief AI Scientist and Vice President at Facebook. LeCun is referred to by many as the “Godfather of AI,” and he is the founder of a major concept in AI known as “Convolutional Neural Networks,” or “CNN.” These networks are nodal graphs similar to synapses in a brain that helped him create a character recognition software used by banks for reading checks more quickly.

¹⁵³ Editorial by Staff, “26 Most Fascinating Entrepreneurs,” *Inc. Magazine*, accessed August 2, 2020, <https://www.inc.com/magazine/20050401/26-index.html>.

Artificial intelligence is such a new frontier that it is difficult to determine its problems and potential rewards. The biographies of the men and women most influencing the development of AI, as it is currently understood, are yet to be written, and no one has yet reaped the rewards. Part of this is because AI itself, and humanity's understanding of it, is constantly changing. Setbacks, such as lack of finances, in the field of AI are not usually life threatening. Work on AI is done safely from a computer desk, unlike that done on the medical or space frontiers. The greatest risks that these individuals take are resistance from their peers in the scientific community and the risk that the fearful prediction could come true- Armageddon by intelligent machines.

All those who breach frontiers assume risks. Those who breached the frontiers in biblical times, medicine, the Great Plains, space, social media, and artificial intelligence, regardless of the risk, clearly shared traits that allowed them to be successful, if they were. Each of the individuals described in this chapter exhibited some or all of the traits of independence, courage, resoluteness, and adaptability.¹⁵⁴

¹⁵⁴ Dr. Dan McAdams, a psychology professor at Northwestern University believes that, "The traits are given, it seems," Conor Friedersdorf, "Do Humans Inherit or Create Their Personalities?" *The Atlantic*, June 29, 2016, accessed March 3, 2020, <https://www.theatlantic.com/health/archive/2016/06/do-humans-inherit-or-create-their-personalities/489266/>; "Risk might be implicated fundamentally in the trajectory of any individual life." Andrew Sant, "On Taking Risks," *Antipodes*, 25 no. 1 (June 2011): 98-9; "The assumptions about science that accompany the frontier metaphor in these speeches are that scientists are heroic risk-takers." Leah Ceccarelli, *On the Frontier of Science* (Michigan State University Press: 2013) 55; "Empirical evidence finds that the premium to entrepreneurial activity is surprisingly low, which raises the question of why people become entrepreneurs." Galina Vereshchagina and Hugo A. Hopenhayn, "Risk Taking by Entrepreneurs," *The American Economic Review* 99, no. 5 (December 2009): 1808; "Psychologists in recent decades have mapped prevailing patterns of preference concerning risk. The new knowledge of risk heuristics explains some part of the differences . . ." Douglas P. Lackey "Taking Risk Seriously," *The Journal of Philosophy* 83, no. 11 (November 1986): 633; "They do know they are risking their lives, but it is a rational decision,' a professor from the University of Notre Dame was quoted as saying about the migrant boat tragedy. 'Because they know for a fact they will be facing death or persecution at home—whatever remains of their home, or assuming there was a home in the first place.'" Kenneth Nolan, "Taking Risks," *Litigation*, 40 no. 3 (Spring 2014): 70-1.

Abraham had to be independent in order to leave his home in Haran. Similarly, he needed to adapt his understanding of what God is capable of when he was asked to sacrifice his son Isaac. He was resolute in his decisions, and his entire life was marked by courage and his faith in God.

The doctors Jenner, Pasteur, Koch, Reed, and Gorgas breached a frontier every time they injected a vaccine into a test patient's arm. They acted independently of the prevailing logic posited by their medical colleagues, they showed courage in the face of death and the death of their patients, and they acted resolutely by continuing to prove their successes after positive results with their first patients. As they were sometimes criticized or embroiled in scandal, they adapted their studies to different diseases, and they adapted their methods in order to keep themselves and others safe from these diseases.

Pioneers on the Great Plains also needed to be independent, because they were mostly on their own. Separated from the centers of civilization, they had to be self-sufficient. Challenged by indigenous people, weather, and poverty, they built their homes, determined to make new lives for themselves. As laws such as the Homestead Act were passed and new technologies were made available to them, they adapted.

Astronauts breached a frontier whenever they were launched into space. Coping with the possibility of mechanical failures in everything surrounding them, leading to certain death, they may have been the most courageous individuals in history. Space entrepreneurs have the courage to invest in space without any certainty of when it can be profitable for them, and they are resolute in protecting their investment or when they are

sued. Social media magnates are sued as well, and they show courage and resoluteness in courtrooms and Senate hearings. Men such as Musk and Zuckerberg adapt to circumstances they are often powerless to foresee or prevent, such as the death of a pilot or the loss of the personal data of millions of people.

In the world of artificial intelligence, those possessing requisite intelligence are set apart from others. Even though their field has not yielded great rewards, they are resolute in their decision to continue their work. They have the courage to continue the development of AI, in the face of the possibility that they could be developing a man-made threat to humanity, similar to that posed by nuclear weapons. They are clearly adaptable, as they need to be, having careers both in academia and in industry.

Those who breached frontiers throughout history needed these traits to survive the terra incognita; the same terra incognita that exists in the physical and scientific realms. Had they not been born with, learned, or developed these traits, like chaff, they would have been winnowed and blown away by the winds of adversity and by the challenges they could not overcome.

CHAPTER III

NORTH DAKOTA AS A FRONTIER

Not only has North Dakota experienced a series of frontiers, the latest of which is that of unmanned aircraft, the state was also long considered to be a frontier, fitting the definitions and features provided by Frederick Jackson Turner and Walter Prescott Webb. This chapter, an account of North Dakota as a frontier, begins, therefore, by revisiting Turner's and Webb's definitions and features of frontiers. It also uses the work of Elwyn B. Robinson, and that of others, to describe North Dakota's frontier features, including the state's central position in the continent, its terrain and topography, its climate and weather, its scarcity of water and lack of trees, its vast expanses of grasslands and fertile soil, its native animals, and its low population density.

Frederick Jackson Turner described a frontier as "the meeting point between savagery and civilization," as "the hither edge of free land," and as an area with few inhabitants.¹⁵⁵ During the time of North Dakota's settlement, those settlers with European backgrounds considered themselves civilized and the indigenous people they encountered, according to their beliefs, were not. Aaron Barth, when writing about the Native Americans in southeast North Dakota, stated that, "up to 1862," at least, all Native Americans, including the Dakota, "were considered 'uncivilized' and 'savage,'" and,

¹⁵⁵ Turner, *The Significance of the Frontier in American History*), 12.

“when the United States deemed it necessary, beyond the legal boundaries of ‘modern organized sovereign states.’”¹⁵⁶

North Dakota was also once Turner’s “hither edge,” an area that was, at the time of settlement, lacking western-style development. This might also be inferred from what Elwyn B. Robinson stated in his *History of North Dakota*. “Up to 1915,” he wrote,

the major problems had been connected with the taking up of the land, the creation of farms and towns and railroads and the whole mechanism of a civilized society—the mighty influx of people and capital from the outside. Now, in 1915, the free lands were gone; the new frontiers of opportunity were the cities.¹⁵⁷

Turner’s description of a frontier as having a low population density also applied to North Dakota at the time of settlement in the late nineteenth century. In 1880, a few years before the Enabling Act of 1889 that divided Dakota Territory into North and South Dakota, what became North Dakota had a population of 36,909.¹⁵⁸ This population was spread across North Dakota’s 70,762 square miles, giving the area a population density of 0.52 people per square mile.

Describing frontiers in his work *The Great Frontier*, Walter Prescott Webb wrote that a frontier “is ‘the sharp edge of sovereignty,’ the door or bastion of a neighbor, friendly or hostile as the case may be. There protocol and diplomacy become important and a ‘frontier incident’ may well become an international affair.”¹⁵⁹ Here Webb is discussing borders such as rivers, mountain ranges, or imaginary lines between nations or

¹⁵⁶ Aaron Barth, “Imagining a Battlefield at a Civil War Mistake: The Public History of Whitestone Hill, 1863-2013,” *The Public Historian* 35, no. 3 (August 2013): 80.

¹⁵⁷ Robinson, *History of North Dakota*, 370.

¹⁵⁸ United States Census Bureau, “Resident Population and Apportionment to the U.S. House of Representatives,” accessed February 14, 2021,

<https://www.census.gov/dmd/www/resapport/states/northdakota.pdf>.

¹⁵⁹ Webb, *The Great Frontier*, 2.

people. Encounters between Native Americans and settlers on frontiers, in his estimation, could be as detrimental an incident to each party as a nation's army crossing another nation's borders.

“In the United States,” Webb also noted,

the word frontier becomes a concept with such wide ramifications and so many shades of meaning that it cannot be wrapped up in a neat definition like a word whose growth has ceased and whose meaning has become frozen. It is something that lives, moves geographically, and eventually dies.

The American thinks of the frontier as lying *within*, and not the edge of a country. It is not a line to stop at, but an *area* inviting entrance. Instead of having one dimension, length, as in Europe, the American frontier has two dimensions, length and breadth. In Europe the frontier is stationary and presumably permanent; in America it *was* transient and temporal. The concept of a moving frontier is applicable where a civilized people are advancing into a wilderness, an unsettled area, or one sparsely populated by a primitive people.¹⁶⁰

North Dakota as a frontier possessed both the length and breadth that Webb's definition required, and, as Webb defined the word “frontier,” its frontier cannot be wrapped up in a neat definition. North Dakota also fit Webb's definition as an area inviting entrance, especially for the German-Russians who had, as Robinson termed it, a “land hunger,” and for others seeking land and opportunity, such as Norwegians and Canadians.¹⁶¹

Both Turner and Webb defined frontiers as having sparse populations, and both also considered civilization central to their definition, alluding to primitive or uncivilized people. They also both wrote of an “edge,” suggesting a border, with Turner using the term “hither,” or the most remote civilized place, while Webb referred to it as “sharp,” meaning a place not to be ventured across. Turner's and Webb's definitions of frontiers

¹⁶⁰ Webb, *The Great Frontier*, 2-3.

¹⁶¹ Robinson, *History of North Dakota*, 284, 557.

not only fit North Dakota, they are also reminders that frontiers present challenges, risks, and ethical issues such as the treatment of indigenous peoples.

Much of what Webb wrote about the characteristics of frontiers can be found in his work *The Great Plains*. It is clear from *The Great Plains* that Webb considered the entire Great Plains to be a frontier, especially when discussing the literature of frontiers and of the Great Plains when “as yet,” he wrote, “there has developed no large body of literature dealing with the frontier of the Great Plains.”¹⁶² This is also apparent in others of Webb’s passages such as, “The Great Plains frontier was a national frontier,” and “the Great Plains frontier developed after the means of rapid communication and transportation were highly perfected.”¹⁶³ Webb also suggested that the Great Plains literally became the American Frontier around the time of the passing of the Homestead Act of 1862.¹⁶⁴ “There was little common experience,” Webb continued,

until the two invading columns of immigrants struck the Great Plains, where both the Northern men and the Southern men found themselves out of their own section. For the first time they met common problems, whether in western Texas or in North Dakota. There was no North or South in the West. When these men wrote home or returned on a visit, they told a *common story*; for once they agreed. The whole nation came to look on the West in the same way as to Indians, as to cattle, later as to wheat and dry farming, as to its romantic and spectacular aspect, and as to its lawlessness.¹⁶⁵

Others also considered the entirety of the Great Plains to be a frontier. “This region, however,” Edwin James wrote about the Great Plains,

viewed as a frontier, may prove of infinite importance to the United States, inasmuch as it is calculated to serve as a barrier to prevent too great an extension of our population westward, and secure us against the machinations or incursions

¹⁶² Webb, *The Great Plains*, 455.

¹⁶³ Webb, *The Great Plains*, 501-2.

¹⁶⁴ Webb, *The Great Plains*, 407.

¹⁶⁵ Webb, *The Great Plains*, 501.

of an enemy that might otherwise be disposed to annoy us in that part of our frontier.¹⁶⁶

In many instances, Webb considered frontiers in terms of the people who were encountering indigenous peoples as they moved across North America. “The term ‘American Frontier,’” Webb suggested, “is used here to include not only the frontier of the United States but that of all the nations which had a frontier in North America, — England, France, Spain, Mexico, and Texas.”¹⁶⁷ He referred to the “Spanish frontier” as the northern border in the middle of the Great Plains where the Spanish encountered the Apache and Comanche. The “Anglo-American” frontier was where the people from New England emerged west from the timber line and encountered the native people of the Great Plains, such as the Mandans, Sioux, Arikara, and Pawnee. “This timber line,” Webb wrote, “comes out of Canada near the eastern boundary of North Dakota, swings southeastward into Minnesota, and passes just south of St. Paul into Wisconsin.”¹⁶⁸

Webb also considered the Great Plains and frontiers in terms of “flora and fauna,” or plants and animals in a specific geographical location with its own topographical characteristics. “A plains environment,” he wrote, “presents three distinguishing characteristics:”

1. It exhibits a comparatively level surface of great extent.
2. It is a treeless land, and unforested area.
3. It is a region where rainfall is insufficient for the ordinary intensive agriculture common to lands of a humid climate. The climate is sub-humid.¹⁶⁹

¹⁶⁶ Webb, *The Great Plains*, 157.

¹⁶⁷ Webb, *The Great Plains*, 59 note 1.

¹⁶⁸ Webb, *The Great Plains*, 5.

¹⁶⁹ Webb, *The Great Plains*, 3.

The “flora” of the Great Plains that Webb described included the area’s grasses. “In the prairie country,” he wrote,

the tall grass falls into three sub-divisions, or communities: the blue-stem sod, the blue-stem bunch grass, and the needle grass and slender wheat grass. The blue-stem sod is found in Illinois, Iowa, eastern Kansas, in parts of Missouri, Oklahoma and Texas, and in western Minnesota, eastern North Dakota, South Dakota and Nebraska.

. . . The needle grass and the slender wheat grass grow in the northern Plains and in Nebraska, North and South Dakota, and Minnesota.¹⁷⁰

The “fauna,” of which Webb wrote, included horses, wolves, coyotes, jack rabbits, prairie dogs, cattle, wild goats, deer, and other wild animals. One animal, however, stood out from the rest on the Great Plains. “In the Plains area lived one animal,” he wrote, “that came nearer to dominating the life and shaping the institutions of a human race more than any other in all the land, if not in the world – the buffalo.”¹⁷¹

Webb also noted that these animals were grass-eaters, that could live with little, or even without, water. They were also difficult to hunt. As new tools were introduced to the Great Plains, however, hunting such animals became less difficult.

According to Webb, some of the features of frontiers are the man-made tools that were developed in order to assist individuals to adapt to life on a frontier. The three tools Webb discussed at length were the six-shot revolver, barbed wire, and windmills. Webb also believed that these were the tools that allowed Anglo-Americans to be successful on the frontier, whereas the Spanish were not.

¹⁷⁰ Webb, *The Great Plains*, 29-31.

¹⁷¹ Webb, *The Great Plains*, 33.

The first major adaptation to the way of life Webb wrote about in *The Great Plains* was the Colt revolver, a pistol capable of firing six bullets before having to be reloaded. Actually, Webb wrote,

. . . the rapid spread of the six-shooter over the whole Plains area is easy to understand. It is not difficult to see why people associate the six-shooter with Westerners of the Plains. Some still believe, such is the force of tradition, that the Westerners “wear ‘em low on the right leg, and pull ‘em smokin’.”¹⁷²

In this passage, Webb brought into question one of the most controversial ethical issues of the frontier. The revolver, to both white men and indigenous peoples, had a cheapening effect on human life on the frontier. What would be classified as murder elsewhere became commonplace and almost acceptable on the frontier, partly because of the revolver. Given the social conditions on frontiers, “the taking of human life,” Webb suggested,

did not entail the stigma that in the more thickly settled regions is associated with it. Men were all equal. Each was his own defender. His survival imposed upon him certain obligations which, if he were a man, he would accept. If he acted according to the code, he not only attested his courage, but implied that he was skilled in the art of living. Murder was too harsh a word to apply to his performance, a mere incident, as it were.¹⁷³

Prior to the development of the six-shooter, pioneers and soldiers alike used single-shot rifles, and they had to dismount from their horses in order to fire at targets, whether animals or enemies. The time required to reload a rifle created dangerous situations for settlers on the Great Plains because the natives, for example, could launch twenty arrows while on horseback and close a distance of three hundred yards before an

¹⁷² Webb, *The Great Plains*, 178.

¹⁷³ Webb, *The Great Plains*, 497.

individual with a rifle could get off a second shot. Natives could also remain mobile while launching arrows at their targets, whereas individuals with rifles could not.

Samuel Colt patented the six-shot thirty-four caliber revolver in 1838 and it “won its fame and fortune.” Texas Rangers were the first adopt the weapon and they used it to devastating effect during the Battle of Perdanales, in which a handful of Colt-armed Texas Rangers defeated seventy Comanches in late July 1844. This was the first time that the six-shooter had been used in battle, and it neutralized the Native Americans’ advantage of being able to fight while remaining on horseback. The Rangers also discovered that “having a shot for every finger on their hand” was an advantage when pursuing bands of Native Americans.¹⁷⁴ As Rangers pursued them, Native Americans often discarded their weapons to reduce weight and allow their horses to run faster, but, as a consequence, they were deprived of weapons and an advantage in future engagements. The six-shooter, because of its advantages in combat, helped push west Turner’s meeting point of “savagery and civilization.” “Whatever sins the six-shooter may have to answer for,” Webb wrote,

it stands as the first mechanical adaptation made by the American people when they emerged from the timber and met a new set of needs in the open country of the Great Plains. It enabled the white man to fight the Plains Indian on horseback.¹⁷⁵

¹⁷⁴ Rangers and others would usually chamber only five rounds in a six-shooter in order to prevent accidental discharges while holstered. “Why Cowboys Only Loaded 5 Rounds in their 6 Chamber Revolvers, *Technology.org*, May 5, 2019, accessed March 27, 2021, <https://www.technology.org/2019/05/05/why-cowboys-only-loaded-5-rounds-in-their-6-chamber-revolvers/>.

¹⁷⁵ Webb, *The Great Plains*, 179.

Barbed wire and windmills, the other two tools Webb discussed that allowed settlers to adapt to the frontier, were complementary. Surface water was scarce, and windmills drew fresh water up from wells and barbed wire fences enabled individuals who owned rights to the water on their land to mark the boundaries.

“When the frontier line left the timbered region and came onto the Prairie Plains,” Webb wrote, “the pioneers found there neither timber nor stone. There was nothing with which to fence the land.”¹⁷⁶ Barbed wire, invented in 1874 and plentiful because of the manufacturing advances made possible by the Industrial Revolution, allowed ranchers to build fences. Barbed wire fences kept a rancher’s cattle and horses from crowding the ranges of other cattlemen, while also keeping cattle from different herds from encroaching on the rancher’s land. Cattlemen could now keep better track and control of their herds and also profit from the fertilizer their animals produced as manure.

Barbed wire was not, however, without its ethical issues. Often, the barbed wire mutilated someone’s livestock or gave rise to quarrels about whether fences had been built so as to stake a claim to another’s land. Webb cited several instances of individuals using wire cutters to cut hundreds of miles of barbed wire on land not belonging to them. If caught, such individuals were sometimes shot on sight by irate landowners.

Another of barbed wire’s benefits, Webb wrote, was that it “revolutionized land values,” and, it

opened up to the homesteader the fertile Prairie Plains, now the most valuable agricultural land in the United States. With cheap fencing the farmers were enabled to stake out their free homesteads, and the agricultural frontier moved rapidly across the prairie to the margin of the dry plains, where the farmers were again checked until further adaptations could be made

¹⁷⁶ Webb, *The Great Plains*, 281.

. . . The farmers took the homesteads there, but they did not and could not always hold them. Conditions were still too hard. The companion piece in this invasion was the windmill¹⁷⁷

Among the most difficult problems facing farmers, ranchers, and others on Webb's Prairie Plains frontier was the lack of surface water for crops, livestock, and humans. Although, as he noted, there was "an enormously large amount of ground water held under the surface of the Great Plains."¹⁷⁸ At first, individuals breaching the frontier attempted to live on small amounts of water. "Then began a long series of agricultural experiments," Webb wrote, and the "practical results of this experimentation led to well-making and the adaptation of windmills, to the development of irrigation, and to the origination of dry farming."¹⁷⁹ Because the ground water was often located at lower depths than in the East and because large numbers of cattle required large amounts of water, new methods of finding it and lifting it to the surface were required. To solve the problem, farmers and cattlemen sunk wells that were often two hundred feet deep or deeper, and they "adopted, adapted, and developed" windmills. A windmill, Webb wrote,

could be made at a cost ranging from \$1.50 up, depending on whether it were home-made or shop-made; it would deliver a small amount of water day and night as long as the wind was blowing. Within a short time after its introduction the windmill became the unmistakable and universal sign of human habitation throughout the Great Plains area.¹⁸⁰

Webb would agree that signs of western-style habitation in the Great Plains included the six-shooter, barbed wire, and the windmill. These three technologies spread quickly

¹⁷⁷ Webb, *The Great Plains*, 317-8.

¹⁷⁸ Webb, *The Great Plains*, 330.

¹⁷⁹ Webb, *The Great Plains*, 333.

¹⁸⁰ Webb, *The Great Plains*, 336.

throughout the Great Plains, in large part, because their advent coincided with that of the railroads and the Industrial Revolution, and they had great effect on the history of the frontier.

Much of the history of the frontier, to Webb, was the dynamic contrast between the line that divided the wooded area of the eastern United States from the Great Plains.

“The contrast begins,” he wrote,

in geology and topography and is continued in climate, reflected in vegetation, apparent in wild animal life, obvious in anthropology, and not undiscernible in history. To the white man, with his forest culture, the Plains presented themselves as an obstacle, one which served to exercise and often defeat his ingenuity, to upset his calculations, to hinder his settlement, and to alter his weapons, tools, institutions, and social attitudes; in short, to throw his whole way of life out of gear. The history of the white man in the Great Plains is the history of adjustments and modifications, of giving up old things that would no longer function for new things that would, of giving up an old way of life for a new way in order that there might be *a* way. Here one must view the white man and his culture as a dynamic thing, moving from the forest-clad land into the treeless plain.¹⁸¹

Fredrick Jackson Turner also discussed the treeless lands to the west of the Appalachian Mountains in his *The Significance of the Frontier in American History*.

“Along the Great Lakes,” Turner wrote in one passage,

the deciduous forests triumphed again, and, in their turn, faded into the treeless expanses of the prairies. In the remaining portions were openings in the midst of the forested area, and then the grassy ocean of prairie that rolled to west and northwest, until it passed beyond the line of sufficient rainfall for agriculture without irrigation, into the semi-arid stretches of the Great Plains.¹⁸²

As did Webb, Turner discussed some of the animals found on the “grassy ocean of prairie,” including horses, dogs, “game,” “beasts,” and, especially, buffalo. Buffalo,

¹⁸¹ Webb, *The Great Plains*, 507-8.

