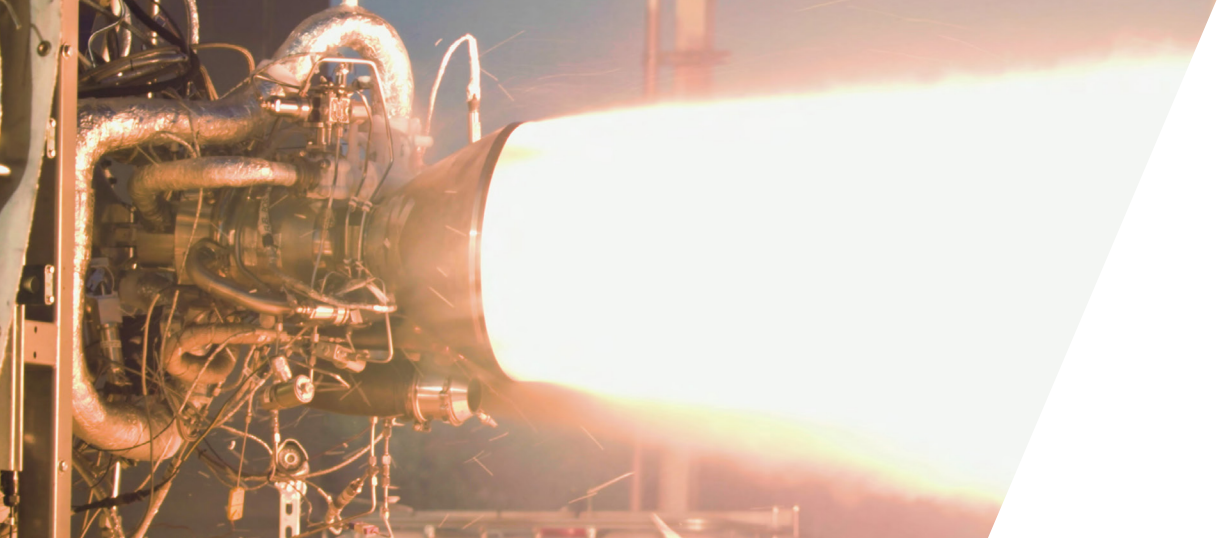
Engineering on the Edge

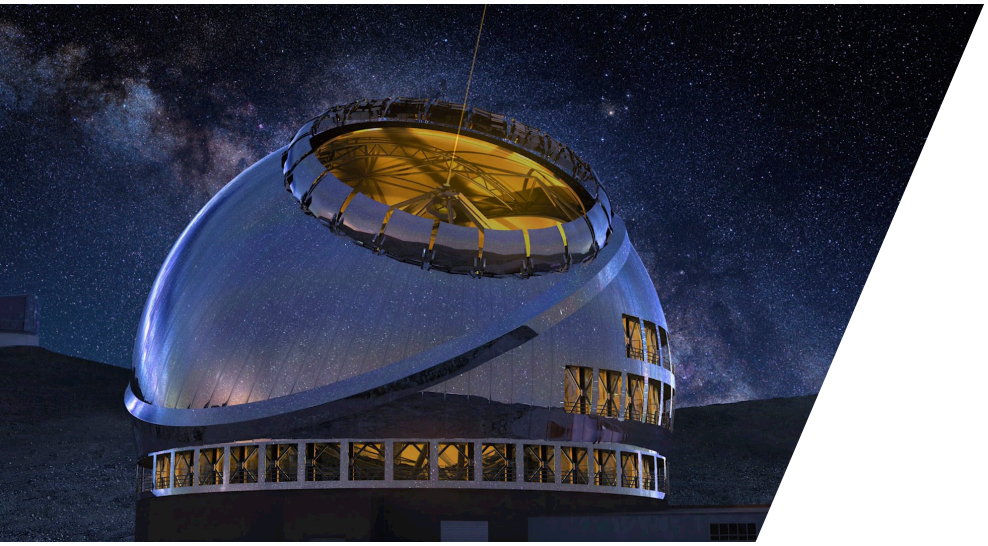
Explore the limits of what's possible with Autodesk

AUTODESK.



