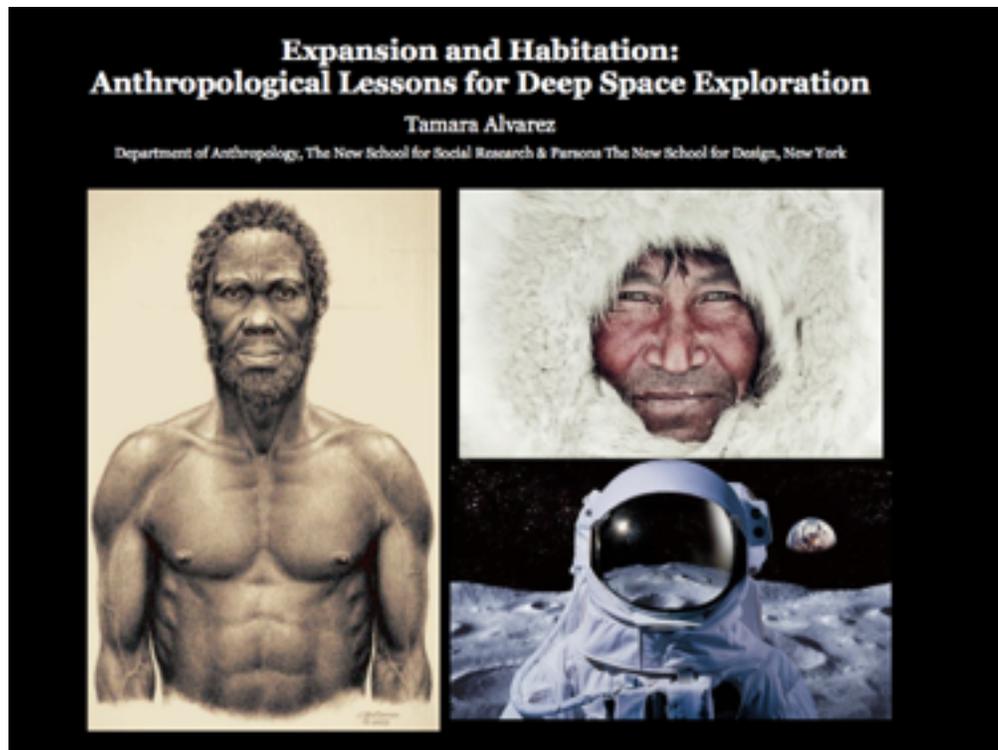


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Expansion and Habitation: Anthropological Lessons for Deep Space Exploration

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Hello everyone. I am Tamara Alvarez, instructor of Transdisciplinary Design at Parsons the New School for Design and also an anthropologist, so in my presentation today I'm gonna speak, from an anthropological perspective, about how deep space exploration might fit in a larger scheme of human territorial expansion and habitation of extreme environments.

Thus, I've split my presentation in two parts:

-First, I'll talk about humans' long history of spatial expansion on Earth, pointing at the ways in which human spaceflight can be understood as a stage in this history;

-And second, I'll discuss some human groups' technological adaptations to terrestrial extreme environments, drawing parallels between these and the human-technology partnerships that may allow for human life off Earth.

So first, expansion.



<https://www.youtube.com/watch?v=CJdT6QcSbQ0>

Since the mid-1980s there's been a pretty broad agreement in the scientific community that homo sapiens originated in East Africa —what is known as the Out-of-Africa theory or the single-origin hypothesis.

In 2005, the journal *Nature* published a now-classic study following Brown, McDougall, and Fleagle's discovery of 160,000 years-old human bones at Herto, Ethiopia, confirming this hypothesis.