¹⁸² Turner, *The Significance of the Frontier in American History*, 130.

Turner wrote, involved an important ethical issue. “The systematic slaughter of millions of buffalo,” he charged,

in the years between 1866 and 1873, for the sake of their hides, put an end to the vast herds of the Great Plains, and destroyed the economic foundation of the Indians. Henceforth they were dependent on the whites for their food supply, and the Great Plains were open to cattle ranchers.¹⁸³

Nor could Turner have written about what he termed the “Middle West” frontier without discussing its plant life.

Turner observed that the Prairie Plains benefitted from the drift deposited by the Laurentide Glacier. This “alluvial” deposit created a soil with a fertility unrivaled in Western Civilization. The fertile soil, had, according to Turner, a major influence on American democracy, “kindling” a pioneer’s imagination, and compelling him to move west. The pioneer’s vision, Turner believed,

saw beyond the dank swamp at the edge of the great lake to the lofty buildings of a mighty city; beyond the grass-clad prairie to the seas of golden grain; beyond the harsh life of the log hut and the sod house to the home of his children. The men and women who made the Middle West were idealists, and they had the power of will to make their dreams come true. Here, also, were the pioneer’s traits, —individual activity, inventiveness, and competition.¹⁸⁴

It was as necessary to use the works of Turner and Webb when discussing frontiers as it is to use Elwyn B. Robinson’s works when treating North Dakota as a frontier. Robinson, the best-known of the state’s historians, earned scholarly respect with an address on the occasion of the seventy-fifth anniversary of the founding of the University of North Dakota in November 1958. In his remarks, Robinson introduced what he termed the six themes of North Dakota history.

¹⁸³ Turner, *The Significance of the Frontier in American History*, 144.

¹⁸⁴ Turner, *The Significance of the Frontier in American History*, 153.

Robinson's address was as timely as it was well received. A year later, he published a revision of the address in an article titled "The Themes of North Dakota History" in the *Journal of North Dakota History*.¹⁸⁵ He then devoted the next twenty years to writing his *History of North Dakota*, the first and best treatment of the state's history. Dr. Kimberly Porter, a history professor at the University of North Dakota, summed up the initial critical reception of *History of North Dakota* best when she wrote that, "At its appearance in 1966,"

History of North Dakota met with rave reviews. Assorted book reviewers described the volume as "absorbing," "fascinating," "astonishingly comprehensive," and "balanced." However, the more adept reviewers noted one additional factor: Robinson's work moved the concept of state history to new heights. Previously, state history had oftentimes met with derision in academic circles.¹⁸⁶

Among the "new heights" to which Porter referred was that Robinson's history was cross-disciplinary. He made extensive use of such disciplines as geography, anthropology, political science, and economics.

As a basis for his history, Robinson developed what he believed to be "the great themes" of North Dakota. They were, as Robinson named them: "first, remoteness; second, dependence; third, radicalism; fourth, a position of economic disadvantage; fifth, the Too-Much Mistake; and, sixth, adjustment to the imperatives of a cool, subhumid grassland."¹⁸⁷ Robinson also reminded readers of the "fundamental facts" defining North

¹⁸⁵ Elwyn B. Robinson, "Themes of North Dakota History," *North Dakota History* 26, no. 1 (Winter 1959): 5-24.

¹⁸⁶ Kimberly Porter, *North Dakota: 1960 to the Millennium* (United States: Kendall Hunt Publishing, 2008), ix-x.

¹⁸⁷ Elwyn B. Robinson, "The Themes of North Dakota History," (Address delivered to the University of North Dakota 1958), accessed November 9, 2014, <http://historyrfd.net/isern/431/6themes.htm>.

Dakota: distance, economic circumstances, weather, politics, hardship, opportunities, and prospects. Robinson's themes of remoteness and adjustment to a cool and subhumid grassland, as well as his fundamental facts of distance and weather, are features characteristic of other American frontiers. Much of what makes the North Dakota frontier distinct, however, is the state's geography, topography, and climate. There are few other points in America where geography defines, not only the economy, but also the character and traits of the people so "vividly" as in North Dakota.¹⁸⁸

Robinson opened his *History of North Dakota* by writing of North Dakota's central position in the United States and noting that its climate "is a result of the state's location at the center of the continent."¹⁸⁹ He discussed North Dakota's geographical location and wrote that the Wisconsin Glacier that receded around 25,000 years ago created "copious" amounts of water that shaped the terrain.¹⁹⁰ Part of the terrain includes a boundary in North Dakota, the eastern side of the state being a drift prairie of the Central Lowlands and the western side of the state being the Great Plains. Robinson wrote that streams in these areas also sculpted the state's topography, cutting large areas into "innumerable canyons, gorges and ravines"¹⁹¹

Continuing on the climate, Robinson wrote that, "North Dakota has a continental climate," with

cold winters and hot summers, warm days and cool nights, light rainfall, low humidity, and much sunshine. It is a climate of extremes. The coldest temperature on record is 60 degrees below zero (Parshall, February 15, 1936); the

¹⁸⁸ Neal R. Peirce, *The Great Plains States of America: People, Politics, and Power in the Nine Great Plains States* (W. W. Norton & Co Inc, 1973), 44.

¹⁸⁹ Robinson, *History of North Dakota*, 8.

¹⁹⁰ Robinson, *History of North Dakota*, 5.

¹⁹¹ Robinson, *History of North Dakota*, 8.

hottest, 121 above (Steele, July 6 1936). January, the coldest month, has an average temperature of 7° F., and July, the warmest, averages 68° F. The mean temperature is 40° F., the lowest of any state until the admission of Alaska. The wind blows much of the time.¹⁹²

Highlighting the state's climatic extremes, Robinson quoted a pioneer who exclaimed that, "Dakota is a great land for extremes, either too hot or too cold, too wet or too dry." these extremes of weather, Robinson noted, made life difficult for those living in the North Dakota.

Eric Severeid, the noted news analyst from Velva, North Dakota, remembered that "it was a trial of the human spirit to live there,"

a triumph of faith and fortitude for those who stayed on through the terrible blasting of the summer winds, the merciless suns, through the frozen darkness of the winters when the deathly mourn of the coyote seemed at times the only signal of life.¹⁹³

Gertrude Anderson, Severeid's friend during his younger years in Velva, was from Germany. She, too, found life in North Dakota difficult. "It was so awful here," Robinson quoted her as commenting, "think of it, from Berlin I came as a bride, to *here!*" "Yet it was wonderful," she remembered, "because of the warmhearted folk in Velva."¹⁹⁴

The warm-heartedness of the state's inhabitants, including those of Velva, fortunately, counterbalanced the extremes of cold and heat. North Dakota, nevertheless, is well-known for its winters, the hallmark of a frontier to which early explorers could attest.

¹⁹² Robinson, *History of North Dakota*, 10.

¹⁹³ Robinson, *History of North Dakota*, 552.

¹⁹⁴ Robinson, *History of North Dakota*, 553.

Pierre Gaultier de Varennes, Sieur de la Vérendrye was the first white man to visit what became North Dakota. Leaving Fort La Reine in Canada on October 18, 1738, he made an overland trek to the Mandan Villages near present-day Bismarck. He began his return to Fort La Reine on December 13, 1738. Of his return to Fort Reine in the dead of winter, much of it through what is now North Dakota, he wrote that never had he experienced such cold and misery.¹⁹⁵

Meriwether Lewis and William Clark, on their Expedition to the Pacific Ocean from 1804-1806, spent more time in what is now North Dakota than they did in any other area through which the Expedition passed. In their journals, the captains recounted the extreme cold and deep snow the men of the Expedition experienced at Fort Mandan on the Missouri River where they spent the winter of 1804-1805.¹⁹⁶

Extremely low temperatures, heavy snows, and strong winds are only a few of the variables of North Dakota winters. Blizzards are the state's worst winter weather events. Discussing them, Robinson cited examples. "A blizzard in April 1873," he noted,

caused heavy loss of livestock; one in March, 1876, marooned two or three hundred people for three weeks on a Northern Pacific train between Fargo and Bismarck; another in February, 1881, killed many cattle. Perhaps the worst struck on January 12, 1888. It covered haystacks, barns, and houses with snow and brought death to nearly a hundred people.¹⁹⁷

¹⁹⁵ Robinson, *History of North Dakota*, 28-32.

¹⁹⁶ Robinson, *History of North Dakota*, 40-5; Gary Mouldan, ed., *The Definitive Journals of Lewis and Clark: From Mandan to Three Forks* (Lincoln: The University of Nebraska Press, 1987), 57; C. Brid Nicholson, *Documents of the Lewis and Clark Expedition* (United States: ABC-CLIO, 2018), 93.

¹⁹⁷ Robinson, *History of North Dakota*, 168.

Webb considered the blizzard to be the “grizzly of the plains,” and its “most ferocious weather feature.” He quoted C. A. Lounsberry who described a North Dakota blizzard as,

a mad, rushing combination of wind and snow which neither man nor beast could face. The snow found its way through every crack and crevice. Barns and stacks were literally covered by drifting snow, and, when the storm was over, cattle fed from the tops of the stacks. . . . Persons lost upon the prairie were almost certain to meet with death, unless familiar with the nature of these storms. . . . I learned of many instances where persons were lost in trying to go from the house to the barn, and of other instances where cords were fastened to the house so that, if the barn should be missed, by holding on to the cord the house could be found again.¹⁹⁸

Although North Dakota often experiences blizzards and heavy snow falls, the state suffers from a scarcity of water. This scarcity is evident in the few natural lakes, low river levels, and lack of rainfall. Robinson noted that some of the state’s counties have neither rivers nor lakes, and the state’s mean annual rainfall is only 17.16 inches.¹⁹⁹

William Sherman, the state’s well-known priest and sociologist, also noted that the state was “a land in serious need of rain.”²⁰⁰ In 1934 and 1936, total rainfall was only 9.5 and 8.8 inches. Lack of rainfall, the plague of the state’s settlement days, is often accompanied by the “threat of drought,” in Robinson’s words, and the threat has made all North Dakotans “weather conscious,” and “a current of anxiety” is always just below the surface of consciousness.²⁰¹

To deal with the scarcity of surface water, North Dakotans adopted windmills, the third of Webb’s tools, and used them to harness the ceaseless winds that blighted the lives

¹⁹⁸ Webb, *The Great Plains*, 25.

¹⁹⁹ Robinson, *History of North Dakota*, 6-8.

²⁰⁰ William Sherman, ed., *Plains Folk: North Dakota’s Ethnic History* (Fargo: North Dakota Institute for Regional Studies, 1988), 3.

²⁰¹ Robinson, *History of North Dakota*, 9-10.

of settlers. Thus, the constant winds that sometimes drove women mad, became, at the same time, their salvation. Windmills drew water from deep in the ground for crops, livestock, and humans. North Dakota Métis erected windmills in the early nineteenth century, and North Dakota farmers built windmills from wood before companies such as the Chicago-based Aermotor introduced the 702 Aermotor, a unit that became commonplace in North Dakota. In 2015, after purchasing a 702 Aermotor for their museum in Stark County, historical society members noted that with a windmill, “you didn’t have to pump the water - it did the work for you.”²⁰²

It was not only the scarcity of water that defined North Dakota as a frontier. “One word,” Robinson believed,

best describes the result of plant adaptation to the environment in North Dakota: grassland. Light rainfall, autumn drought, and prairie fires discouraged trees, so grass, a drought enduring flora, became the dominant vegetation. Before settlement, 95 per cent of North Dakota was covered by three large grass communities, each of which developed its own type of soil.²⁰³

North Dakota tall grass, medium grass, and short grass conjure up the image of Turner’s “grassy ocean,” a feature of a frontier. Bluestem, the most common type of prairie grass in North Dakota, is a tall grass, the grass that Webb believed was a feature of the Great Plains frontier. Other types of prairie grass in North Dakota include feather bunch grass, slender wheat grass, western wheat grass, prairie June grass, needle and thread grass, and blue grama.

²⁰² Linda Sailer, “Historical Society Purchases Windmill for Prairie Outpost Park,” *AgWeek*, August 24, 2015, accessed January 10, 2021, <https://www.agweek.com/news/3823987-historical-society-purchases-windmill-prairie-outpost-park>.

²⁰³ Robinson, *History of North Dakota*, 12-3.

Wheat, another type of grass, grows well in North Dakota for the same reasons that the area favored the prairie grasses. Wheat was once North Dakota's major crop, and because it grew so well in North Dakota, it became known as King Wheat, and the state became known as "the land of the No. 1 hard."²⁰⁴ No. 1 hard was a special grade established in the Minneapolis grain exchange to designate a "high-protein grain" best for making bread.²⁰⁵

The Barnes-Parnell Chernozem soil found in North Dakota is the darkest upland soil of any in the United States and it was the best soil in the country on which to grow wheat. "Before 1870," Turner wrote,

the vast and fertile valley of the Red River, once the level bed of an ancient lake, occupying the region where North Dakota and Minnesota meet, was almost virgin soil. In 1875 the great Dalrymple farm showed its advantages for wheat raising, and a tide of farm seekers turned to the region.²⁰⁶

In sum, Turner wrote, "Good soils have been the most continuous attraction to the farmer's frontier," and North Dakota, sometimes referred to as being a part of "the farmer's last frontier," was blessed with these "good soils."²⁰⁷

Farming could, however, be detrimental to the soil and to the land, an ethical issue linking North Dakota to other frontiers. Converting the prairie to crops required breaking the sod, or as a member of the territory's Sioux tribe expressed it, turning the sod "wrong side up."²⁰⁸ Although "turning the sod wrong side up" was necessary to

²⁰⁴ Robinson, *History of North Dakota*, 10.

²⁰⁵ Robinson, *History of North Dakota*, 11.

²⁰⁶ Turner, *The Significance of the Frontier in American History*, 162.

²⁰⁷ Turner, *The Significance of the Frontier in American History*, 25; Gordon L. Iseminger, "North Dakota's Cornhusking Contests, 1939-1941." *Agricultural History* 71, no. 1 (Winter 1997): 38.

²⁰⁸ Erling Rolfsrud, *The Story of North Dakota* (Alexandria: Lantern Books, 1964), 171-4; Robinson, *History of North Dakota*, 196.

make farming possible in North Dakota, it also destroyed the grasses that were the state's great natural resources.²⁰⁹ Moreover, as Robinson noted, plowing reduced or destroyed the food supply of many of the area's grass-eating animals, the herbivores, and, because "the carnivores ate the herbivores, one can say that all subsisted on the grasses."²¹⁰

Turner and Webb wrote that specific animals were features of frontiers because they had adapted to the existing conditions, and it is clear from Robinson's descriptions of those animals living in the area that would become North Dakota that they too had adapted to conditions. "The distribution of early North Dakota wildlife," wrote Robinson,

demonstrated practical adaptation to variations in environment. Short-legged Nebraska cottontail rabbits favored brushy cover along streams in eastern North Dakota and as far west as the Missouri and Mouse rivers, while the long-legged Wyoming cottontails took to the open country of the Badlands. Jack rabbits ranged all of the state except the forested areas. Tree squirrels and woodchucks lived along the Red River and those streams which carried lines of timber into the prairie. . . . White-tailed deer and black bears liked the cover of brush and woods along the streams; elk were equally at home in timber and on the grassland; buffalo, antelope, and mule deer lived only in the open country.

In one way or another, all living things had to adapt to conditions on the vast, open plain, with its drought and bitter winter cold. Some became sparing in the use of water²¹¹

Buffalo, Robinson noted, were especially indicative of North Dakota as a frontier. They thrived on prairie grass, preferred open areas, endured cold temperatures, and survived on little water. Alexander Henry, a fur trader and explorer, in 1800, testified to the number of buffalo in the area that became North Dakota. According to Robinson, after being awakened by bellowing buffalo, Henry wrote,

²⁰⁹ Robinson, *History of North Dakota*, 13.

²¹⁰ Robinson, *History of North Dakota*, 15.

²¹¹ Robinson, *History of North Dakota*, 14-5.

I dressed and climbed my oak for a better view. I had seen almost incredible numbers of buffalo in the fall, but nothing in comparison to what I now beheld. The ground was covered at every point of the compass, as far as the eye could reach, and every animal was in motion.²¹²

Military authorities later encouraged the industrialized killing of buffalo in order to deprive Native Americans of their means of survival. Such encouragement is an ethical issue, among others that are often features of frontiers. Robinson quoted an Assiniboine chief, who, in 1853, stated that, “as the white man advances, our means of life grow less.”²¹³ The chief was referring not only to the loss of buffalo, but also the decline in the fur trade, wars, and smallpox.

North Dakota’s climate, weather, topography, and grasses may explain the large variety of wild animals, but the same features often deterred humans from coming to or remaining in the state. Among the consequences was the low population density that Turner used to identify a region as a frontier. Low population density has been a challenge confronting the state throughout its history. Robinson called attention to this challenge when he quoted Eric Ramstad, the first settler at Minot, North Dakota. Ramstad remembered that the area “was a wilderness; no preachers, no doctors, no neighbors, nothing; but we came out all right.”²¹⁴ North Dakotans adapted to this feature of frontiers by valuing their friendships and by individuals taking on several roles. Linda M. Hasselstrom, a rancher and writer who writes about life in the Dakotas, elaborated on this in her book *Woven on the Wind: Women Write about Friendship in the Sagebrush West*. “Our choices are limited here,” she wrote,

²¹² Robinson, *History of North Dakota*, 15.

²¹³ Robinson, *History of North Dakota*, 106.

²¹⁴ Robinson, *History of North Dakota*, 548.

we form friendships that we expect to last for the rest of our lives, that must be built with understanding and flexibility to withstand any storm, bend to any amount of sunlight. Out here, our friends aren't categorized. There aren't the people from church, separated from the mothers from school and the ladies I see at work, or the wives of my husband's friends. They are all the same. I may have seen the same woman Friday night, be on a booster club committee with her Tuesday afternoon, and teach church school with her Wednesday. I might have visited with her husband at the feed store on Thursday, heard a story about her son on Friday.

We are sisters in the truest sense. We share the cycle of this land, tied together by location, circumstance, history and relationships that entangle business, personal, familial, and political aspects of our lives.²¹⁵

Low population density in North Dakota remained, and continues to be, a challenge.

Rural North Dakota in 1970 had an average population density of four people per square mile, but some counties had fewer than Turner's standard of 2.1 people per square mile, including Billings, Bowman, Golden Valley, McKenzie, and Slope.²¹⁶

Low population density, together with risks, challenges, ethical issues, climate, weather, and open space were intertwined on the North Dakota frontier, forcing those who lived there to adapt. Hasselstrom noted this in another of her works titled *Feels Like Far: A Rancher's Life on the Great Plains*. "All my life," she wrote,

I have looked to the Black Hills for clues about the immediate future. A thunderstorm that veered around the south side of the peaks, for example, would usually hit our ranch, while clouds that moved northward would miss us. Black or purple clouds bubbling up meant a fire in the nearby forests, while a purple haze signaled fires burning in the Rocky Mountains. The brown haze looked like the dust we usually see rising from the plains on a windy spring day when someone plows native grasses that should never be turned over. I soon realized that this particular darkness was pollen from the pine trees and from the plains grasses knee-deep after heavy spring rains.

Grasses I hadn't seen for years waved alongside my car as I drove down the ranch road; timothy and orchard grass, porcupine and witch grass. Native

²¹⁵ Linda M. Hasselstrom, *Woven on the Wind: Women Write about Friendship in the Sagebrush West* (New York: Houghton Mifflin Company, 2001), 16.

²¹⁶ William Sherman, *Prairie Mosaic: An Ethnic Atlas of Rural North Dakota* (Fargo: North Dakota Institute for Regional Studies, 1983), 132.

prairie plants, adapted by centuries of life here to variable weather, had taken advantage of the humidity to spread. Each surly breeze swept pollen into the murky air. I recalled how difficult breathing was in past years with high pollen counts. Cows coughed all night.²¹⁷

This passage is particularly telling because, in it, Hasselstrom noted that humans had adapted, and are adapting, to the features of a frontier just as plants did and are.

Robinson also acknowledged that in the area that became North Dakota, humans, as well as animals and plants adapted to the flat, arid, and cold plains of a frontier. To make his point, he included an observation by Wallace Craig, a North Dakota biologist, writing in 1907. “But more impressive, to my mind than all the isolated facts,” Craig wrote in *North Dakota Life: Plant, Animal, and Human*,

is the deep-lying sympathy between the plants, the animals, and the men, that must all adapt themselves to the same hard conditions; the consequent similarity of behavior in even the most diverse forms of life; and, finally, the extent to which the most wonderful products of plains civilization have been foreshadowed, and in some cases, I may say, even excelled by the work of the primeval inhabitants.²¹⁸

Adaptation, as discussed in this passage, is not only one of Robinson’s themes, nor only a frontier trait, but it is also perhaps the most important way North Dakotans have always dealt with the challenges facing them. Only by adapting, could North Dakotans be successful, just as those breaching other frontiers had adapted. They were successful, finding North Dakota ultimately to be a land of opportunity, or as William Sherman put it, “a new ‘land of Canaan.’”²¹⁹

²¹⁷ Linda M. Hasselstrom, *Feels like Far: A Rancher’s Life on the Great Plains* (New York: First Mariner Books, 2001), 167.

²¹⁸ Robinson, *History of North Dakota*, 565.

²¹⁹ Sherman, *Plains Folk: North Dakota’s Ethnic History*, 17.

This chapter should have made clear that North Dakota fits Turner's and Webb's definitions of a frontier. For example, the tools that won the frontier for those breaching it, according to Webb, such as the six-shooter, barbed wire, and the windmill, proliferated in North Dakota. Moreover, the state's location, topography, weather, scarcity of water, treelessness, expanse, soil, flora, and fauna, together with its low population density—all characterize and describe the state as being a frontier. North Dakotans have also faced the challenges and ethical issues so common to frontiers. Believing they were surmounting challenges by doing so, settlers first killed the grass, then the wild animals, and then the indigenous people.

Now, North Dakotans are facing a new frontier and they are having to adapt to one of the most promising of new technologies- Unmanned Aircraft, or drones. But, just as those before them who adapted tools with which to breach other North Dakota frontiers, they are adapting to this new technology and using it as a tool with which to breach the latest frontier confronting them.

CHAPTER IV

NORTH DAKOTA'S NEW FRONTIER: UNMANNED AIRCRAFT

This chapter treats Unmanned Aircraft Systems, or drones, as North Dakota's new frontier. This new North Dakota frontier, as did those discussed by Frederick Jackson Turner and Walter Prescott Webb, has identifying features. This frontier, as did others discussed earlier in the thesis, also presents risks, challenges, ethical issues, and legal problems, while, at the same time, it presents opportunities, benefits, and advantages. Those breaching the new North Dakota frontier also share characteristics and traits with those who have breached other frontiers. These individuals are intrepid, courageous, inventive, innovative, and adventuresome. They also demonstrated a character trait emphasized by Elwyn B. Robinson. Above all, these individuals are adaptable. They have adapted to UAS: North Dakota's new frontier.

