AIRBUS

REIMAGINING THE FUTURE OF AIR TRAVEL

Video courtesy of Airbus

FROM GRAND VISION TO PRACTICAL PRODUCT

Schaefer is part of Airbus's Emerging Technologies and Concepts group in Germany, led by Peter Sander. Sander's small team of engineers—he calls them "crazy guys" for their boundary-pushing ideas—pursues projects to take the industrial process into the future.

After introducing the Concept Plane, the team members began to explore components that would use the new technologies they'd proposed. They chose an unassuming but key piece of the aircraft: the partition that separates the passenger compartment from the galley in the Airbus A320 cabin.

This new partition had to:

- be significantly lighter than the current partition, to meet the goal of reducing the weight of the plane,
- be strong enough to anchor two jump seats for flight attendants during take-offs and landings,
- have a cutout to pass wide items in and out of the cabin,
- be no more than an inch thick, and
- be attached to the plane's airframe in just four places.

Meeting these design constraints required a major departure from traditional engineering approaches. Schaefer began working with Autodesk Research, using generative design to develop what the team called "the bionic partition."

WHAT IS GENERATIVE DESIGN?

Generative design is a technology that mimics nature's evolutionary approach to design. It starts with your design goals and then explores all of the possible permutations of a solution to find the best option. Using cloud computing, generative design software quickly cycles through thousands—or even millions—of design choices, testing configurations and learning from each iteration what works and what doesn't. The process lets designers generate brand new options, beyond what a human alone could create, to arrive at the most effective design.

Airbus's bionic partition needed to meet strict parameters for weight, stress, and displacement in the event of a crash with the force of 16g. To find the best way to meet these design requirements and optimize the structural skeleton, the team programmed the generative design software with algorithms based on two growth patterns found in nature: slime mold and mammal bones.

The resulting design is a latticed structure that looks random, but

SLIME MOLD

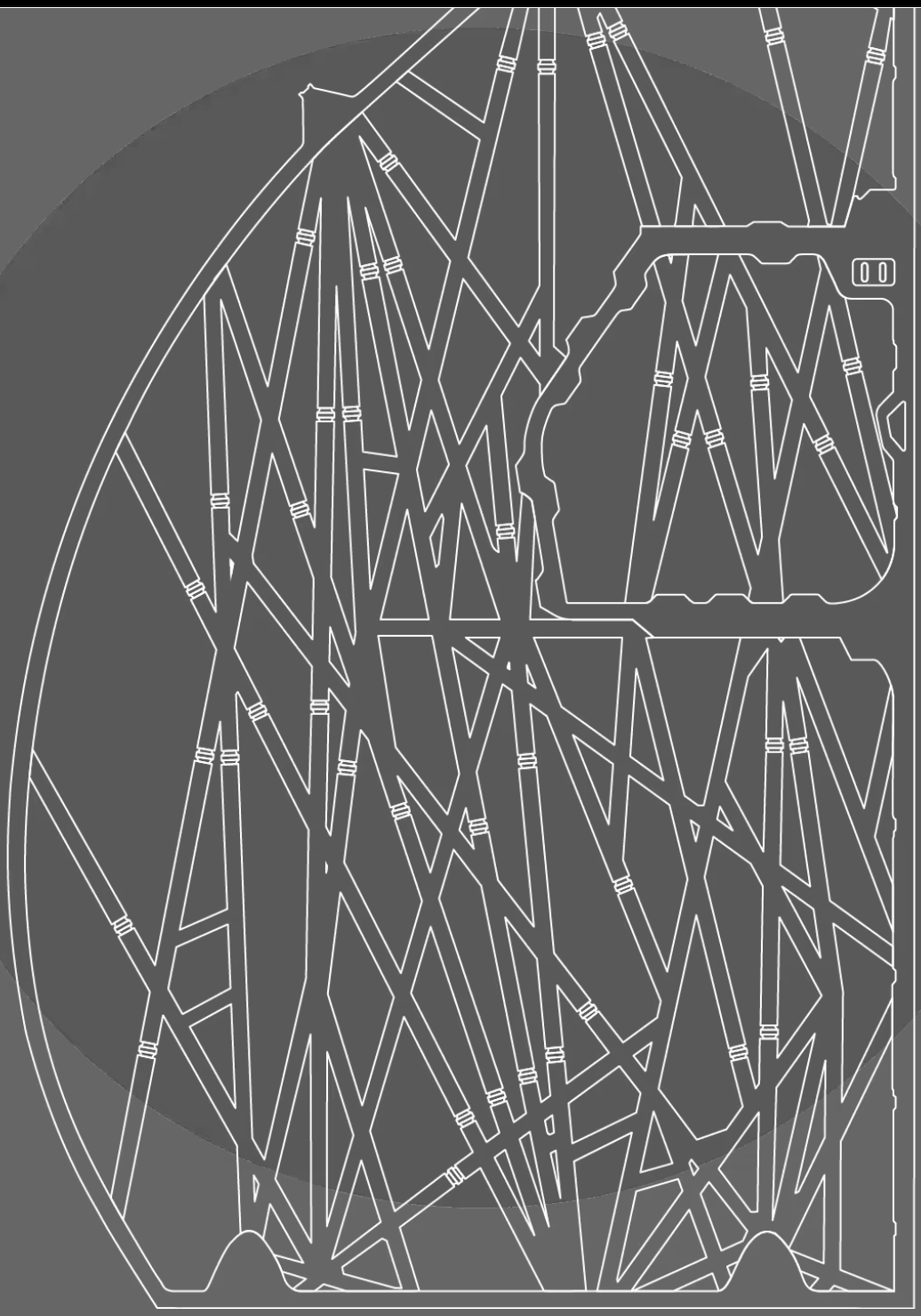
The algorithm for the partition frame was based on the growth patterns of slime mold, a single-celled organism that connects multiple points with uncanny efficiency.

