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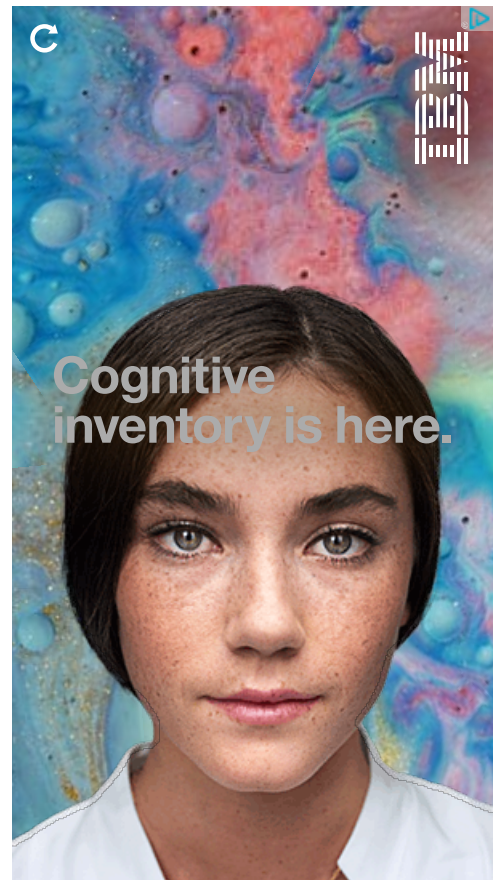
THERE has, in recent years, been much talk of holidays in space. Though things have not gone well for one aspiring space-tourism business, Virgin Galactic, whose prototype suborbital rocket plane blew up on a test flight in October, those with truly deep pockets can still book a trip to the International Space Station courtesy of an American firm called Space Adventures that arranges seats on Russian launches. But for people who cannot quite stretch to the \$20m or so such a trip will cost, there may soon be an alternative to rocketing upwards in search of adventure: heading in the other direction.

This, at least, is the hope of Stockton Rush, the boss of a company called OceanGate. Mr Rush is the mastermind behind *Cyclops*, a five-seat submarine that will be able to brave depths currently accessible by but a handful of research vessels.

Cyclops aside, there are eight such deep-diving

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submersibles in the world. Most date back to the Cold War. One of the best known is *Alvin*, which surveyed the wreck of the *Titanic* in 1986. But *Alvin* exemplifies the problem of manned submersibles. Around 90% of its weight is dedicated to keeping the three people within it alive. Only the remaining 10% is applied to the job of scientific investigation. It is also ruinously expensive to maintain and operate. It has, for example, just undergone a \$42m refit, and it costs over \$50,000 a day to keep at sea, because of its need for a large, specially adapted support vessel. The trend in deep-ocean research, as in the exploration of outer space, has thus been to prefer robots: ROVs (remotely operated vehicles), which are tethered to a ship, and AUVs (autonomous underwater vehicles), which swim freely. These have progressed in leaps and bounds over the past 20 years. They can now dive to the ocean's deepest trenches, glide beneath ice caps for months at a time or fix underwater drilling rigs.

Mr Rush, however, believes he can buck this robotic trend. And *Cyclops*, unveiled in Seattle on March 11th, is his attempt to do so. It has a steel pressure hull that will let it dive 500 metres beneath the waves and a battery which will allow it to manoeuvre for up to eight hours when it gets there. It also has a specially strengthened acrylic window (which inspired the craft's name) at the front for the crew to observe what is going on, and a life-support system that will last three days. It is packed with the latest marine technology, including a swanky sonar, a PlayStation games controller instead of conventional thruster controls and wraparound LED mood lighting to lessen the crew's feeling of claustrophobia. Its successor, *Cyclops 2*, which should be ready next year, will have a carbon-fibre hull and a borosilicate-glass window that are good for a depth of 3,000 metres, an autopilot and 24 hours' battery life.

Carbon fibre, though more resistant to pressure than steel, is less forgiving of microscopic fractures. This means holes drilled through the hull to control *Cyclops 2*'s thrusters and external lights will need to be kept as small as possible, to reduce the risk of structural failure. Mr Rush therefore plans to use narrow fibre-optic cables to carry instructions to electronic instruments held in spherical pods mounted outside the hull. Some pods will control *Cyclops 2*'s thrusters, lights and mechanical "arms". Others will crunch data from sensors, cameras and microphones. The pods themselves will be filled with oil to avoid life-threatening implosions if the pressure proves too much for them.

Mounting the vessel's electronics this way, instead of inside the craft, means they can be swapped swiftly in case of malfunction, making maintenance far cheaper. This, in combination with the use of a novel launch rig that can be towed behind a variety of support ships, rather than having to rely on specially built vessels of the sort that support *Alvin*, means, Mr Rush believes, that *Cyclops 2* will be as cheap to run as an ROV while offering the advantages of having its human operators actually within it. It could even act as the control-centre for a fleet of AUVs, letting people keep an eye on them directly, rather than relying on images on television screens.

Most of *Cyclops*'s early customers, Mr Rush thinks, will be scientific institutions. But it has other potential uses. Sub-aquatic tourism is one—he reckons bespoke cruises to sunken ships and coral reefs should be possible for as little as \$1,000 a person. And he foresees lucrative opportunities selling to the offshore oil and gas industry. The market for ROVs in this business is worth about \$1.5 billion a year. Manned submersibles will not replace robots for most of that, but Mr Rush reckons there are enough awkward jobs which are

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