Unlike the others discussed in the thesis, the drone frontier requires the use of terms and acronyms that may be confusing to lay readers. The terms and acronyms will, therefore, be identified and explained, in order to make them understandable to the uninitiated.

Although the term "Unmanned Aircraft Systems" (UAS) has been current for barely a dozen years, a number of individuals have written about them and many describe them as constituting a frontier.²²⁰ Unmanned Aircraft, or drones, are frequently referred

²²⁰ A release from the Department of Defense outlined how the military will integrate UAS over a twenty-five year period. The work was called a "roadmap." "This roadmap adopts the terminology unmanned aircraft (UA), rather than unmanned aerial vehicle (UAV), when referring to the flying component of an unmanned aircraft system. Unmanned Aircraft Systems (UAS) are the focus of this roadmap. This change

to as frontiers by scholars and practitioners alike.²²¹ The study of UAS is itself a frontier, and this chapter is one such study, that of Unmanned Aircraft Systems as North Dakota's new frontier.

in terminology more clearly emphasizes that the aircraft is only one component of the system, and is in line with the Federal Aviation Administration's decision to treat "UAVs" as aircraft for regulatory purposes." "Unmanned Aircraft Systems Roadmap: 2005-2030" Office of the Secretary of Defense. August 4, 2005.

²²¹ Alex Niehenke, "The Next Frontier: Drones," Scale VP Blog, August 24, 2016, accessed March 16, 2017, <https://www.scalevp.com/blog/next-frontier-drones>; Sandy Hausman, "Drones: A New Manufacturing Frontier in Virginia," *WVTF Radio*, September 26, 2016, accessed March 16, 2017, <http://wvtf.org/post/drones-new-manufacturing-frontier-virginia#stream/0>; Ian Parker, *UAV Expert News*, "Portland Startup Wants to Help You Navigate the Drone Frontier," February 11, 2017, accessed March 15, 2017, <http://www.uavexpertnews.com/navigate-drone-frontier/>; Colin Neagle, "Drone Management: The Next Frontier," *Network World*, December 15, 2014, accessed March 16, 2017, <http://www.networkworld.com/article/2859282/software/drone-management-the-next-frontier.html>; Jason Dearen, "The New Frontier of Mind-Controlled Drones," *The Associated Press*, April 22, 2016, accessed March 15, 2017, <http://www.cbsnews.com/news/the-new-frontier-of-mind-controlled-drones/>; Ladd Sanger, "UAS: A New Legal Frontier in Aviation," Slack Davis Law Firm, last modified July 21, 2014, accessed March 15, 2017, <https://www.slackdavis.com/uas-legal-frontier-aviation/>; Jenna Portnoy, "Drone Airspace: A legal frontier," *The Washington Post*, July 15, 2017, accessed March 16, 2017, https://www.washingtonpost.com/local/virginia-politics/va-ag-to-drones-not-in-my-backyard/2015/07/15/6465fd58-2b0a-11e5-a250-42bd812efc09_story.html?utm_term=.9cb8fdee9e35; Jack Smith, "Drones Are the Hot New Frontier for Top Law Firms," *The Observer*, November 14, 2017, accessed March 16, 2017, <http://observer.com/2014/11/drones-are-the-hot-new-frontier-for-top-law-firms/>; "UAS & the New Frontier into Commercial Airspace," Harris Geospatial Solutions, last modified January 21, 2014, accessed March 15, 2017, <http://www.harrisgeospatial.com/Learn/CaseStudiesDetail/TabId/320/ArtMID/1302/ArticleID/13784/UAS-the-New-Frontier-into-Commercial-Airspace.aspx>; Eyragon Eidam, "Aviation's New Frontier: How Ohio Aims to Be a Leader in Drone Research," *Government Technology*, January 18, 2016, accessed March 16, 2017; "Flying parcel-carriers are the next logical frontier for delivery companies." Ben Popper, "UPS Researching Delivery Drones that Could Compete with Amazon's Prime Air," *The Verge*, December 3, 2013, accessed March 16, 2017, <http://www.theverge.com/2013/12/3/5169878/ups-is-researching-its-own-delivery-drones-to-compete-with-amazons>; Bruce Y. Lee, "The Next New Frontier for Drones: Saving Lives," *Forbes*, June 30, 2016, accessed March 16, 2017, <https://www.forbes.com/sites/brucelee/2016/06/30/the-next-new-frontier-for-drones-saving-lives/#666efddf4296>; Danielle Grady, "The Unmanned Frontier: Drone Entrepreneurs Take Advantage of New FAA Rule," *The News and Tribune*, December 17, 2016, accessed March 16, 2017, http://www.newsandtribune.com/news/the-unmanned-frontier-drone-entrepreneurs-take-advantage-of-new-faa/article_a71bbbcc-c3cc-11e6-9464-83bd7caf8d30.html; Aaron Burch, "VR Drone Racing: The Next Frontier in Competitive Racing," Touchstone Research Blog, August 19, 2016, accessed March 16, 2017, <https://touchstoneresearch.com/vr-drone-racing-the-next-frontier-in-competitive-racing/>; Sean Varah, "Drones Could be the Next Big Frontier for Entrepreneurs," MotionDSP Blog, May 18, 2016, accessed March 16, 2017, <https://www.motiondsp.com/drones-could-be-the-next-big-frontier-for-entrepreneurs/>; "Drone Technology the New Frontier in Business," Good Work Labs, last modified January 6, 2017, accessed March 16, 2017, <http://www.goodworklabs.com/drone-technology-the-new-frontier-in-business/>; Averi Haugesag, "It's a Bird! It's a Plane! It's a — UAS? In Gamble Hall?," UND CoBPA News Stories, accessed March 16, 2017, <https://business.und.edu/news/2016/08/its-a-bird-its-a-plane-its-a-uas-in-gamble-hall.cfm>; Cornerstone Insurance Brokers, home page, accessed March 16, 2017, <http://www.csib.org/drones-frontier-risk-management/>; Richard Newman, "Drones: A New Frontier for

“Pilotless aircraft” are essentially any device capable of flight without a human on board. As is true of UAS, pilotless aircraft, the first aircraft in history, were a frontier. Their technology was and is relatively unexplored, and, as industries, they were and are unexplored industries. Another definition of a UAS is any system that consists of an aircraft with no onboard pilot, a ground station, and a command link with which to control the airframe while flying, all operating in concert.²²² Remotely Piloted Aircraft (RPA), Remotely Piloted Aircraft System (RPAS), Remotely Piloted Vehicle (RPV), Unmanned Aircraft (UA), pilotless aircraft, aerial torpedo, Unmanned Combat Aerial Vehicle (UCAV), Unmanned Aerial Vehicle (UAV), Unmanned Aircraft System (UAS), and drone are all acceptable ways with which to describe a controllable flying object.²²³ That the many acronyms and terms, such as “drone,” are, or almost are, synonymous with

Insurers,” *The Record*, November 15, 2015, accessed March 16, 2017, <http://archive.northjersey.com/news/business/insurers-bracing-for-drone-onslaught-1.1455812?page=all>; Paul Mutter, “Islamic State’s Armed Drones Herald a New Frontier in Air Wars,” *Geek Time*, October 19, 2016, accessed March 16, 2017, <http://www.geektime.com/2016/10/19/islamic-states-armed-drones-herald-a-new-frontier-in-air-wars/>; Christian Davenport, “The New Frontier for Drone Warfare: Under the Oceans” *The Washington Post*, November 27, 2016, accessed March 16, 2017, <http://www.tampabay.com/news/military/war/the-new-frontier-for-drone-warfare-under-the-oceans/2304100>; Sean Peasgood, “From Air to Water: The Next Investment Frontier for Drones,” *The Cantech Letter*, September 16, 2015, accessed March 16, 2017, <http://www.cantechletter.com/2015/09/from-air-to-water-the-next-investment-frontier-for-drones/>; Richard Stevens Burington, “New Frontiers.” *Science* 101, no. 2622 (1945): 313-20; and Joe Vacek, “The Next Frontier in Drone Law: Liability for Cybersecurity Negligence and Data Breaches for UAS Operators.” *Campbell Law Review* 39, no. 1 (2017): 135-64.

²²² Syllabus from “ENTR 395: Unmanned Aircraft Systems in Business,” Course taught at the University of North Dakota, 2018.

²²³ “UAS” is used as both singular and plural forms of the acronym in this thesis and its spelling does not change to denote either. “It should be noted that UAS (Unmanned Aircraft System) is now the official term adopted by ICAO (International Civil Aviation Organization), EUROCONTROL, EASA (European Aviation Safety Agency), JARUS (Joint Authorities for Rulemaking on Unmanned Systems), the majority of the national civil aviation authorities (including FAA), as well as the world’s two principal international standards organizations, RTCA and EUROCAE. The acronym UAS is invariant (in plural it does NOT take an additional “s”).” Mark Ballinger, “What’s in a Name?” *UAS Vision*, August 31, 2011, accessed May 4, 2021, [https://www.uasvision.com/2011/08/31/whats-in-a-name/#:~:text=In%20the%20mean%20time%2C%20the%20official%20terminology%20is%20Unmanned%20Aircraft%20System.&text=The%20acronym%20UAS%20in%20invariant,additional%20%E2%80%9Cs%E2%80%9D\).%20%5D](https://www.uasvision.com/2011/08/31/whats-in-a-name/#:~:text=In%20the%20mean%20time%2C%20the%20official%20terminology%20is%20Unmanned%20Aircraft%20System.&text=The%20acronym%20UAS%20in%20invariant,additional%20%E2%80%9Cs%E2%80%9D).%20%5D).

“UAS” poses a difficulty for the UAS industry and they contribute to the lack of a universally accepted definition of UAS.

Those writing on UAS, or drones, formulate arguments and ideas and they pose bothersome questions, just as those writing about the geographical and scientific frontiers treated in previous chapters. Just as the term frontier is referred to as the “F-word,” for example, the term “drone” is sometimes referred to as the “D-word.”²²⁴ The word “drone” has also recently become a verb.²²⁵ To “drone” individuals is to spy on them or to attack those who do not have the ability to strike back. The study of the drone frontier, similarly to the study of any frontier, also involves bothersome ethical and legal issues. Often the ethical issues are legal in nature, similar to those involving land ownership, and one example is the ownership of the sky.²²⁶ Another legal issue is that of appellate courts rendering rulings that contravene the regulations of the Federal Aviation Administration (FAA).²²⁷

Another difficulty when treating drones as a frontier is that they, being a relatively unexplored technology, are as undeveloped as manned aircraft were in World War I, and much of drone technology, as was that of manned aircraft, has yet to be explored and developed.²²⁸ Suggesting the lengths UAS still have to go in development, Dr. Bruce Smith, former dean of the University of North Dakota’s College of Aerospace stated that

²²⁴ Mark Corcoran, “Drone Wars: The Definition Dogfight,” ABC Net, February 28, 2017, accessed March 16, 2017, <http://www.abc.net.au/news/2013-03-01/drone-wars-the-definition-dogfight/4546598>.

²²⁵ For example, see the title of this article: Ian Shaw and Majed Akhter “The Dronification of State Violence,” *Critical Asian Studies* 46, no. 2, 211-34.

²²⁶ Stuart Banner, *Who Owns the Sky* (Harvard University Press, 2008), 330.

²²⁷ Miriam McNabb, “This Michigan Court Ruling Could Have a Major Impact on Commercial Drone Operations,” *DroneLife*, April 3, 2021, accessed April 18, 2021, <https://dronelife.com/2021/04/03/this-michigan-court-ruling-could-have-a-major-impact-on-commercial-drone-operations/>.

²²⁸ David Deptula, *The Rise of the Drones*, PBS Documentary, 2010.

“UND’s commercial aviation program is in good shape,” until, “one is willing to fly in an airplane without a pilot.”²²⁹

Another reality of the drone frontier to which individuals must become accustomed is their use in business and in the public sector, especially when used in place of manned aircraft. The largest commercial mission for UAS in the United States is in the energy sector, partly because the federal government requires oil companies and utility companies to inspect their production and transmission facilities. UAS can fly close to pipelines, wind turbines, and electric lines, for example, and detect leaks or other problems better and more efficiently than can be done in conventional ways. UAS are also used for cinematic purposes, to produce photos and videos at heights and angles previously impossible for expert and amateur producers alike. Drones are also used in the public sector for search-and-rescue, firefighting, law enforcement, and package delivery, when the use of manned aircraft would be impossible, impractical, or unsafe. Each of these reasons for which drones are used also involve the ethical issue of the invasion of privacy, because members of the public can possibly be near the flight operations. As plainsmen adopted the six-shooters, barbed wire, and windmills, businesses and public sector entities have made, or are making, the switch from manned aircraft to unmanned.

The lack of a clear definition of UAS, the relatively unexplored nature of UAS, the challenges and ethical issues posed by UAS, the UAS airframes, and the uses to

²²⁹ Quote from Bruce Smith. “Nowhere but North Dakota: Interview with the Author,” Prairie Public Radio. Accessed March 31, 2018. <http://news.prairiepublic.org/post/author-interview-nowhere-north-dakota-north-dakota-missouri-river-stakeholders>; Bruce Smith, *Nowhere But North Dakota: Clear Skies and Open Airspace* (Grand Forks: University of North Dakota Press, 2014).

which they are being put – all attest to UAS being a new frontier. And, just as all frontiers throughout history, whether the Great Plains, medicine, or space possessed distinct frontier features, North Dakota’s UAS frontier has distinct features. These features include legislators, educators, researchers, institutions, businesses, military bases, public organizations, and missions. A discussion of the chronological development of North Dakota’s UAS frontier features indicates again that UAS is a frontier, but, most importantly, that UAS is North Dakota’s new frontier.

The development of UAS in North Dakota begins, not with the University of North Dakota’s John D. Odegard School of Aerospace Sciences (JDOSAS), but with the establishment of the Grand Forks Air Force Base and with the North Dakota Air National Guard Base. Before the existence of the base, the 319th Bombardment Group was formed in October 1942, made up of B-26 Marauders stationed in England under the 12th Air Force.²³⁰ Flying P-51 Mustangs, the “Happy Hooligans” of the 119th Wing were stationed at the Fargo base that had been established at Hector Field in Fargo, ND, in 1947. The 119th Wing lost its P-51 Mustangs in 1954. Grand Forks Air Force Base was completed in 1957, and the 478th Fighter Group became the base’s host unit. The wing eventually evolved into a nuclear bomber and intercontinental ballistic missile base, and this was around the first time recreational Radio Controlled (RC) aircraft, which arguably meet the definition of UAS, were used in North Dakota. The 319th Bombardment Group, renamed the 319th Bombardment Wing, moved to Grand Forks in 1963.²³¹ Once

²³⁰ “History of Grand Forks Air Force Base and the 319th Air Base Wing,” History Office, 319th Air Base Wing, Grand Forks Air Force Base, June 30, 2021, 7.

²³¹ Ibid.

the Cold War seemed no longer to be a threat, a new doctrine, reducing the number of air defense bases in the United States, led, in 1990, to the Defense Base Realignment and Closure Act (BRAC).

Perhaps in anticipation of potentially losing the North Dakota military base, discussions among politicians, military officials, and academics gained traction and culminated in North Dakota's first UAS initiatives in early 2002. These were the earliest UAS plans, briefings, and research projects in North Dakota. Though UAS was not the focal point, UAS was first mentioned in a meeting in the spring of 2002, when Senator Byron Dorgan invited the eleven presidents of North Dakota institutions of higher education to a meeting in Bismarck, ND.²³²

At the meeting, the presidents learned that \$700 million had been earmarked by Senator Dorgan to create the "Red River Valley Research Corridor" (RRVRC). The RRVRC was intended to attract new technologies and highly-skilled jobs to North Dakota. UAS, as a new and unexplored technology, was mentioned. Major General Mike Haugen, North Dakota's Adjutant General in 2002 and the former commander of Fargo's Happy Hooligans, was insistent on finding a replacement fleet of aircraft for the eighteen aging F-16 aircraft and a "sunrise" mission for the Fargo installation.²³³ This led him to visit the Pentagon many times over the period of 2002-2005, and, eventually, with the assistance of Senator Dorgan, he was successful in bringing the large fixed-wing MQ-1 Predator UAS to Fargo, thereby protecting the base from closure.

²³² U.S. Senator Byron Dorgan, interview by author, Accra, June 21, 2021.

²³³ Major General Michael Haugen, interview by author, Grand Forks, April 19, 2021.

In 2003, UND had its first formal exposure to UAS as a potential research project or educational opportunity through a briefing given by Brigadier General Alan Palmer. A former Chief of Staff of the North Dakota Air National Guard, General Palmer was commissioned by the Office of Naval Research to give what came to be known as the “UAS Puzzle Brief” to the School of Aerospace Sciences at UND.²³⁴ In June 2004, the first funding for a UAS project was made available to the Departments of Mechanical Engineering and Electrical Engineering in the College of Engineering and Mines at the University of North Dakota.²³⁵ The National Science Foundation awarded a grant of \$15,000 to be used to purchase components for a one-hundred pound unmanned aircraft to research such an aircraft’s sensor-carrying capabilities.²³⁶ The aircraft flew at Camp Grafton in Devil’s Lake, ND, where special permissions for flight research could be granted by the North Dakota National Guard. Among the reasons the team was given permission to execute such flight operations is because of the area’s low population density. This is the extent of professional UAS activities in North Dakota before May 16, 2005, when the catalyst of UAS in North Dakota, the BRAC list, was published.

Using the BRAC as legislation to serve as a mechanism with which to reduce the Department of Defense’s budget, in 2005 a list was published designating those military installations slated for closure. Included on the list were the Grand Forks Air Force Base and the North Dakota Air National Guard installation in Fargo, ND. With the publication

²³⁴ Brigadier General Alan Palmer, interview by author, Grand Forks, June 30, 2021.

²³⁵ William Semke, interview by author, Grand Forks, June 9, 2021.

²³⁶ UND NSF Report to Turtle Mountain Community College, June 2005. See Appendix B.

of this list, many North Dakotans determined to counter the severe detrimental economic effects that would result from the base closures.

Senator Dorgan, from his positions on the Senate Appropriations Committee, the Senate Aviation Committee, and the Senate Defense Appropriations Sub-Committee, took the lead to prevent the closing of the Grand Forks Air Force Base. He arranged a meeting with then Senator Kent Conrad and Congressman Earl Pomeroy, both representing North Dakota, to speak with General John Jumper, Chief of Staff of the United States Air Force.²³⁷ General Jumper had the authority to bring a new defense mission to North Dakota, and he chose to send the Northrop Grumman RQ-4 Global Hawk to Grand Forks and the General Atomics MQ-1 Predator to Fargo. Senator Dorgan and General Jumper, together, accelerated the growth of the UAS presence in North Dakota by the largest order of magnitude to date, and their work can be seen as the underpinnings of the North Dakota UAS industry.

The first scholarly mention of the development of North Dakota's UAS industry was that of Dr. Bruce Smith. In his book, *Nowhere But North Dakota: Clear Skies and Open Airspace*, Dean Smith discussed the beginning of major UAS initiatives in North Dakota. "An unexpected phone call in summer 2005," he wrote,

sent the Odegard School in an entirely new direction. This time the call came from Sen. Dorgan's chief of staff, Brian Moran. His call came in advance of an impending visit by the Defense Base Closure and Realignment Commission (commonly known by the acronym BRAC). Grand Forks Air Force Base (GFAFB) was in peril of being closed, and the senator's office had come up with a strategy that could result in a realignment rather than closure. Moran told me, "Log on to the Internet and find out everything you can about unmanned aircraft systems (UASs)."

²³⁷ U.S. Senator Byron Dorgan, interview by author, Accra, June 21, 2021.

Just like the success of the Odegard School hinges on being in North Dakota, it is also the only place that holds all the elements needed for UAS success. The strategy of highlighting the Odegard School, UND and unmanned aircraft systems in the context of the elements needed to succeed made an impression on the BRAC committee. Taken along with the efforts of all of the participants, the final results of the BRAC shifted from closing the base to realigning the base missions to UASs, opening the door for Predator, Reaper and Global Hawk flights from GFAFB. It also brought UAS missions to the Air National Guard in Fargo for flying combat support in Afghanistan and Iraq and to the Department of Homeland Security and Border Protection at Grand Forks airport.²³⁸

Community events related to UAS were planned in Grand Forks to foster the local UAS industry and as it became apparent that such opportunities could complement the UAS degree program at UND. Senator Dorgan used some of his earmarked funds from the RRVRC to defray the cost of the first “UAS Action Summit” in 2005. Now renamed the “UAS Summit,” the conference has attracted hundreds of UAS subject-matter experts from various industries to Grand Forks for a three-day conference every year since, except for 2011. The organization that hosts the UAS Summit in its current form is “BBI International,” and, from its headquarters in Grand Forks, it publishes *UAS Magazine*, which is an aggregator of UAS news from around the world.²³⁹

Also in 2006, with assistance from Senator Dorgan, Professor Mark Askelson in the Atmospheric Sciences Department at UND was awarded a \$9.65 million grant from the Air Force Research Laboratory (AFRL) at Creech Air Force Base to start the UAS Air Battle Lab Project at UND. A year later, in 2007, the Department of Defense Center

²³⁸ Bruce Smith, *Nowhere but North Dakota: Clear Skies and Open Airspace* (Grand Forks: University of North Dakota Press, 2014): 95-100.

²³⁹ The “BBI” in “BBI International” is the spelling of the company’s name, and it is not an acronym. Dayna Bastian, interview by author, Grand Forks, ND, June 8, 2021.

of Excellence for UAV Education was established at UND.²⁴⁰ Its name was changed later to the Center for UAS Research, Education, and Training.

Senator Dorgan also chose to work with Governor John Hoeven, Dean Bruce Smith, and other educators at UND to approach the North Dakota Centers of Excellence Commission at the North Dakota Economic Development Foundation to request a \$3.5 million grant.²⁴¹ Although these individuals did not secure all of the \$3.5 million, Bruce Smith wrote this of the beginnings of UND's UAS program,

The Unmanned Aircraft System Center of Excellence exploded out of the blocks like an Olympic sprinter. By May 2006 we had secured a grant of \$1 million from the state's Centers of Excellence funding provided through the North Dakota Department of Commerce to establish the center and to cover start-up salaries. This was followed by the first UAS Action Summit, held by Sen. Byron Dorgan on campus at Clifford Hall. By the end of the year, we had obtained \$5.2 million in state and federal funding, and \$1 million in-kind from Lockheed for the use of one of their unmanned aerial platforms.

