Bam!...Bam!...Bam!...Bam!

By Colin Johnston, Science Communicator

NASA recently announced that its next manned spacecraft will be the Orion CEV, a capsule which will be carried into space by a rocket. Weighing 25 tonnes, each Orion will carry up to six people to Earth orbit or up to four to the Moon. Accommodation on board is cosy at best, cramped at worst. Orion missions will hopefully begin in 2014.

Imagine another spacecraft called Orion. As tall as a sixteen-storey skyscraper, and shaped like a giant bullet, this one weighs 4000 tons– about 40 times as much as the Space Shuttle. It has a crew of up to a hundred and fifty people who live on aboard in privater cabins complete with home comforts. Their Orion is tough, built by a

> "this Orion returns from Saturn. The year is 1975 "

shipyard specializing in submarines; its skin is of heavy steel plate. This giant Orion's performance makes the capabilities of NASA's Orion look puny. This imaginary Orion blasts off from the Nevada desert into space- and keeps going! A few months later it arrives at Mars and the crew begin to study the Red Planet in their spaceship's extensive scientific laboratories. A year later, the Orion is ready to leave Mars. But not to return to Earth, in fact this space odyssey is only getting started, for instead the huge space cruiser hurtles away from the Sun. The ship spends a year speeding through the darkness; as the months pass, through its giant windows the crew can see a dazzling sight growing ever larger. Saturn and its great rings lie ahead of them. The lucky crew spends another year orbiting Saturn, marvelling at the wonders they have

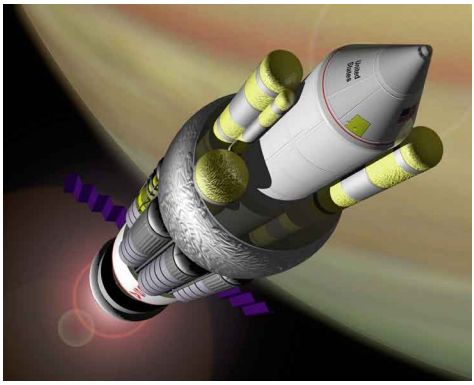

Image Credit: NASA

Flight of Fancy This is the final 'small' Orion to be launched by a Saturn V (note the Apollo-style Command Module). The vital shock absorbers are the tubes towards the rear. Although designed for an Earth to Mars trip, it appears to cruising past Jupiter in this artist's impression.

discovered before it is time to go home. After a five year mission, this Orion returns to its home planet, with a precious cargo of samples from Mars, Phobos, Deimos, Enceladus, Iapetus and Saturn's rings. The year is 1975.

Is this preposterous science fiction? Perhaps but this Orion was very seriously proposed in 1958 by physicists Stanislaw Ulam and Cornelius Everett and studied by some of the world's smartest scientists under US government contract for several years. The project was highly secret until it ended in 1964. So how would it have worked? Why has it never been built? The answer to the first of these questions goes a long way to explaining the second. To achieve its amazing performance, the original Orion would use a very unusual form of fuel. The fuel supply consists of racks of about 1000 polyethylene capsules, each about the size of an oil drum, at the centre of each capsule, embedded in the

plastic, is a small thermonuclear fusion device. Thermonuclear fusion device is a polite way of saying nuclear bomb.

Here is how Orion would have worked: a complex feed and ejector mechanism grabs a bomb capsule from its rack and shoots it out of a chute in the rear of the spaceship. Sixty metres behind the ship, the bomb detonates, in a blast equivalent to thousands of tonnes of TNT. The bomb transforms itself and the surrounding plastic into white-hot radioactive plasma expanding outward at 100 000 m/s. Part of this wave of debris is caught by the thick steel pusher plate which forms the spacecraft's base, slamming the vehicle forward at 12 metres per second. Seconds later the next fuel capsule detonates and the ship surges forward again, another bomb is ejected and the process is repeated. Each detonation adds an extra 12 m/s to the ship's velocity and this cycle continues until Orion reaches its cruise velocity. Far above this radioactive inferno, as each bomb explodes the crew experience not a series of bone-crushing blows but a steady, tolerable thrust. Gigantic damped springs, the shock-absorbers, behind the pusher plate

"Even interstellar flights were a possibility"

smooth the instantaneous acceleration to levels that humans can withstand, say 1–3g. An Orion blast-off would be the most spectacular sight ever created by humans. The ship would have left a trail brighter than the Sun behind it and would be remarkably noisy (this article's title hardly does it justice). About 800 such explosions would get the ship into Earth orbit, the hardest part of any space mission. As the craft moved away from Earth, it would be visible across a whole hemisphere.

By now you may be tempted to give up in disbelief, but this concept was calculated to be feasible. A coating of a special graphite-based oil would have been sprayed on the pusher plate between blasts to protect it from being vaporized by the exploding bombs. The shock absorbers were perfectly standard engineering. Mathematical analysis showed the bigger and

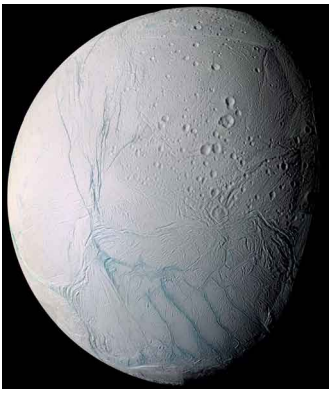

Image Credit: NASA

Saturn's moon Enceladus The Orion engineers imagined chilling their martinis with ice scooped from the surface of this frigid world.

heavier the Orion, the more efficient the powerplant became so a sturdy and cheap construction of steel like a sea-going vessel made perfect sense. As a result of this analysis, a submarine building company was indeed selected to construct the craft. An Orion could lift an enormous weight into space and accelerate it to fantastic speeds (8% to 10% of the speed of light would have been possible by a city-sized version) making even interstellar flights a possibility.

The people working on the project were enormously enthusiastic and convinced it was a viable idea. Many of the physicists involved expected be crew members on future missions to the planets. So why was this idea not pursued? Apart from the cost of building it, there were niggling technical problems to be resolved. For example, the bomb ejection mechanism had to be made utterly foolproof as a bomb jamming in the chute would be disastrous. Probably issues such as this could have been solved, but there was a massive problem with the concept which was impossible to eliminate. The spacecraft would have left a trail of extremely unpleasant radioactive exhaust behind it. It would have flown straight up until it cleared the atmosphere to minimize radioactive contamination, but even so, British-born physicist Freeman Dyson, a true genius and a leading figure in the project, calculated that each Orion launch would lead to the death by cancer of at least ten people world-wide which was clearly unacceptable. The obvious way around this was to use ordinary

rockets to launch the craft so that the nuclear bomb powerplant would only be activated far from Earth. A scheme for a smaller three person Orion carried into space on a couple of Saturn V boosters was studied. This 80 tonne Orion could make a round trip to Mars in six months but was never built. An international treaty banning nuclear explosions in space finally made the whole project technically illegal and it ended.

Many space enthusiasts today regret that Orion was never built and there are some who passionately decry the decision to end the project.

Orions still show up often in science fiction novels by the more technically-minded authors, the best-known example is Niven and Pournelle's alien invasion epic 'Footfall'. Today it is hard to see any circumstances where a nuclear Orion would be built (it may be useful in one of those 'doomsday asteroid' scenarios though). It is strange to think though that if it had been built in the 1960s that people could have landed on Mars before the Viking probes or visited Saturn before the Voyagers!