The Campaign For
UC San Diego

UNDERSTANDING THE PAST

TRANSFORMING THE FUTURE

Photo: Charles Eshbach

AN IMPACT REPORT FEATURING

MARK HENDRICKSON

2016 Andrew W. Mellon Foundation New Directions Fellow

Presented with gratitude to
THE ANDREW W. MELLON FOUNDATION

A history of nontradition

At UC San Diego, challenging convention is our most cherished tradition. Here, we are committed to empowering the next generation of changemakers to serve humanity and improve the health of our planet.

The support of forward-looking partners like the Andrew W. Mellon Foundation enables our visionary faculty, like Mark Hendrickson who is featured in this report, to take intellectual risks and collaborate across disciplines to spark discoveries that have the potential to change our world.

Thank you for helping us continue the nontradition.

MESSAGE FROM
CRISTINA DELLA COLETTA

In an age increasingly characterized by technological ubiquity, it becomes more important than ever to invest in humanities research and education. Disciplines in the humanities equip students with capacities that are foundational, transferable, and enduring — the lifelong basis for identifying and advancing value in a wide variety of functions. It is through their interdisciplinary collaborations that students, faculty, and leaders acquire the perspective to translate humanity's rich and diverse cultural history as a wellspring for a better future.

Together, the Andrew W. Mellon Foundation and UC San Diego are committed to sparking boundary-breaking innovation through support for up-and-coming intellectual leaders. Your New Directions Fellowship grant allows researchers like Mark Hendrickson, associate professor of history at UC San Diego, to pursue research into the interconnectedness of fields as wide-ranging as history and engineering, economics and geology, science and foreign policy, and to use these projects to better understand our current socio-political environment. I hope you enjoy reading this report, in which Professor Hendrickson shares his experience as a New Directions Fellow and the influence the grant has had on his work.

As we continue to push the boundaries of knowledge to better understand the human condition, we look forward to a future in which the Andrew W. Mellon Foundation enables visionary thought leaders to continue to look deeper at our society and our world. Thank you for supporting interdisciplinary research that encourages unfettered curiosity and groundbreaking discovery.

Thank you,

Cristina Della Coletta
Dean, Division of Arts and Humanities
UC San Diego

TABLE OF CONTENTS

"Our civilization … is founded on coal, more completely than one realizes until one stops to think about it. The machines that keep us alive, and the machines that make machines, are all directly or indirectly dependent upon coal …

"Watching coal-miners at work, you realize momentarily what different universes people inhabit. Down there where coal is dug is a sort of world apart which one can quite easily go through life without ever hearing about. Probably majority of people would even prefer not to hear about it. Yet it is the absolutely necessary counterpart of our world above. Practically everything we do, from eating an ice to crossing the Atlantic, and from baking a loaf to writing a novel, involves the use of coal, directly or indirectly."

George Orwell
The Road to Wigan Pier
"Down the Mine"
1937

FROM THE UNDERGROUND UP

Mining Engineers, Geologists, Foreign Direct Investment, and American Economic Development

In January of 1886, the Engineering and Mining Journal celebrated the increasing importance of American mining engineers: "Every year brings a wider recognition of the fact that, in mining and in practical metallurgy, our American engineers are the most successful and economical in the world, and their services are in request in nearly every country in the world." These were indeed heady days for young and ambitious American mining engineers and geologists, most of whom had just recently cut their teeth working for U.S. mining companies or the recently created U.S. Geological Survey. In the last decades of the nineteenth century, they fanned out around the globe to potential and existing mines in China, Mexico, Siberia, South Africa, and beyond. My study explores how the international experience and learning occurring in the context of these efforts helped shape the development of American capitalism, science, and foreign policy into the twentieth century.

When I began this study, I thought of mining and mining history as a lens through which I could examine a narrow range of issues associated with risk management in this field. I intended to write a book and move on to other issues, but my time as a Mellon New Directions fellow opened my eyes to a whole range of actors, processes, interconnections, technologies, and issues associated with the industry and its history. The impact of mining is all around us, but it often remains, as George Orwell reminds us in his discussion of coal, "a world apart." It is a world that — however necessary — a "majority of people would even prefer not to hear about." I find this juxtaposition of necessity and ignorance remarkable, enduring, and troubling. When workers and machines pull material up from thousands of feet underground, the impact of this seizure of resources ripples through space and time and impacts everyone from the consumers who purchase the final products to the generations who live with the political, economic, social, and environmental consequences of extraction and processing. The last three years of study have pulled me into this industry in ways that I never could have foreseen. No longer is my work in this area a path to another book and promotion; instead, I now see it as a great puzzle of modern life. This fellowship opened up entirely new lines of inquiry for me and has done nothing less than to transform my intellectual agenda, not for years, but for decades into the future.