It was my vision to have a degree program and a full curriculum in UASs. As luck would have it, I had gotten wind of a person who was not only perfectly suited to build that curriculum but was also headed to Grand Forks. It was as if all of the stars were aligned for us when Col. Kathleen Concannon was transferred to GFAFB to serve as the new commander of the Medical Squadron. As you would expect, her husband Bob Concannon – known in U.S. Air Force circles as “Mr. UAS” – was moving to Grand Forks with her. When I heard about his reputation and his capabilities in the UAS training world, I called to tell him I was interested in hiring him to set up our UAS programs. After ironing out the details of hiring, benefits and relocation, he accepted a position in the Aviation Department. When Concannon showed up for his first day of work, we met and he said, “Now that I'm here, what do you want me to do?” I said, “I want you to build an undergraduate, Bachelor of Science degree curriculum for UASs within the Aviation Department including the integration of the private, commercial, instrument, and multiple-engine pilot ratings, a segment on air traffic control, and included UND's Engineering College's courses on payloads, sensors and composite structures.” He replied, “Is that all?” I said “yes” and he went to work.

²⁴⁰ University of North Dakota Website, accessed April 18, 2021, <http://www.uasresearch.com/about/>.

²⁴¹ UND COE Grant Application December 2007; John Hoeven, “John Hoeven: The North Dakota Drone Industry is Taking Off,” *Grand Forks Herald*, April 21, 2016, accessed June 8, 2021, <https://www.grandforksherald.com/opinion/4014497-john-hoeven-north-dakota-drone-industry-taking>; Also see Appendix E.

When he finished, in time for the start of fall 2008 classes, UND became the first university to offer a bachelor's degree in unmanned aircraft systems.²⁴²

The four-year undergraduate degree of which Smith wrote, approved by the North Dakota State Board of Higher Education in 2006, was, officially, in “Unmanned Aircraft Systems Operations.”²⁴³

In 2007, Fargo's Air National Guard unit installed its first UAS ground stations at Hector Field, and the Grand Forks Economic Development Corporation initiated a cooperation with the Grand Forks-based Praxis Strategy Group to publish a two-hundred page “roadmap” on the UAS industry as it then existed, along with a plan for further development. The roadmap, published May 31, 2007, would prove to be largely inaccurate in its optimistic predictions, but it became a useful conceptualization for community leaders and it served to increase the appreciation of UAS in North Dakota.²⁴⁴

In 2008, Raytheon, a major American defense contractor, chose to work with the UND Department of Mechanical Engineering program to fly training missions with UND UAS students at Camp Grafton using new, and advanced, flight Certificates of Authorization (COA).²⁴⁵ This was UND's first UAS COA.²⁴⁶

When UND officially launched its UAS degree program under President Robert Kelley, the first department chairs were Professors Jeff Kappeman and Bill Watson.²⁴⁷ In

²⁴² *Nowhere but North Dakota*, 115. Also see Appendices D and M.

²⁴³ Bruce Smith, interview by author, Abidjan, June 16, 2021.

²⁴⁴ MTSI Grand Forks Unmanned Aviation Business Development Roadmap, May 31, 2007.

²⁴⁵ “UAS Fly Days Set at Camp Grafton South” *Grand Forks Herald*, July 27, 2008, accessed April 2, 2018, <http://www.grandforksherald.com/news/2077744-higher-education-notebook>

²⁴⁶ See Appendix G.

²⁴⁷ “RRV: First Students in the Nation Graduate with Unmanned Aircraft Systems Degree,” *Grand Forks Herald*, June 6, 2011, accessed April 18, 2021, <https://www.grandforksherald.com/news/3964140-rrv-first-students-nation-graduate-unmanned-aircraft-systems-degree>; “A First: UND Offers Degree Program in

2009 and 2010, North Dakota's first commercial UAS technology start-ups were incorporated, the first being Field of View, a limited liability company founded by David Dvorak, an entrepreneur and graduate of the master's degree program in the UND Mechanical Engineering Department.²⁴⁸ General Atomics, another well-known American defense contractor, sent its first employees to Grand Forks then. General Atomics built an operations building in the Grand Forks Industrial Park, near the UND rugby field and the BioLife Medical Services building. The company, and the United States Customs and Border Protection (CBP), signed a lease with the Grand Forks Air Force Base to facilitate the operations of the MQ-1 Predator aircraft and use them on missions to patrol the borders with Canada and Mexico. These aircraft were also used in 2011 for the nationally televised police enforcement action against a farmer in Lakota, ND, which was the first time a federally owned UAS was used in an arrest of an American citizen.²⁴⁹

Professor John Bridewell, who became chair of the UAS program at UND in 2016, received a \$5.5 million dollar grant in 2010 from the Air Force Research Laboratory (AFRL), in partnership with General Atomics, to install the MQ-1 Predator Research Integrated Network Combat Environment (PRINCE) training system. In 2010, an Environmental Impact Study conducted by the United States Air Force concluded that the Grand Forks Air Force Base was the ideal location for the RQ-4 Global Hawk UAS.

UAV Piloting," *Homeland Security News Wire*, January 5, 2010, accessed April 18, 2021, <http://www.homelandsecuritynewswire.com/first-und-offers-degree-program-uav-piloting>.

²⁴⁸ ND Secretary of State Website: Business records search.

²⁴⁹ "Police rushed in and made the first known arrests of U.S. citizens with help from a Predator, the spy drone that helped revolutionize modern warfare." Brian Bennet, Police Employ Predator Drone Spy Planes on Home Front, *The LA Times*, December 10, 2011, accessed February 4, 2018, <http://articles.latimes.com/2011/dec/10/nation/la-na-drone-arrest-20111211>.

The flat land was suitable for the aircraft's runway, and the low population density made easier the establishing of restricted airspace. The study also concluded that the area was suited to the Global Hawk because there are few airline passenger flights in the local airspace.²⁵⁰

After General Atomics brought MQ-1 Predators to Grand Forks, Northrop Grumman delivered the first Global Hawk to Grand Forks Air Force Base on May 26, 2011, to serve in the Battlefield Airborne Communications Node (BACN) mission.²⁵¹ The Global Hawk was part of the 69th Reconnaissance Group, later renamed the 319th Operations Group, in acknowledgement of the base's earlier host unit. A year later, with the help of Alan Palmer, the new UAS Department Chair, UND received another grant, this time for \$4.1 million, to launch the Limited Deployment Cooperative Airspace Project (LDCAP) in partnership with the FAA. In June of the same year, the first five students graduated from UND with degrees in Unmanned Aircraft Systems Operations.

In 2012, UND established the UAS Compliance Committee as an institutional review board for student-based UAS projects.²⁵² The committee was later renamed the UAS Research, Ethics, and Compliance Committee. Also in 2012, the Grand Forks

²⁵⁰ "Environmental Impact Statement for the BRAC Beddown and Flight Operations of Remotely Piloted Aircraft at Grand Forks Air Force Base, North Dakota," January 2020, 2-21; See Appendix H.

²⁵¹ First Global Hawk UAS Arrives at New Home In North Dakota, *Composites World*, June 6, 2011, accessed February 2, 2018. <https://www.compositesworld.com/news/first-global-hawk-uas-arrives-at-new-home-in-north-dakota>.

²⁵² See Appendix J.

County Sheriff's Department integrated UAS into law enforcement, the first department in the Northern Great Plains to do so.²⁵³

Not long after, North Dakota's Congressional delegation formed a group to bring together a major initiative to Grand Forks: The Northern Plains Unmanned Aircraft Systems Test Site, which was subordinate to the newly formed Northern Plains UAS Authority under the direction of Lieutenant Governor Drew Wrigley.²⁵⁴ They also established the first North Dakota state-sponsored social media presence on May 22, 2014, with an inaugural twitter post and the first mention of "Team North Dakota" forming around UAS.

The years 2014 and 2015 came with major building investments and landmark successes for UAS in North Dakota. On October 9, 2014, ground was broken for Robin Hall, a \$22 million facility named for donor Si Robin, on the UND campus next to Ryan Hall.²⁵⁵ On February 18, 2015, the country's only UAS "Enhanced Use Lease" agreement was signed for private UAS use of federal land at what was named "Grand Sky" at Grand Forks Air Force Base.²⁵⁶ In May, UND was awarded a partnership with

²⁵³ Eric Hylden, "Grand Forks Sheriff's Department Launching UAS Program," *Grand Forks Herald*, March 2, 2012, accessed April 12, 2018, <http://www.grandforksherald.com/news/2171740-grand-forks-sheriffs-department-launching-uas-program>. Also see Appendix I.

²⁵⁴ See Appendix L.

²⁵⁵ Kerry Lynch, "UND Aerospace School Breaks Ground On Research Center," *Aviation Week Network*, October 13, 2014, accessed March 31, 2018, <http://aviationweek.com/awin-only/business-aviation-brief-und-aerospace-school-breaks-ground-research-center>.

²⁵⁶ Patrick Miller, "Lease Agreement with Air Force Creates North Dakota UAS R&D Park," *UAS Magazine*, February 19, 2015, accessed February 26, 2018, <http://www.uasmagazine.com/articles/995/lease-agreement-with-air-force-creates-north-dakota-uas-rd-park>.

the FAA's prestigious Alliance for System Safety of UAS through Research Excellence (ASSURE) at the FAA's Center of Excellence for UAS Research.²⁵⁷

On June 6, 2015, SkySkopes became the first UAS startup in North Dakota to be approved by the Federal Aviation Administration to fly commercial UAS. The company also executed the first commercial UAS flight legally conducted on a USAF installation, the Grand Forks Air Force Base, on September 9, 2015, two days before the groundbreaking of the \$80 million Grand Sky complex on the Runway 35 Alert Pad.²⁵⁸ A month later, on October 15, Northrop Grumman committed to an \$80 million facility and one-hundred new jobs at Grand Sky in a groundbreaking ceremony attended by the North Dakota Congressional Delegation.²⁵⁹ In the future, large UAS operated out of Grand Sky will be able to conduct large-scale inspection flights for oil pipelines and powerlines, among other missions.²⁶⁰

In North Dakota, manned aircraft, motorized vehicles, and individuals on foot have often been replaced by UAS to inspect railroads, oil pipelines, powerlines, and farm fields. Xcel Energy, a North Dakota utility, flew UAS to inspect powerlines on October 28, 2015, in Joliette, ND.²⁶¹ This was one of the first operations demonstrating the value

²⁵⁷ http://www.assureuas.org/NewsEvents/docs/2015//UND_FAA_UAS_COE.pdf

²⁵⁸ "The initial flight also marked the first time a commercial UAS received FAA permission to operate on a U.S. military base." Grand Sky Partners with SkySkopes for Visual Imagery, October 7, 2015, accessed March 31, 2018. <http://grandskynd.com/news/grand-sky-partners-with-skyskopes-for-visual-imagery/>. Also see Appendix Q and Appendix N.

²⁵⁹ Northrop Grumman Breaks Ground on Grand Sky's Largest Expansion Project, October 15, 2015, accessed March 31, 2018, <https://news.northropgrumman.com/news/releases/northrop-grumman-breaks-ground-on-grand-sky-s-largest-expansion-project>. Brandi Jewett, "Northrop Grumman Breaks Ground on \$10 Million Facility Near Grand Forks," *Grand Forks Herald*, October 15, 2015.

²⁶⁰ David Dvorak, interview by author, Accra, June 18, 2021.

²⁶¹ Kevin Bonham, "Xcel Energy Launches North Dakota's First Unmanned Aircraft for Utility Flight," *Forum News Service*, October 28, 2015, accessed April 12, 2018, <http://www.inforum.com/news/3870948-xcel-energy-launches-north-dakotas-first-unmanned-aircraft-utility-flight>.

of UAS to the energy industry, as it was more cost-effective than a manned aircraft and it presented less risk to a pilot than using a manned aircraft to collect similar data. The same utility, with SkySkopes, used UAS at night to test the efficacy of collecting thermal data on utility poles and lines to detect faults. SkySkopes was the first North Dakota company given permission to fly at night, making such a mission possible.²⁶² With such data a utility could determine whether its power lines were overheating, indicating an impending power failure. Xcel Energy added UAS flights to its storm assessment efforts in Mayville, ND, on February 23, 2017, becoming the first company in the nation to fly both large and small UAS simultaneously following a mock tornado.²⁶³ The utility flew UAS over such utility installations as substations and powerlines and to find and recover individuals injured by debris, and to assess damage. The large UAS flew circular flight patterns at a high altitude. When its flight crew located a simulated damaged powerline or injured individual, they communicated with the flight crews of small UAS who then dove to the indicated locations and flew UAS at lower altitudes to get better images. This data was used to confirm data collected by the large UAS, in order to determine whether UAS could shorten the time required to recover the injured and determine the extent of damage.

The same large UAS used by Xcel Energy for that project, the Elbit Systems Hermes 450, was modified with different sensors to fly agricultural data collection

²⁶² “Grand Forks Company Among First to Fly Drones at Night,” SkySkopes, Inc.’s website, December 10, 2017, accessed April 12, 2018, <https://www.skyskopes.com/news-updates/grand-forks-company-among-first-to-fly-drones-at-night>.

²⁶³ Kevin Killough, “Mayville Project Shows Commercial Potential for UAS,” *Grand Forks Herald*, February 24, 2017, accessed April 12, 2018, <http://www.grandforksherald.com/news/4224627-mayville-project-shows-commercial-potential-uas>.

missions over farms in Hillsboro, ND, and Carrington, ND, for the Department of Agricultural and Biosystems Engineering at North Dakota State University on May 19, 2016.²⁶⁴ About one month after this flight, the Federal Aviation Administration released its new rules under 14 CFR Part 107 to allow individuals without section 333 exemptions and private pilots' licenses to fly UAS commercially. The Federal Aviation Administration's study guide for a new UAS pilot's certification, specifying what types of questions would be on their exam, was used by many in North Dakota.²⁶⁵ Farmers can use the multispectral data, which shows the reflectivity with different bands of light than the electro-optical (EO) cameras commonly found on UAS, collected by the sensors on the Hermes UAS to predict crop yields, detect plant diseases, and locate weeds. Other UAS can then be used with which to spray herbicides and pesticides on parts of farm fields more precisely and more frequently than could be done using traditional methods. North Dakota-based pilots were allowed to conduct flights with this aircraft because the UAS professionals in the state were granted new waivers, which alleviated airspace restrictions, and the Hermes was the first large UAS to fly commercially in the United States.

On July 11, 2018, the Grand Forks Air Force Base was the launch site of the first trans-Atlantic Medium Altitude Long Endurance (MALE) UAS flight operation. General Atomics Aeronautical Systems launched an MQ-9 Reaper from the base on a flight to the

²⁶⁴ Ellen Crawford, "NDSU Testing Large UAS Role in Agriculture," NDSU Agriculture Communication, North Dakota State University Website, May 20, 2016, accessed April 13, 2018, <https://www.ag.ndsu.edu/news/newsreleases/2016/may-16-2016/ndsu-testing-large-uas-role-in-agriculture/>.

²⁶⁵ See Appendix O.

Royal Air Force (RAF) Fairford station in Gloucestershire, England.²⁶⁶ The event was to commemorate the founding of England’s Royal Air Force in 1918, and it reminded North Dakota’s UAS personnel that flying UAS beyond-visual-line-of-sight (BVLOS) will be of immense value when it becomes lawful to do so.

Another major feature of the North Dakota’s UAS frontier occurred in October 2019 at the “Statewide UAS Network Industry Day,” held at the Delta Hotel in Fargo, at which state officials announced that they were building a BVLOS radar system for UAS.²⁶⁷ The state legislature had, only five months earlier, appropriated \$28 million with which the Northern Plains UAS Test Site (NPUASTS) could build a series of radar installations that can detect drones and thereby reduce the risk of manned aircraft colliding with UAS. One year later, the NPUASTS announced that it would call the radar network “Vantis,” and that three companies, Thales Aerospace, L3Harris Technologies, and Collins Aerospace, a Raytheon Company, would be the contractors for the project.²⁶⁸ The development of the Vantis network is progressing well in 2021.

The beginnings of North Dakota UAS and its developments are also features of the UAS frontier. Just as the Great Plains frontier had characteristic features, such as soil types, grass varieties, native animals, and topographical configurations, the North Dakota

²⁶⁶ Mark Harris, “The Risky First Transatlantic Flight of a Reaper Drone,” *TechCrunch*, March 9, 2020, accessed April 18, 2021, <https://techcrunch.com/2020/03/09/the-risky-first-transatlantic-flight-of-a-reaper-drone/>.

²⁶⁷ “North Dakota Statewide UAS Network Industry Day a Success,” State of North Dakota Website, October 16, 2019, accessed April 18, 2021, <https://www.nd.gov/news/north-dakota-statewide-uas-network-industry-day-success>.

²⁶⁸ Josh Spires, “North Dakota Announces Vantis, a Statewide BVLOS Network,” *DroneDJ*, October 28, 2020, accessed April 18, 2021, <https://dronedj.com/2020/10/28/north-dakota-announces-vantis-a-statewide-bvlos-network/>.

UAS frontier has characteristic features, such as individuals, businesses, missions, and aircraft.

All frontiers, including UAS, North Dakota's new frontier, present risks, challenges, ethical issues, and legal problems. They also, however, present opportunities and benefits. Privacy is the most obvious ethical issue for UAS, and individuals in North Dakota have experienced it, and are attempting to mitigate the issue, in many ways. A bill was introduced in the North Dakota Legislature during the 2019 session that would have severely hampered the use of UAS in North Dakota. Grounds for the bill were that UAS can invade the privacy of individuals who are unaware of their presence. Russ Buchholz, the individual overseeing UAS initiatives at the North Dakota Department of Transportation (NDDOT), believing the bill to be unnecessary, helped to defeat it. Had it passed, the bill could have hampered the work of UAS pilots coming out of UND's UAS program.

Under Dean Bruce Smith, UND reorganized the John D. Odegard School of Aerospace Sciences' curriculum to train unmanned aircraft pilots in addition to training manned aircraft pilots. This was an ethically questionable proposition for many in the university's administration and faculty, given that drones are often seen as a threat to pilots who do not want to be replaced by computers. Smith accepted the risk and created the UND's UAS department, seeing it as an opportunity. The current chair of the UAS department, Professor Paul Snyder, also sees opportunities in the risks. "The challenges are our opportunities," Snyder told UND's official news source, "all of the things people are concerned about – from privacy to safety – they are the very reasons why we are

doing this.”²⁶⁹ One of the opportunities these ethical issues affords the university is educational, and UND in January 2020 launched a course titled “The Ethics of UAS,” which considers ethical issues associated with UAS used in defense, in the commercial sector, and in academia.

Small UAS (sUAS), or drones that weigh less than fifty-five pounds, are the most prevalent and the most likely to cause ethical issues in North Dakota’s commercial UAS sector, and startups and established organizations alike are adapting to them and incorporating them into their businesses. One established North Dakota firm is Cass County Electric, a utility headquartered in Fargo, North Dakota. Chris Erickson is the company’s chief pilot, and he believes that for organizations such as his, “buying, flying, internalizing and outsourcing UAS is inevitable.”²⁷⁰ Cass County Electric has also created new privacy policies for its drone pilots. Erickson said, “we are making sure that we do what we can to keep it so privacy issues do not come into play.” The company has sent communications and brochures to its members, informing them that Erickson’s pilots may fly a small UAS over their homes to inspect the power lines. Often, as Erickson described, the utility’s pilots need to knock on the doors of homeowners in its service area to assure residents “that we are not using UAS for suspicious activity or in a nefarious way.”

The ethics of using the Hermes 450 UAS, being foreign-built and also used in combat, were considered by UND’s Research Ethics and Compliance Committee.

²⁶⁹ David Dodds, “Big Step for UND, Giant Leap for UAS in Society,” *UND Today*, March 21, 2019, accessed April 25, 2021, <http://blogs.und.edu/und-today/2019/03/big-step-for-und-giant-leap-for-uas-in-society/>.

²⁷⁰ Chris Erickson, interview by author, Grand Forks, March 23, 2021.

Committee members determined that use of the aircraft for commercial purposes was acceptable. One of the reasons that the aircraft could be used without fear of negative reactions was that those involved requested, and received, permission for the mission from the FAA. Though the aircraft was foreign-owned, Americans had control over the aircraft while it was being used as well, which eased tensions.

The first time a federally owned UAS was used in an arrest of an American citizen occurred in North Dakota, and it presented of the most important UAS ethical dilemmas the state has faced.²⁷¹ Rodney Brossart, a Grand Forks County cattle rancher, refused to return a neighbor's cattle that had wandered onto his land. When the SWAT team from Grand Forks arrived at his home to arrest him, Brossart and his two sons took up arms in a standoff. The SWAT team called the Customs and Border Protection (CBP) office in Grand Forks and requested that a predator drone fly over the Brossart farmstead and locate the three individuals and their weapons. When the CBP UAS confirmed the location of the Brossarts, the SWAT team determined that they had the advantage, and team members entered the house to arrest the family. When Brossart contested his arrest in court on the grounds that using a UAS against an American citizen was illegal and an

²⁷¹ "Police rushed in and made the first known arrests of U.S. citizens with help from a Predator, the spy drone that helped revolutionize modern warfare." Brian Bennet, Police Employ Predator Drone Spy Planes on Home Front, *The LA Times*, December 10, 2011, accessed February 4, 2018, <http://articles.latimes.com/2011/dec/10/nation/la-na-drone-arrest-20111211>; Jason Koebler, "North Dakota Man Sentenced to Jail in Controversial Drone-Arrest Case," *U.S. News and World Report*, January 15, 2014, accessed May 13, 2021, <https://www.usnews.com/news/articles/2014/01/15/north-dakota-man-sentenced-to-jail-in-controversial-drone-arrest-case>; Michael Peck, "Predator Drone Sends North Dakota Man to Jail," *Forbes*, January 27, 2014, accessed May 13, 2021, <https://www.forbes.com/sites/michaelpeck/2014/01/27/predator-drone-sends-north-dakota-man-to-jail/?sh=65f0545d324c>.

invasion of privacy, a judge dismissed his claim and sentenced him to three years in jail. This is the best-known example in North Dakota of UAS being used in law enforcement.

Also, an important ethical issue using UAS in law enforcement can be discerned from the way the Grand Forks County Sheriff's Department responded to a situation, as was explained in an excerpt from an article published in *Government Fleet* in May 2016:

Grand Forks, N.D. County Sheriff's deputies on early morning patrol about 18 months ago saw a vehicle driving erratically and signaled for it to stop. The driver stopped, but all three suspects ran out of the vehicle and into a cornfield. The deputies called for an unmanned aircraft system (UAS) from the Northeast Region UAS Unit to assist in searching for the men. Deputies caught one suspect quickly, and another got away, but deputies caught the third suspect the next morning. Asked why he hid rather than run, the captured third suspect said he could see the UAS and knew if he moved, the UAS would see him.