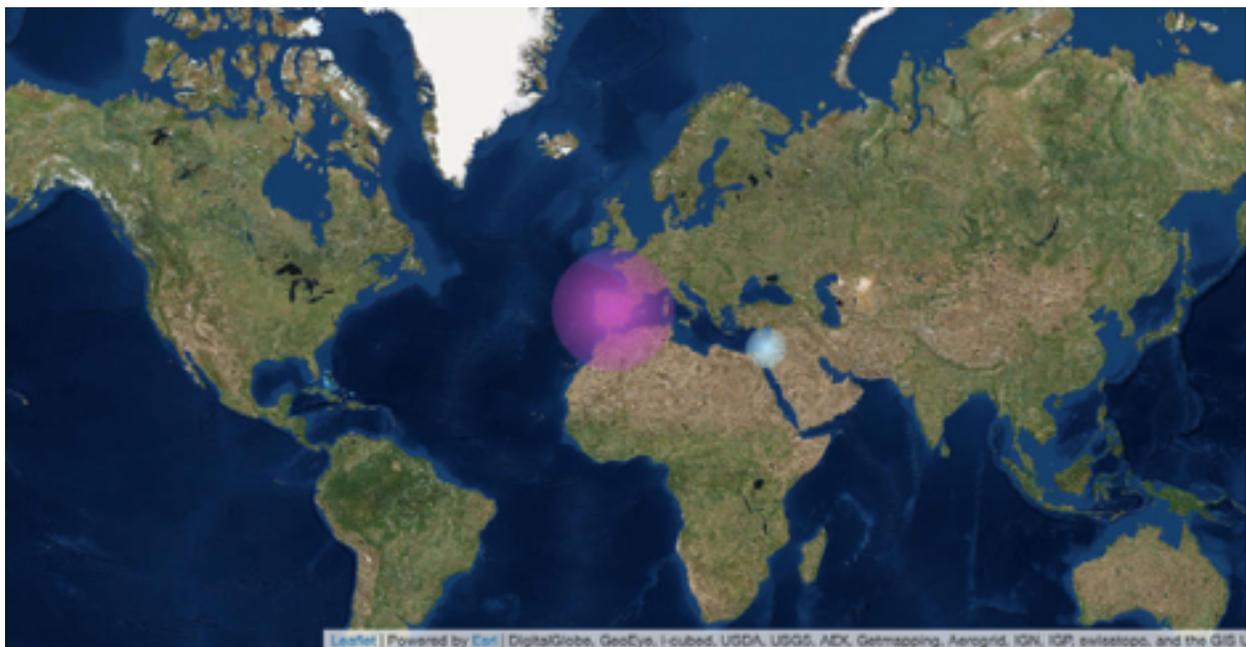
Very recently, in June this year, older human remains (dated 315,000 years old) were found in Jebel Irhoud, near the Moroccan Atlantic Coast, complicating things: today this animation would perhaps start in Jebel Irhoud, or most probably, in both West and East Africa.

Regardless the exact point, or points of origin, the fossil record suggests that groups of these early humans left Africa around 60,000 years ago, and approximately 50,000 years ago some of them reached Australia.

Around this time a second group, we don't know how large, crossed the Red Sea, gradually populating the Middle East and East Asia.

Only 40,000 years ago homo sapiens arrived in Western Europe; it was around this time that Neanderthals went extinct. For years it was believed that homo sapiens and neanderthals were two completely separate species, but it is now known that we mated with them and, in fact, we all carry different percentages of Neanderthal DNA within us.

Finally, during the Ice Age (around 15,000 years ago), homo sapiens expanded into the American landmass, de facto completing the species' occupation of the Earth's continents.



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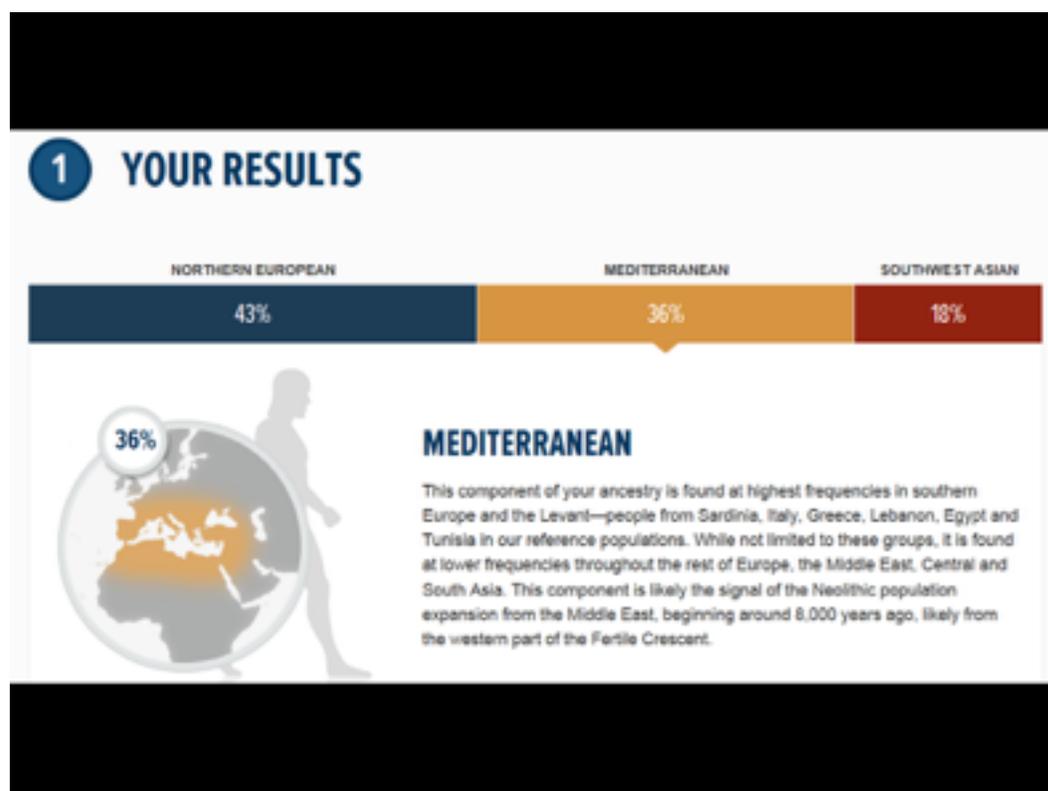
Southwestern Europe

