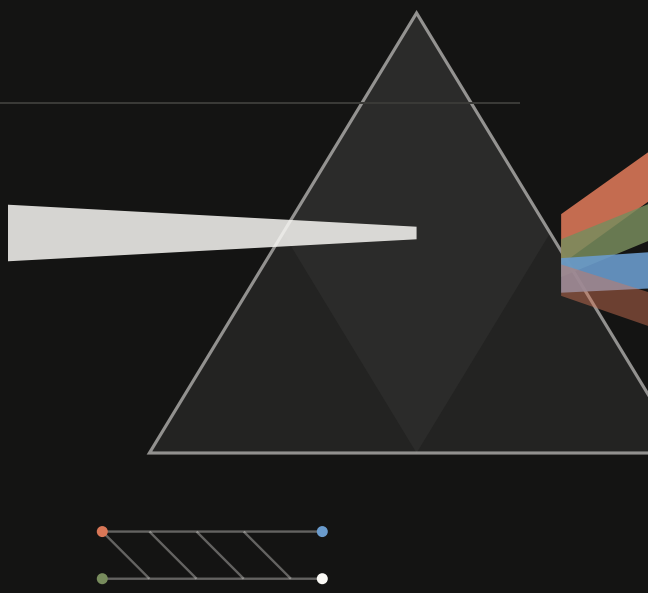
INFLECTION.

THE WEEKLY MAGAZINE OF INNOVATION

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DEEP DIVE — ROBOTS BUILDING IN ORBIT



THE FEATURE · ASSEMBLY, NOT LAUNCH

Launch the bricks, not the *castle.*

Caltech's robot has started building an antenna truss in orbit, one strut at a time. The demonstration is small and imperfect. Its logic reverses decades of space engineering: stop designing structures to survive a rocket, and start shipping parts that become structures once they are up there.

INSIDE Against the Grain: the wrong-looking move that is actually right · Signals from medicine, energy and electronics · By the Numbers

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PREVIOUSLY · ISSUE 01

Photonic Computing.

Constraints are design variables. For decades, the hardest rule in space has been the rocket's shape. Everything that goes up must fit inside a fixed envelope, so engineers fold their antennas, telescopes and solar arrays like origami and pray that every hinge opens on the first try.

This week's feature starts from a different question: what if the constraint is the thing you change? When a small Caltech robot built a third bay of an antenna truss in orbit this month, it was not a triumph of hardware so much as a change of premise. The payload was a box of parts about a cubic metre in size, and the structure was assembled after launch rather than unfolded before it.

Our lens for this issue is simple and worth carrying into your week: when a limit feels fixed, ask who gets to decide where the work happens. Across the rest of the issue you will find that question answered in an electronics lab, a refinery membrane and a mouse study, each in its own way. Read on, and bring a pen.

— THE EDITORS

Sources for every figure are listed on page 09. Where a number is a projection or a preprint, the text says so.

DEEP DIVE · ASSEMBLY IN ORBIT

Launch the bricks, *not the castle*

Space hardware has been designed around the rocket's shape for decades. A robot on a six-month mission is testing the opposite bet: pack flat parts into a small box, then let a machine assemble them where gravity and launch loads no longer matter.

BY THE INFLECTION EDITORS · RESEARCHED, WRITTEN & DESIGNED WITH CLAUDE

In the first days of a spring morning, a box about one cubic metre left Vandenberg Space Force Base as one of ten passengers on a commercial rideshare. Inside, folded into a compact package, was an experiment called ASTRA, short for Autonomous In-Space Tensioned Reflector Assembly. Its job was to build something no one has ever built in orbit: the frame of a large antenna, one bay at a time, with nobody on board.

The problem nobody likes to say out loud

A rocket fairing is a hard boundary. Whatever you want to put in orbit must fit inside it, and that single rule has shaped satellite architecture for generations. Large antennas and telescopes therefore fold up, the way a paper fan does, and unfold once they are in space. Each hinge, latch and spring has to work on the first attempt, far from any repair crew.

The price of that approach is brittleness. A deployable structure is only as reliable as its weakest mechanism, and the more it folds, the more ways it can fail. Engineers have become very good at this, but the ceiling is set by what can be packed, not by what is needed.

The space-industrial reframing

The Defense Advanced Research Projects Agency (DARPA) began a program in 2022 called NOM4D, which stands for Novel Orbital and Moon Manufacturing, Materials and Mass-efficient Design. Its stated aim is to develop the foundations for building robust, precise structures in space, with the vision of ferrying raw materials from Earth and manufacturing in orbit.

ASTRA is one of the first flight tests of that idea. It asks a narrower question than the program's grand vision: can a machine take a kit of struts, joints and reflective film and assemble a precise, prestressed antenna, while operators on the ground send commands through brief passes overhead?