10,000 DESIGN OPTIONS GENERATED FOR THE BIONIC PARTITION

MAMMAL BONES

The algorithm for the structure within the partition frame was based on the grid structures of mammal bone growth, which are dense at points of stress but lighter everywhere else.

45% LIGHTER THAN TRADITIONAL AIRBUS PARTITION DESIGN

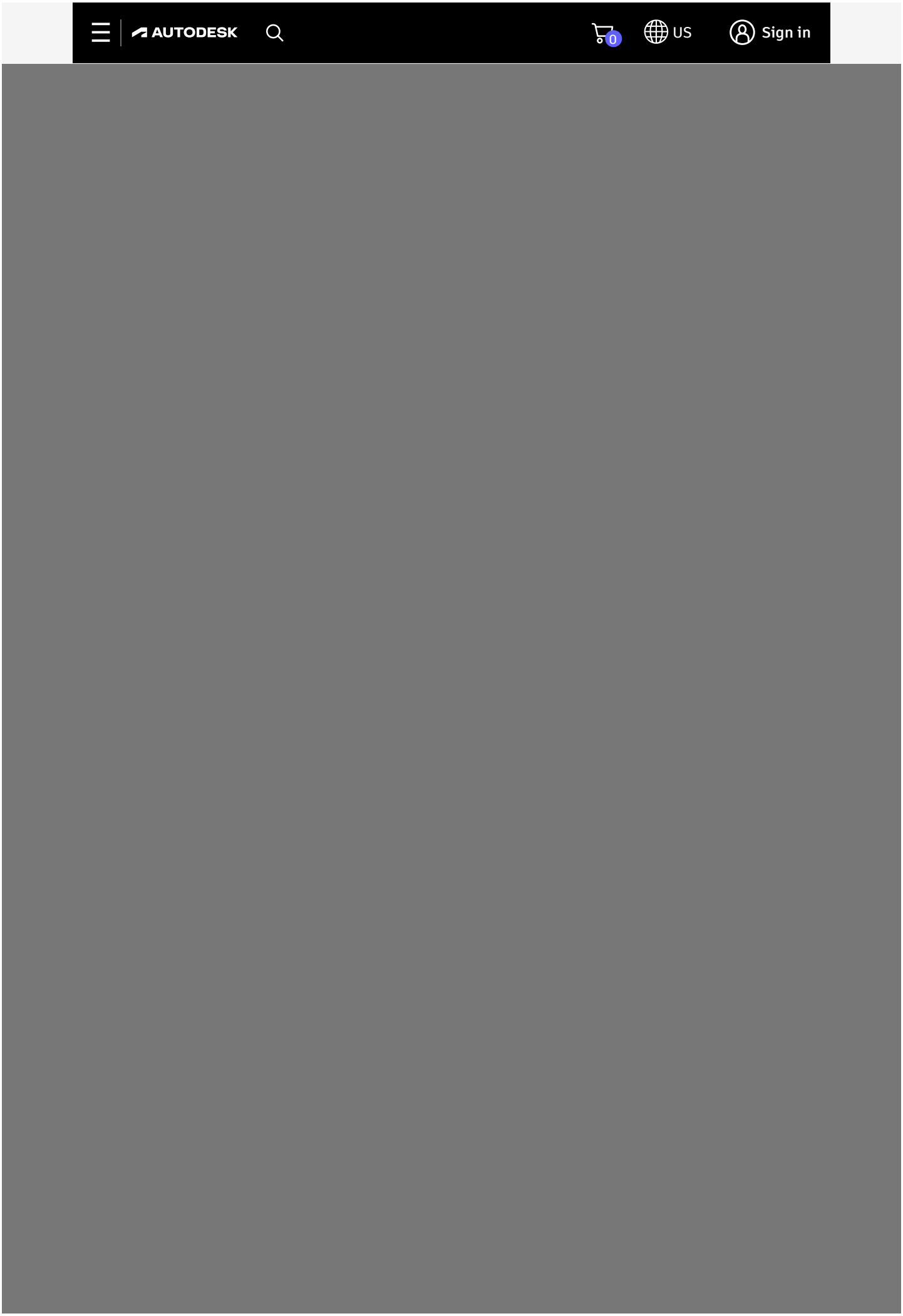


The team digitally mapped the thousands of options created in the generative design process against weight, stress, and strength parameters to decide which to prototype. To make the partition, the team used 3D printing—also called additive manufacturing—in which physical objects are created by depositing material in layers, based on a digital model.

More than 100 separate pieces, made of a high-strength metal alloy developed by Airbus, were 3D-printed and then assembled. The resulting bionic partition is the world's largest 3D-printed aircraft cabin component, and it more than meets the Airbus team's requirements: stronger, thinner, and lighter than the partition it will replace.

Final stress tests on the partition will be conducted in summer 2016, followed by a certification test with aviation authorities. Once testing is complete, the partition could appear in commercial A320-series planes by 2018.