"This fellowship opened up entirely new lines of inquiry for me and has done nothing less than to transform my intellectual agenda, not for years but for decades into the future."

Over the course of my term as a Mellon New Directions fellow, I gained substantive and methodological training in a number of different fields that shed light on various aspects of the mining industry, including extractive metallurgy, mining engineering, mineral economics, environmental studies, and industrial archeology. Training in these fields has equipped me with the skills and tools necessary to better explicate the relationship between scientific understandings of the world below ground and the societies and peoples late nineteenth and early twentieth century mining engineers and geologists encountered above ground.

The impact of the fellowship reached into the classroom. During fall 2018, I offered a course that I created, entitled HIUS 137: Mining and American History that draws directly on what I learned as a Mellon New Directions fellow. In designing the course, I reached out to current and recently retired faculty across the country who would be likely to offer a course on this topic. While all surveyed professors indicated an interest in such a course, no one had designed a course that centered mining in the narrative of U.S. history. At UC San Diego, the course attracted perhaps the best group of students I have encountered in the classroom. This was due in no small measure to the intellectual diversity and interests of the students. While a number of history majors took the course, it also attracted students from thirteen other majors, including engineering, management science, international studies, economics, biology, and sociology. A number of these students commented that the course's focus on mining invited participation from non-history and especially STEM majors.

Mark Hendrickson stands near the #5 underground mine shaft at the Quincy Mine in Hancock, Michigan. (Photo: Tom Wright)

PARTNERING ACROSS DISCIPLINES

Gaining First-Hand Experience at Michigan Technological University

During fall semester 2016, I worked with a number of industrial archeologists, mineral economists, historians, mining engineers, and specialists in environmental studies at Michigan Technological University (MTU). It was a remarkable experience. The dozen or so MTU scholars that I worked with focused on various aspects of the mining industry. I went into the semester thinking that I would focus narrowly on mineral extraction methods and technology. The scholars at MTU did indeed inform my understanding of extraction methods, but they also helped me think about entirely new ways of understanding the mining industry and its methods.

Until the late nineteenth century, the copper mines that surround Michigan Technological University (MTU) produced as much as 95 percent of U.S. copper production. The mining sites that surround the campus make the university an ideal site to learn more about the development of the mining industry. During my time in Michigan, Tom Wright provided me with a private tour of the Quincy Mine in Hancock, Michigan. This mine ceased operation in the 1970s but a non-profit association maintains access to the mine as a heritage site and is part of the larger National Park Service operated Keweenaw National Historical Park. At nearly 10,000 feet, the Quincy mineshaft was once the longest shaft in the world, and the miners who worked it extracted copper from what was then the richest copper lode in the world. Almost all of the mine is flooded now, but you can still enter the upper section via an adit (a horizontal tunnel or access point to the mine) that allows access to the seventh level of the mine. It is one thing to read about the conditions under which miners labored, but actually being underground gives you an entirely different sense of what it was like. I also had guided tours by MTU industrial archeologists of a number of other mine sites and abandoned mining communities in the region.

Mark Roberts, retired mineral economist at Michigan Technological University, and his dog, Emma, join Hendrickson in exploring the remains of the Cliff Mine. The Cliff Mine was one of the first successful copper mines in the Keweenaw Peninsula.

Uncovering New Avenues of Understanding

Over the course of the 2017 MTU fall semester, four lines of inquiry came into view. First, mineral economists Gary Campbell and Mark Roberts helped me to better understand the ways in which mining companies make decisions about how and if to proceed with a particular investment. In addition to these firm-level, microeconomic issues, Campbell and Roberts also introduced me to larger macroeconomic issues that impact not just the industry but also the global political economy. Our discussions introduced me to an entirely new line of inquiry that I will address in the larger book project currently under development and perhaps in an article: specifically, why did mineral economics as a discrete field within the economics profession emerge in the early 1930s, and what impact has this relatively new field had on the broader profession and on the industry?

A second line of inquiry emerged from my work with Nancy Langston, who is one of the premier environmental studies scholars working today. Langston recently joined MTU after a long and successful career at University of Wisconsin, Madison. Over the course of the semester, Langston helped me to better understand the environmental and social consequences of mining.