A kit, not a cathedral

The payload is built around a simple design principle: the robot carries no finished structure, only inventory. An autonomous manipulator picks struts and joints from nearby dispensers and attaches them into a truss. The target antenna is a 1.4-metre reflector with eleven bays in its full design. The mission launched two prebuilt bays, and the robot constructed a third in orbit.

The reflector surface is itself a clever piece of engineering. A netlike perforated film, co-invented with Igor Bargatin's group at the University of Pennsylvania, forms two reflective cable nets held taut by springs. Tension, rather than rigidity alone, gives the surface its shape. The tensioning idea is what lets a loose kit become a precise instrument.

The part that makes engineers wince

Operations are the hard part. Ground contact comes in seven or eight windows a day, each about fifteen minutes long. Caltech's team describes the work as repeated attempts to overcome problems that arose during operations, and says the robot's progress was slowed by many such surprises. The team does not expect to finish all eleven bays before the mission ends in December.

That candour is itself informative. A demonstration is supposed to prove a concept, not a product, and the concept has been proved at the level that matters: a robot in orbit can take a kit and make a structure.

> *"It appears unlikely that the demonstration will be able to complete the full truss assembly."*
>
> CALTECH, ON THE ASTRA MISSION · 5 NOVEMBER 2026

The team behind it

The project is led by Sergio Pellegrino, who is a senior research scientist at NASA's Jet Propulsion Laboratory as well as a Caltech faculty member. Jaden Suh, a former Caltech postdoctoral researcher now an assistant professor at the University of Texas at Austin, is among the researchers named on the project. Andrew Detor, the DARPA program manager, is named on the program, and a second NOM4D project runs at the University of Illinois Urbana-Champaign.

Timeline in brief

March 30, 2026 — launch on SpaceX Transporter-16 from Vandenberg, aboard Momentus Inc.'s Vigoride 7, one of ten payloads.
Mission window — about six months in orbit.
December 2026 — mission scheduled to end.

Sources: Caltech news release (5 Nov 2026); ScienceDaily (9 Nov 2026); DARPA NOM4D program page.

The three-step logic

Most of us assume a machine that builds things must be sophisticated, and that the sophistication lives in the arm. The ASTRA result suggests the sophistication lives in the parts. Struts, joints and film are designed so that a clumsy robot can place them and a reliable structure appears. Simplicity is moved from the machine into the inventory.

That trade has a market shape. If parts can be shipped flat and assembled on arrival, then the cost of an orbital asset is no longer dominated by the fairing volume of a single launch. It becomes a question of how many kits you can ship, how many machines you can station, and how often a structure can be extended or repaired. Those are operations questions, which means logistics firms, satellite operators and defence buyers, not only aerospace primes, have a stake.

Three things would have to be true before this becomes a business. The first is a demonstrated assembly rate, not just a single successful bay. The second is a published mass and cost budget, which Caltech's release does not yet provide. The third is a customer willing to pay for a structure that is grown rather than launched complete.

Each of those is measurable within two to three years, and the program's own timeline suggests the first answers will come from the NOM4D Phase 3 demonstrations the agency has flagged for 2026 and after.

FIELD NOTES · HOW IT WORKS

1. **Pack**
   Struts, joints and reflective film are stored as a flat kit in a box about one cubic metre. Nothing has to survive launch in a finished shape.
2. **Assemble**
   An autonomous manipulator picks parts from dispensers and joins them into truss bays, one after another. The third bay was built this way.
3. **Tension and verify**
   Springs pull the film into two prestressed reflective nets. The payload carries eleven cameras to monitor the work, while operators send commands during short ground passes.

Glossary

Deployable structure
A frame that is folded for launch and opens in orbit. Reliable, but limited by how much it can fold.

Truss bay
One repeating square section of a truss. An antenna is built from many bays joined end to end.

Prestress
Tension built into a structure so it holds its shape. A tensioned net stays flat even when loosely connected.

Ground pass
A short window in which a satellite is within radio range of a station on Earth. Here, about seven or eight per day.

Sources: Caltech news release (5 Nov 2026); ScienceDaily (9 Nov 2026); DARPA NOM4D program page.

Everyone is optimising the rocket. *The move is to stop caring about it.*

Watch the field and you will see a race to build bigger fairings, cheaper launches and more folding mechanisms. Almost every serious conversation about large space hardware begins with the same boundary, and then asks how to cross it with a better design.

The unexpected move is to treat the boundary as irrelevant. If the payload is a kit rather than a machine, the fairing stops being a design constraint and becomes a shipping container. Like the famous move in which AlphaGo played a stone that looked like an error to every strong player and turned out to be the winning shape, this one only makes sense once you see that the board has changed. The robot is not an add-on to the rocket problem. It replaces the rocket problem with a logistics problem, and logistics is a problem humans have been solving for centuries.

A strong competitor could take the same idea further: stock a station with kits and let machines assemble antennas, sunshades and radiators as needs arise, rather than launching each one as a finished object.