Interestingly, Southwestern Europe may have been the last refuge for the Neanderthals, due to its relatively sheltered position during the glacial maximum. European hunter-gatherers also may have taken refuge there 20,000 years ago. Eventually, the first farmers arrived

If you're curious, you can now track your DNA and find out about your genetic ancestors' migrations. Several non and for-profit organizations in the US, like ancestry.com or 23andme.com are offering "ancestry" services that reveal all kinds of things hidden within yourself —from your predisposition to certain diseases to your ability to run long distances, among many others.

Last summer I met the director of one of these organizations, National Geographic's The Genographic Project, and decided to give them a sample of my DNA.

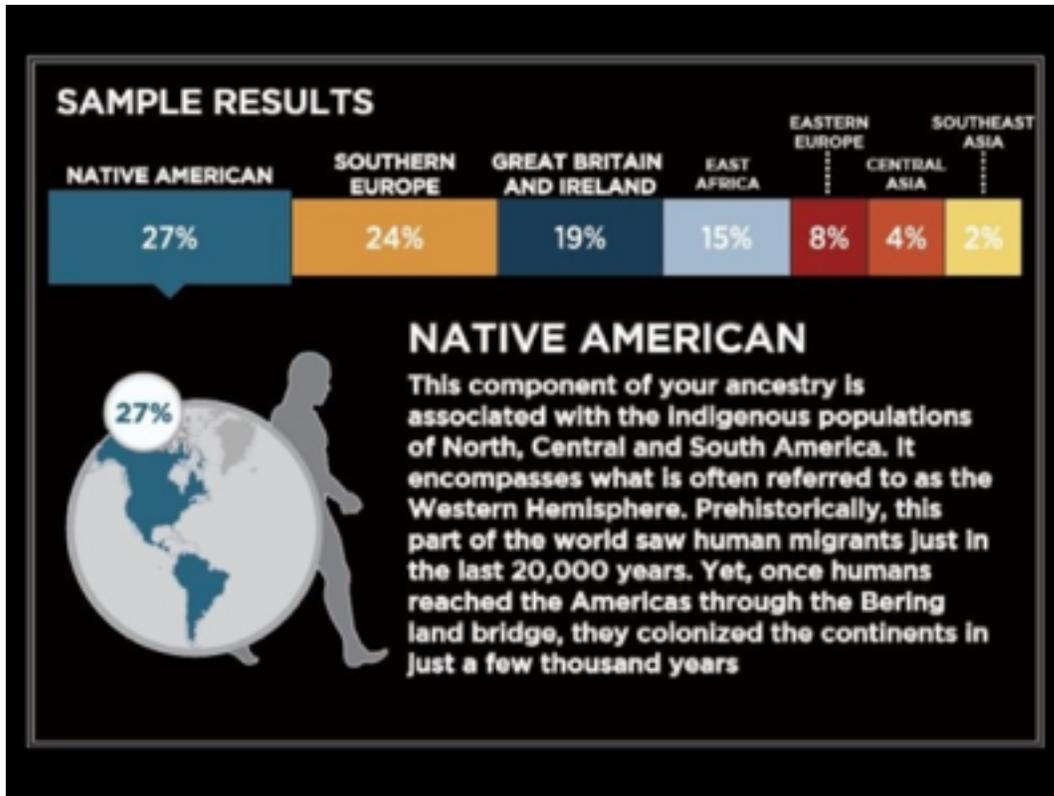
These are my results, which are pretty boring: my ancestors seemed to have migrated to Spain very long time ago and just stayed there for hundreds and hundreds of generations.



Other people's results though, tell much more interesting stories. Like this one, that illustrates the long history of miscegenation in the Mediterranean.

Or this other one, which is fascinating: a single human's DNA revealing the entire scope of human migration, from Africa to Asia, Europe and America.

Though this is not the purpose of this presentation, I must highlight that these histories should not be romanticized: in many cases, genetic admixture hasn't been the result of love, but rather of warfare and slavery.