Mark Hendrickson stands atop a haul truck. (Photo: Paul Taylor)

A third line of inquiry focused on the actual extraction and processing of minerals and allowed me the opportunity to work with a range of scholars, including Steve Walton, Fred Quivik, Larry Lankton, Hugh Gorman, Tim Scarlett, Bruce Seely, Sam Sweitz, and a number of graduate students currently enrolled at MTU. When I went into the semester, I thought I would focus most of my work with these experts on extraction issues, but it quickly became apparent that it was equally, if not more important, to understand the processing of ore above ground. Particularly in the period I am addressing in my book project, many of the major innovations that allowed for profitable mining of lower-grade ores occurred above ground in processing facilities that separated out the minerals from the waste material or gangue.

Another MTU colleague, Ebrahim Tarshizi, a professor of geological and mining engineering, opened up fourth and final line of inquiry for me that focused on mining engineering.

ACQUIRING NEW CONTEXT

Advancing Research at Colorado School of Mines

During fall semester 2017, I served as visiting faculty at Colorado School of Mines (CSM) where I worked with a number of mineral economists, economic geologists, mining engineers, and extractive metallurgists. I also built relationships with a number of current and former mining engineers and mineral economists affiliated with CSM and with the industry more generally. In conversations, lectures, readings, and in trips to operating and closed mines, these current experts in the field helped me to better understand how the industry operates and what is the scope of its impact. At CSM, I developed three lines of inquiry that focused on mineral economics, extractive metallurgy, and underground/open pit mining.

First, in the field of mineral economics, I had the opportunity to learn from a number of leaders in the field. The cornerstone of this experience was participation in Dr. Rod Eggert's offering of EBGN 535 Economics of Metal Industries and Markets course. In addition to serving as the chair of the Division of Economics and Business, Rod is also the deputy director of the Critical Materials Institute (CMI), which is funded by the Department of Energy. The CMI does a number of different things, but Rod focuses on supply chain concerns for many minerals. Eggert's course examined several aspects of the economics of the mineral industry, including factors influencing the supply and demand for metals; the organization of the industry; the impact of public policies (environmental, taxation, and nationalization among them) on the development of mineral extraction and processing; and metals and economic advancement in developing countries and former centrally planned economies.

In addition to my work with professor Eggert, I also had the opportunity to meet with other CSM mineral economists who are leaders in their field, most notably Dr. John Tilton and Dr. Graham Davis.

An abandoned headframe at Newmont's Cripple Creek and Victor gold mine near Victor, Colorado.

Collaborating Across Disciplines

In addition to working with these professors, I also got to know the chief economist for Newmont Mining, Tom Brady. Since completing his PhD in 1996 at CSM, Brady has worked as a risk capital advisor on extractive industries for Arthur Anderson and in various positions for the Newmont Mining Corporation. Brady provided unique insights into the myriad of factors that mining companies consider when contemplating an investment in domestic or foreign mines. Brady helped me to better understand the ways that mining companies attempt to manage risk, which is a major topic that I will be considering in the book project. In addition to forecasting, Brady also works to cultivate investors for Newmont. His work in this area was particularly interesting because it provides insight into the ways in which mining companies have to compete for capital with exchange traded funds and other investment outlets related to the mining industry.

A second broad line of inquiry focused on extractive metallurgy. As in mineral economics, my experiences unfolded in the classroom and in the field. In the classroom, I attended two courses. Dr. Erik Spiller's MNGN 322: Introduction to Mineral Processing that exposed me to a broad range of techniques used in the industry to separate out the sought-after mineral from the gangue or waste material. While much of the technology has changed, many of the techniques and methods for this sort of separation have been in place for decades if not centuries. They often include sorting by size and density and utilizing surface chemistry to parse out the desired material from the waste material. My work is focused on the late nineteenth century and the first decades of the twentieth century, which was a period when many modern techniques in mineral processing came into practice.

In addition to Spiller's course, I also attended Dr. Corby Anderson's MTGN 538 Hydrometallurgy course. This was an upper division/graduate course that focused on teaching mining engineers how to employ in a modern setting many of the metallurgical practices (the cyanidation process for gold and silver extraction, Beyer process for bauxite treatment, electrolysis for recovering copper, and various forms of leaching) that were developed between 1887 and WWI.

Finally, I also had the opportunity to work with professor Brock O'Kelly who specializes in rare earth processing techniques. O'Kelly spent many years working at the Mountain Pass mine in California, which, at one point, was the largest producer of rare earth materials in the world.