> "WE HAD ALREADY INTRODUCED SMALL 3D-PRINTED ITEMS INTO OUR PLANES, LIKE THE BRACKETS THAT HOLD THE CABIN COMPARTMENTS IN PLACE. OUR GOAL WAS TO DEFINE A KIND OF ROADMAP BETWEEN THE SITUATION TODAY WITH SMALL PRINTED COMPONENTS AND THE BIG VISION OF THE AIRBUS CONCEPT PLANE. THE BIONIC PARTITION IS A PATHFINDER PROJECT, TO FOSTER THE EVOLUTION OF 3D PRINTING IN OUR MANUFACTURING PROCESS."
>
> — Bastian Schaefer, Innovation Manager, Airbus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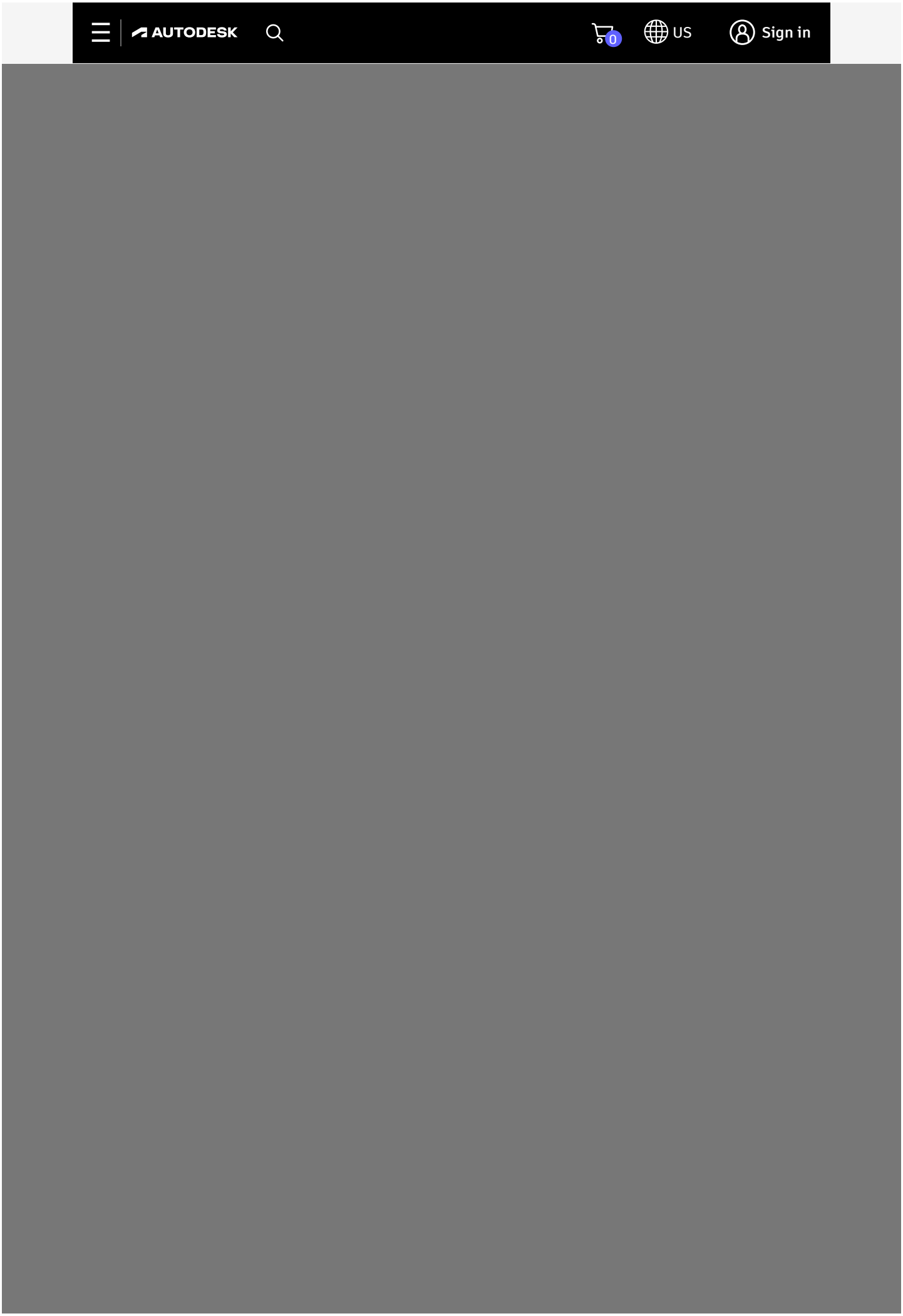
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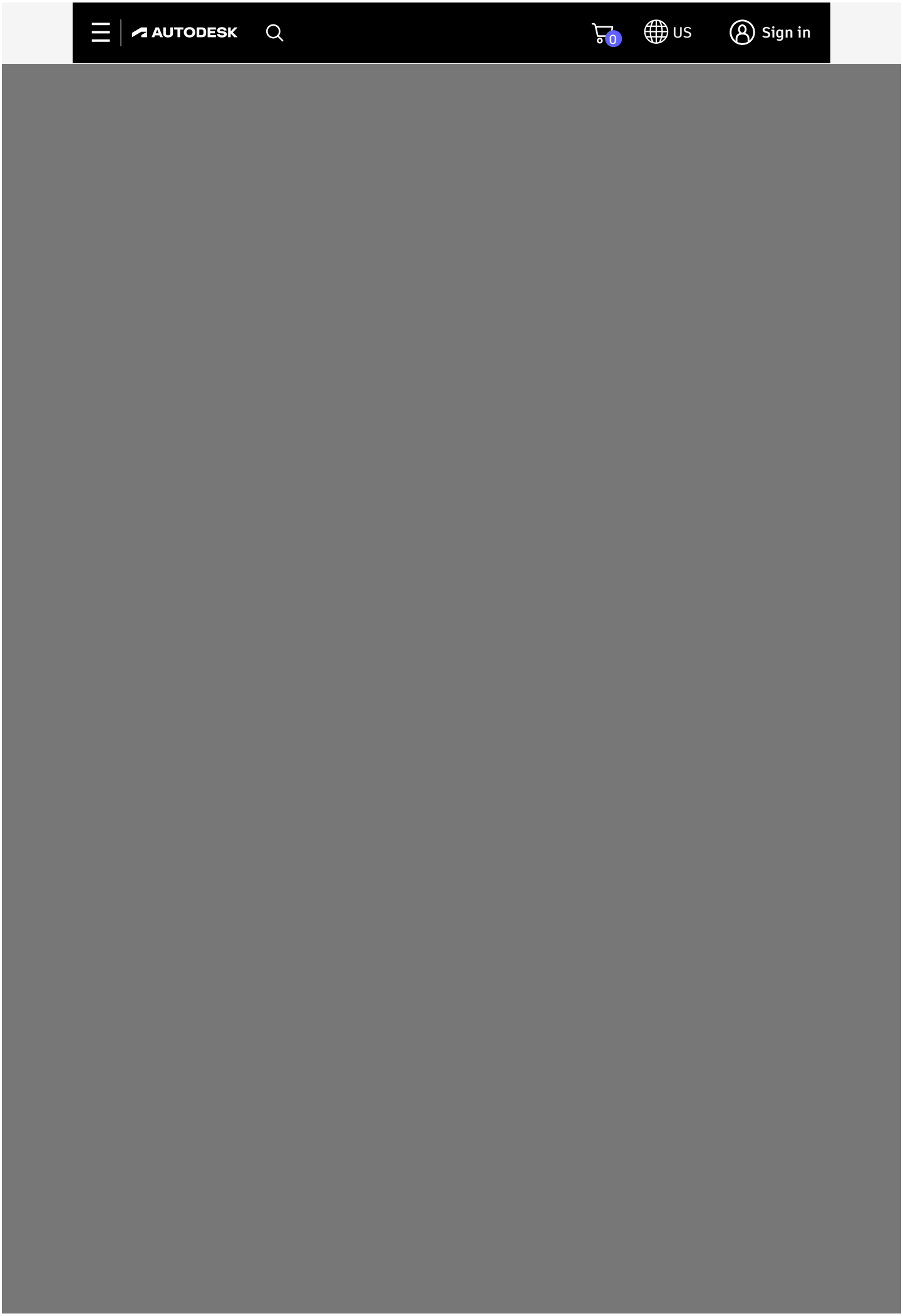
