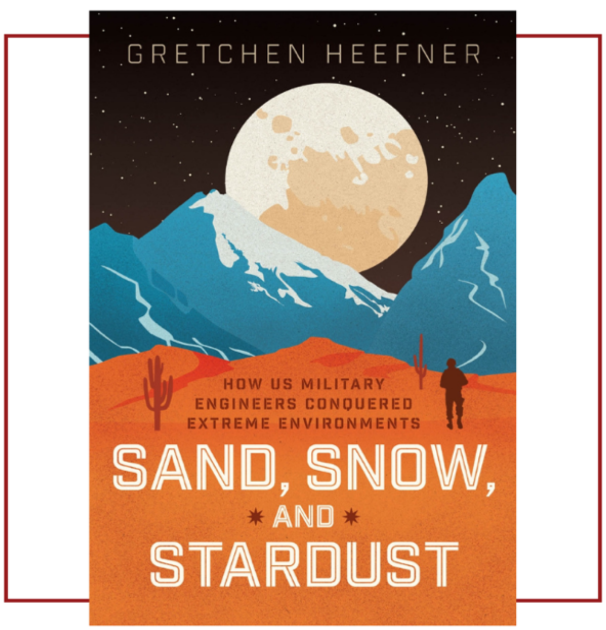
Interviews with CENFAD Fall 2025 Speakers

Dr. Gretchen Heefner, Northeastern University, author of *Sand, Snow, and Stardust: How US Military Engineers Conquered Extreme Environments*

On November 5, Dr. Gretchen Heefner delivered a talk at CENFAD on her book *Sand, Snow, and Stardust: How U.S. Military Engineers Conquered Extreme Environments*. Afterwards, I had the chance to chat with her about the project and the ideas behind it.



Marcella Aline Toledo: Dr. Heefner, thank you for your time! Before we start, I'm curious about the challenges of writing a book that bridges history and science. You move so fluidly between archival research and scientific explanations. How was the process of finding that balance?

Dr. Gretchen Heefner: It's still a process and I'm still finding it, so I cannot say that I actually found balance.

I just wanted to explain the science and technology at the heart of this story in a way that made sense to me, like how I would actually explain to someone without having to check my footnotes. So, for every topic I tried to go three steps deeper than surface level information - I read a lot - and then use that to tell a story. I just approached thinking about scientific topics, not as things that were terrifying or things I couldn't unpack or understand but just recognizing that it was a new thing I had to learn about. It is not that different from what I do about any subject or topic; before I write about it, I have to know it well enough that I feel I could answer some questions about it or know how and where to send someone to learn more.

MAT: Could you tell us a little bit about your decision to include a "Cast of

Characters" before the introduction, a choice less common in academic works.

GH: It was actually a recommendation that one of my writing partners made. I'd circulated a couple of chapters that were mostly about the desert and there were some unexpected characters that kept appearing - people who did not work in the military and were not engineers. For example, in the early desert sections there are writers, a conservationist, and a botanist. My writing partner's suggestion was to have a cast of characters not only so people will take notice of the unexpected individuals who appear so briefly, but also because a lot of characters reappear across the book - so it is good to be able to track them and identify them. It was also an effort to highlight the fact that even when you are telling a story about the military and military knowledge and practices, local people and places matter. Foregrounding the cast of characters was an important way for me to alert readers to this immediately.

MAT: That helped me a lot!

GH: Oh, good. I'm glad it was useful! And they were fun. They were fun little snippets to write, too.

MAT: You structured your book around three elements - sand, snow, and stardust. Were there moments in your research when one of them challenged your expectations or offered a new perspective?

GH: The entire book came out of the challenge that writing about materials provided. It is probably most useful to start from the beginning - this is not the book I intended to write. I had set out to write something quite different about the construction of U.S. military bases in Northern Africa and around the world in the 1950s. But as I started reading the engineering documents about these bases, I noticed that they were writing about sand all the time. At first, I kind of ignored it. Who cares? And then I realized, actually, they're writing about the materiality of the place they're in, because that was their overwhelming experience of it. And they didn't really know how to grapple with it.