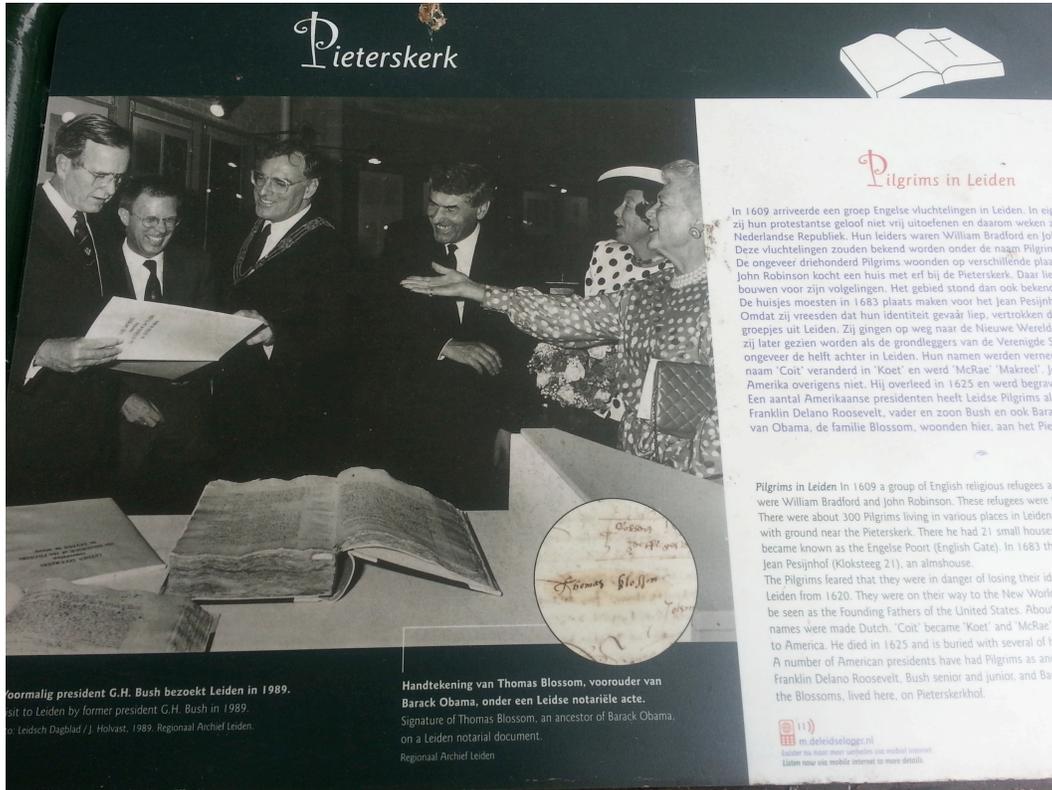


If you decide to have your DNA analyzed, you might also discover, like I did, that you share ancestors with some famous figures (in my case, Abraham Lincoln and Napoleon).



Or even that you are related to people you'd never imagine: like US presidents Barack Obama and George Bush, both descendants of Thomas Blossom (an English puritan who left the Netherlands for America to join the Plymouth Colony in 1629).

Here you can see president George H.W. Bush in his 1989 visit to Leiden, eyeing at the pilgrim papers in disbelief before Queen Beatrix of Holland.



So this for the deep past. What about expansion in our time?



12,000 years ago, the population of homo sapiens exploded with the advent of agriculture, and since then we have kept growing and expanding after every technological revolution. We need to take into account, though, that this expansion took place *horizontally*, that is, along the surface of the Earth, with our feet stuck to the ground by the action of Earth's gravity.



<https://www.youtube.com/watch?v=6yNBDCOGTpg>

However, I argue that in the last decades of the 19th century, and especially throughout the 20th and 21st centuries, the angle of this expansion changed in a crucial way, shifting from horizontal to vertical.

On one hand, around that time and especially during and after the World Wars, we witness a very rapid development of aviation technologies. Of course the dream of flight had been around since at least Leonardo Da Vinci's flying machines, probably much earlier, but it was the industrialized production of aeronautical technologies brought about by the wars that made planes ubiquitous in the sky.



Also around that time cities began to grow vertically, as the first skyscrapers were built first in the US and later in other urban areas around the world. With these developments, homo sapiens managed to challenge gravity and began to inhabit places hundreds of meters above the Earth's surface.

This vertical expansion is not only directed up, but also down. Mines became deeper than ever, and underground systems (like this one in London, that began operating in 1863), were built.