FIREFLY AEROSPACE

Get an inside look as Firefly races to be the next great private space company, and see what 1 million horsepower looks like.



DYNAMIC ATTRACTIONS

See what it takes to discover new worlds and explore the boundaries of our universe—from right here on Earth.

ROKION

How to design a battery-powered vehicle for range, safety, and off-road capability, then operate it miles underground. (Hint: start from scratch.)


FIREFLY
AEROSPACE
Building a 21st-century
aerospace company

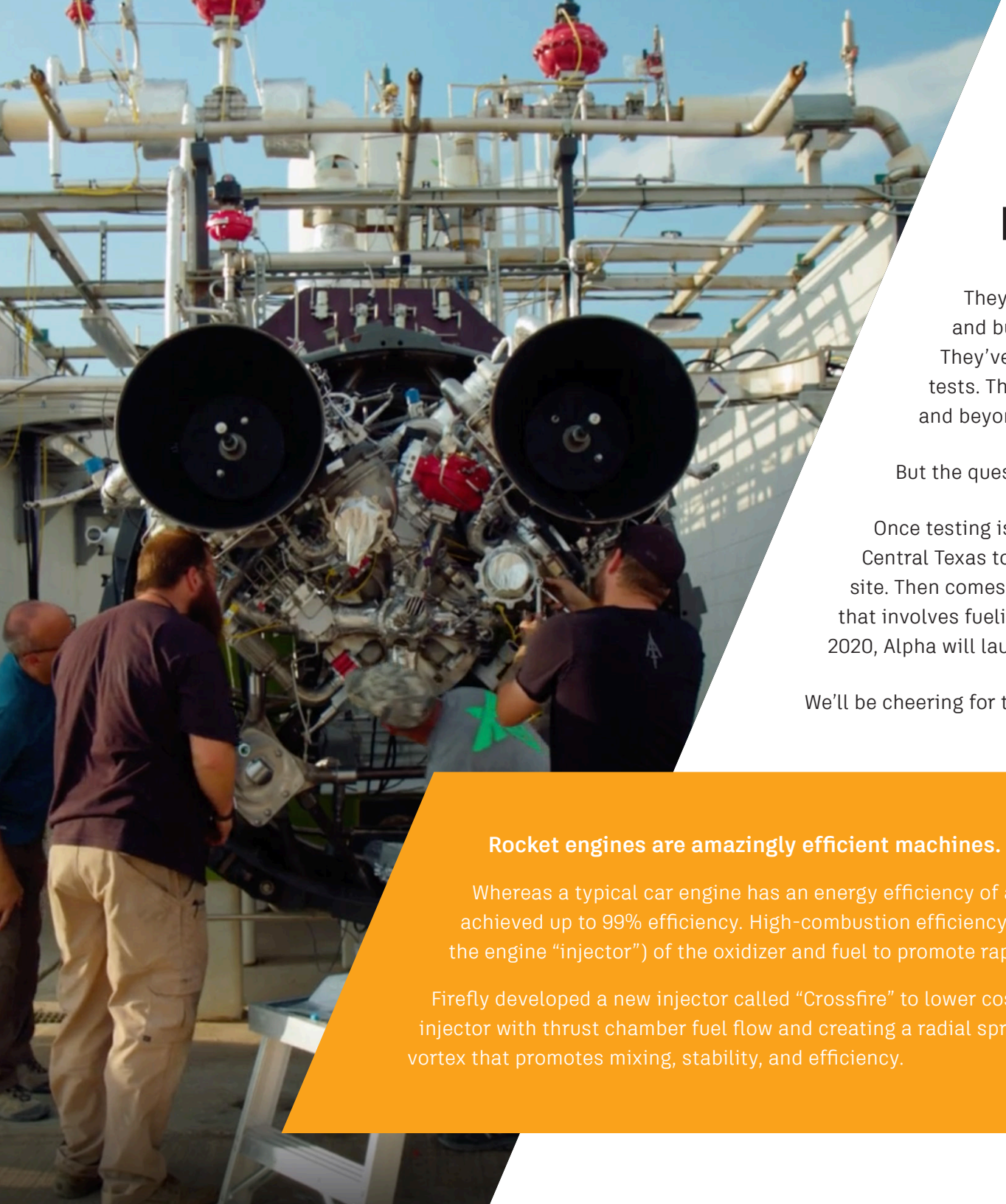
Firefly Aerospace

With a career trajectory that includes NASA and every major private space company in the United States, Tom Markusic decided to build his own rocket. Now, after five intense years, Firefly Aerospace is just about ready to soar into space, but the stakes are incredibly high. Most experts believe that the private space industry won't support more than a top handful of players. And Tom, along with 300+ engineers, technicians, and rocket scientists, is bent on being one of them.

"It's like a thousand sports cars running at the same time."

Building spacecraft is one of the hardest mechanical things you can think of doing—and we always need to be doing things better. Autodesk gives us the advantage to stay ahead of the competition.

Tom Markusic, Co-Founder & CEO
Firefly Aerospace



Firefly Aerospace

Many will try. Few will succeed.

They've built the engines. (Their in-house designed and built Reaver 1 generates 736.1 kN of thrust.) They've successfully completed a series of static-fire tests. They've secured commercial customers for 2021 and beyond.

But the question remains, "When will it fly?"

Once testing is completed early this summer, work moves from Central Texas to Southern California and a modified Delta 2 launch site. Then comes the "wet dress rehearsal," a practice countdown that involves fueling the rocket. And finally, sometime in the fall of 2020, Alpha will launch into space.

We'll be cheering for them the entire way.

Rocket engines are amazingly efficient machines.

Whereas a typical car engine has an energy efficiency of about 30%, rocket engine thrust chambers have achieved up to 99% efficiency. High-combustion efficiency is primarily achieved through proper mixing (in the engine "injector") of the oxidizer and fuel to promote rapid and complete combustion chemical reactions.