Right away engineering centers and processes were put in place to grapple with these material foundations. In this way, the story found me. As I started looking at the sand and the archive, not just through engineering documents, but also the diplomats who would write about it, and the people sent to these places to live and work, they would write about it too! I started to realize that that was an important way people understood and experienced extreme environments. Places like the deep desert sand seas, or Arctic ice sheets, where there's really nothing else. The materiality is the overwhelming experience you have of a place. Thing of it: there's no trees, so it's hard to tell distance. And so, it becomes the overwhelming experience people have.

Once I saw that, I couldn't unsee it, and so that completely transformed the way I thought about telling the story. Instead of it being about local negotiations and how land was thought about by different groups of people as landscapes became militarized, it became about how engineers thought about these places. How they tried to manipulate them to fit certain strategic needs. And then finally what that information means for how we understand these places today. So, the grains completely change the story. There was nothing subtle about it.

"Why is it that sand acts like a liquid when it's dry and a solid when it's wet?

MAT: In your talk, you mentioned that granular materials are "particular," and then, reading the book, I came across phrases like "sand is not quite liquid, not quite solid," and "it can shift without warning." I was also fascinated by the idea that deserts follow a "geometric order." I felt that this part of the book perfectly captures a key theme of your argument: the military wants to master the environment, but in this case, the sand doesn't fully cooperate, and that becomes a kind of challenge.

GH: I am glad you liked the geometry of the desert, because that was the contribution of one of the people in the book Ralph Bagnold, who I don't actually end up talking about very much. But he was one of the first people I looked at. He was a British military engineer who was one of the first Western Europeans to write about the physics of sand and deserts and dune formation. When you think about or imagine sand dunes, they look beautiful, they're so dramatic, but Bagnold actually looked at the physics of them and asked questions: why did they form this? Why do certain shapes form in certain places? How do they move? Dunes move in very specific ways - he thought they were lifelike as they slide across the desert floor and replicated. And so, Bagnold measured sand and dunes. When he was in Egypt with the British empire, he would travel out to the desert and just watch the dunes; he took measurements; he spent hours in the middle of sandstorms so he could write down what was happening. He challenged the idea that these places that seemed so simple - place made up only of sand - in reality were complicated. The desert he wrote, is "vaguely disturbing to the imaginative mind."

Even today, the physics of granular materials is poorly understood. Why is it that sand acts like a liquid when it's dry and a solid when it's wet? It doesn't make any sense, right? Ice is the same way. If you think of snow, if you try to make a snowball, it's the same, it's the same phenomenon. Dry ice acts like a liquid, but wet ice packs into a nice, hard snowball. Bagnold was one of the men at midcentury who struggled with how to understand these landscapes, and due to that expertise, he was brought into a lot of military projects, both with the British and the Americans. He was also hired by oil companies and later, by NASA to look at dune formations on Mars. But he always cautioned people, based on his own experience in the desert, that something which looks simple never really is. In the book, he highlights that for those sent to the extremes, there was a constant sense of places being unsettled.

The engineers became of particular interest to because they saw how unsettled these places could be and still tried to turn them into recognizable forms and places. They would see these places and be disoriented by them and then try to turn them into cookie cutter shapes. And it often didn't work. Sometimes it would work temporarily, but it never worked for a long term. This is where the vantage point of environmental history comes in: the environment always pushes back. There's always something that's going to push back against the engineered technological projects and shape them in ways that are unexpected. That's how the granular story comes into what seemed a traditional military story: the military tries to conquer these environments, but it does actually not succeed. The grains get in the way.

MAT: Historically, space - and Mars in particular - has been such a compelling focus for popular culture. You mention some films and figures like Arthur C. Clarke, and personally, I couldn't help thinking of David Bowie, who so often turned to space in his work. Today, as we talk about colonization beyond Earth, it seems that space is still a canvas for imagination. How do you think the way we imagine outer space today differs from how people imagined it in the mid-twentieth century?