The other suspect could see the aircraft, which projected a mild omnipresence where he felt, 'If I move they'll see me so I'll stay right here.' It contained him rather than having him flee and escape like the other suspect," said Alan Frazier, associate professor with the University of North Dakota Department of Aviation and deputy sheriff at Grand Forks County. Frazier oversaw the creation of a regional law enforcement unmanned aircraft system (UAS) unit in the state that assists in emergency services such as law enforcement, fire, and search and rescue operations.²⁷²

A concern raised by these two examples is whether it is unfair to suspects that law enforcement officials have UAS and use them to their advantage. UAS in the hands of officers of the law certainly raises ethical issues, regardless of the unfairness to a suspect. The use of UAS, however, makes it less likely that lethal force needs to be used on a suspect.

²⁷² Daryl Lubinsky, "Unmanned Aircraft Improve Agencies' Operations," *Government Fleet*, May 2016, accessed April 12, 2018, <https://www.government-fleet.com/channel/law-enforcement/article/story/2016/05/unmanned-aircraft-improve-agencies-operations.aspx>.

Privacy is the critical ethical issue with UAS around the United States and no less in North Dakota. The advent of drones has brought with it the stigma of being able to “spy” on people or conduct “surveillance” on them. UAS operators prefer to fly in low population density areas in order to reduce the likelihood of complaints that a UAS has breached an individual’s privacy. The irony, however, especially in North Dakota, is that some individuals purchase land on which to live far from populated areas, specifically to enjoy privacy by being secluded. Often, such individuals become annoyed, or worse, when a UAS flies near their property. According to John Nowatzki, a UAS researcher at North Dakota State University, some North Dakota ranchers also do not want UAS flying over their ranches, generating imagery displaying how many head of cattle they own, or assessing the condition of their land, because then their gross annual income could possibly be calculated.²⁷³ Aaron Reinholz, however, another UAS researcher at North Dakota State University, stated that of the dozens of North Dakota farmers he contacted about an overflight with the Hermes UAS, only two refused to give permission to fly over their land.²⁷⁴

The same frontier features that made the North Dakota frontier a difficult one on which to live, are also the challenges, risks, and opportunities of the state’s UAS frontier. North Dakota’s climate, temperature extremes, topography, low population density, and wind make the state ideal for UAS and their uses.

One UAS company, Zipline, located some of its flight testing in North Dakota specifically because of the state’s extreme winters. Zipline, founded in 2014, uses drones

²⁷³ John Nowatzki, interview by author, Grand Forks, March 25, 2021.

²⁷⁴ Aaron Reinholz, interview by author, Grand Forks, April 20, 2021.

to drop packages containing goods from the air, and winter flight practice will aid the company to achieve greater economies of scale for its UAS delivery service. According to a March 9, 2021, article written by Ann Bailey in the *Grand Forks Herald*, “Flying the drones in the real-world winter conditions of wind, snow, and cold is why Zipline set up a test site near Hatton, 40 miles southwest of Grand Forks.”²⁷⁵

Dr. Mark Askelson, Associate Dean of the John D. Odegard School of Aerospace Sciences at the University of North Dakota and Executive Director of UND’s Research Institute of Autonomous Systems, also flies UAS in North Dakota winters. Askelson noted that the North Dakota weather that is beneficial to UAS is the same weather that others consider undesirable or extreme. He said, “There are challenges, for example the low-level winds. Operationally though, and this is true everywhere, North Dakota is a great place to make our UAS more robust for weather hazards.”²⁷⁶ North Dakota is an ideal place to fly UAS, Askelson posits, because North Dakota can give a pilot “any kind” of weather phenomenon, and the state is also an ideal place for test missions and data simulations. He mentioned also that in North Dakota, the “cold, dense air gives the best pressure for upwards lift over the wings and props. Although cold can shorten the life of batteries, North Dakota weather makes new business cases for UAS such as

²⁷⁵ Ann Bailey, “North Dakota’s Nasty Winter Weather is Ideal for California Drone Company’s Testing,” *Grand Forks Herald*, March 9, 2021, accessed April 18, 2021, <https://www.grandforksherald.com/news/6924630-North-Dakotas-nasty-winter-weather-is-ideal-for-California-drone-companys-testing>. An employee noted that, “We really were looking for true, deep cold,” and that they “were looking around the country for a place where the weather was right.”

²⁷⁶ Mark Askelson, interview by author, Grand Forks, January 29, 2021.

calculating the volume of snow piles, and cold oil pipeline leaks.”²⁷⁷ To Askelson, UAS and North Dakota’s weather also capture the state’s “frontier spirit.”²⁷⁸

American Crystal Sugar, a company that processes sugar from beets grown in the Red River Valley, is another business that takes advantage of North Dakota’s weather and UAS. The winter’s cold temperatures allow the company to store beets in outdoor piles, where they are frozen and thereby prevented from spoiling and becoming unfit for processing.²⁷⁹ The company has trained a number of UAS pilots to fly over its beet piles with thermal sensors to detect whether heat is building up in the piles, accelerating the natural process of sucrose turning into alcohol.²⁸⁰ These pilots are enabled to inspect beet piles with UAS more effectively than they could with manned aircraft, because the UAS can fly closer to the piles and produce images with high resolution. Deep snow also often prevents American Crystal Sugar employees from driving to piling sites and walking around the beet piles. They can, however, use drones to determine whether there is any damage to the beets or, if there is, to determine how severe the damage is. According to one of the UAS professionals at American Crystal Sugar, “drones have only made our jobs better.”²⁸¹

An obvious reason for UAS’ being useful in the flat terrain of North Dakota is the relative absence of obstacles. Trees, mountains, and other elevated features are examples of what UAS need to avoid, and North Dakota has few of them. Dr. Greg Vandeberg, a

²⁷⁷ Ibid.

²⁷⁸ Ibid.

²⁷⁹ Brian Ingulsrud, interview by author, Grand Forks, April 1, 2021.

²⁸⁰ Spencer Roth, interview by author, Grand Forks, April 1, 2021.

²⁸¹ Ibid.

Professor of Geography at the University of North Dakota, teaches courses on remote sensing. He said that the state's land surfaces are conducive to the use of UAS, and that "with similar topography across the state, pilots can train in consistent land masses that have different weather patterns from east to west."²⁸² "North Dakota's topography," he also stated, "is beneficial to agriculture." The size of the farm fields in the state tend to be larger than is the case elsewhere, and "we have more continuous crop fields than in other locations."²⁸³ Vandeberg also noted that in the Red River Valley, also partly because of its topography, such fields make UAS a useful tool.

To Mike Whitted, an employee of the North Dakota UAS airspace consulting company called "InnoVets," topography was the "biggest part" of the company's decision to move to North Dakota.²⁸⁴ He equated the UAS industry to the "wild west" because of its regularly emerging technologies and constantly changing regulations. He stated that the state's flat terrain and the "population density, being sparse," were conducive to agriculture and agriculture was conducive to UAS. It did not take very long, he said, for people to "put two and two together" and discern that the topography and low population density allowed UAS, or "that frontier endeavor," to be developed in North Dakota.

Dr. Josh Riedy, CEO of Airtonomy, is another businessman on the North Dakota UAS frontier. Riedy's company is among the national leaders in the UAS-based inspection and subsequent data analysis of wind turbines. The Great Plains, of which

²⁸² Greg Vandeberg, interview by author, Grand Forks, February 26, 2021.

²⁸³ Ibid.

²⁸⁴ Mike Whitted, interview by author, Grand Forks, March 4, 2021.

North Dakota is a part, is the United States’ “wind corridor” because of its flat land. Companies such as Xcel Energy have built large numbers of wind towers on the Great Plains because the flat terrain makes it easier for them to install the towers, and the strong winds help produce energy in the same way that they helped settlers draw water from wells with windmills. Riedy established Airtonomy in North Dakota, mostly because of the opportunities to form partnerships with larger UAS-oriented companies, such as Xcel Energy, and because North Dakota is one of the top ten wind-energy-producing states in the nation.²⁸⁵ Airtonomy requires four full seasons, spring, summer, fall, and winter, during which to build artificial intelligence models, getting images captured with drones of every season’s distinctive colors, such as green grass in the summer or white snow in the winter, in the background of the images of turbine blades. The different colors help Airtonomy’s machine-learning-algorithms isolate the parts of images the company wants to analyze and deliver to its clients.

The North Dakota winds that can be used to produce electric power and serve as the reason for the location of companies such as Airtonomy in the state are the same winds that drove individuals mad on North Dakota’s early frontier. The same winds, however, are the perhaps the only one of North Dakota’s frontier features that can be detrimental for the use of UAS.²⁸⁶ Of the dozens UAS professionals in North Dakota interviewed for this thesis, all stated that winds are the most important weather feature they have to account for before and during operations, and many reported that UAS missions have been canceled because of winds.

²⁸⁵ Josh Riedy, interview by author, Grand Forks, April 6, 2021.

²⁸⁶ Greg Gust, interview by author, Grand Forks, February 21, 2021.

Although strong winds almost always negatively affect UAS operations, some UAS businesses are drawn to North Dakota specifically because of the research conditions that such winds provide them. One such company is PEMDAS Technologies founded by Mary Lockhart.²⁸⁷

Mary Lockhart became familiar with the effects of weather on UAS when she was a United States Air Force meteorologist. An issue in the early 2000's was that MQ-1 Predators and RQ-4 Global Hawks were being lost to icing, causing hundreds of millions of dollars in damages. According to Sergio Fernandez-Gonzalez, winds are “. . . decisive in the appearance of icing,” and Lockhart developed a technology called “ASAPS” which, when put into a UAS, instantly measures the “state parameters,” or status, of the UAS in a stream of information.²⁸⁸ With ASAPS, pilots can note the temperature, humidity, and pressure, and, with algorithms onboard the aircraft, determine whether there is any threat of icing. The same artificial intelligence can make flight decisions on its own, regardless of the pilot's control, to make mid-air corrections based on weather-related data. As a businesswoman, Lockhart transferred similar technology to UAS used in the civilian sector and she needs the winds in North Dakota in order to test the weather sensors she has on UAS. Lockhart noted that accounting for winds is necessary for the

²⁸⁷ Lockhart affectionately chose “PEMDAS,” the pneumonic device to remember the order of operations in a mathematical expression. It stands for “Parenthesis, Exponents, Multiplication, Division, Addition, and Subtraction,” or, to her, “Please Excuse My Dear Aunt Sally.” Mary Lockhart, interview by author, Grand Forks, February 3, 2021.

²⁸⁸ Sergio Fernandez-Gonzalez, et al., “Weather Features Associated with Aircraft Icing Conditions: A Case Study,” *The Scientific World Journal* 2014, (February 2014): 1.

future of UAS, and she conducts flights in strong winds because “you want to be able to fly regardless of the weather.”²⁸⁹

Ultimately, Lockhart need winds such as those that blow in North Dakota in order to stay in business, but most companies’ UAS flights are canceled by winds so infrequently that North Dakota is still an ideal place in which to fly UAS. When considering the positive and negative characteristics of North Dakota climate, Nick Flom, Executive Director of the Northern Plains UAS Test Site, which is headquartered at UND, asked, “Can weather cause issues with UAS operations? Yes. Does it affect UAS companies to the point where they do not want to fly in North Dakota? Not at all. The weather does not actually deter people from doing their work.”²⁹⁰

Low population density is a North Dakota feature that is undeniably conducive to individuals conducting work with UAS in the state, and, as a consequence, there is a reduction in the number of incidents involving UAS and aircraft. If an aircraft crashes, the fewer people in the area, the fewer who are likely to be injured or killed. According to Flom, “the safety component is important here. Low population density on the ground means low traffic density in the air as well. It is easy to introduce new technologies where there is low [population] density.”²⁹¹ “Frontier counties,” according to the Northern Plains UAS Test Site, are the counties in the state with such low population densities that they make ideal locations in which the FAA can allow riskier UAS

²⁸⁹ Mary Lockhart, interview by author, Grand Forks, February 3, 2021; The president of the University of North Dakota also said, “Researching here will give you capability anywhere.” Andrew Armacost, interview by author, Grand Forks, February 10, 2021.

²⁹⁰ Nick Flom, interview by author, Grand Forks, February 24, 2021.

²⁹¹ Ibid.

operations. Beyond-visual-line-of-sight (BVLOS) operations are perhaps the most risky, and are the most important to the UAS industry as well as to North Dakota.

Those associated with UAS in North Dakota agree that the state's low population density is conducive to the testing of UAS and especially for beyond-visual-line-of-sight flights. Rural areas are safer for testing UAS missions such as package delivery, and they also stand to benefit from UAS-based package delivery, because items can be delivered as quickly there as they can in urban areas.

Low population density areas, perhaps more than anywhere else, are benefitted by UAS, and UAS, perhaps more than anywhere else, are benefitted by low population density areas. Such areas in North Dakota, coupled with the highest per capita of UAS experts in the United States, attract UAS to the state in disproportionately large numbers when compared to other states.

The major developmental steps UAS as an industry has taken to the present day in North Dakota; its frontier features; and the issues, risks, and opportunities of UAS in North Dakota; all suggest consideration of the traits that those involved with UAS in North Dakota share. These individuals are intrepid, courageous, inventive, innovative, and adventuresome.

Intrepidity, which is "characterized by resolute fearlessness, fortitude, and endurance," according to a dictionary definition, is a trait shared by those at SkySkopes, a North Dakota Drone Service Provider (DSP).²⁹² The company had no funding when it was incorporated in October 2014, and, at the time, it was illegal to fly UAS for business

²⁹² Definition of "intrepid," Merriam-Webster, accessed May 15, 2021, https://www.merriam-webster.com/dictionary/intrepid?utm_campaign=sd&utm_medium=serp&utm_source=jsonld.

purposes. In its start-up phase, the company survived on grant dollars and a small budget. The organization's personnel persevered through difficult times, as the UAS industry matured and companies interested in the benefits of UAS started to embrace the technology.

David Dvorak, CEO of Field of View, is a particularly intrepid individual on the North Dakota UAS frontier. Dvorak was the first UAS entrepreneur in North Dakota and endured when there were no other UAS companies in the state to support him. Even as some of his employees left the company, Dvorak continued in business, selling sensor attachments that allow for UAS mapping and three-dimensional models. The intrepid Dvorak made way for others to follow and he demonstrated that courage and fearlessness were necessary qualities for one breaching the UAS frontier.

Nick Flom, head of the NPUASTS, is a courageous individual on North Dakota's UAS frontier, who is always involved in some new and risky UAS initiative. His colleagues also show courage, flying UAS at altitudes other organizations are prohibited from attaining. The ambitious new Vantis BVLOS network, the construction of which is overseen by Flom's NPUASTS, received tens of millions of dollars from the North Dakota Legislature, and the implementation of work on the network is not for the faint of heart. The NPUASTS has been instrumental in gaining permission to fly large UAS, such as the MQ-1 Predator. Because such missions attract public attention, a mishap can tarnish the image of the NPUASTS and that of the UAS' manufacturer. Mishaps could also mean losses in the millions of dollars.

Sean Johnson, the courageous individual in charge of UAS activities at the North Dakota Department of Emergency Services (NDDDES), demonstrated that the MQ-1 works well in flood relief efforts. The aircraft detects changes to flood lines, changes in the land, and changes in ice jams. The Synthetic Aperture Radar (SAR) on the MQ-1 was able to “burn through” overcast clouds during a flood in Minot, North Dakota in 2011, giving the NDDDES valuable information about the situation on the ground.²⁹³

Johnson also worked with federal organizations that brought MQ-1 Predators and MQ-9 Reapers to the Dakota Access Pipeline (DAPL) protests beginning in April 2016. These aircraft were especially helpful because the pilots in manned aircraft, observing the protest, had to land and refuel frequently, whereas the large unmanned aircraft did not. At the DAPL protests, protesters were also using UAS and they flew small quadcopters in ways that jeopardized the safety of the police officers stationed at the site. One drone was flown so close to a police officer that he plucked it out of the air with his hands and confiscated it.²⁹⁴ To make the airspace safer, Johnson instituted a Temporary Flight Restriction (TFR) around the protest, but he allowed the protestors a “bubble” of four hundred feet to fly UAS so that their freedom of the press was not infringed upon. The issues Johnson and the NDDDES dealt with are some of the most controversial and can turn into disasters if mismanaged. Johnson successfully utilized UAS in this instance, and he conducted himself correctly.

Courage can be a deciding factor in one’s success on the UAS frontier, though inventiveness is another trait demonstrated by those using UAS in North Dakota. Dr.

²⁹³ Sean Johnson, interview by author, Grand Forks, April 25, 2021.

²⁹⁴ Ibid.

Susan Ellis-Felege, UND associate professor of biology, is one who demonstrated this inventiveness.²⁹⁵ Ellis-Felege realized that UAS offer opportunities to collaborate with industry, and, in March 2020, she worked with Airtonomy to use UAS to count the remains of over ninety different species of birds and bats killed by wind turbine blades.²⁹⁶ She also developed new validation techniques to compare images of breeding ducks and geese taken with cameras on UAS with data obtained without using UAS. Her graduate students are also developing best practices for the use of UAS in wildlife research. Such work can prevent birds and other animals from being disturbed by researchers. Ellis-Felege's inventiveness on the frontier of UAS led her to turn her research into a business, and she employs several UAS pilots to fly missions to collect wildlife data.²⁹⁷ Their payroll contributes significantly to the North Dakota economy.

Individuals in the energy industry, a major North Dakotan economic driver, display inventiveness in order to combat the decline in oil prices caused by COVID-19. Oil pipeline companies are required by the federal government to inspect large pipelines every two or three weeks to detect leaks that can be hazardous and that can contaminate soil. UAS are an effective means with which to make these inspections because they can fly closer to the pipelines than manned aircraft can, thereby producing better inspection data.²⁹⁸ SkySkopes has opened an office in Minot, ND, in order to use LiDAR and

²⁹⁵ Skip Wood, "Researching Geese with Unmanned Flight," *Prairie Public Broadcasting*, October 15, 2015, accessed April 25, 2021, <https://news.prairiepublic.org/post/researching-geese-unmanned-flight-chef-rosey-pumpkins>.

²⁹⁶ Patrick C. Miller, "UND, Airtonomy Receive State's First Microsoft AI for Earth Grant," *UND Today*, March 12, 2020, accessed April 25, 2020, <http://blogs.und.edu/und-today/2020/03/und-airtonomy-receive-states-first-microsoft-ai-for-earth-grant/>.

²⁹⁷ Susan Ellis-Felege, interview by author, Grand Forks, March 31, 2021.

²⁹⁸"Each operator shall, at intervals not exceeding 3 weeks, but at least 26 times each calendar year, inspect the surface conditions on or adjacent to each pipeline right-of-way. Methods of inspection include walking,

Optical Gas Imaging sensors in these inspections by oil companies in the Bakken Region near Williston, ND.²⁹⁹ LiDAR, which stands for Light Detection and Ranging, is a sensor that uses lasers to generate survey data of land and man-made assets, while Optical Gas Imagers (OGI) are thermal sensors that can detect several different types of gas leaks. These capabilities did not exist in the state of North Dakota prior to SkySkopes' developing its services.

Innovation, together with inventiveness, is a trait shared by individuals on the North Dakota UAS frontier. Mike Anderson at the North Dakota Game and Fish Department, for example, is an innovative individual, who became a UAS pilot when he encountered the state's UAS frontier. Since then, he has innovated with ways for his department to deliver educational messages to the public by incorporating videos taken by cameras carried by UAS. The "North Dakota Outdoors" newscast, which has been broadcast for twenty-seven years, uses Anderson's imagery.

The North Dakota Game and Fish Department has also innovated with ways to preserve over 220,000 acres of North Dakota State Wildlife Management areas.³⁰⁰ The department's rules now forbid anyone other than Mike and one other qualified UAS pilot in the department to fly UAS in these areas. Anderson had to receive special permission to fly UAS in his own Wildlife Management area when a truck and an icehouse fell through melting ice on a lake to see if anyone had drowned or if the truck could be

driving, flying or other appropriate means of traversing the right-of-way." 49 CFR § 195.412 (a) *Inspection of Rights-of-Way and Crossings Under Navigable Waters*.

²⁹⁹ Joe Skurzewski, "SkySkopes Expanding Drone Program in the Magic City," *Minot Main Street Minute*, KFYR TV, December 19, 2016, accessed April 12, 2018, <http://www.kfyrtv.com/content/news/Minot-Main-Street-Minute-SkySkopes-expanding-drone-program-in-the-Magic-City-407510135.html>.

³⁰⁰ Mike Anderson, interview by author, Grand Forks, April 2, 2021.

recovered. Not knowing with whom to speak, given that his department had never sought such permission, he appealed to the head of the National Wildlife Refuge System for permission to fly his UAS over the lake. The request was initially rejected on the grounds that federal wardens confiscate dozens of UAS operated without permission every year. When the National Wildlife Refuge System agreed that this mission would be an innovative way to instruct the public about how people should take care on frozen lakes, it gave Anderson permission to complete his mission.

Law enforcement agencies and first responders in North Dakota have used UAS with impressive effect as part of their mission for over a decade. The Northeast Regional UAS Unit, renowned for its excellence, was established in 2011 at the Grand Forks County Sheriff Department and it also consists of the Grand Forks Fire Department and the Grand Forks Police Department. Detective Michael Gavere oversees the unit and mentioned that one innovation police departments must make in acknowledgement of UAS is to pair them with their dogs.³⁰¹ If untrained, dogs will not work well in tandem with drones, so officers train their dogs to become familiar with UAS, and they adjust their tracking methods to use UAS in tandem with dogs.

In 2016, after having gained experience using UAS for law enforcement purposes, the unit innovated a “proactive” policy to replace their “reactive” policy for the deployment of UAS.³⁰² The law enforcement section of the unit also observes the need to minimize privacy issues, and it innovated a policy of keeping images for ten days,

³⁰¹ Michael Gavere, interview by author, Grand Forks, February 3, 2021.

³⁰² April Baumgarten, “Grand Forks Officers will Take Drones with Them on Patrol,” *The Bemidji Pioneer*, February 27, 2018, accessed April 25, 2021, <https://www.bemidjipioneer.com/news/4410140-grand-forks-officers-will-take-drones-them-patrol>.

before destroying them, “unless the images have evidentiary value.”³⁰³ Gary Lorenz heads the firefighting section of the Northeast Regional UAS Unit.

Grand Forks’ Fire Chief Lorenz noted that over ninety percent of incidents potentially requiring the assistance of firefighters are over in fifteen minutes, which is too little time to deploy a UAS in a useful way.³⁰⁴ He and his department, therefore, worked with UND graduate students to study innovative ways to incorporate UAS into fire departments. One of the studies used UAS to evaluate property damage after a fire. Lorenz sees a future in which many, if not all, firefighting vehicles will be equipped with UAS. Anderson, Gavere, and Lorenz are innovative individuals, and their organizations are innovating with UAS.