Firefly developed a new injector called "Crossfire" to lower cost and complexity. By integrating the liquid oxygen injector with thrust chamber fuel flow and creating a radial spray pattern, the resulting flow creates a toroidal vortex that promotes mixing, stability, and efficiency.

Firefly Aerospace

Designing a rocket from scratch

Inaugural launch:	H2 2020
Commercial operation:	2021
Payload LEO:	1,000 kg
Payload SSO:	630 kg
Total length:	29.75 m

STAGE 1

Propulsion:	Reaver 1 (4x)
Propellant:	LOX / RP-1
Thrust:	736.1 kN

STAGE 2

Propulsion:	Lightning 1 (1x)
Propellant:	LOX / RP-1
Thrust:	70.1 kN

Avionics

Firefly Avionics hardware utilizes a combination of custom-designed, state-of-the-art, and commercial off-the-shelf (COTS) components.

Data Acquisition is accomplished using a rugged, modular Data Acquisition Chassis, which provides analog-to-digital conversion of all sensor data, and further packages the data and transmits to the Flight Computer via an on-board Ethernet network.

The Flight Computer incorporates all vehicle telemetry and transmits data and video along the flight trajectory to various Earth ground stations for the duration of the flight.

Structure

Alpha is built with advanced carbon-fiber composites for its entire airframe, including the state-of-the-art, linerless, cryogenic propellant tanks. Composite materials are ideally suited to launch vehicle structures due to their high-strength, low-density, and tailorable material properties. All of which allow it to lift heavier payloads than a similar metal rocket.

Propulsion

Alpha uses copper regen-cooled LOX/RP-1 thrust chambers, a simple tap-off cycle which drives single-shaft turbopumps, nozzle-mounted turbine exhaust manifolds, and hydraulic actuators. Firefly innovations include the “Crossfire” injector, tap-off geometry, dual-mounted and electrically actuated trimmable propellant main valves, and ultra-compact horizontal turbopump mounting.

Firefly Aerospace

How Firefly stays one step ahead with Autodesk

PRODUCT DESIGN & MANUFACTURING COLLECTION

INVENTOR®

The ease of designing with Inventor® helps Firefly move at a pace that's simply unheard of in the aerospace industry.