GH: That's a good question. There was real optimism and a sense of possibility at midcentury; the technologic advances of World War II were remarkable, and people believe they could be harnessed somehow for exploration, not military, not weaponized. Especially rockets. The midcentury space boosters were really thinking that we were on the edge of this new version of how humanity could be hurled into space. Of course, they had a very specific version of what that humanity could be and who it could be: it was racialized and gendered. Midcentury space was for white men in the United States. Full stop. Few other people were involved in that conversation, as far as I can tell. I mean, there were people, but not actually involved in the places where it mattered. So, these men had a very utopian vision of what that would look like for them.

Today it's a different conversation, right? Even less open in that the space conversation is captured by billionaires who want to escape Earth. So even though NASA has this Artemis mission, and they want to continue what was going on in the 50s and 60s, launching humans to space, that is not the narrative we're talking about.

I'm actually not a space enthusiast. It has never been something I am that interested in, but the sand and snow turned to Moondust and Stardust, so I followed it there in this project. In fact, I would probably say that its best for humans not to go into space; it's expensive, and it just takes so many resources that we need for other things. Machines, fine, little robots, that's great. But getting humans to space leads to all of these mind-boggling problems and gets away from the very interesting concept of what is actually out in there in space.

> *"I want people to ask what kinds of stories we should know about the military and its impact on knowledge"*

MAT: *Sand, Snow, and Stardust* shows how the United States became a planetary power through its scientific and technological achievements. As you argue, the U.S. military activities had long-lasting effects on what we know and how we think about the world but also had an impact on the world's environment. Given this U.S. environmental expertise, do you think it should also give the country a special role, or even an obligation, in addressing today's climate crisis?

GH: The short answer to your question is yes, 100% the U.S. military has a role to play in addressing the climate crisis. For many reasons, not just because of the work they did in extreme environments. The U.S. military is an enormous emitter of greenhouse gases, and also its entire apparatus is in place to protect the corporations and economic structures that emit greenhouse gases. There's just no hiding from that fact.

In terms what you were asking as it relates to my book, in very specific locations we can draw direct lines between what the military was doing in these places in the 50s and 60s, and the knowledge we have about them today. I'm thinking specifically about the Greenland ice cap where the US military was and remains responsible for much of the infrastructure that enables scientific work. This is a somewhat awkward relationship that people don't like to talk about. Science is taking place along military logistical networks. And this military infrastructure does not have a good record when it comes to environmental stewardship. In the 50s and 60s, for example, the military did an enormous amount of damage wherever it went. In Greenland, the engineers building facilities just left stuff wherever they were. Most items to Greenland were on a 1-way ticket. The US military dumped old gear, toxic materials, radioactive waste, trash - basically everything. Today Greenlanders are asking for those places to be cleaned up - dozens of them.

So, there is this uncomfortable reality that the U.S. military has put all this stuff in place that makes the acquisition of knowledge about the global environment possible, and it has also devastated local environments. At the same time, of course, the military has not always used the knowledge it has acquired in a way that's been global. Military knowledge is for very specific strategic reasons. How to deploy, how to move, how to make sure weapons and machines work in difficult places. In the 1950s the military and its research teams were studying if the ice cap was melting precisely because it would open up a northern route across the polar North. This was a strategic problem. It was also a climate problem. Yet, this was not information that was readily turned over to climate or environmental scientists, even though it could have been quite useful. So, there's a contradiction in here that I don't necessarily know how to answer, but I want to reveal it so that people can grapple with it. I want people to ask what kinds of stories we should know about the military and its impact on knowledge. Because today, still, the US military has the most remarkable planetary capabilities. We should think more carefully and collectively about what that might mean.

MAT: Yes, absolutely. Well, Dr. Heefner, I really enjoyed our conversation. Thank you so much!