Innovation pairs well with adventure, and those who succeed on frontiers, no less on the UAS frontier, are of an adventuresome nature. Adventuresome by nature, UND professor Mark Askelson worked to establish the Research Institute for Autonomous Systems (RIAS) at UND.³⁰⁵

Departing from his professional background in meteorology, Askelson was the co-author of a publication summarizing the results of a national survey revealing that individuals across the United States, as well as those in North Dakota, are becoming more accepting of drones. Askelson has also become more familiar with coding languages, such as Python, in order to spur UAS integration into the United States’ National

³⁰³ Daryl Lubinsky, “Unmanned Aircraft Improve Agencies’ Operations,” *Government Fleet*, May 4, 2016, accessed April 25, 2021, <https://www.government-fleet.com/156716/unmanned-aircraft-improve-agencies-operations>.

³⁰⁴ Gary Lorenz, interview by author, Grand Forks, March 30, 2021.

³⁰⁵ Mark Askelson, interview by Author, Grand Forks, January 29, 2021.

Airspace (NAS). Askelson, with a reputation of being an amenable individual with whom to work, has also used his position at RIAS to persuade private organizations to join RIAS research projects.³⁰⁶ Having a part in almost every new UAS-based research project, all of which are themselves adventures, Askelson is clearly an adventuresome individual.

Grand Sky, perhaps the highest-profile UAS business park in the United States, is an adventure operated by Grand Forks County and the Grand Sky Development Company. The Grand Sky Development Company grew out of a real estate company called Infinity Development Partners. Infinity Development Partners, seeing opportunity in UAS, incorporated a new entity, the Grand Sky Development Company, to construct buildings to accommodate the needs of UAS, such as building UAS simulator foundations and installing extra fiber optic cables. The company is overseen by Tom Swoyer, whose name conjures images of Mark Twain and Twain's *The Adventures of Tom Sawyer*. Swoyer jumped into the UAS industry, from a background in real estate, in order to help attract, and retain, such UAS organizations as Northrop Grumman and General Atomics.

Those individuals breaching the UAS frontier share the traits just discussed, and they also share the trait most necessary to succeed on a frontier- that of adaptability. As did those who breached the frontiers discussed in previous chapters, almost all individuals, entities, and agencies engaged with UAS have adapted to their use.

Academics adapt their courses teaching methods, research, research methods, and

³⁰⁶ David Dodds, "UND Makes UAS History," *UND Today*, December 27, 2018, accessed April 25, 2021, <http://blogs.und.edu/und-today/2018/12/uas-first-in-north-dakota/>.

publications to UAS. Military personnel adapt tactics and strategies to UAS. Those engaged in business adapt business models, contracts, websites, hiring practices, corporate vision, inventories, budgets, and procedures to UAS. Public sector employees adapt investigations, equipment, methods, plans, decisions, rules, and procedures to UAS. Farmers adapt planting and harvest schedules to UAS. Data specialists adapt artificial intelligence models, approaches to data collection and storage, and security protocols to UAS. Collaborations between North Dakota UAS organizations and individuals are also adaptations, according to David Dodds in UND Today.³⁰⁷

The adaptations North Dakotans have made to UAS are reminders that UAS are not only a North Dakota frontier, but also its new frontier. North Dakotans, according to Elwyn B. Robinson, are noted for being adaptable, and they have adapted to UAS more readily than individuals elsewhere. As evidence, they have adapted their fiscal practices, time, actions, and frames of mind to UAS.³⁰⁸ North Dakota institutions of higher education, other public organizations, and the state's private companies have also adapted to UAS.

North Dakota State University's (NDSU) has made significant changes in order to take advantage of UAS. The university has extension centers, or satellite research locations, throughout the state. Dr. Benjamin Geaumont, a wildlife researcher at an NDSU extension center, said that those at the extension center have had to adjust for

³⁰⁷ "Odegard's push to new frontiers in aviation at UND fostered a number of collaborative efforts throughout campus over the years." David Dodds, "Legacy of Collaboration," *UND Today*, October 11, 2016, accessed April 8, 2018, <http://blogs.und.edu/und-today/2016/10/legacy-of-innovation/>.

³⁰⁸ Much of the following is based on several dozen interviews with North Dakotan UAS subject matter experts. These interviews will be maintained on a hard drive in the author's possession for three years after publication.

drones being used in their research at least “ten percent of the time.”³⁰⁹ Geaumont researches populations of sharp-tailed grouse in North Dakota, and now that he has incorporated UAS into his research, he is better able to count the number of males in a given area that successfully attract females. Adapting his research methods to include UAS and artificial intelligence, he can detect which grouse are male and which are female. Geaumont also uses artificial intelligence to process UAS-collected data on the density of flowers, which can affect honeybee populations and honey production. North Dakota is the nation’s leading honey producer.

Dr. David Kramar, another researcher at one of the NDSU extension centers, uses UAS for scouting crops, detecting invasive species, and estimating surface biomass. Kramar has adjusted his research to include new software programs to account for the data he collects using UAS. The data is turned into a Digital Elevation Model (DEM), or a topographical map, which gives him a better understanding of the natural resources in the area over which he flies UAS. The flat land in North Dakota is advantageous, he said, because he can keep the UAS at a more constant altitude.³¹⁰

Dr. Amit Chatterjee, a professor of soil science at NDSU, has incorporated UAS into his research on soils and crops.³¹¹ Author of numerous articles on the use of UAS in agriculture, Chatterjee uses UAS to detect the levels of protein, nitrogen, and sugar in crops grown in various types of North Dakota soils.³¹² This information helps farmers

³⁰⁹ Benjamin Geaumont, interview with author, Grand Forks, April 7, 2021.

³¹⁰ David Kramar, interview by author, Grand Forks, April 6, 2021.

³¹¹ Amit Chatterjee, interview by author, Grand Forks, April 8, 2021.

³¹² Dan Olson, Amitava Chatterjee, and David W. Franzen, “Can We Select Sugarbeet Harvesting Dates Using Drone-based Vegetation Indices?” *Agronomy Journal* 111, no. 5 (August 2019): 2619-24; Dan Olson, Amitava Chatterjee, et al., “Relationship of Drone-Based Vegetation Indices with Corn and Sugarbeet Yields,” *Agronomy Journal* 111, no. 5 (August 2019): 2545-57.

decide when to add fertilizer and when to start the harvest. Chatterjee also uses UAS to measure the height and health of various crops. Given the large amounts of data he collects using UAS, Chatterjee has incorporated new methods of image validation. Chatterjee has also developed processes to incorporate Geographic Information Systems (GIS) software into his evaluation procedures. Although he has collected data on soils for years, with UAS he has had to adjust his research methods to include UAS and he also had to adapt to new ways of data storage, data transmission, and data security.³¹³

John Nowatzki and Aaron Reinholz, two more prominent NDSU researchers using UAS, have worked together on numerous UAS missions. Nowatzki, among the most respected specialists using drones in the field of agriculture, has adapted his writing and publications to include the ways that UAS capabilities influence his research.³¹⁴ To Nowatzki, most UAS are “scouting tools.” Using UAS with multispectral sensors, he can detect nutrient deficiencies in plants, locate herbicide-resistant weeds using infrared (IR) sensors, and, with electro-optical (EO) sensors, he can conduct surveys of animal numbers.³¹⁵ Nowatzki is also among the best-known pioneers in the country using drones as crop dusters.

Expanding his network of contacts, Nowatzki has worked with more privately-owned companies to get to support for his research than he did with his previous

³¹³ Amit Chatterjee, interview by author, Grand Forks, April 8, 2021.

³¹⁴ Nadia Delavarpour, Cengiz Koparan, John Nowatzki, et al., “A Technical Study on UAV Characteristics for Precision Agriculture Applications and Associated Practical Challenges,” *Remote Sensing* 13, no. 1204 (2021); Renée Jean, “Drones Could help North Dakota Farmers Spot Herbicide-Resistant Weeds,” *The Williston Herald*, March 13, 2019, accessed April 25, 2021, https://www.willistonherald.com/news/drones-could-help-north-dakota-farmers-spot-herbicide-resistant-weeds/article_ffea7a30-454e-11e9-863a-1bc7d2f760c5.html.

³¹⁵ John Nowatzki, interview by author, Grand Forks, March 25, 2021.

research. Seeing the fruits of his research using UAS, numerous for-profit organizations have contacted him to explore the possibilities of forming partnerships.³¹⁶

Nowatzki has also adapted to North Dakota's UAS frontier by becoming more familiar with local regulations on airspace than he had to be before. These regulations prohibit him from using UAS to spray crops because it is difficult to find pilots who meet the qualifications required at the state level, even though they meet federal standards.

Aaron Reinholz works closely with Nowatzki in his UAS research at NDSU, and he was also the university's representative for the Northern Plains UAS Test Site for a time. Reinholz has worked with Nowatzki when using drones as "spot sprayers" to spray smaller areas than can be done by a crop duster.³¹⁷

Both Nowatzki and Reinholz worked to gain permission from the FAA to fly the Elbit Hermes 450, which was the first MALE UAS used for commercial purposes in the United States. The sensors on the Hermes aided them in collecting data to determine whether MALE UAS could detect hail damage on crops. They went to great lengths, in partnership with the NPUASTS, to gain permission from the FAA to fly, and they also contacted every landowner whose land they planned to fly over. Nowatzki and Reinholz allowed landowners the option of receiving the imagery collected, and they also allowed them and adjacent landowners the option of opting out of overflights. Reinholz and Nowatzki held meetings, to which they invited farmers, and others, to inform them of flight plans and to assure them that the research missions were not intended to invade privacy. Such respects for privacy are adaptations Nowatzki and Reinholz would not

³¹⁶ Ibid.

³¹⁷ Aaron Reinholz, interview by author, Grand Forks, April 20, 2021.

have made prior to the arrival of UAS in North Dakota, because their previous methods of collecting data were out of the public eye. Reinholz has also been required to take out new types of insurance policies, specific to UAS, in order to protect him and his employees in the event of accidents that cause property damage. Reinholz and Nowatzki have also been involved in UAS projects at the University of North Dakota.

UND adapted its campus to UAS by adding Robin Hall, in which the UAS department is located. Both the NPUASTS and the UAS department at UND originally reported to the School of Aerospace Sciences until the NPUASTS, in a move to accommodate the fluidity of the UAS frontier, was moved under the UND Office of the President.³¹⁸

Also at the University of North Dakota, all colleges have incorporated some component of UAS into curricula or research. The College of Arts and Sciences, for example, has adapted course offerings that acknowledge the ethical issues involved with UAS. The College of Arts and Sciences offers the nation's first university-level course on ethical issues involving UAS, titled "The Ethics of UAS." A major tenet of the course is that UAS affect almost every profession and that almost every profession can use UAS to its benefit.

UND has also adapted its organizational structure to UAS, with the understanding that ethical issues arising with them cannot be ignored. The university established a committee dedicated to considering the ethics of using UAS, titled the UAS Compliance

³¹⁸ Brandi Jewett, "UND's Unmanned Aircraft Systems Center Will Report to University President," *Grand Forks Herald*, June 30, 2016, accessed April 25, 2021, <https://www.grandforksherald.com/news/education/4065644-unds-unmanned-aircraft-systems-center-will-report-university-president>.

Committee. Because of the ever-changing nature of UAS, the title was changed to the UND UAS Research, Ethics, and Privacy Committee. In 2020, the committee was disbanded, and now students and faculty planning to conduct research with UAS at UND are required to do so with the approval of UND's new Committee for the Strategic Enhancement of Autonomous Systems Research (CSEASR).

Russ Buchholz, a retired United States Army lieutenant colonel, has worked with UND on UAS initiatives, so he is familiar with committees such as CSEASR. As an employee of the North Dakota Department of Transportation (NDDOT), Buchholz is the department's Strategy and Innovation Director. He has garnered significant successes for the NDDOT, especially while he was the program administrator of the NDDOT's UAS Integration Pilot Program (IPP).³¹⁹ While the program administrator, Buchholz secured the first waiver from the FAA for state highway patrol officers to fly UAS over motorists and pedestrians.³²⁰ To do so, he adapted existing UAS technology by adding parachutes to UAS to assure safety to vehicles and individuals. The Integration Pilot Program is another of Buchholz's adaptations. He needed to adjust his, and the duties of his personnel, in order to make time for the projects that would come with the IPP. The IPP was created by executive order of President Donald Trump in October 2017 to help expedite advanced UAS permissions. Ten states, North Dakota among them, were awarded membership in the program, and the NDDOT was charged with leading the

³¹⁹ Senator John Hoeven was a significant factor in securing the IPP for the NDDOT. "Hoeven: We Have Laid the Groundwork for Unmanned BVLOS Flights Across North Dakota," May 29, 2019, accessed June 8, 2021, <https://www.hoeven.senate.gov/news/news-releases/hoeven-we-have-laid-the-groundwork-for-unmanned-bvlos-flights-across-north-dakota2>.

³²⁰ Dave Kolpack, "North Dakota Agency gets Waiver to Fly Drones Over People," *The Associated Press*, July 7, 2019, accessed April 25, 2021, <https://apnews.com/article/b8dd49a8a71b406893d6b21098fa79a3>.

state's effort. Another of the permissions Buchholz secured through the IPP was BVLOS flights with UAS.

The NDDOT has used UAS in multiple ways. Its UAS fleet is used to survey stockpiles of raw materials such as gravel up to thirty-two times faster than can be done by an engineer measuring a stockpile on foot, and the department uses Light Detection and Ranging (LiDAR) sensors on UAS with which to survey the elevation of roads and ditches with extremely high accuracy.³²¹

Riedy, Ellis-Felege, Dvorak, and others in North Dakota have visions of a future that includes commercial UAS, and they have adapted by creating new UAS businesses. American Crystal Sugar has adapted its business model to include UAS. Some defense businesses, such as Northrop Grumman and General Atomics, have added large UAS to their business model and they have established satellite operations in North Dakota at Grand Sky.

The Grand Forks Air Force Base, the installation at which Grand Sky is located, had to adapt to a new force structure, significantly reducing the number of personnel on the installation when it moved from a KC-135 tanker aircraft mission to an RQ-4 Global Hawk mission. Personnel had to modify aircraft hangars to accommodate large UAS instead of the refueler aircraft, and they altered operations centers to control the UAS. The base also designed new ways to share the pad on which B-52 bombers once sat on alert. Its runway is also shared with Grand Sky, so that civilian UAS can takeoff from the same once used by military UAS. Northrop Grumman and General Atomics, located

³²¹ Russ Buchholz, interview by author, Grand Forks, March 25, 2021.

at the base, have also adapted to the UAS frontier, and, partly because the companies are located in North Dakota, they have found ways to bring their large defense-specific UAS into the commercial sector.

Another Grand Forks company employing UAS pilots is the previously mentioned Airtonomy founded by Josh Riedy. Riedy adapted to the UAS frontier by applying the skills and acquaintances garnered as a university administrator to his new UAS venture, which, although only a few years old, is attracting national attention. Riedy found new ways to acquire funding, such as through grants with the National Science Foundation, Microsoft, the state of North Dakota, and private individuals. He adapted by applying his background in higher education to the UAS frontier, and he learned new UAS languages, that is, types of codes. Riedy learned Python, a particularly valuable coding language. That allows his UAS to fly in automated flight paths, thereby reducing chances of human error and increasing the accuracy of his data. With his UAS company, Riedy has successfully breached the North Dakota UAS frontier.

This chapter has made clear that UAS is North Dakota's new frontier. The development of UAS in North Dakota is a journey into the unexplored, and the state represents what could be argued is Turner's "hither edge" of the UAS frontier. UAS in North Dakota bring with them risks, challenges, ethical issues, and legal problems, while, at the same time, presenting opportunities and benefits. Those breaching this frontier share the character traits of those who have breached other frontiers, and they also have had to adapt to the conditions found on this frontier. In sum, North Dakota's new frontier, that of drones, has all the defining characteristics of a frontier.

CHAPTER V

CONCLUSION

There can be few better ways to conclude this thesis on Unmanned Aircraft Systems (UAS) as North Dakota's new frontier than to cite Joe Burnett, a senior biologist with the California Condor Recovery Program, on the program's success in bringing the California condor back from the brink of extinction. Condors will survive and continue to increase in numbers, Burnett believes, because "like the settlers of the frontier," they are "resourceful and resilient."³²²

Extending Joe Burnett's analogy, the "settlers" on all the frontiers discussed in this thesis were resourceful and resilient. Indeed, they had to be resourceful and resilient in order to overcome the challenges they encountered on the frontiers they breached. A few examples will serve to illustrate the point.

On the medical frontier, Edward Jenner, the "Father of Immunology," noted that milkmaids who had contracted cowpox were immune to smallpox. Jenner took matter from the sores on the hands of a dairymaid infected with cowpox and injected the matter into cuts on a healthy boy's arm. The boy contracted cowpox, but developed an immunity to smallpox. Walter Reed, a medical officer in the United States Army, discounted the belief that yellow fever was caused by breathing night air or by drinking foul water. In a number of daring experiments using human volunteers, he proved that yellow fever was transmitted by mosquitoes. He also demonstrated that yellow fever

³²² Frank Lidz, "Rising Again," *Smithsonian Magazine* (June 2021): 62-72.

could be controlled, if not eradicated, by killing mosquitoes and by destroying their breeding places. Employing Reed's work on yellow fever, William Gorgas, army officer and chief sanitary officer of the Panama Canal Commission, helped make the construction of the Panama Canal possible by using mosquito netting to protect workers when they were sleeping and by destroying the mosquitoes that carried yellow fever and malaria.

The settlers on the Great Plains frontier were also resourceful. Lacking trees from which to construct log cabins, they made sod houses. Lacking fencing material, they planted living fences of Osage orange, trees with thorns that turn cattle and other livestock. Lacking sources of surface water, they dug wells and pumped water from them with windmills.

Those breaching the North Dakota's UAS frontier are resourceful as well. Dr. Bruce Smith, the former Dean of the School of Aerospace Sciences at the University of North Dakota expanded the John D. Odegard School of Aerospace Sciences to include UAS. Working with his faculty, he also contributed to the successful effort to keep the Grand Forks Air Force Base in operation when it was threatened with closure by the Department of Defense's Base Realignment and Closure (BRAC) process. The base now has a new mission, one that includes UAS. Dr. Susan Ellis-Felege, in UND's Department of Biology, is also resourceful. Using cameras attached to drones, she counts and monitors nesting ducks in the state's pothole region without disturbing the ducks to the point that they abandon their nests.

Many North Dakota businesses are resourceful in their adoption of UAS or drones. Exxon Corporation utilizes drones to monitor its pipelines and check for leaks. Oil drilling companies use drones to check well pads, pumps, storage tanks, flare stacks, and pipeline corridors. Airtonomy, a UAS software and artificial intelligence company in Grand Forks, utilizes UAS as an efficient and effective means of inspecting wind turbine blades for damage.

Individuals breaching frontiers, like the California condors, are also resilient. Louis Pasteur, known as the “Father of Microbiology,” proved that many diseases are caused by germs that multiply in people’s bodies. He also proved that if microbes are first weakened in a laboratory and then placed in an animal’s body, the animal develops and immunity to the microbe. Although not a licensed physician, he risked his reputation and censure by medical authorities by injecting his untested rabies vaccine into a boy who had been bitten by a rabid dog. His vaccination was successful. The boy did not contract rabies.

Robert Koch, a German physician who is known as the “Father of Bacteriology,” was also resilient. Believing that his research was too important to be hampered by teaching and administrators, he left his secure teaching position at the University of Berlin to focus on his work. At great risk to his physical health, he discovered the germs that cause tuberculosis, cholera, and anthrax.

Those breaching the Great Plains frontier were also resilient. George Reeves was a rancher in South Dakota’s West River country. A “sticker,” he stayed on his ranch and survived the Great Depression and years of drought. Linda Hasselstrom, a South Dakota

rancher and author writes of the women, who, like Reeves, are resilient. They endure storms and they remain on the land, even when the pollen from native plants makes breathing difficult. Because women in this part of South Dakota are few in number, each one must play several roles in the community by joining organizations and serving on committees. Gertrude Anderson, a friend of Eric Sevareid, the well-known news anchor from Velva, North Dakota, came to western North Dakota from Berlin. As resilient as the women of whom Hasselstrom writes, she stayed in Velva, despite the heat and drought of summers, the harsh winters, the scarcity of people, and the loneliness.

Neil Armstrong and John Glenn, who breached the space frontier by being the first astronauts in Project Mercury, were also resilient. They confronted uncertainties every day when training and always when they were on missions. They needed to be not only physically resilient, but also psychologically and emotionally resilient. Because any number of malfunctions could have caused their deaths, being resilient was part of “the right stuff” required on this frontier.

Pilots breaching North Dakota’s UAS frontier must also be resilient when conducting flight operations in the face of many obstacles. Obstacles include high winds that can cause the loss of aircraft, subzero temperatures that freeze exposed flesh and shorten battery life, and the public perception that drones equipped with cameras are an invasion of privacy.

This thesis is on Unmanned Aircraft Systems as North Dakota’s new frontier. Having been breached, North Dakota’s UAS frontier is becoming settled. The settlers include those who have established new businesses and services based on UAS, those

who have adopted UAS for use in their existing businesses and services, and those who have incorporated UAS into their research and teaching. All these settlers will likely survive and increase in numbers, because, like the California condors, they are resourceful and resilient.

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APPENDICES

Appendix A
"Feasibility and Cost Analysis of Private Aircraft Transportation for the University of
North Dakota" By John D. Odegard, 1967

FEASIBILITY AND COST ANALYSIS
OF PRIVATE AIRCRAFT TRANSPORTATION
FOR THE UNIVERSITY OF NORTH DAKOTA

by

John D. Odegard

B.S. in Business Administration
University of North Dakota 1966

A Thesis
Submitted to the Faculty
of the
University of North Dakota
in partial fulfillment of the requirements
for the Degree of
Master of Science

Grand Forks, North Dakota
June
1967

U N I V E R S I T Y O F  N O R T H D A K O T A

Undergraduate Research in Sensor Development at the University of North Dakota

William H. Semke, Ph.D.
Mechanical Engineering

Richard R. Schultz, Ph.D.
Electrical Engineering

School of Engineering & Mines
University of North Dakota



Turtle Mountain Community College Visit
July 8, 2005

Unmanned Aerial Vehicle

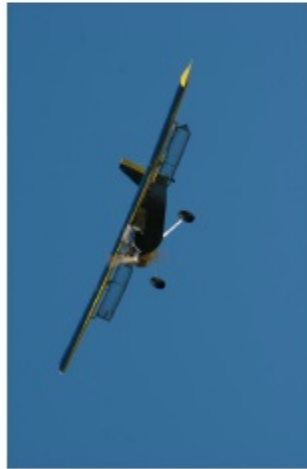
Mission: Build a reusable platform for payload development and test

Launch: Summer 2004

Effective Dates: 2004 to Present

Personnel: NSF REU Site participants

Budget: \$15K in equipment and supplies



U N I V E R S I T Y O F  N O R T H D A K O T A

Smart Border Project

Mission: Reconnaissance imaging on the Northern Border

Drivers: Senator Kent Conrad, Governor John Hoeven

Academic Partners: UND Aerospace, UND Engineering

Corporate Partners: Computer Sciences Corp., Hewlett Packard

Federal Partners: Homeland Security, Border Patrol



Turtle Mountain Community College Visit
July 8, 2005

Appendix C
BRAC Report, 2005



DEPARTMENT OF DEFENSE

**BASE CLOSURE
AND
REALIGNMENT REPORT**

VOLUME I

PART 2 OF 2: DETAILED RECOMMENDATIONS

MAY 2005

Nowhere but in North Dakota

Nowhere but in North Dakota exists all of the elements needed to the success of the UAS Center. North Dakota has unlimited-uncontested airspace, low population density, northern border proximity, support from the FAA, ND State Aeronautics Commission, local airports and local communities, federal legislative contingent, the Governor, along with existing UAS missions for the US Air Force, ND Air National Guard, Homeland Security, Border Protection, tied to a major research university and the largest collegiate flight training program in the country, in a cold weather climate with a complete range of flying conditions.