VAULT

As they race against the clock, Vault keeps version control simple, so Firefly doesn't need to worry about duplicate work.

FUSION 360™

Once Alpha is flown successfully, Firefly will use the generative design features in Fusion 360® to optimize their designs for even greater performance.

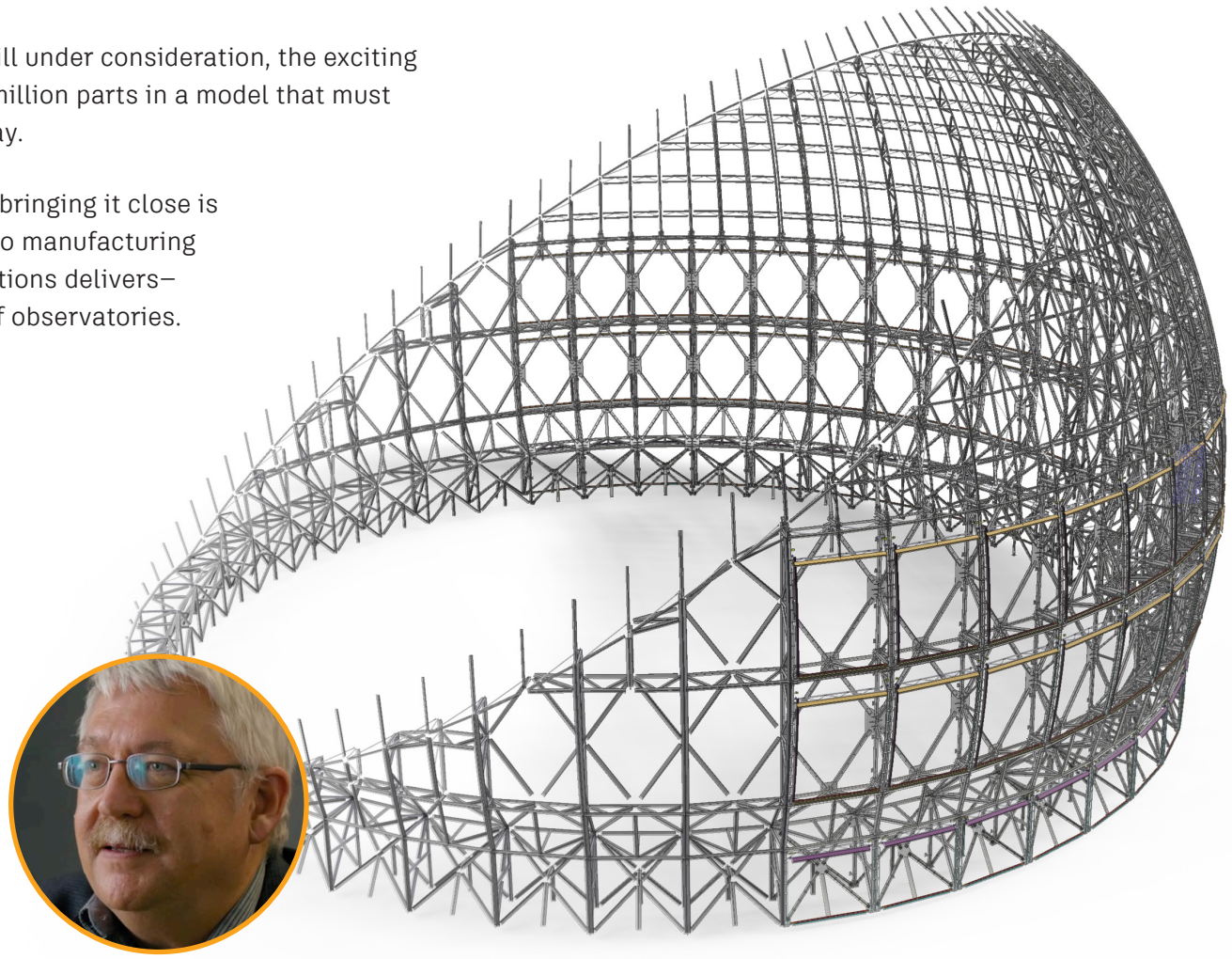

DYNAMIC
ATTRACTIONS
Bringing the
universe closer

Dynamic Attractions

For almost 100 years, Dynamic Attractions has been designing and fabricating astonishing steel structures—from buildings to bridges to amusement park rides. And yes, even some of the world's biggest telescope observatories.