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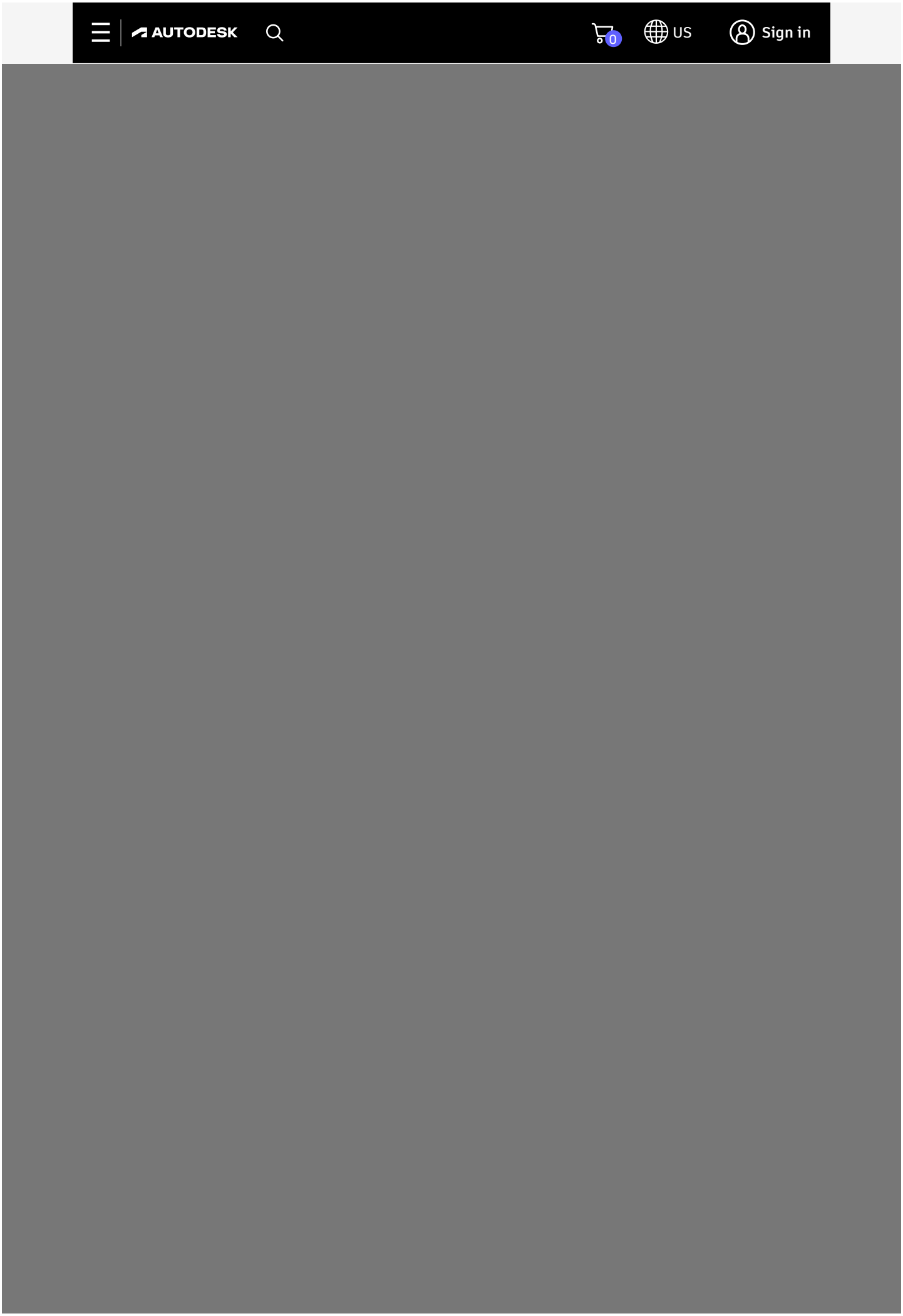
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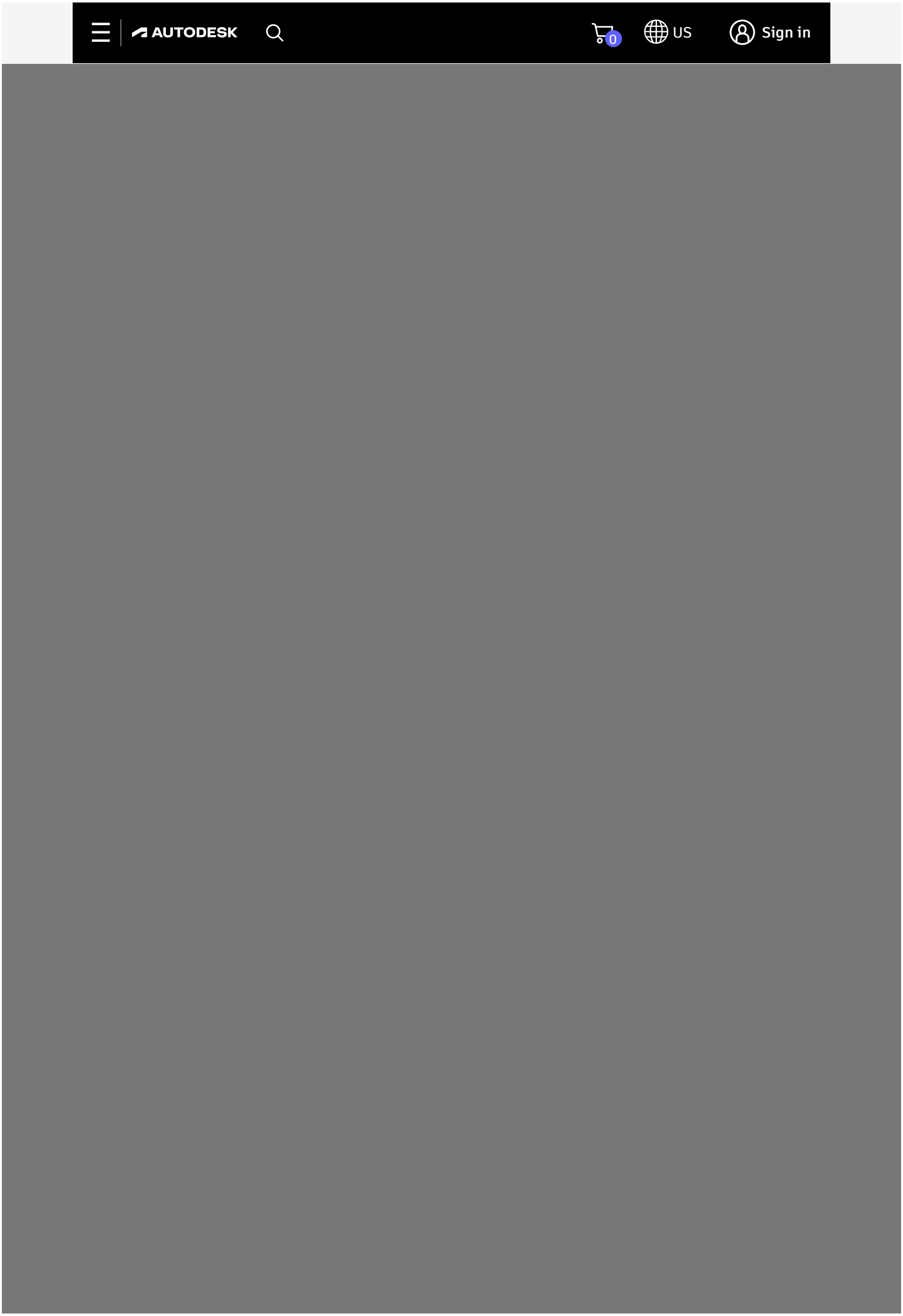
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