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# SPACESUITS

WHAT CAN THE DESIGN OF  
SPACESUITS REVEAL ABOUT US?

The direct interplay of fiction and reality has never been so apparent to me as when I consider the fact that we are living in an era when we're simultaneously prototyping spacesuits that will take humans to the surface of Mars while also dreaming up what fictional spacesuits for exploring Mars should be like. We're seemingly so close to fiction meeting reality by landing humans on Mars, but for now it's narrowly out of reach. In conceptualizing the spacesuits that will take us there, we know we can't use the lunar spacesuits of the 1960s and 1970s for the surface of Mars. For one thing, it will be a lot easier to go for long walks on a planet that has one-third of Earth's gravity; compare that with the Moon's gravity, which measures one-sixth of Earth's and which had Apollo astronauts hopping around in bulky suits that weren't known for their flexibility. Reality often inspires fiction, but sometimes it's the other way around; Boeing notably debuted bright-blue spacesuits a few years ago that invoked aspects of *2001: A Space Odyssey*. Over the decades, spacesuit design has become so intertwined with fiction, reality, and nostalgia that the three can't avoid playing off of and inspiring one another.

Spacesuits are not merely tiny human-shaped spaceships; they are also a form of fashion, an expression of a piece of our humanity. From 2007 to 2009, NASA organized an Astronaut Glove Challenge to spur new designs for spacesuit gloves, which were notoriously uncomfortable and difficult to manipulate. One

of the awardees of the challenge, Ted Southern, came from the fashion industry. He has a degree in sculpture as well as experience building costumes for film and TV, including the wings worn by Victoria's Secret models.

Wanting to better understand spacesuits through the eyes of fashion and design, I talked with Nicholas de Monchaux, a space enthusiast who wrote an architectural history of the Apollo spacesuit and is now professor and head of architecture at MIT. He spent ten years researching and writing about spacesuits from a design perspective, and his book, *Spacesuit: Fashioning Apollo*, explores our relationship to spacesuits. I also spoke with Adam Savage, who brings the eyes of a maker and craftsman to the spacesuit discussion. Savage cohosted *MythBusters* for several seasons and has built everything from spacesuits and futuristic weapons to fine-art sculptures and dancing vegetables.

We convened in Savage's workspace, where we were surrounded by life-size replica astronaut suits from *Alien*, NASA's Apollo and space shuttle missions, and even a replica of the earliest practical pressure suit from the 1930s. Looking at these vastly different takes on spacesuits, I was struck by how they aesthetically spoke to the fictional and real cultures that inspired their various designs. In the US, we often hold a stereotypical view of an astronaut in a bulky white spacesuit, but as more governments and private companies participate in exploring Earth's orbit, the Moon, and eventually Mars, spacesuits of the future could look very different.

**ARIEL WALDMAN:** There are so many iconic spacesuits in film and TV. From *2001: A Space Odyssey* introducing color-blocking to *Sunshine*'s dazzling disco-ball spacesuits, each creatively demonstrates how the form a spacesuit takes can differ widely. Do these different expressions communicate something about the world they exist in?

**NICHOLAS DE MONCHAUX:** I love films

that aesthetically convey what a spacesuit actually does, which is sort of transform the human body into something more than itself. The Harry Lange spacesuit from *2001* is so canonical in that. Despite being a completely function-free design, it also conveys what a spacesuit actually does.

What's more, the word "suit" comes from the Latin "to follow"—like pursuit, you're following someone or something. And so to be in a suit means that you're adapting to a certain kind of environment. The film *Gattaca* makes a very strong statement to this effect at the end of the movie. Ethan Hawke is seen wearing a tailored vintage business suit in the last shot of *Gattaca* as he prepares to launch into space after struggling to be considered perfect enough for spaceflight. It's such a commentary on how suits are the ultimate normality and conformity that he has been rebelling against, but in a way no one around him can see.

What I love about that film and its depiction of a literal suit as a spacesuit is it has all these undertones of drag and "passing" for someone or something. *Gattaca* shows all the ways in which fashion gets used in the culture at large and then transmutes it onto the spacesuit. RuPaul said, "We're all born naked, and everything else is drag." We're all suiting ourselves to the world as we find it, and we try to find our place in it through what we wear.

**ADAM SAVAGE:** *Alien* is maybe one of the first movies to deromanticize putting on a spacesuit, and I love Kane's spacesuit from *Alien* for that reason. It was built by John Mollo and his Academy Award-winning effects team, and designed by Jean Giraud, aka "Moebius," one of the great illustrator-imagineers ever to live. I love how it evokes its workmanlike qualities on its sleeve. It looks like an ancient diving suit from the turn of the last century. It has callbacks to samurai armor and cricket armor, but mostly it feels unadorned by any fashion sense. It's hot and uncomfortable—not only in the film, but also behind the scenes. Apparently the actors were all passing out constantly on set from wearing the spacesuits, and there's all these shots of them backstage sweating bullets while on smoke breaks.

But to me, [putting on] a spacesuit is the closest we can get to being a superhero. Every superhero's outfit helps them



and gives them extra powers. Spacesuits give us perhaps the greatest power: of exploration. I can't stop wearing spacesuits because of this.