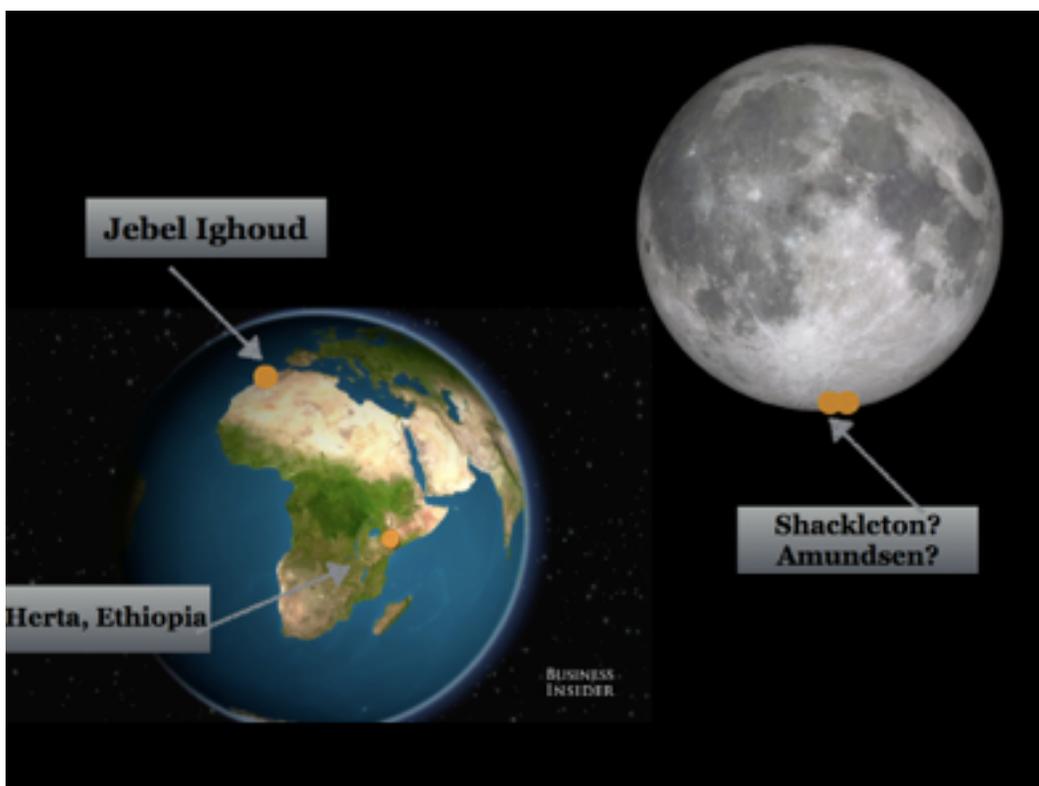
In the 20th and 21st centuries, better diving technologies allowed humans, like French homo sapiens Jacques Cousteau here, to explore deeper, not only on Earth but also in underwater environments.



Finally, with the launching of Sputnik in 1957 and especially with Gagarin's first flight in 1961, this vertical expansion that was already underway crossed a crucial threshold, and de facto took us off the planet.



If humans manage to settle on the Moon or Mars, as we've been discussing at ESTEC this week, exploration of those extraterrestrial lands would imply going back to these beginnings (Africa), and a new cycle of "horizontal" expansion would start.