Opportunities and challenges have emerged at Grand Forks Air Force Base due to the mission change from manned tankers to unmanned aircraft systems. This emerging sector offers considerable promise for long-term, sustained community development and job creation as the relatively young field of unmanned aircraft systems. Additionally, no other state is as well positioned as North Dakota for national and international leadership in unmanned aircraft systems.

**Center of Excellence for Economic Development in
UAVs and Simulation Applications**



**University of North Dakota
Team Members:**

John D. Odegard School of Aerospace Sciences
School of Engineering and Mines
Northern Plains Center for Behavioral Research (Nursing and Psychology)
Center for Innovation



December 5, 2005

Centers of Excellence Committee
for Economic Development
State of North Dakota

Dear COE Committee Members:

Enclosed is the University of North Dakota's application for a Center of Excellence for Economic Development in UAVs and Simulation Applications. The John D. Odegard School of Aerospace Sciences will serve as lead for the Center, collaborating with the School of Engineering and Mines, Northern Plains Center for Behavioral Research (Nursing and Psychology) and the Center for Innovation.

The civilian UAV industry is poised to rapidly expand in the next few years. Thus it is critical to receive the \$3.4 million in requested funding for this Center of Excellence to aggressively foster the expected private sector job growth right here in North Dakota. UND and the Odegard School are uniquely positioned to lead this economic development project because of its entrepreneurial spirit and past success at self-generating large grants and contracts as well as numerous innovative ideas resulting in private sector job growth.

All private industry partners for this UAV Center of Excellence have approached UND because of our reputation in Aviation education excellence. Furthermore, the FAA and DoD have designated UND as a Center of Excellence for general aviation research and UAV education respectively. We don't ask for money for a building in this application because, in addition to the Odegard School's superior infrastructure, we have a one-of-a-kind, top rated behavioral research facility beginning construction through Nursing and Psychology. Thus we are asking for funding for personnel and operating costs to jump start this economic development initiative.

The opportunities are huge for example, with Lockheed Martin contributing \$1 million of in kind support to UND toward UAV development in the civilian aviation industry. We definitely see the UAV industry as a major growth industry for many years to come. Please help us facilitate this growth here in North Dakota by funding the Center of Excellence for Economic Development in UAV and Simulation Applications.

Thank you for your careful consideration. If you have any questions, please do not hesitate to call me at 701-777-3196 or email bsmith@aero.und.edu.

Regards,


A handwritten signature in cursive script that reads "Bruce A. Smith".

Bruce A. Smith, Ph.D.
Dean

Office of the Dean

John D. Odegard School of Aerospace Sciences
University Avenue & Tulane Drive
P.O. Box 9007
Grand Forks, ND 58202-9007
(701) 777-2791 • FAX (701) 777-3458

Appendix F
MTSI Grand Forks Unmanned Aviation Business Development Roadmap, 2007

		4725B Eisenhower Avenue Alexandria, Virginia 22304
www.mtsi-va.com		Phone: 703-212-8870 Fax: 703-212-8874

31 May 2007

Ms. Diane Blair, Coordinator
Base Realignment Impact Committee (BRIC)
Grand Forks Region Economic Development Corporation
600 DeMers Avenue, Suite 501
Grand Forks, ND 58203

Subject: Grand Forks Unmanned Aviation Business Development Roadmap, Deliverable 4, Final Copy, dated 31 May 2007.

As the Prime Contractor for the subject Roadmap, Modern Technology Solutions, Inc., (MTSI) is pleased to submit the final copy of all deliverables from the MTSI-CEO Praxis Team's Grand Forks Unmanned Aviation Business Development Roadmap. This submittal contains all tasks as required by this date, in final form. In addition, it provides a Microsoft Project work plan for implementing the Roadmap's recommendations.


Should you have any questions or need additional information, please contact Mr. Mark Micieli at 703-212-8870 x121 or 703-587-8418 (c).

Sincerely,

Philip L. Soucy
Co-President, MTSI

Enclosures:
Grand Forks Unmanned Aviation Business Development Roadmap (Final Copy), dated 31 May 2007

Appendix G
University of North Dakota: First UAS Certificate of Authorization, 2008

DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION	
CERTIFICATE OF WAIVER OR AUTHORIZATION	
<small>ISSUED TO</small>	UNIVERSITY OF NORTH DAKOTA
<small>ADDRESS</small>	3980 Campus Road Mail Stop 9007 Grand Forks, ND 58202
<small>This certificate is issued for the operations specifically described hereinafter. No person shall conduct any operation pursuant to the authority of this certificate except in accordance with the standard and special provisions contained in this certificate, and such other requirements of the Federal Aviation Regulations not specifically waived by this certificate.</small>	
<small>OPERATIONS AUTHORIZED</small>	Operation of the Cropcam UAS in Class G and E airspace at or below 1,200 feet above ground level (AGL) in the Flying S operating area under the jurisdiction of Grand Forks AFB RAPCON. See Special Provisions.
<small>LIST OF WAIVED REGULATIONS BY SECTION AND TITLE</small>	
<small>STANDARD PROVISIONS</small>	
<ol style="list-style-type: none"> 1. A copy of the application made for this certificate shall be attached and become a part hereof. 2. This certificate shall be presented for inspection upon the request of any authorized representative of the Federal Aviation Administration, or of any State or municipal official charged with the duty of enforcing local laws or regulations. 3. The holder of this certificate shall be responsible for the strict observance of the terms and provisions contained herein. 4. This certificate is nontransferable. 	
<small>Note-This certificate constitutes a waiver of those Federal rules or regulations specifically referred to above. It does not constitute a waiver of any State law or local ordinance.</small>	
<small>SPECIAL PROVISIONS</small>	
Special Provisions are set forth and attached.	
This certificate 2008-CSA-16 is effective from September 11, 2008 through September 10, 2009, and is subject to cancellation at any time upon notice by the Administrator or his/her authorized representative.	
BY DIRECTION OF THE ADMINISTRATOR	
<u>FAA Headquarters, AJR-36</u> <small>(Region)</small>	 <u>Ardyth Williams</u> <small>(Signature)</small>
<u>September 10, 2008</u> <small>(Date)</small>	<u>Air Traffic Manager, Unmanned Aircraft Systems</u> <small>(Title)</small>

FAA Form 7711-1 (7-74)

Appendix H
Grand Forks Air Force Base Environmental Impact Survey, 2010



**FINAL ENVIRONMENTAL IMPACT STATEMENT (EIS)
FOR THE BRAC BEDDOWN AND FLIGHT OPERATIONS OF
REMOVEDLY PILOATED AIRCRAFT AT GRAND FORKS AIR FORCE
BASE, NORTH DAKOTA**




Prepared for:
**Air Mobility Command
United States Air Force**

July 2010

Appendix I
Grand Forks County Sheriff: First UAS Certificate of Authorization, 2011

FAA FORM 7711-1 UAS COA Attachment
2011-CSA-67-COA

Page 1 of 23

DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION	
CERTIFICATE OF WAIVER OR AUTHORIZATION	
ISSUED TO	Grand Forks County Sheriff's Department
	122 S. 5 th Street, Suite 210 Grand Forks, ND 58201
	This certificate is issued for the operations specifically described hereinafter. No person shall conduct any operation pursuant to the authority of this certificate except in accordance with the standard and special provisions contained in this certificate, and such other requirements of the Federal Aviation Regulations not specifically waived by this certificate.
OPERATIONS AUTHORIZED	Operation of the Draganflyer X6 Unmanned Aircraft System (UAS) in Class D,E and G airspace within the confines of 48-59-59.56N/ 100-18-33.94W by 49-0-020.03N/ 97-13-36.55W by 47-14-20.04N/ 96-49-58.33W by 47-12-59.28N/ 100-17-17.19W (16 Counties' within North Dakota) from the surface to 400 feet Above the Ground (AGL) under the jurisdiction of the Fargo Terminal RADAR Approach Control (TRACON), Grand Forks RADAR Approach Control (RAPCON), Minneapolis Air Route Traffic Control Center (ARTCC), the Grand Forks Air Force Base (AFB) Tower and the Grand Forks Air Traffic Control Tower. See special provisions
LIST OF WAIVED REGULATIONS BY SECTION AND TITLE	N/A
STANDARD PROVISIONS	
	<ol style="list-style-type: none"> 1. A copy of the application made for this certificate shall be attached and become a part hereof. 2. This certificate shall be presented for inspection upon the request of any authorized representative of the Federal Aviation Administration, or of any State or municipal official charged with the duty of enforcing local laws or regulations. 3. The holder of this certificate shall be responsible for the strict observance of the terms and provisions contained herein. 4. This certificate is nontransferable.
	Note-This certificate constitutes a waiver of those Federal rules or regulations specifically referred to above. It does not constitute a waiver of any State law or local ordinance.
SPECIAL PROVISIONS	
	Special Provisions are set forth and attached.
	This certificate 2011-CSA-67-COA effective from November 28, 2012 through November 27, 2014 and is subject to cancellation at any time upon notice by the Administrator or his/her authorized representative.
BY DIRECTION OF THE ADMINISTRATOR	
	
<u>FAA Headquarters, AJR-115</u> <small>(Region)</small>	<u>Douglas Gould</u> <small>(Signature)</small>
<u>November 28, 2012</u> <small>(Date)</small>	<u>Air traffic Manager, Unmanned Aircraft Systems</u> <small>(Title)</small>

FAA Form 7711-1 (7-74)

Version 2.1: June 2012

Appendix J
UND UAS Research Ethics and Privacy Charter, 2012, Page 1

University Committee Charter

Committee: Committee on Unmanned Aircraft Systems Research Ethics & Privacy

I. GENERAL ADMINISTRATION

Committee Background History: The University of North Dakota has been involved in Unmanned Aircraft Systems (UAS) training and research for a number of years, and awards the only fully accredited degree in this discipline. As a leader in UAS research the University has been working with a number of public and private groups to study specific applications for UASs in the national air space. It is clear that some of these applications may raise ethical issues particularly with respect to privacy. As a consequence of the proposed uses at the national level, various groups have issued position statements and the US Congress is set to take up the issue of privacy with respect to UAS usage. As a leader in UAS applications the University has held meetings to develop a plan to address the ethical issues related to UAS research associated with UND. The Committee outlined in this Charter is the University's response. It is based upon similar committees presently functioning under Federal regulations for human subject research, biological materials research, animal studies, and usage of recombinant DNA and is based to a large extent on community values.

Classification/Terms of Charter: The Committee on Unmanned Aircraft Systems Research Ethics & Privacy ("Committee") will be a standing committee of the Division of Research and Economic Development. The Charter will be reviewed at least annually by the Committee in cooperation with the Vice President for Research and Economic Development.

Formal Charges: The Committee will review and approve all research using unmanned aircraft systems: 1) Conducted by any members of the University of North Dakota, including faculty, staff, and students; and 2) Conducted under the purview of the Northern Plains Unmanned Systems Authority. Research falls within the scope of the Committee when it involves: 1) flight; or 2) use of existing data collected via UAS. No research may be undertaken without prior approval of the Committee. The Committee will consider the ethical consequences of the proposed research and apply community standards in determining whether a research project may be approved. The Committee will determine whether a proposed research project can be approved as described, needs modification to be approved, or will be denied. If the Committee denies a research project, there is no appeal process. Any research project which the Committee determines needs modification may be approved following completion of the required modifications. Depending upon the potential risk of the proposed research, the research may be reviewed by an exempt, expedited, or full board process. The Vice President for Research and Economic Development may suspend approved research if the research is not in the best interests of the University. An appropriate official or body (e.g., the Director of Safety) may also suspend approved research if the research does not meet defined safety standards.

The Committee will consider the review of other applications that do not meet the criteria defined above on a case-by-case basis.

Reporting Channels/Procedures: The Committee will report to the Vice President for Research and Economic Development.

Relationship of the Committee to Other University Committees: Research that has been reviewed and approved by the Committee may be subject to review and subsequent approval or disapproval by University officials or other Committees.

II. COMMITTEE ORGANIZATION AND STRUCTURE

Membership: The Committee will consist of six (6) appointees employed by and representing the University, three (3) appointees representing emergency responders, three (3) appointees representing government, and three-to-five (3-5) appointees representing the community at large. In the event of a vacancy, the Committee will approve the nomination of a new member and forward the name to the Vice President for Research and Economic Development who will cooperate with the Committee Chairperson in the appointment of a replacement as expeditiously as possible. In no event will one or more vacancies prevent the Committee from fulfilling its charge, provided that the University, emergency responders, government, and the community at large are each represented substantially as provided herein.

In addition, the Committee will have four (4) ex-officio, non-voting members including the Associate Vice President for Research and Economic Development, a coordinator from Research Development & Compliance, a representative from the University Police, and a University legal advisor.

Appointments: The Committee will approve the nomination of new members and forward names to the Vice President for Research and Economic Development, who will appoint members in writing.

Membership Terms: Committee members will be appointed for three (3) year terms with the possibility of subsequent reappointment.

Officers: Officers of the Committee will include a Chairperson and a Vice Chairperson.

- A. Chairperson: The Committee Chairperson will be a faculty member at the University of North Dakota who is capable of managing the Committee and matters brought before it with fairness and impartiality. The Chairperson must be an experienced member of the Committee with at least six (6) months of service on the Committee. The Chairperson is elected annually from the membership of the Committee to serve a one-year term of office. The number of consecutive terms that a Chairperson may serve is not limited.
- B. Vice Chairperson: The Committee Vice Chairperson must be an experienced member of the Committee with at least six (6) months of service on the Committee. The Vice Chairperson is elected annually from the membership of the Committee to serve a one-year term of office. The number of consecutive terms that a Vice Chairperson may serve is not limited.

Subcommittees: The Committee Chairperson, with the approval of the Committee, may appoint standing subcommittees or ad hoc subcommittees. Each subcommittee shall be composed of at least three (3) members. The Chairperson may appoint non-Committee members to a subcommittee. Each standing or ad hoc subcommittee shall have those powers and that authority stipulated in the motion authorizing the subcommittee. Each standing or ad hoc subcommittee shall serve at the pleasure of the Committee.

III. COMMITTEE FUNCTIONS AND OPERATIONS

Frequency of Meetings: The Committee will meet as necessary to complete review in a timely manner of all research projects involving UAS but not less than twice a year.

Research Submission Requirements: Investigators are required to submit a signed paper copy and a signed electronic copy of the application form at least two (2) weeks prior to a scheduled meeting. If the Committee Chairperson or Vice Chairperson determines that the submitted materials are not adequate, investigators may be required to submit additional information. No incomplete submissions will be reviewed by the Committee.

UND UAS Research Ethics and Privacy Charter, 2012, Page 3

Notice of Meeting/Meeting Agenda and Support Materials: Notice of meetings will occur through announcements in the University Letter and Research Newsletter, and a meeting calendar will be available on the Committee website. Committee members will be notified through the office of Research Development & Compliance and will be sent all necessary supporting information concerning research proposals.

Committee Minutes: Minutes will be of sufficient detail to show attendance at the meeting; actions taken by the Committee; the vote on actions including the number of members voting for, against, and abstaining; and the basis for requiring changes in or disapproving research.

Committee Reports: Committee reports and recommendations will be prepared for and submitted to the Vice President for Research and Economic Development.


Document Management and Retention: The office of the Vice President for Research and Economic Development will retain all records regarding research project applications (regardless of whether it is approved) for at least three (3) years. For all applications that are approved and the research initiated, the Vice President for Research and Economic Development must retain all records regarding that research for at least three (3) years after completion of the research.

Meeting Quorum: A simple majority of voting members will constitute the necessary quorum for conduct of official business. Committee members who recuse themselves due to a conflict of interest cannot be counted towards quorum. If quorum is lost during the meeting, the Committee cannot conduct voting until it is restored.

Voting: A majority of members must vote in favor of an action for the action to be accepted by the Committee. The vote will be recorded in the minutes. Members with a conflict of interest must recuse themselves from the discussion and voting and such will be noted in the minutes.

Amendment of Charter: Should any amendments to this Charter be required, the Committee Chairperson or Vice Chairperson will work with the Committee in developing suitable language. Proposed changes will be submitted to the President for approval in a timely manner.

This University Committee Charter is effective as of May 1, 2016.



Edward Schafer
President



Grant McGimpsey
Vice President for Research and
Economic Development

INTRODUCTION TO UNMANNED AIRCRAFT SYSTEMS



Richard K. Barnhart
Stephen B. Hottman
Douglas M. Marshall
Eric Shappee

 CRC Press
Taylor & Francis Group

Unmanned Aircraft Systems Test Site



**OTHER TRANSACTION AGREEMENT (OTA)
MEMORANDUM OF AGREEMENT BETWEEN
FEDERAL AVIATION ADMINISTRATION AND
UAS TEST SITE OPERATOR**

Date: December 3, 2013

Northern Plains UAS Test Site Charter, 2013, Page 2

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT		CONTRACT ID CODE	PAGE OF PAGES	
1 AMENDMENT/MODIFICATION NO 0001		3 EFFECTIVE DATE See Block 1e1	4 REQUISITION/PURCHASE REF NO	5 PROJECT NO. (if applicable)
6 ISSUED BY NAME: ACQUISITION TEAM 3 FAA William J. Hughes Technical Center 4th Floor, Building 300 Atlantic City International Airport Atlantic City NJ 08405		7 ADMINISTERED BY (if other than item 6) CODE		
8 NAME AND ADDRESS OF CONTRACTOR (No street county State and ZIP Code) NORTH DAKOTA STATE OF NORTH DAKOTA DEPARTMENT OF COMMERCE 1600 E CENTURY AVE STE 2 BISMARCK ND 58503-0649		9A AMENDMENT OF SOLICITATION NO		
CODE		9B DATED (SEE ITEM #1)		
FACILITY CODE		9C MODIFICATION OF CONTRACT ORDER NO D7FACT-14-A-00002		
		9D DATED (SEE ITEM #1) 12/30/2013		
10. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS				
<input type="checkbox"/> The above numbered solicitation is amended as set forth in item 14. The hour and date specified for receipt of Offers <input type="checkbox"/> is extended <input type="checkbox"/> is not extended. Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods: (a) By completing items 8 and 10 and returning _____ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment number. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.				
12 ACCOUNTING AND APPROPRIATION DATA (if required) See Schedule		\$0.00		
13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS. IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.				
<input type="checkbox"/> A THIS CHANGE ORDER IS ISSUED PURSUANT TO (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.				
<input type="checkbox"/> B THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in buying office, appropriation date, etc.) SET FORTH IN ITEM 14.				
<input type="checkbox"/> C THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO THE AUTHORITY OF				
<input checked="" type="checkbox"/> D OTHER (Specify type of modification and authority) Reference Article 11 - Change, Modifications				
E. IMPORTANT: Contractor <input type="checkbox"/> is not <input checked="" type="checkbox"/> is required to sign this document and return _____ 1 _____ copies to the issuing office.				
14 DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible) Unmanned Aircraft Systems Test Site - Other Transaction Agreement (OTA)				
(1) This modification is hereby issued to delete in its entirety the OTA dated May 4, 2015 which was issued with Modification 0002, and replaced with the attached OTA, dated January 17, 2017.				
(2) All other terms and conditions remain the same.				
COR/Tech Rep: Bonnie Schmidt Period of Performance: 12/30/2015 to 09/30/2018				
Except as provided herein, all terms and conditions of the document referenced in item 8A or 10A, as heretofore changed, remains unchanged and in full force and effect.				
15A NAME AND TITLE OF SIGNER (Type or print) <i>Andrea M. Maerty</i> Co-Deputy Commissioner		15B NAME AND TITLE OF CONTRACTING OFFICER (Type or print) <i>Daniel Farrell</i>		
15B CONTRACTOR OFFEROR <i>Andrea M. Maerty</i> (Signature of person authorized to sign)		15C DATE SIGNED 1/26/17		15D CONTRACT AUTHORITY Digitally signed by DANIEL FARRELL JR Date: 2017.02.01 07:58:49 -0500
				15E DATE SIGNED 02/01/2017

Appendix M
AeroCom Article, 2014



A MESSAGE FROM THE DEAN

On December 28th 2013 the headlines read; "North Dakota named as one of the six National Test Airspace Sites for Unmanned Aircraft." This designation was made by the FAA after a fierce competition that included proposals from almost the entire United States. Being designated as a National Test Airspace Site is a huge step forward for the Odegard School's Unmanned Aircraft Systems (UAS) program as it continues to be the leader in moving unmanned aircraft into commercial operations in the national airspace. This announcement heralds an incredibly bright future for UND, North Dakota and the nation.

It is amazing that this headline can be traced back to a single phone call I received from Senator Dorgan's Chief of Staff in the summer of 2005. The call referenced the potential closing of Grand Forks Air Force Base and the role the Odegard School could play to keep it open. Understanding the role that UASs would play in the future of aviation and being able to align the capabilities of the Odegard School and the University of North Dakota not only kept the Base open but realigned its mission to include UASs. At the same time it launched the Odegard School into a leadership position in this exciting and emerging technology.

Clearly the recognition there would be a need for the transition of UASs from military to civilian and commercial applications and access into the national airspace would turn out to be profound, but also the opportunities it would provide for training, education, and research for every aspect of UASs was invaluable. This vision would lead to the creation of the Odegard School's Center of Excellence (COE) for UASs.

Over the course of its past eight years the UAS COE has leveraged the capabilities of the Odegard School to obtain over \$50 million in funding from the FAA, Department of Defense, the State of North Dakota, private industry and private benefactors. These funds have stimulated collaborations benefitting other colleges at UND, North Dakota State University, and other state entities and businesses as partners.

Seizing the opportunity provided by that first phone call has led to the Odegard School and UND becoming the first University to offer a Bachelor of Science Degree in UASs, the first private-sector user of a Predator UAS training system, and the first to establish a UAS Research Compliance Committee. Now, with this test site designation, we have achieved the next step by becoming the first to develop and leverage a test site which will open the doors to flying UASs in the national airspace.