**WALDMAN:** We often see depictions of spacesuits with magnetic boots like in *The Expanse*, or augmented-reality heads-up displays like in *Star Trek into Darkness*, but what technologies in fiction are most likely to influence NASA and the future of spacefaring?

**DE MONCHAUX:** I think the thing that NASA would most want from fictional spacesuits is the ability for astronauts to move easily in them. A spacesuit is a highly pressurized environment in a vacuum. If you imagine the hardest basketball, that's how hard and stiff a spacesuit is when it's inflated. Just like a basketball, the spacesuit wants to be round, and you're not round. So the problem of getting this incredibly hard, pressurized environment around your body, and also giving you the ability to move in it, is the difficult design problem of spacesuits that most people don't understand, especially from watching movies.

I was able to try on a contemporary EVA [extravehicular activity] spacesuit once. What I found so interesting about it as an

architect was that I had the realization like, "Oh, this does not feel like clothing; this feels like the smallest building I've ever been in. This has more structural integrity and thought and intensity than any building I've been in, but it's like an inch away from my body." If you had an ounce of claustrophobia, you'd get that feeling while in it.

**SAVAGE:** Astronaut Chris Hadfield told me that after an eleven-hour spacewalk he was so tired from working in his spacesuit that he basically crawled into a corner of the International Space Station and shivered for a couple of hours just to let his muscles untense from the incredible exertion.

**DE MONCHAUX:** Astronaut Kathryn Thornton, who was a space shuttle astronaut that helped repair the Hubble Space Telescope and other satellites, told me that when she performed those EVAs, she would just say goodbye to her fingernails. The spacesuit glove is the least spherical, most flexible part that's wrapping your body, and so just the effort of moving the glove fingers was incredibly physically intense.

In the Apollo era they did actually try mechanical pressure suits as an alternative solution. But I kid you not, these suits involved putting on about eighty layers of nylon stockings, to the point where it gave enough mechanical pressure to be able to survive in a vacuum. There's the most amaz-

ing, hilarious video of a man, a scientist in a laboratory, explaining what he's doing while he literally begins putting on eighty layers of women's nylon stockings all over his body until he physically can't move. That mechanical pressure suit didn't work.

Much more recently, an aerospace engineer, Dava Newman, had the great insight that with some smart materials and electrically actuated materials, you could have a suit that both was comfortable to put on and could shrink to provide enough pressure. Layering as a concept for spacesuits makes some sense, but if you have a fiberglass suit and something hits it, you're toast. Whereas a tear in a multilayered suit has a better failure mode. There ended up being twenty-one layers in the first Apollo suits and twenty-eight layers in the second. So suits that combine layering, pressure, and flexibility in a functionally elegant way have been in demand for a long time.

**WALDMAN:** There's so much variety in spacesuits that we see on-screen, and many of them reference different cultures or different time periods, or trying to invent something completely new. What do you think the future of spacesuits will look like?

**DE MONCHAUX:** In my work, I've been most impressed by the female astronauts

that I've interviewed, especially because they came up in the eighties in a very difficult time, a very difficult, male-oriented culture. I would love to see spacesuits for every different kind of body, every different color of body. I think that's the biggest issue we have in how we depict a relationship to science and technology, as we depict the world of science and technology as being more available to some of us than others.

**SAVAGE:** To look at the future, I have to look at the past, at the Russians, who really deserve tremendous props for consistently going in other directions than we in the United States ever considered.

In mission-critical engineering, everything you can remove is an advantage. The simplicity equals safety. The ingenuity of design from Russia over the decades has gone on to influence better designs for all of space exploration. You can see it in a lot of their spacesuits that don't have separate helmets or intricately designed airtight zippers like we see with NASA's. Russia's Orlan spacesuit was designed with a clever rear entry: you'd open the backpack of the suit and climb into it that way. NASA took that inspiration and ran with it so they could begin designing surface-exploration spacesuits that won't require an airlock to use. I love efficiencies like that, and I think the future of spacesuits has a lot of inspiration that it can pull from the past.

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When looking to the future of spacesuit design, it's clear that there's room for many visions of what space exploration looks like and how it functions. While science fiction and history are often great sources of inspiration, if we're not careful they can hold us back by dictating what the future is *supposed* to look like. Instead, we should look to the array of spacesuits that have been imagined over the decades in science and fiction as permission to keep imagining futures for ourselves that have not yet been sketched out.

One of my personal favorite efforts in this area is NASA astronaut Nicole Stott's Spacesuit Art Project, which invites children in hospitals, refugee centers, orphanages, and schools from around the world to paint pictures onto patches of fabric that are sewn together into a spacesuit. The resulting suit is a literal patchwork of hundreds of brightly colored paintings that is worn by astronauts in space. The project is so striking in part because it forces people to realize that they've never seen astronaut suits that look anything like this one. But it's also remarkable in how well it communicates a different vision for space exploration, one that speaks to a collective and collaborative future. What we see affects us—it has the power to excite us, intimidate us, or even repel us. Spacesuits in this way are a crucial part of the story we tell ourselves about who we are as explorers and where we're going. It's possible that our future may be bright and colorful, if we so choose.