PART TWO: HABITATION

Habitation

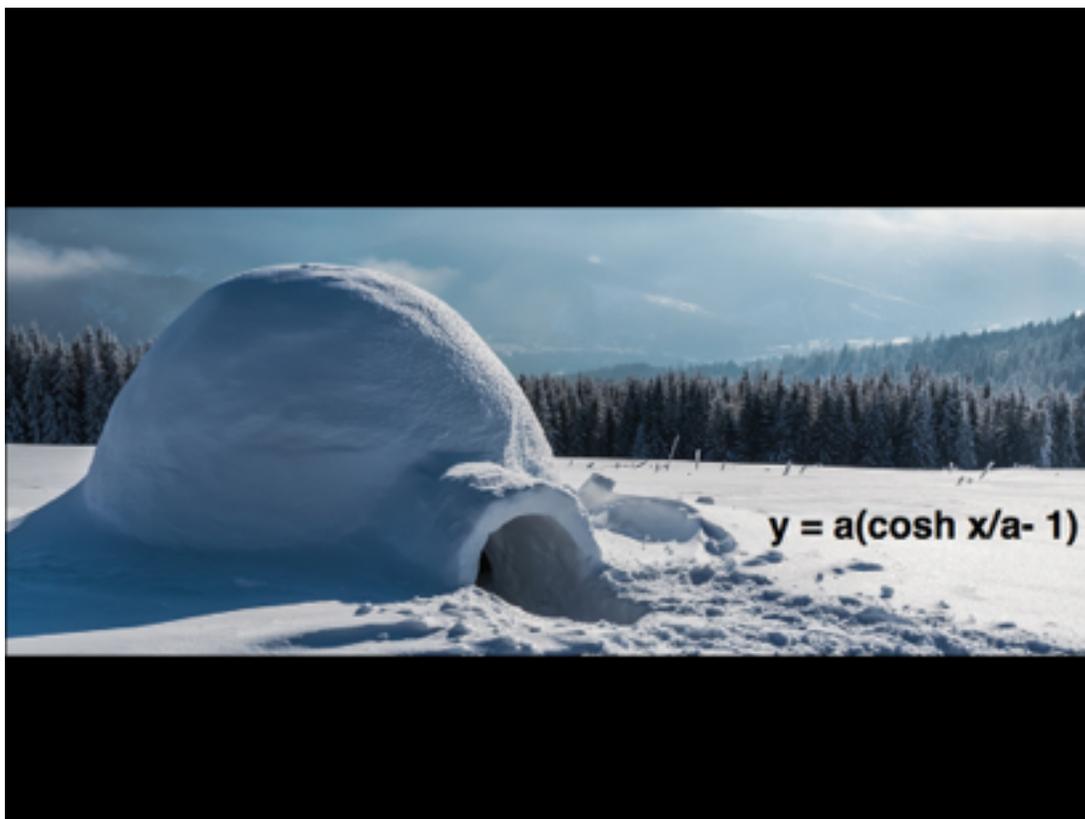
Now, in the second part of my talk I'd like to speak about some human adaptations to extreme environments. Of course we're all familiar with physical and genetic adaptations to these environments, like higher hemoglobine concentrations in Tibetan populations that equip them to better adapt to hypoxic conditions, or the higher metabolic rates of the Alacalufa indians of the Chilean Patagonia, that allow them to acclimate to the region's extreme cold.



In fact many have already speculated about the kinds of physical traits that we would develop after generations in microgravity: our spines would expand so we would be taller, we'd have weaker bones in the absence of Earth's gravitational pull, etc.

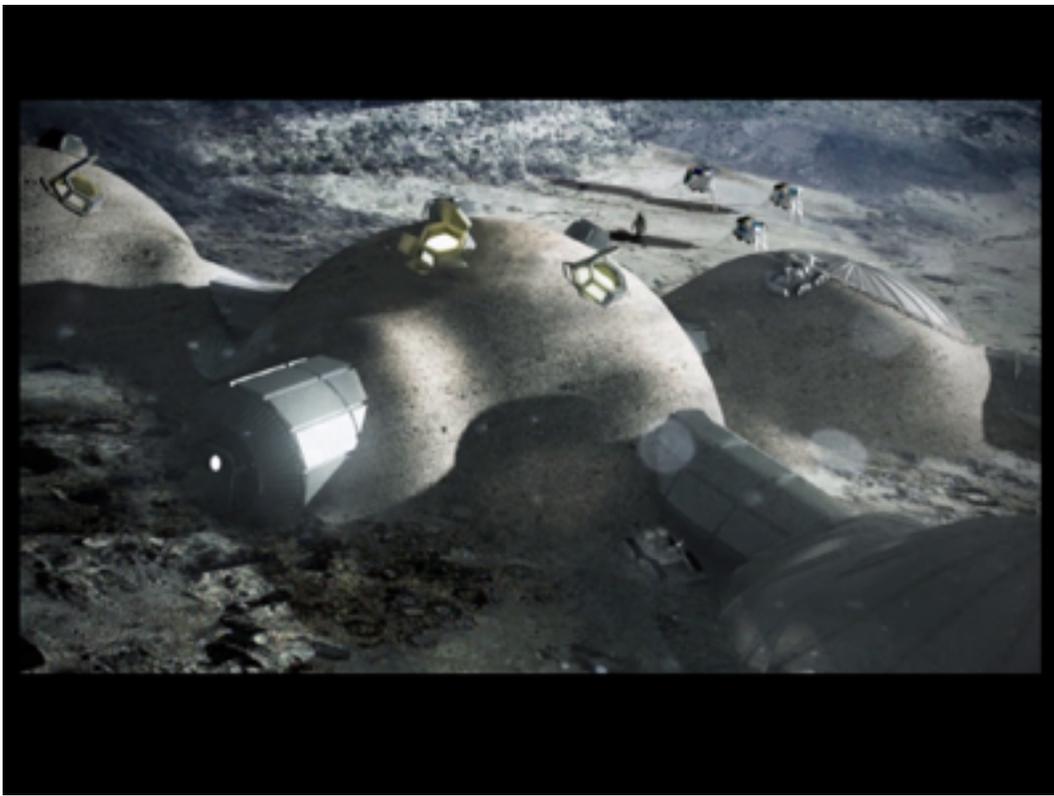
This picture is from the science-fiction show the Expanse, where the inhabitants of Eros, Ceres and asteroids, people Earthers and Martians call the Belters, have already undergone those physical changes (note the Belter-prisoner's height and complexion).