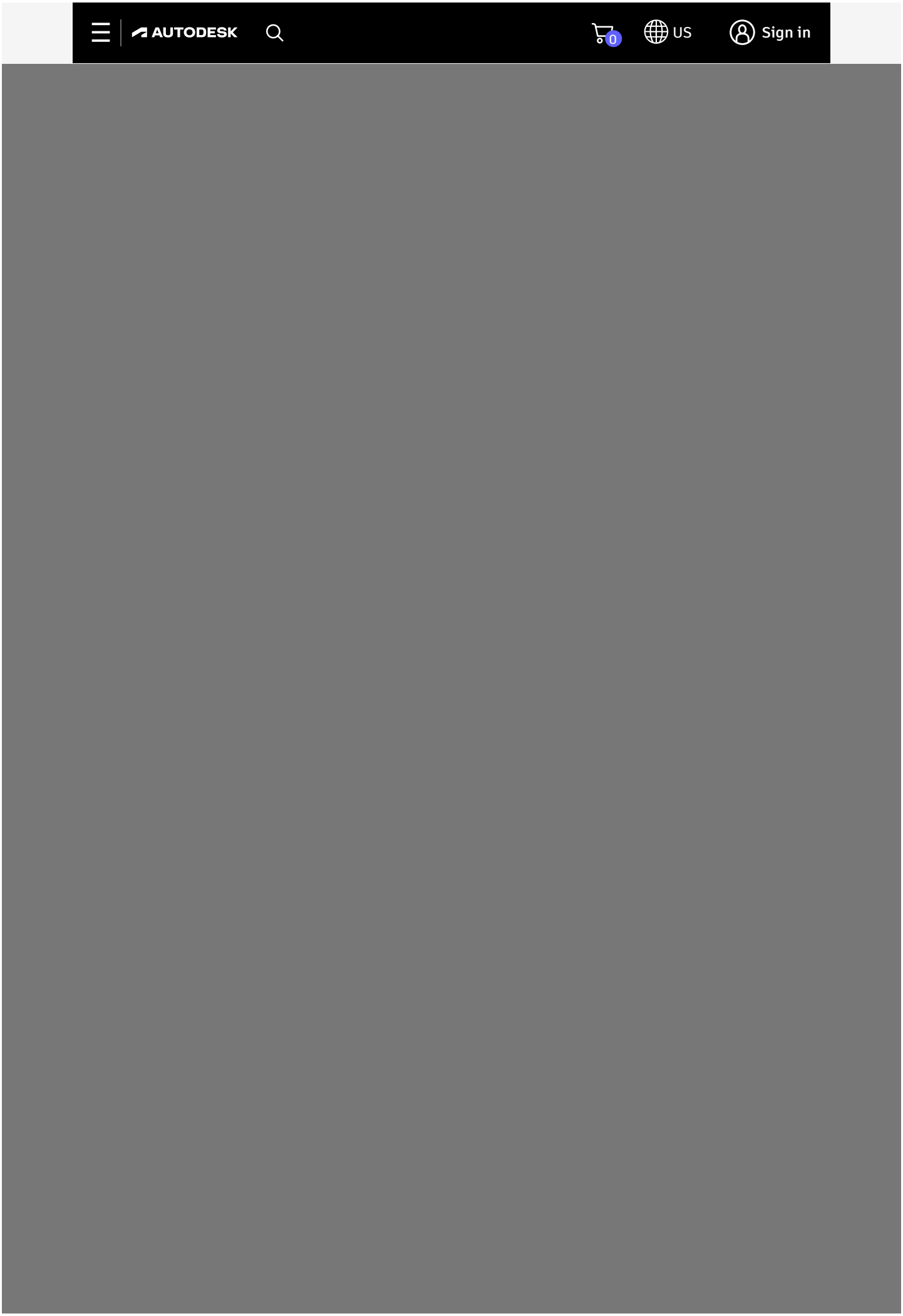
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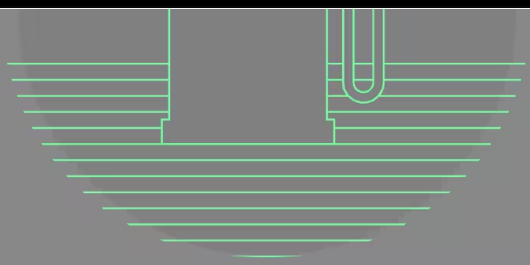
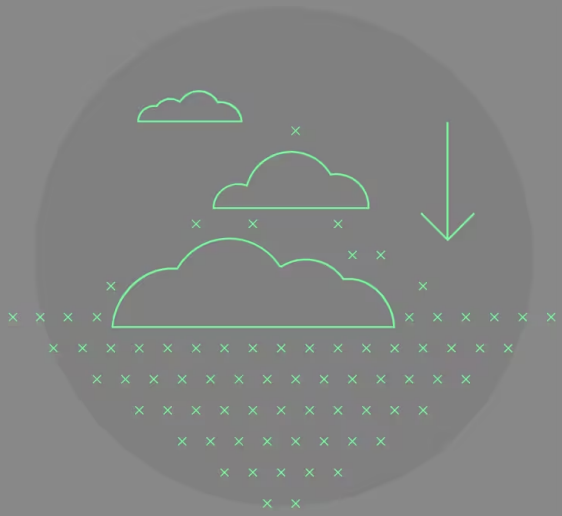
MAKING AIR TRAVEL GREENER