Our past is historic, our present is impressive and our future is breathtaking. Unmanned Aircraft Systems will become the dominate choice for all airborne missions except passenger travel and general aviation. The investments we have made in UAS technology will continue to attract private industry and ensure the growth in our research and training programs through future grants and contracts. In all of these cases, the National Test Airspace designation ideally positions the Odegard School at the leading edge of UAS development and applications and provides another testament to our reputation as one of the pre-eminent aerospace colleges in the world.

A handwritten signature in black ink that reads "Bruce A. Smith".

Bruce A. Smith | Dean, John D. Odegard School of Aerospace Sciences

Appendix N
 Flight Plan: First Commercial Use of UAS on U.S. Military Base, 2015, Page 1



DEPARTMENT OF THE AIR FORCE
 319TH OPERATIONS SUPPORT SQUADRON (AMC)
 GRAND FORKS AIR FORCE BASE, NORTH DAKOTA

9 September 2015

MEMORANDUM FOR 319 OSS/OSA

FROM: Snowy Owl Productions

SUBJECT: Snowy Owl Productions concurrence with *Grand Forks Air Force Base Instruction 13-204, Airfield and Air Traffic Operations*.

This memorandum signifies that Snowy Owl Productions agrees to the procedures outlined in the *Grand Forks Air Force Base Instruction 13-204, Airfield and Air Traffic Operations* dated 25 July 2015.

1. Snowy Owl Productions will ensure all aircrews are familiar with and adhere to procedures outlined in the *Grand Forks Air Force Base Instruction 13-204, Airfield and Air Traffic Operations* while operating in GFAFB Class D airspace.
2. Contact information: It is the responsibility of Snowy Owl Productions to ensure GFAFB Airfield Operations has the most up to date contact information.

Primary point of contact:	MATT Dunlevy, President Sky Scripts/Snowy Owl Productions
Secondary point of contact:	CHRISTOPHER R. YAKABE, PRESIDENT NORTH AMERICAN INNOVETS
Pilot-in-Command/Shelter Number:	COMMR GRAF 45
Other:	RYAN ACH PROJECT MANAGER Sky Scripts/Snowy Owl Productions

3. This agreement is valid until, rewritten, rescinded or superseded.


 CHRIS YAKABE
 President, North American InnoVets

ATTACHMENT 2
Tenant Unit Agreement

FLIGHT PLAN		DATE		ARMS/CHART CALL SIGN		ARMS/CHART DESIG AND TO CENTER	
MILES TO BE FLIGHT		9 Sep 15		Grand St, 01		DSI 51000+	
TIME	TYPE	CLASS	CLASS	CLASS	CLASS	CLASS	CLASS
VFR	25 kts	Alert Pol	2200 Z	3000' and below	0.5 NM E Lockholes 47°-56'N 97°-24.5'W		30 min
<p>REMARKS: VFR UAS Commercial Operations to be conducted in the immediate vicinity of the GAFB Alpha Alert Pol (Grand Stg Family) located 0.5 NM SW of the approach end of GAFB Runy 35.</p>							
<p>NAME AND NUMBER CODE</p>							
FILE NUMBER	ALTA AIRFIELD	SITE TO ALTA	NOTAMS	WEATHER	WT AND BALANCE	ARMS/CHART NUMBER, UNIT, AND HOME STATION	
0+30						N27155 (OPR0715156) Grand Stg Pol Production	
SIGNATURE OF APPROVAL AUTHORITY	CREW/PASSENGER LIST	ATTACHED	SEE PAGER HANDSETS	PILOT	NAME	OPERATION/UNIT LOCATION	
Clay				Grating	Civilian	Grand Stg Productions, Grand Stg	
COMMAND							

Appendix O
FAA-G-8082-22, Remote Pilot Study Guide, 2016



U.S. Department
of Transportation

**Federal Aviation
Administration**

FAA-G-8082-22

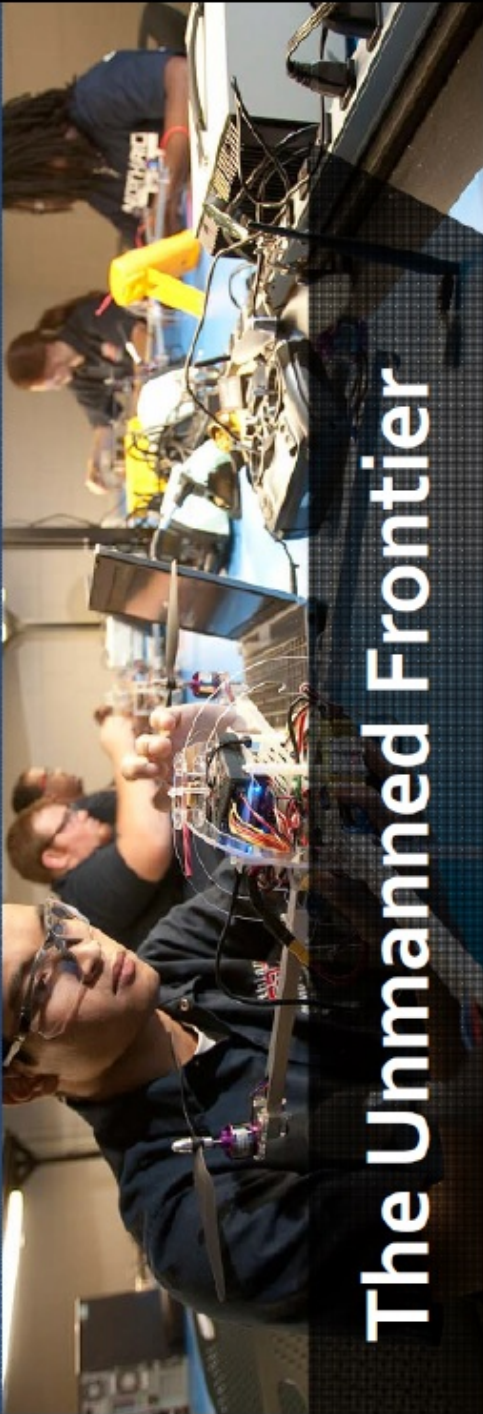
**Remote Pilot – Small
Unmanned Aircraft Systems
Study Guide**

August 2016

**Flight Standards Service
Washington, DC 20591**

11/10/2016

Appendix P
Robins Kaplan Presentation, November 2016



The Unmanned Frontier

Unmatched Opportunities for
Entering America's UAS Marketplace
via North Dakota

North Dakota
UNIVERSITY

UMD
Center for Unmanned
Aircraft Systems

ROBINS KAPLAN
ASSOCIATES
PRACTICING LAW FIRM

Unmanned Aircraft Systems (UAS) Program

The Legislature appropriated \$5 million for the UAS program for the 2013-15 biennium. Of this amount \$1 million was for costs related to obtaining FAA designation as a test site and \$4 million for the operations of the test site. In 2015, the Legislature allowed for carryover of unexpended funds from the original appropriation and appropriated an additional \$2,718,620 for the 2015-17 biennium, of which \$1.2 million was restricted for business incentive match funds.

Pursuing Test Site Designation

Of the \$1 million appropriated to pursue FAA test site designation, \$480,804.46 was spent and the remaining amount was carried over to be used for operating expenses. The expenses include:

- \$77,190.09 to Duetto Group, LLC
- \$37,658.32 to Avian, LLC
- \$8,785.15 to NDSU
- \$219,709.54 to UND
- \$39,435.47 to Development Counsellors International (DCI)
- \$16,859.93 to Unmanned Applications Institute (UAI)
- \$81,165.96 to Systems Engineering & Technology, LLC (SeaTec)

2013-15 Startup and Operating Expenses

Of the \$4 million appropriated for operating expenses during the 2013-15 biennium, \$2,659,052.66 was spent and the remaining amount was carried over for future operating expenses. The expenses include:

- \$278,829.92 to Duetto Group, LLC
- \$118,903.23 to Avian, LLC
- \$132,363.27 to NDSU
- \$1,771,409.59 to UND
- \$157,647.97 to Development Counsellors International (DCI)
- \$39,490.37 to Unmanned Applications Institute (UAI)
- \$136,752.00 to Simulyze
- \$22,256.42 in miscellaneous, non-contract expenses

2015-17 Operating Expenses

The Legislature appropriated \$2,718,620 in additional funds for the 2015-17 biennium and allowed carryover totaling \$1,860,143, for a total of \$4,578,763 that would have been available, including \$1.2 million designated for business incentive match funds. This amount was reduced by \$56,515 due to the budget allotments. There has been a total of \$1,833,160.07 spent to date through February 2017.

- \$218,000 to Duetto Group, LLC
- \$14,335.20 to Avian, LLC
- \$145,391.89 to NDSU
- \$1,378,779.94 to UND
- \$43,070 to Simulyze

2015-17 Incentive Funding

\$25,430.59 has been spent of the \$1.2 million designated for business incentive match funds. A total of \$241,709 has been allocated to ongoing projects. The projects include the following businesses:

- Airware: \$7,414.04 spent and project is complete.
- Altavian: \$11,271.16 spent out of \$70,377 allocated.
- Sharper Shape: \$14,897.84 spent out of \$72,234 allocated.
- Elbit: \$91,684 allocated and project has not yet started.

Vendor Roles

Development Counsellors International (DCI): National and international media relations services – Promotion of the NP UAS TS

Duetto Group: Provides comprehensive planning and technical support that delivers continued awareness of UAS-related issues within government, industry and other UAS Test Sites.

University of North Dakota (UND): Provides FTE resources along with fixed and operating costs and test site operational support services in support of delivering the NP UAS TS program of work.

North Dakota State University (NDSU): Provides NP UAS TS with planning and test site operational support services.

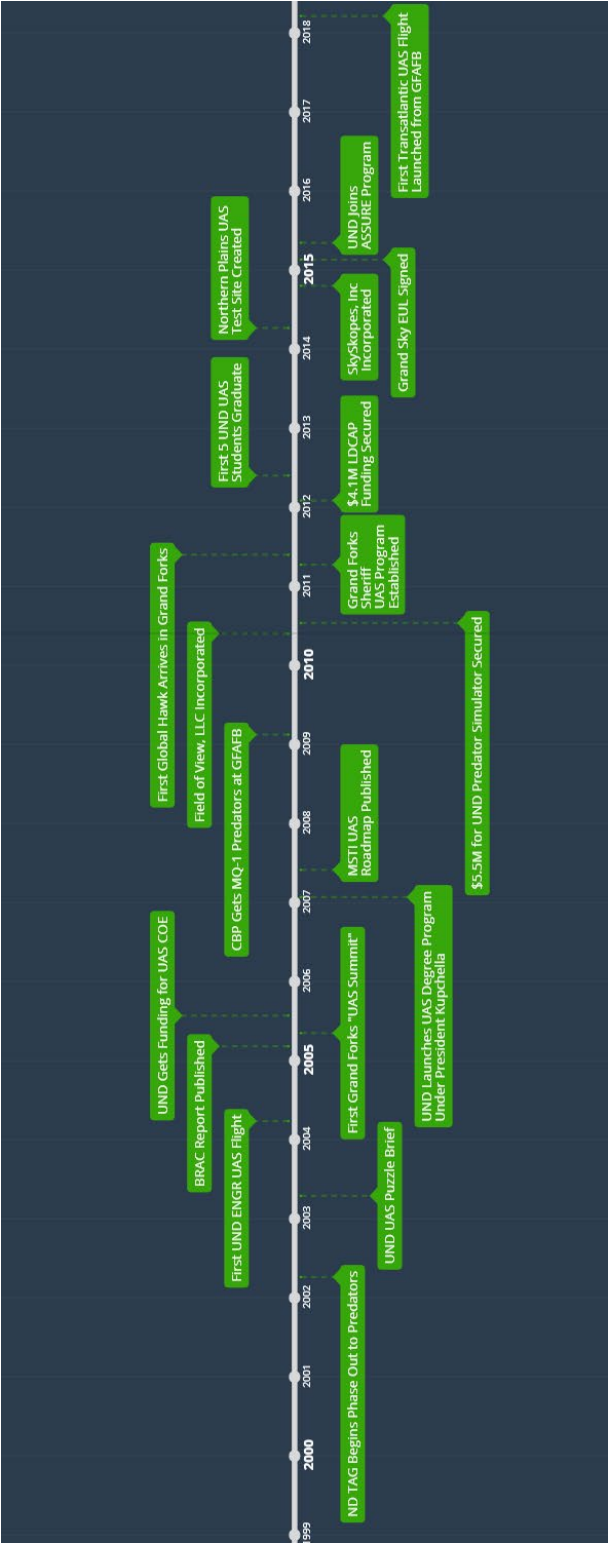
Avian: Provide technical support and services related to specific aspects of Research, Development, Test and Evaluation of UAS, along with infrastructure and operational policies and procedures advisory services.

Unmanned Applications Institute International (UAI): Provide marketing and business development strategy development and support to the NP UAS TS.

Systems Engineering and Technology (SeaTec): Provide advisory and strategy services to finalize the North Dakota team's preparation and response to the FAA's final review and selection of the UAS test sites.

Simulyze: Provide services to identify and recommend a solution to collect, integrate and report UAS planning and flight data from UAS operations conducted by the NP UAS TS.

Appendix R A Timeline of Historical UAS Events in North Dakota



Appendix S
Letter from Senator Kevin Cramer

KEVIN CRAMER
NORTH DAKOTA



United States Senate

May 10, 2019

Dear Matt and SkySkopes Team,

I am writing to let you know how pleased I am with the growth and success of SkySkopes over the past five years. You have been part of a number of historical UAS milestones, and along the way have established yourself as among the key economic drivers in the region.

Many of us have worked tirelessly to develop the UAS ecosystem. As part of the Congressional Unmanned Systems Caucus, our mission has been to acknowledge the overwhelming value of UAS applications to the defense, intelligence, homeland security, law enforcement and scientific communities, and to ensure legislative and regulatory policy supports this advancement. SkySkopes aligns with many of these missions and is creating new jobs and wealth for North Dakota's world-class industrial base.

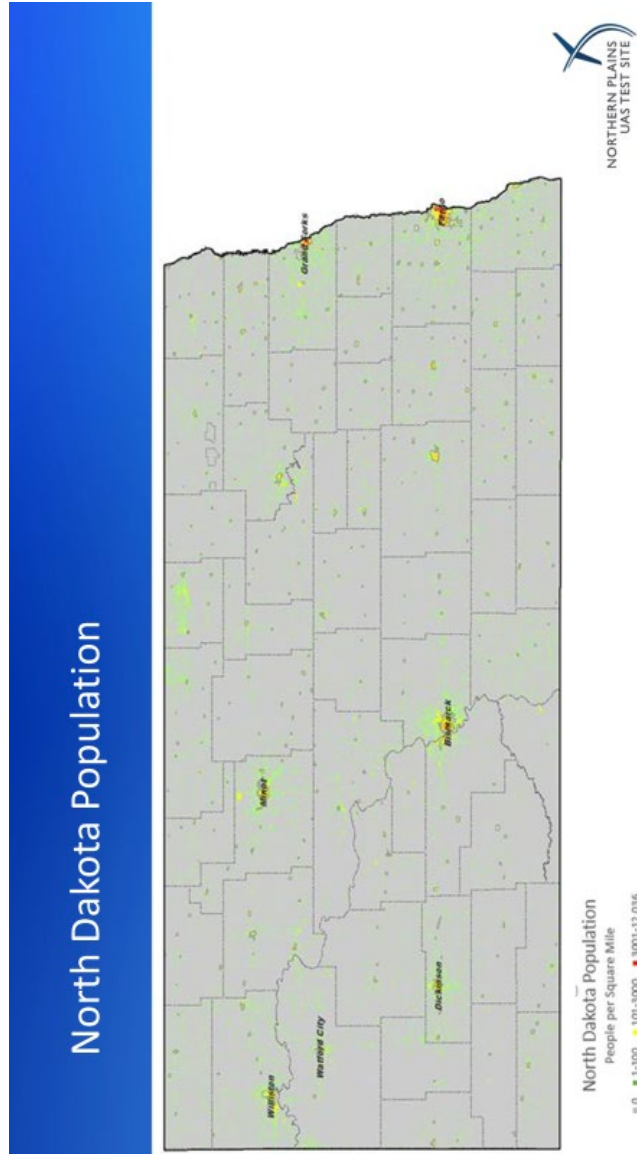
You are an integral part of this exciting new frontier and I look forward to SkySkopes continuing to be a leader in this exciting effort.

Sincerely,

A handwritten signature in blue ink, appearing to read "Kevin Cramer".

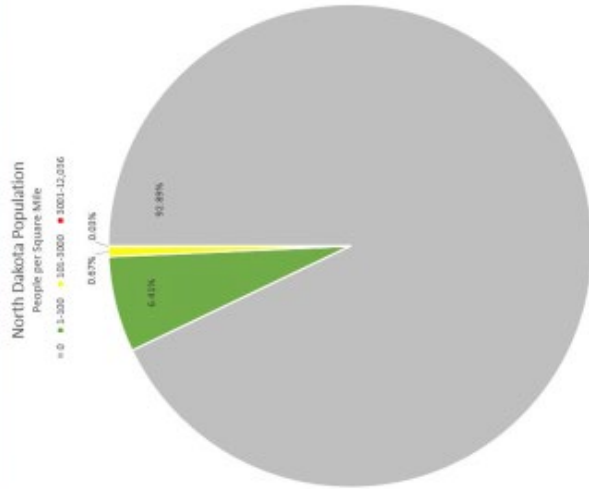
Kevin Cramer
United States Senator

Appendix T
PowerPoint Slide from NPUASTS Considering North Dakota Population Density





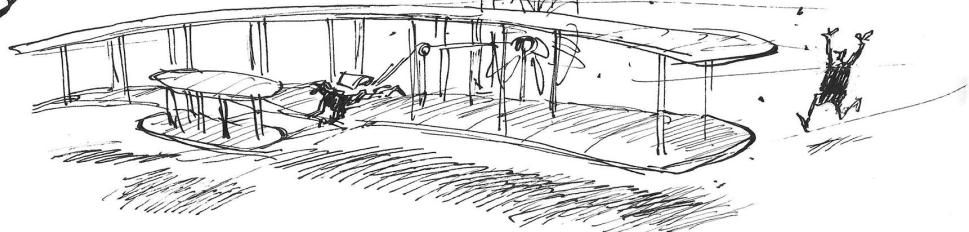
North Dakota Population



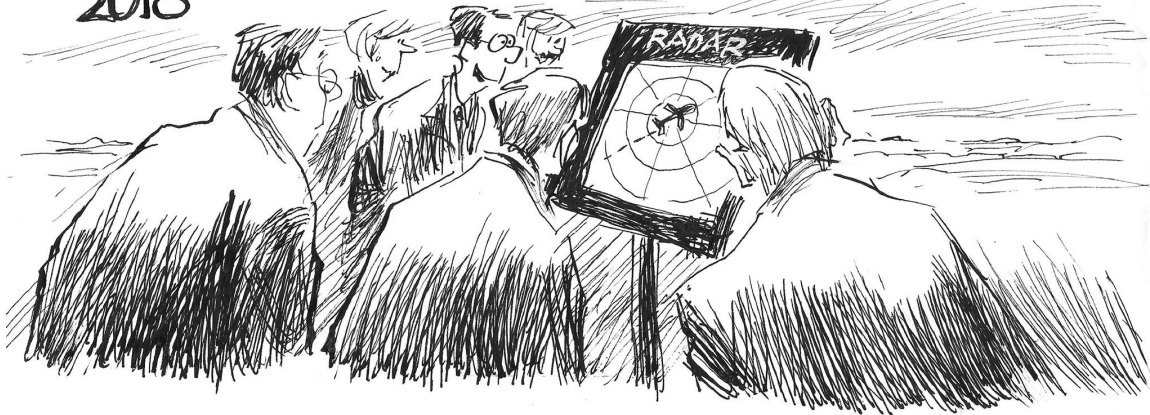
Appendix V
Cartoon from the *Fargo Forum* Considering BVLOS

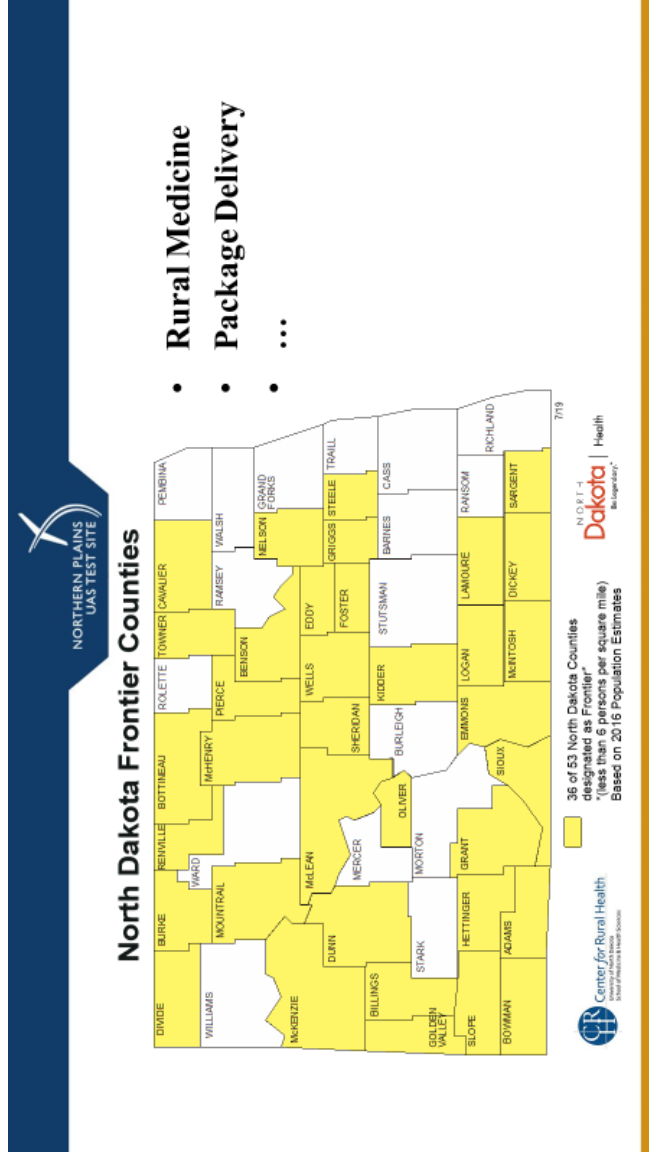
KITTY HAWK, NC: SITE OF FIRST MANNED FLIGHT
1903

TIM WEDGON
2018 The Forum



GRAND FORKS, ND: SITE OF FIRST UNMANNED OUT-OF-SIGHT FLIGHT
2018





Appendix W
Nick Nowatzki at NDSU: First UAS Flight in North Dakota, October 1999