In addition to O'Kelly, Spiller, and Anderson, I also benefited from opportunities to discuss pyro-metallurgy with Dr. Pat Taylor. All of these experiences helped me to better understand the importance of what happens above ground — where the ores are largely processed into a purer or metallic state — to the mining process.

Gaining Perspective

Coming at the mining industry from the experiences below ground — that is to say in the extraction of the ore from underground or open pit mines — my work with CSM faculty allowed me to build on a third line of inquiry rooted in some of the work I had done with Dr. Ebrahim Tarshizi during fall 2016.

At CSM, I had the pleasure of meeting with Dr. Hugh Miller and Dr. Emmanuel De Moor. Both provided a number of keen insights into changes in the industry, and Miller introduced me to Paul Jones who has decades of experience in the field and who assists Miller in his mine design course at CSM. Through his industry connections, Jones arranged for me to get a personal tour of the Cripple Creek and Victor gold mine, which is Colorado's largest gold mine and has one of the largest heap leaching pads in the world. Jones also gave me a tour of the Mining Hall of Fame in Leadville, CO, where he serves on the board of directors, and he provided me with tours of a number of different abandoned mines that operated during the period I am considering in my book.

The view from the floor of Newmont's Cripple Creek and Victor gold mine near Victor, Colorado.

Uniting Knowledge

Let me close with a brief explanation of my deep gratitude to the Andrew W. Mellon Foundation for the opportunities that the New Directions fellowship has afforded me these last three years. I have learned a tremendous amount, met some outstanding and fascinating people, and experienced the mining life in ways that I could not have even imagined. I have no doubt that these experiences will shape my work and my intellectual agenda not only for the purposes of this present project/book, but well into the future.

Rodney Greb (right) gives Mark Hendrickson (left) a tour of Newmont's Cripple Creek and Victor gold mine. (Photo: Paul Taylor)

APPENDIX A

Related Publications

RELATED PUBLICATIONS

"The sesame that opens the door of trade: John Hays Hammond and foreign direct investment in mining, 1880-1920," *Journal of Gilded Age and Progressive Era* 16 (July 2017), 325-346.

"The United States Geological Survey, Mineral Exploration, and the Mineral Road to Globalization, 1890-1900," forthcoming in *History and Technology*.

APPENDIX B

Other Related Work

OTHER RELATED WORK

"American Mining Engineers on a Global Stage: The Case of John Hays Hammond from the 1870s to the Great Depression," 2019 Society for Mining, Metallurgy, and Exploration Annual Conference and Expo and Colorado Mining Association 121st National Western Mining Conference, February 26, 2019, Denver, Colorado.

"The United States Geological Survey, Mineral Exploration, and the Mineral Road to Globalization, 1890-1900," Society for the History of Foreign Relations and Diplomatic History Conference, Philadelphia, Pennsylvania, June 22, 2018.

"To Liberate and Separate: Innovations in Ore Dressing at the Braden/ El Teniente Mine, Chile," Guest Lecture in MNGN 322: Introduction to Mineral Processing, Colorado School of Mines, December 8, 2017.

"To Liberate and Separate: Innovations in Ore Dressing at the Braden/ El Teniente Mine, Chile," Extractive Metallurgy Group of Denver, November 9, 2017.

"Exporting Expertise and Capital: American Mining Engineers and Foreign Direct Investment in the Braden (El Teniente) Mine, 1894-1914," Society for the History of Technology Annual Meeting, Philadelphia, Pennsylvania, October 27, 2017.

"Advance Agent of Empire: George F. Becker, The United States Geological Survey, and American Expansion, 1890-1900," German Historical Institute West Inaugural Workshop: "Empires of Knowledge: Expertise and Imperial Power Across the Long Twentieth Century," September 15-16, 2017, University of British Columbia, Vancouver, Canada.

"The sesame that opens the door of trade:" John Hays Hammond and foreign direct investment in mining, 1880-1920," Michigan Technological University, December 14, 2016.

BUILDING A COMMUNITY OF INNOVATION

Established in 1960, UC San Diego has been shaped by exceptional scholars who aren't afraid to push boundaries, challenge expectations, and redefine conventional wisdom to make our world a better place. Financial support from like-minded donors, including the Andrew W. Mellon Foundation, is critical in helping us continue to drive innovation, advance society, propel economic growth, and inspire change far beyond our campus.

Thank you for your generous support of faculty working to advance new discoveries. By underscoring the importance of the humanities and arts, the Andrew W. Mellon Foundation allows academic leaders to experiment and explore new ideas with the potential to change our world.