And while the site for their latest project is still under consideration, the exciting new design is well under way—with almost 2 million parts in a model that must open, connect, and update flawlessly every day.

The universe is a very big place, after all, and bringing it close is no small undertaking. From detailed designs to manufacturing and construction, the team at Dynamic Attractions delivers—imagining, and creating the next generation of observatories.



"The most complicated thing I have ever done."

I couldn't conceive of designing a telescope enclosure without the Product Design & Manufacturing Collection. It's become such an indispensable tool for us.

Craig Breckenridge, Lead Designer
Dynamic Attractions

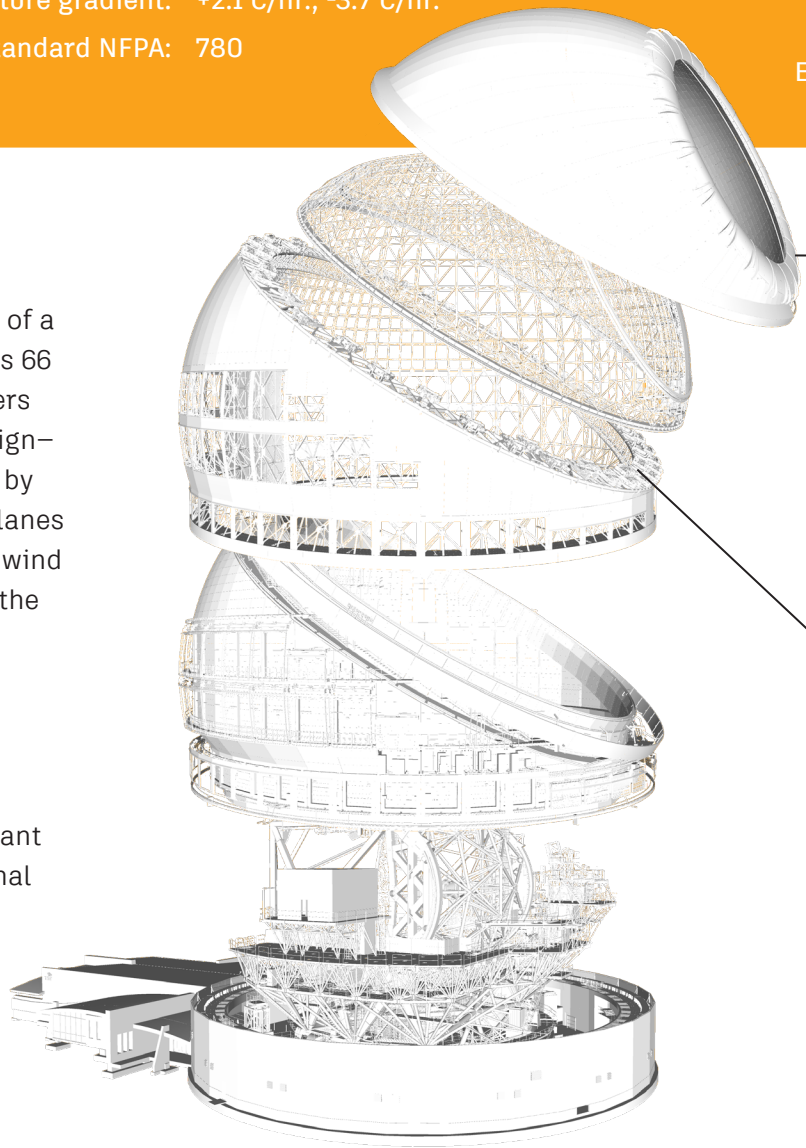
Dynamic Attractions

Inside one of the biggest telescopes on Earth

Telescope resolution: 12X sharper than Hubble
Temporal air temperature gradient: +2.1 C/hr., -3.7 C/hr.
External lightning strikes per standard NFPA: 780

SURVIVAL THRESHOLDS

Ambient temperature range: -16 C to +30 C
Air pressure range: 590 hPa to 1,025 hPa
External wind speed: 83.7 m/s



Structure

About 35% larger than the width of a football stadium, the enclosure is 66 meters in diameter and 207 meters in circumference. Its calotte design—one of only two in the world and by far the largest—rotates on two planes to safeguard the telescope from wind and to improve the efficiency of the spherical structure.