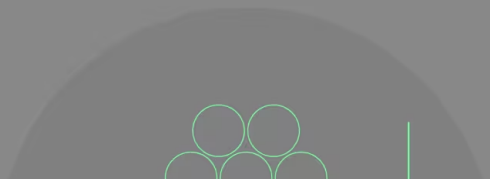
3,180 KG OF FUEL SAVED PER PARTITION, PER YEAR

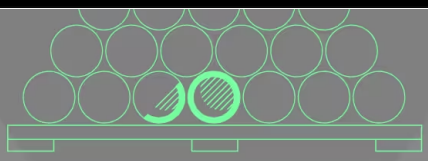
The bionic partition may be a relatively small part of the plane, but installing this lighter component could help airlines begin to make a positive difference for the environment. For each 1 kilogram (2.2 pound) reduction in weight, jet fuel use is cut by 106 kg (233.2 lb) a year, helping to decrease the carbon footprint of air travel. Each partition is approximately 30 kg (66 lb) lighter than the standard partition.



166 METRIC TONS OF CO2 EMISSIONS CUT PER YEAR, PER PLANE, FOR AN AIRBUS A320 INSTALLED WITH BIONIC PARTITIONS

If bionic partitions are installed throughout the entire cabin of an Airbus A320—four per plane—that would remove up to 500 kg (1,102 lb) of weight. The resulting decrease in fuel use would cut CO2 emissions by up to 166 metric tons per aircraft each year. Multiply that by the thousands of new A320s on order, and airlines have the potential to reduce CO2 emissions by hundreds of thousands of metric tons per year.





95% LESS RAW MATERIAL

In addition, 3D printing will help reduce the company's environmental impact. The process uses only 5% of the raw material that the traditional process of milling parts down from a metal block uses. And with 3D printing, whatever raw materials are left over can be reused to manufacture another part.

"WE ARE COMMITTED TO REDUCING GREENHOUSE GAS EMISSIONS FROM OUR PRODUCTS BY 50% BY 2050, AND THIS REQUIRES US TO DEVELOP NEW TECHNOLOGIES THAT MAKE AIRPLANES MUCH LIGHTER. THE REASON WHY WE WERE ABLE TO REDUCE THE WEIGHT OF A COMPONENT LIKE THE BIONIC PARTITION BY 45% IS SIMPLY BECAUSE WE COMBINED GENERATIVE DESIGN AND 3D PRINTING."

– Bastian Schaefer, Innovation Manager, Airbus

FROM BIONIC PARTITION TO BIONIC AIRLINER

The lessons Airbus learned in designing the bionic partition pave the way for changing how an entire aircraft is conceived and manufactured. The next generation of Airbus planes—with components based on generative design, built by 3D printing, using innovative materials—will bring us closer to the vision of the bionic airliner of 2050. Airbus plans to evolve its methods on larger structures inside a plane: for example, the cockpit wall,

bulletproof to protect the pilots, or the structure that houses the galley for food and beverage service.

But Airbus's success in applying generative design and 3D printing also highlights new challenges. The additive printers to produce large components with a single printer. And it will be critical to train engineers to understand these new design and production methods. Airbus has only recently begun retraining its 10,000 engineers, and the company is sponsoring

"I'm a mechanical engineer with more than 30 years' experience," Peter Sander says. "And I see here the biggest change I've ever seen. Every one of us has to understand a new way of working."

LEARN ABOUT SOME OF THE PRODUCTS AND SERVICES AIRBUS USED TO CREATE THE BIONIC PARTITION

- Autodesk Nastran
- Robot Structural Analysis
- Dynamo Studio
- SimStudio Tools
- Fusion 360
- Simulation Mechanical

Meshmixer

Project Dreamcatcher

Project Saturn

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