How technology metals play a pivotal role in allowing remote work during the pandemic

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aleem Ali, the University of Delaware's Blue and Gold Distinguished Professor of Energy and the Environment and the founding director of the Minerals, Materials and Society (MMS) Program, discussed how technology metals played a key role in allowing the switch to remote work during the COVID-19 pandemic. Credit: University of Delaware

Saleem Ali is the University of Delaware's Blue and Gold Distinguished Professor of Energy and the Environment and the founding director of the Minerals, Materials and Society (MMS) Program. Ali recently produced a short, educational documentary featured on the United Nations Environment Programme's YouTube channel highlighting the role of technology metals that allowed people around the world to switch from working in an office to working remotely during the COVID-19 pandemic. UDaily spoke with Ali about these technology metals and the role they play in helping power a remote-work world.

Q: During the COVID-19 pandemic, many professionals and students had to switch from working in an office or learning in a classroom to doing remote work. Could you talk about some of the minerals and materials that made this switch possible?

Ali: We call them technology metals, and it's a broad range of metals. The infrastructure for the internet is made of massive cables. Some of those cables have fiber optics in them, but they also have metals. The cable itself is a composite of the fiber optics—which is essentially silicon-dioxide, glass—but they also have a lot of metal with them, mostly copper. Apart from the physical cables, you also have the servers, which is where the internet storage and processing happens. The servers have a wide range of metals and materials. They have storage devices that include, in some cases, rare earth elements like neodymium which have been used for hard drives, but they also contain the more common metals like copper, silver and tin.

Q: What about the computing devices that we use to work remotely?

Ali: That is where you have rare earth elements used. The screen of the computer has a wide range of these more exotic elements that are used. In telephones, you need certain kinds of rare earths which are used for the vibration of the phone, to make the batteries more effective. You have capacitors, which require columbium/niobium and tantalum, and you also have lithium, which is very important for the lithium-ion battery. That has revolutionized the way we have cell phones and iPads because it's the highest density of energy you can store in a small location. Otherwise, we'd be carrying around enormous battery packs.

Q: Could you talk about the impact that working from home has had on the environment?

Ali: The material footprint of working from home is vast and often neglected. As we are thinking about reducing our carbon footprint, we often feel very smug about the fact that we are now working from home and we're not commuting so we do not have car emissions. We have to keep in mind that all that information processing requires energy. There's no free lunch, and we have to keep track of all that. It may well be that in many cases, working from home has a lower carbon footprint, but in other ways, a lot depends on how we manage that internet infrastructure. Where are the server farms? What's the energy source for the server farms? Many of them have been moved to locations like Iceland because they have to be kept cold and as you process a lot of information, the servers generate a lot of heat. You have to air-condition the rooms where they are kept. They moved them to Iceland because there's geothermal energy so you get relatively free energy compared to other sources and you also have a cold storage environment for them. There are all these very complex interactions which go into ensuring that our Zoom call is seamless and effective across the globe.

In terms of no free lunch, information itself has certain properties and in order to process information, you always dissipate energy of some kind. Thus you always have to have some kind of energy injection to process information. If you do it physically when you're next to someone, you'll just have the direct interaction with that person. But if you are at a distance, the only way you can process that information will require some energy. We now have much more complex ways of transmitting information, which is much more energy intensive than what was required to just pick up a phone and talk.

If you are conveying a photo image with color, you need much more energy because you are transmitting far more information. Each pixel has information in terms of what's being transmitted. If you want to be able to communicate that information, you will have to use energy. Either you use the energy to physically move yourself or you use the energy to have a high-quality video call with each other. If you want to have a lower energy call, you pick up the phone. But that's not as useful. It's astonishing how we have been able to harness the elements of the earth to make our lives convenient in small ways.

Q: Is there one section of the Earth that provides these technology metals or do they come from all over?

Ali: They're quite widely distributed. It depends on which metal you're talking about. The cobalt in batteries for electric cars, 60% of that comes from the Democratic Republic of Congo. Lithium, primarily, comes from Chile, Argentina and Australia. There are some countries that are dominant in metals. Australia is one of them. It's a mineral superpower because it has the world's largest iron-ore production, aluminum production, copper, some of the rare earth elements. Basically, every major metal you get is in Australia. Canada is another major mineral super power. In the developing world, you have countries like Congo and

Zambia and in South America, Chile produces a vast amount of copper. The world's largest copper and lithium producer right now is Chile.

