



Thinking about space laundry for a trip to Mars



Eduardo Muñoz at his desk at the Aeronautical and Technical Institute in São José dos Campos, Brazil.

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—Eduardo Muñoz

How do you do laundry on a nine-month trip to Mars? Answer: You don't. At least, scientists have not yet figured out the answer to this challenge—one of space travel's interesting problems.

A water-based solution is out of the question—water is heavy and expensive to ship, and what water one does carry needs to be used for human hydration. And while using fabric impregnated with anti-microbial agents might help the fabric allow you to maintain your health, it may not improve your smell.

Needless to say, wearing dirty clothes for days on end can create unpleasantness. Astronauts must exercise for two and a half hours a day to ensure that their muscles don't atrophy. And they can't exactly take a shower. Moreover, there is no washing machine inside a space capsule.

To date, the solution has simply been to wear clothing for longer than is normal on Earth, and after a time, throw it away, trading in one's ensemble for fresh clothes that one brings along. The trashed clothes then burn up upon entering the Earth's atmosphere. For astronauts at the International Space Station, bundles of clothing are sent along on a regular basis to replace what is discarded.

But this is an extremely expensive proposition, since it costs \$10,000 per pound to send items to the space station. Surely there's a better way.

Eduardo Muñoz has given the space laundry issue some thought. Muñoz conducts research at the Aeronautical and Technical Institute in São José dos Campos, Brazil. While a master's student in engineering at the same institute, he and his classmates were given an assignment to use systems engineering to tackle the "space laundry for a trip to Mars" problem. The idea was that via the exercise, the students would see first-hand how systems engineering is effective at designing a solution for highly complex systems.

Muñoz and his team used GENESYS™, a model-based systems engineering tool, for their project.

"I was really excited as I started to use GENESYS in modeling elements of the project," he said. "The visibility features provided by GENESYS are great, speeding the process and leaving room for innovative ideas."

Spoiler alert: Muñoz and his teammates did not discover a solution to the space laundry problem. "We didn't have access to real stakeholders, nor did we have the ability to prototype anything," he noted. But what they did learn in thinking through the problem using the systems engineering thought process was eye-opening. "It was fruitful from our student perspective to actually see the flows and functions."

Systems engineering, Muñoz notes in his team's paper on the project—*Systems Engineering for Innovative Space Clothing Solution**—teaches one to balance performance, risk, cost, and schedule via an iterative process. He believes that performing the rigor of systems engineering actually allows one to increase one's opportunity for innovation. "The model-based systems engineering perspective and the identification of emergent properties in a system increase the innovation opportunities," he writes. "Perfection thus arrives out of imperfect steps matured throughout structured layered iterations."

Muñoz notes that systems thinking also helps you avoid preconceived solutions in your design—in this case caused by "terrestrial-valid premises." In other words, systems thinking helps you examine assumptions that while correct on Earth, may not be valid in space.

In working through the problem, Muñoz saw that GENESYS provided a flexibility that could capture the inputs without losing rigor. "Having all the data in one database and capturing the ever-changing data and requirements and inputs was great. You can refresh the inputs and deal with them in an almost real-time situation," he said. "This makes it easy to collect data from different stakeholders and different groups of people."

Since Muñoz carried out the exercise with his teammates in 2017, he has completed his Master's of Science in Engineering. These days, he looks at ways to help companies improve their manufacturing process by using systems engineering to reduce cost and spark innovation. "Systems thinking is always on my mind," he said.

With researchers like Muñoz thinking through the space laundry problem, someone is sure to come up with a solution. But if they don't, there's one consolation: Astronauts reportedly lose their sense of smell in space.

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