The mission to build a reusable launcher for Europe

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US company SpaceX is one of several who are developing reusable launchers. Credit: Bill Jelen/Unsplash

The race is on to develop a European reusable rocket that can ensure Europe's autonomous and cost-effective access to space while increasing the sustainability of launches.

Launch vehicles—or rockets—are essential to deliver satellites and space probes into space. Once they've served their purpose, they're typically disposed of. But with the annual number of new satellites expected to grow four-fold in the next decade, researchers are now developing more sustainable, less costly reusable launchers.

The first reusable launch system—where some or all components are recovered—was NASA's Space Shuttle, in use from 1981—2011. All of its parts were reused except for the external fuel tank which would burn up in the atmosphere. But maintenance costs were high, which led to the view that it was cheaper to use expendable systems.

Ansgar Marwege from the German Aerospace Center (DLR) and his colleagues think that reusable rockets can be cost effective if they are landed upright. "The Space Shuttle was very complex, because it had wings and so on," said Marwege. "With a vertical landing, you want to make that all simpler."

One of the advantages of landing upright is that the load during take-off and landing is similar, which is easier in terms of design. Although more fuel is required for the descent compared to other landing configurations due to braking manoeuvres, Marwege says that it would have little impact on the overall cost since fuel is relatively cheap.

Marwege and his team—along with other research and industry partners—are investigating the key technologies necessary to land a launcher vertically after a mission as part of the RETALT project. They are looking at landing a rocket by using retro-propulsion, where the vehicle is decelerated by generating thrust in the opposite direction to its motion. They will also examine how to steer a vehicle during landing. Since the base of a rocket is expected to heat up, one of the project partners is designing thermal protection out of cork.

Launchers

The team has concepts for two different types of launchers. One is a heavy lift launcher that can carry a payload of up to 14,000 kg, like a weather forecasting satellite, to an orbit about 36,000 km above the Earth's surface. The second design is for smaller payloads of up to 500 kg that need to be transported to distances of up to about 140 km. "This configuration could theoretically be used for zero gravity experiments or demonstrator flights," said Marwege.

So far, the researchers have started on all the technical work such as initial designs of the landing legs. In the next year, they will conduct structural tests and wind tunnel experiments to test the aerodynamic behaviour using scaled-down models of their launchers. One experiment will test the rocket motors in the wind tunnel using hot combustion, which is challenging and not often done. Using hot gases, however, better mimics how motor power is generated in real life.

In addition to reducing costs, Marwege and his colleagues expect their technologies to have a positive environmental impact. Expendable systems create debris when they break up in the atmosphere, where some parts fall to the ground while others remain in space. Reusable systems will pollute the environment and space less, according to Marwege.

Currently, in Europe, there are no launchers available to get small satellites in orbit.

When a small satellite needs to be transported to space, it typically hitches a ride on a heavy launcher with a bigger satellite. But that means that the departure date and the orbit are chosen by the contractor sending the larger load.

"It's like a bus that leaves (the small satellite) a little bit far from their

orbit so they need a propulsion system to go to their desired orbit," said Xavier Llairo, the co-founder and COO of Pangea Aerospace in Barcelona, Spain.

Service

A launch service for small satellites is currently offered by the American-New Zealander company: Rocket Lab. Although it allows for a tailored service, it's more expensive than ride-sharing on a heavy launcher. And Europe is set on having its own small launchers so it can control its access to space. "It's important for geostrategic reasons," said Llairo. "And because it's a new market it would be great to create growth and give opportunities in Europe."

For a project called RRTB, Llairo and his team are aiming to create a small launcher that is cost effective and can be reused at least ten times. They are developing a novel landing system using electric ducted fans, a propulsion system currently used in drones and UAVs. It allows for a soft and precise landing, which is important if the system will be reused.

"The technology is already proven and exists in other sectors so it's not very expensive," said Llairo.

The main engine isn't used to land which limits thermal stress and increases reusability.

The project, which kicked off last month, is now looking at how to make the fuel tanks reusable since they are expensive components of a launcher. The team is also starting to investigate how to control the vehicle during re-entry into the atmosphere by doing simulations. It's a challenging part of the mission due to the weight and high speed of the launcher and will require either generating some lift or finding a way to slow down the vehicle. "We are analysing different scenarios and we'll

choose the most promising one," said Llairo.

In addition to transporting small satellites into space for scientific, commercial and civil uses, Llairo thinks that some of their components could have other applications too. The lightweight aerospike engines they are developing, for instance, could also be adapted as propulsion systems for satellites in space. And their landing system could be used to deliver relief to disaster areas. "Right now, you have planes with a parachute to land (supplies) but our system could be used to have a more precise landing," said Llairo.

Having less of an environmental impact is one of their goals too. Apart from the greener credentials earned by being reusable, the rocket will use liquid oxygen and liquid methane as propellants, where 80% of the emissions will simply be water. And their aerospike engines should be about 15% more efficient than current designs. "We believe that (sustainability) is the way to go in this market," said Llairo. "In 10 or 20 years from now, it will be absolutely common."

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