Acting like a chameleon eye, the design can control the airflow in and around the telescope much more effectively and is a significant improvement over more traditional “slot design” enclosures.

Aerodynamics

Actuated flaps help to control airflow and minimize buffeting of the telescope (turbulent wind pressure), which is not ideal when trying to look at something 10,000 light-years away. Vents aid in this regard, but also provide laminar airflow across the surface of the primary mirror to aid clarity.

Bogies

Imagine rotating something almost 66 meters in diameter and positioning it with an accuracy of around 0.5 centimeters. To achieve that level of precision, you need exceptional bogies. There are 32 main Azimuth bogies, each one with a motor and three wheels. Together, they can turn all 2,800 tonnes 180 degrees in just three minutes. Again and again. For the next 50 years.

How Dynamic Attractions explores new frontiers

PRODUCT DESIGN & MANUFACTURING COLLECTION

INVENTOR®

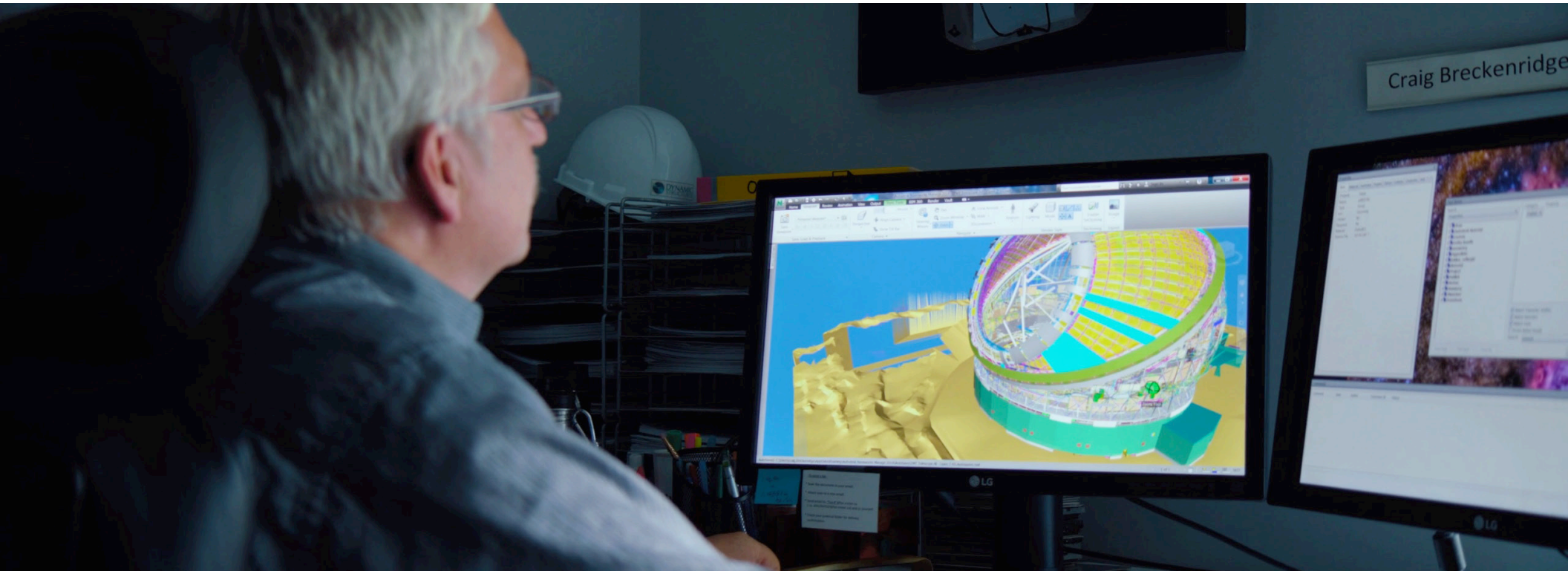
Dynamic Attractions relies on Inventor to help them create structures of vast size and complexity—including some of the largest structures built anywhere on Earth.