But these speculations might not be very helpful to us right now, since those physical changes take many, many generations to develop. For this reason we need to look at other kinds of adaptations, in particular, technological adaptations.



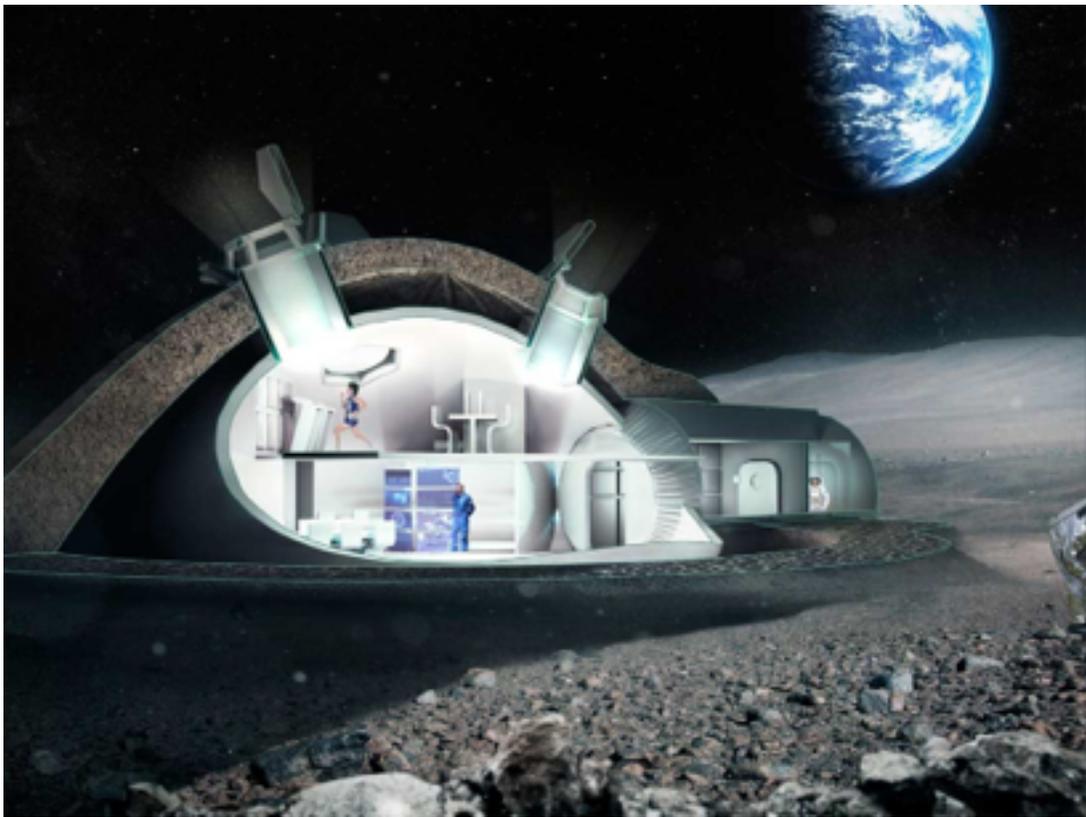
Eskimos figured out (thousands of years before this conference) that these catenary-shaped domes, ever-present in Moon Village visions, are more energetically efficient and protective from harsh environments than others (like Leiden's gable roofs, better adapted to the Netherlands's incessant rain). This week we've even seen a proposal for the lunar village, Ice Shell, that featured ice-capped shelters. The rationale behind was precisely the same as for the Eskimos' igloos: the inherent power of ice to isolate and protect from a threatening exterior.

For comparison, see Foster and Partners' Moon Village project [here](#).



And two artist renditions of igloo and lunar shelter interiors, respectively.