There are also prospects to mine these metals in the deep sea. Right now, we do not have deep sea mining. But that's something that's being proposed, and that's another area which I'm studying.

Q: What is the role of the United States in terms of these technology metals, especially, rare earth elements?

Ali: I wrote an op-ed for the Hill recently that was in response to the Biden Executive Order. It's currently important for the government, and it's a bipartisan issue. Even President Trump had an executive order on mineral supply because of the concern around the dominance of China with rare earth metals.

Ninety percent of rare earths come from China. So there is a concern that China would use this as leverage on international trade. I believe we should find a way to cooperate globally on mineral supply rather than making it an issue of competition. Ultimately, most of these technologies are global endeavors. Especially the internet. Originally, it started as a Defense Department effort, but it was quickly embraced as a global enterprise and the World Wide Web. The norms under which it has operated since has been very much open internationally. I'm hoping that on mineral supply, we see global infrastructure around minerals in a similar way.

Right now, the security imperatives are there, especially because of the defense use of these metals. One of the things I have argued for is a global agreement on minerals, and you can have a look at some of my earlier writings around that. I published a paper in nature in 2017 with a group of colleagues where we argued for having a global agreement on minerals. I am currently working on an article about this issue with several European scholars and the United Nations Environment Assembly is also considering some tangible action towards such an agreement.

Q: What are the concerns around the supply and demand of these materials?

Ali: One of the concerns is that as new technologies are developed, the materials you need for those new technologies are kept secret for intellectual property reasons. But if you want to upscale those technologies, you need to have those metals available. If there isn't that communication between the demand centers and the supply centers, you end up with a bottleneck when you get ready to upscale. I have also argued for a model of Smart Mineral Enterprise Development (SMED) with colleagues at the Columbia Center on Sustainable Investment in an earlier publication.

If we had some kind of a global agreement on how you plan for these kinds of metal supply needs, then you would also do the mining and extraction in places which have the most potential. Mining is different from other industries in that you are beholden to where you can mine based on where the ore reserves are. For example, there are geological reasons why Congo has so much cobalt, or similarly, Jamaica has so much bauxite. For years, Jamaica was the world's largest aluminum producer. And those are geological reasons that human agency has very little control over. This is the same for petroleum too. If we had a better system around making sure that there is supply security for these minerals because of the need for global infrastructure like the internet or for green technologies to meet the carbon emission targets, then we would be in a much better place.

Climate change is a global threat. That's an issue where even Biden and Trump said we can cooperate with China. Well, if you say you can cooperate with China over climate change, how are you going to meet those targets? You need technology. Under the Paris Agreement now, there's no mention of how we are actually going to resource the infrastructure to meet the Paris targets. China is still the world's leading producer of solar and wind power, and they have the metals. So having a cooperative mechanism would be helpful for the whole planet. Climate change is not going to be selective in terms of particular countries. It may be disproportionately impacting certain latitudes, but that often will likely transcend countries.

Q: What is UD doing to help address these problems?

Ali: We have our Minerals Materials and Society Program, which launched a graduate certificate program in 2020. UD is also trying to build a critical mass of research and teaching interest in this area. My colleague, Julie Klinger, has a new NSF Grant that links to this. I'm the senior person on that grant, and I'm quite involved with it behind the scenes. That grant focuses on illicit supply chains. When you have a rise in demand for these metals, people are going to see a rise in the price if the supply is constrained. Then, you'll have all these illegal supply chains. So that grant is focusing on trying to use spatial techniques along with machine learning to see if we can trace and track illicit supply chains of technology metals through data analytics. We are also part of the U.S. State Department sponsored "Public Private Alliance for Responsible Minerals," and our students, from CEOE and Lerner College, have been working on semester-long experiential projects with the U.S. Department of Labor as well. UD has the potential to be a national leader in this space through our campus-wide competencies.

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