VAULT

Every bit of data associated with a structure 18 stories tall is managed seamlessly in Vault. That way, designers and engineers have a single source of truth for each and every part.

NAVISWORKS®

A million-part model doesn't fit on your laptop. That's why Dynamic Attractions uses Navisworks® to take their designs to the shop floor for the highest fidelity in manufacturing.




ROKION
Building electric
trucks from the
(under)ground up

Rokion

Fifty years ago, if an engineer wanted to design a vehicle to move people in and out of a mine, they probably just modified a basic diesel truck. But this is the 21st century, when advancements in occupational safety—not to mention the high costs of ventilation deep inside the Earth—mean that diesel just won't cut it anymore.

Which means going electric. And when it comes to heavy industrial electric vehicles, no one does it better than Rokion.

Unlike with most of the industry, each Rokion model is designed from the ground up, with lithium iron phosphate batteries for safety, two electric motors for monster torque, full-time four-wheel drive for maneuverability, and four-wheel independent suspension for comfort. It's no wonder that once drivers get into the seat of a Rokion truck, they never go back.

"Inventor has been an incredible tool."

All of our desgners are very fluent in Inventor. They can access the information they need; they can do whatever they need to do. But to have our electrical team map out the harness in 3D in advance of assembly, that is really valuable to our team.

Ryan Kolenosky,
Production Engineering Supervisor
Rokion

Pushing the limits on innovation

Rokion R400 Series drive:	full-time 4WD	Battery voltage:	350 VDC	Max range:	180 km
GVWR:	7,257 kg	Battery capacity:	100 kWh	Ramp range:	70 km
Max payload:	2,948 kg	Peak power:	186 kW	Max speed:	32 kph
Drawbar force:	3,625 kg				

Safety

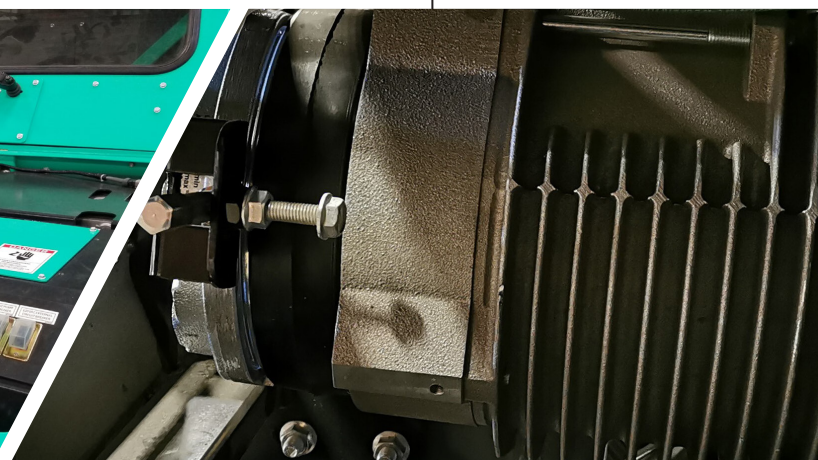
The need for a safe ride is amplified underground, which is why in every Rokion truck you'll find traction control, speed limiters, safety interlock systems (charge and drive interlocks), as well as seat belts, fail-safe parking brakes, lighting systems, and options for integrated backup cameras, safety strobes, and programmable LED lighting.

Power

Rokion's vehicles are propelled by lithium iron phosphate battery technology (also referred to as LiFePO4 batteries). Unlike lead acid batteries, LiFePO4 batteries do not off-gas during charge cycles. This eliminates the need to have special ventilation systems in place to deal with off-gassing. LiFePO4 batteries are stable, easy to manage, require no maintenance, and are a safe, reliable energy storage device.