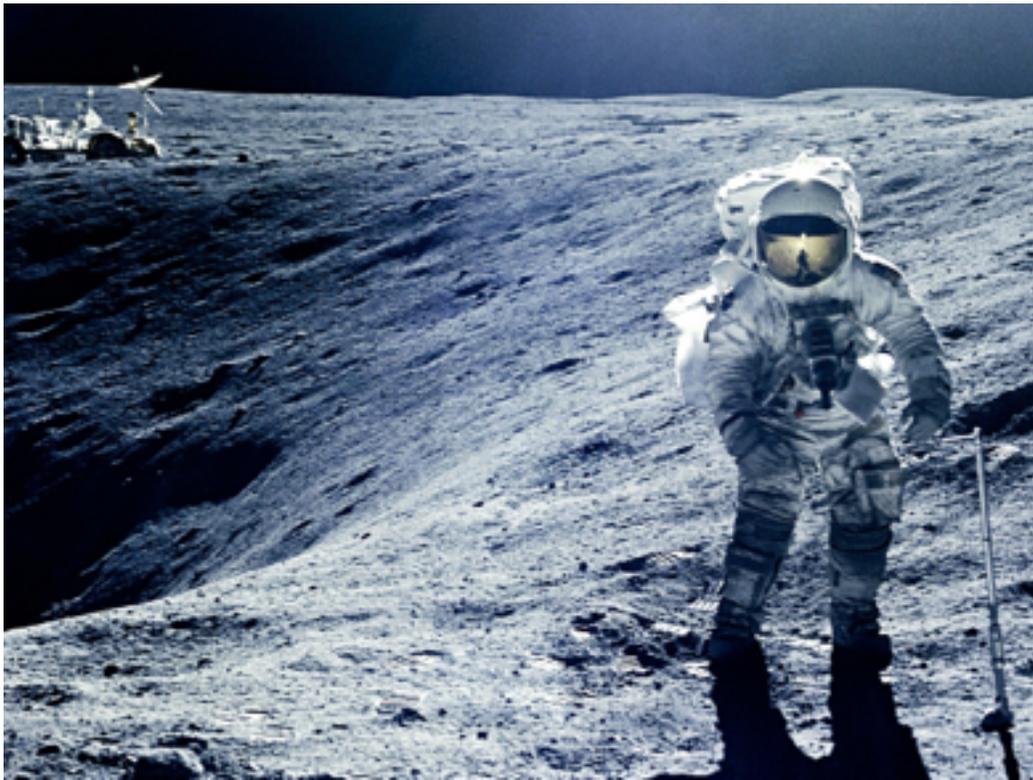


Another adaptation that is common for both Eskimo and space explorers, and I'd say, for all humans, is the clothing.

This is a Inuit man wrapped in a caribou coat, a protective shell Eskimos have been wearing for more than 4,000 years.



And this is the Apollo astronaut's version of the Inuit's caribou coat.



Here you can see a waterproof parka and matching gloves, that the Inuit used when kayaking and fishing, and in bad weather. They're made of seal intestines and sewn with sinew thread to ensure watertightness. On the bottom right corner there are a couple of Russian Orlan spacesuit gloves. In both cases, the goal is, again, isolation from the elements: for the Inuit, the fatal enemy is the freezing water; for the cosmonaut, it is the vacuum.





To safeguard themselves from the Sahara's harsh elements, the Tuareg also build catenary-shaped domes (see these made of mats) and wrap themselves in protective clothing. Specifically, they wear loose tunics, as the movement of the fabric provides a natural cooling system. These tunics hide their entire bodies, including the head and the face, to shield them from the blinding and burning sunlight; additionally, their turbans cover their noses, ears, and mouths, that protect them during sandstorms.



Much has been said lately about underground habitats on the Moon or Mars, since they might provide astronauts with appropriate radiation protection. As with catenary-shaped domes, caves have also been inhabited by homo sapiens for thousands of years (though I must note that the popular troglodyte myth is quite an exaggeration: caves have always been dangerous places, dark dens of predators and home to deadly microbes). In any case, I'd like to show you some examples.

These, for instance, are the entrances to Guyaju's famous cave dwellings, some kilometers west of Beijing.



These are grottoes in the Palestinian Occupied Territories, that were increasingly occupied after the 1967 Arab-Israeli War.



This one is a cave in the Sacromonte neighborhood of Granada, Spain, where gypsies have lived for generations (now they're also used as flamenco tablaos for tourists).



Some have even transformed caves into a luxury business. See for example this hotel in Matera, Italy.



And finally, this is Germany's Za Architects mars colonization vision, though, of course, there are many others proposing similar underground habitat concepts.



In sum, my goal with this presentation was to place space exploration in a larger scheme of humans' relationship to their environment.

To finish, I just wanted to show you this clip of Werner Herzog's *The Cave of Forgotten Dreams*, a film about the Chauvet Cave paintings found in 1994 in France.



https://www.youtube.com/watch?v=W_seBLuIQjU&t=8s

These paintings, that depict extinct species such as the cave lion, or animals that no longer roam over Europe, like the rhinoceros, are 35,000 years old; nevertheless, they reveal the artists' extraordinary sensibility towards their surroundings, very early in homo sapiens' evolution.

I saw this film for the first time this year, and it made me think: if we finally begin exploration of other worlds and dwell underground, be it in lava tubes or in caves we dig ourselves, what kind of marks would we leave in those places for the generations to come? Maybe they'll be as beautiful as these.

Thank you.