WHY THE CONSENSUS DISAGREES

The strongest counter-argument is not that robots are slow. It is that folding structures already work. Deployable antennas and arrays have flown for decades, and engineers know how to qualify them. Adding a manipulator adds moving parts, software and communication dependencies, and each of those is a new way for a mission to fail. A folded reflector that opens once is simpler than a robot that must succeed through a dozen fifteen-minute passes.

The evidence in this very mission supports that caution. Caltech says the full eleven-bay truss is unlikely to be completed, and describes many unforeseen problems during operations. No mass figure has been released, so nobody outside the team can yet say whether a kit-based approach beats a folded one per kilogram delivered, which is the number that matters to a buyer. We also cannot tell whether the tension-based reflector will hold its precision over a long mission rather than a short one.

So our contrarian read is conditional. The idea is strong, the first demonstration is honest, and the economics are still unproven. Treat the move as a serious hypothesis to test, not as a verdict.

Sources: Caltech news release (5 Nov 2026); ScienceDaily (9 Nov 2026); DARPA NOM4D program page.

Three stories from other domains, each with a number that deserves a second look.

MEDICINE

2 of 2

A brain-tumour therapy eliminated the cancer in every mouse model tested

Researchers at UC San Francisco report that a new cell-based therapy completely eliminated diffuse midline glioma, a lethal childhood brain tumour, in two mouse models. Mice whose tumours were later re-implanted rejected the new cancer cells. The authors state the work is preclinical and say trials at UCSF Health could begin as early as April 2027. The headline result appeared in Science Translational Medicine on 28 October; the university release followed on 8 November.

SOURCE · ScienceDaily, 8 Nov 2026, citing Science Translational Medicine 18(873), DOI 10.1126/scitranslmed.aed9994

ENERGY

32%

A clogged filter could cut refining energy, and the effect is larger than expected

A KAIST and Georgia Tech team describes a crude-oil membrane whose permeation rate is about 23 times higher than previous leading membranes, stable across 28 consecutive days. Process simulations project a cut of nearly 32 percent in refining energy and almost 38 percent in carbon emissions. These are projections from simulation, not measurements from operating refineries, and the story is an important reminder to read them that way.

SOURCE · ScienceDaily, 5 Nov 2026, citing Nature 654 (8120), DOI 10.1038/s41586-026-10677-3

ELECTRONICS

100,000×

Electrons respond to light faster than we can yet exploit, and the limit is a goal

A Regensburg and Max Planck team measured that electrons respond to a light field with a lag of roughly 500 attoseconds, and that local current densities can reach a trillion amperes per square centimetre. The "100,000 times faster" headline describes a long-term aspiration, not a demonstrated device. What is real is the measurement: a precise picture of how fast the electrons in a solid can actually move.

SOURCE · ScienceDaily, 7 Nov 2026, citing Nature Photonics 20(8), DOI 10.1038/s41566-026-01932-0

BY THE NUMBERS

Seven figures, each with its caveat.

11

bays in the full ASTRA truss design

Two launched prebuilt; one built in orbit. Completion is unlikely this mission.

1.4 m

diameter of the reflector antenna

Built from composite tubes, aluminium joints and a Kapton reflective surface.

~1 m³

stowed size of the whole payload

Everything needed to build the structure fits in one box before launch.

7–8

ground-contact windows per day

Each about fifteen minutes. This sets the pace of the entire operation.

32%

projected cut in refining energy

From process simulation, not operating plants.

23×

higher membrane permeation rate

Compared with previous leading crude-oil membranes, reported stable for 28 days.

~500 as

electron lag behind a light field

Attoseconds: a billionth of a billionth of a second.

Sources: Caltech news release (5 Nov 2026); ScienceDaily (5, 7 and 9 Nov 2026).

Look across this issue and a single pattern appears. The robot in orbit, the refinery membrane and the mouse therapy each succeed by changing where a hard problem lives. ASTRA moves complexity out of the rocket and into a kit and a machine. The refinery work reconsiders how crude is separated, using a membrane rather than a conventional process. The mouse study turns engineered cells themselves into the therapy.

None of these is finished. Caltech is candid that its truss will likely be incomplete. The refinery numbers are simulations. The electronics figure is a horizon, not a device. Yet the honesty of each source is itself useful: the strongest technology stories now arrive with their limits attached, and a reader who ignores those limits will be the first to be surprised.

The lesson for anyone building things is to ask, before optimising the obvious lever, whether the constraint you accept is really fixed. Sometimes it is. Often the thing to change is the question of where the work happens.

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NEXT ISSUE · FRIDAY

"Where in your work are you launching a castle when you could be shipping bricks?"

THE LENS · ANSWER IT IN THE MARGIN

Researched, written & designed with Claude. Typeset in Poppins & Lora on the Anthropic palette.

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