Ramp Performance

On ramp ascent, Rokion trucks can navigate a 20% grade at full GVWR at its maximum programmed speed over a distance of 13 kilometers, for a total vertical rise of 2,500 meters. Down ramp, trucks take full advantage of regenerative braking by storing regenerative energy in its battery modules for later use.



How Rokion builds for off-road and underground

PRODUCT DESIGN & MANUFACTURING COLLECTION

INVENTOR®

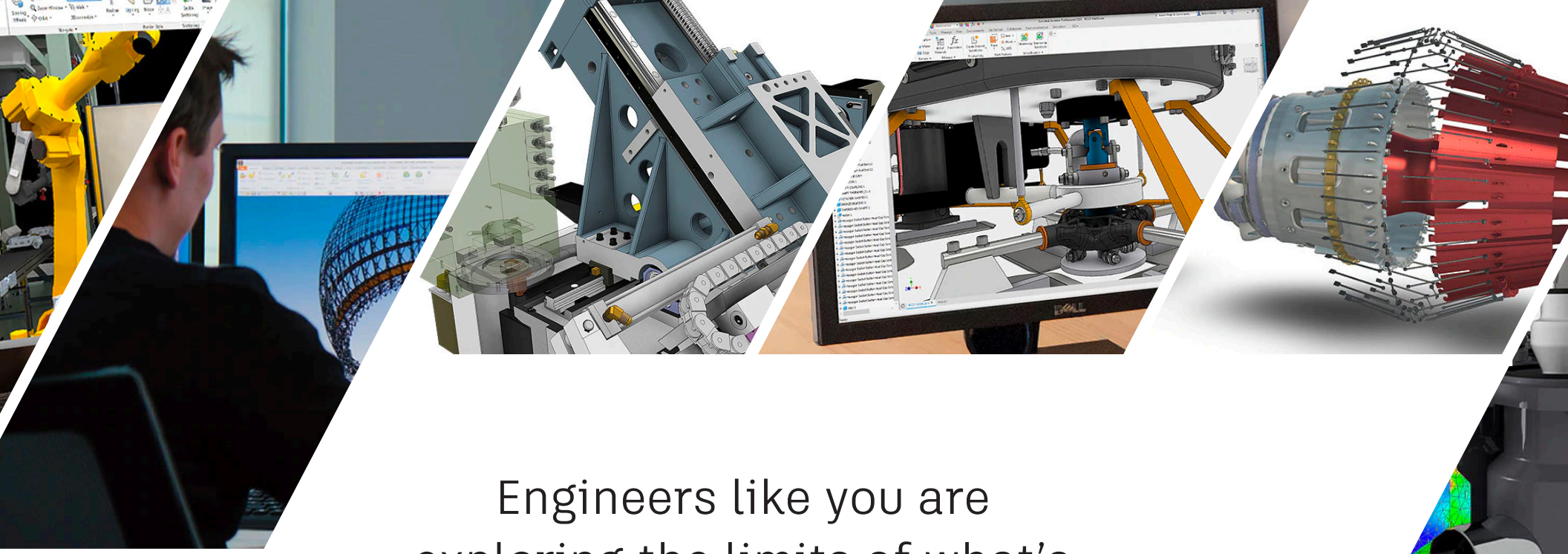
Rokion relies on the Inventor 3D model to see between revisions and know exactly which parts belong on which truck and where they belong in an assembly. That even includes work like 3D harness routing to translate some of the electrical design into the truck itself.

AUTOCAD®

On the shop floor, AutoCAD® helps Rokion ensure that the design intent is translated faithfully for metal fabrication and welding.

VAULT

Every time Rokion engineers a part, it's released in Vault and automatically transmitted into their ERP system. Later, if changes occur or problems surface, they can put that part on hold in the ERP system, triggering a change order. It's a seamless process that helps ensure quality is always maintained.



Engineers like you are exploring the limits of what's possible with Autodesk.

Discover more ways to push your own boundaries by creating, exploring, connecting, and automating with the Product Design & Manufacturing Collection.

autodesk.com/collections/product-design-manufacturing