NASAfacts

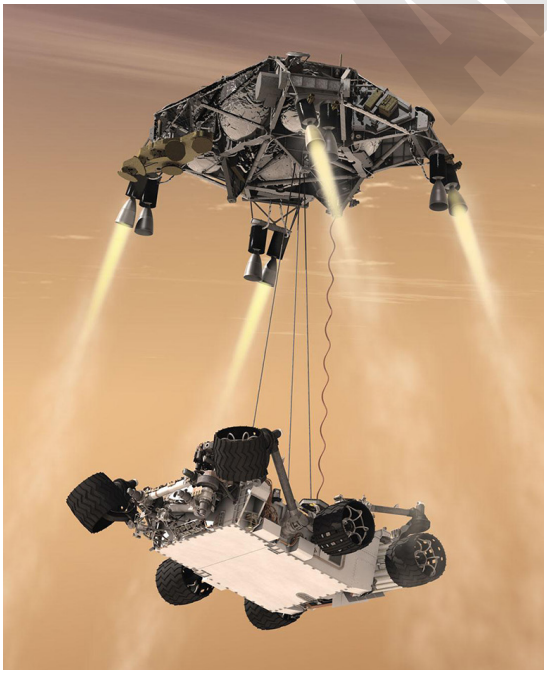
Space Technology
Game Changing Development
Propulsive Descent Technologies (PDT) Project

At 900 kg, the Mars Science Laboratory (MSL) is the largest system to have landed on Mars.

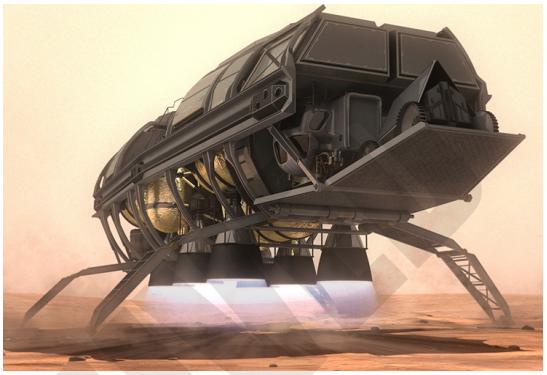
Future advanced robotic and human missions to Mars will require the ability to land much larger payloads. To do this, NASA is investigating the use of supersonic retro propulsion (SRP).

SRP is an entry, descent and landing (EDL) technology that relies on retrorockets at supersonic speeds to decelerate the vehicle as it's traveling through the atmosphere.

Martian gravity is only 38% of Earth's, yet the planet's low atmospheric density provides very little atmospheric drag. This means that aerodynamic decelerators, such as parachutes, have a limit due to mass and size scaling. Landing the Curiosity vehicle, for example, required the elaborate "sky crane" architecture shown below.



MSL with sky crane.



Human-scale mars landing.

Compared to the MSL, a human mission to Mars will likely require decelerating and landing masses perhaps 20 to 40 times that of Curiosity.

Propulsive deceleration at supersonic conditions mitigates a major gap in EDL performance for large-mass landings.

Recent SpaceX Falcon 9 v1.1 first stage demonstration flights show that progress with propulsive descent capabilities relevant to Mars EDL can be made in the long term.

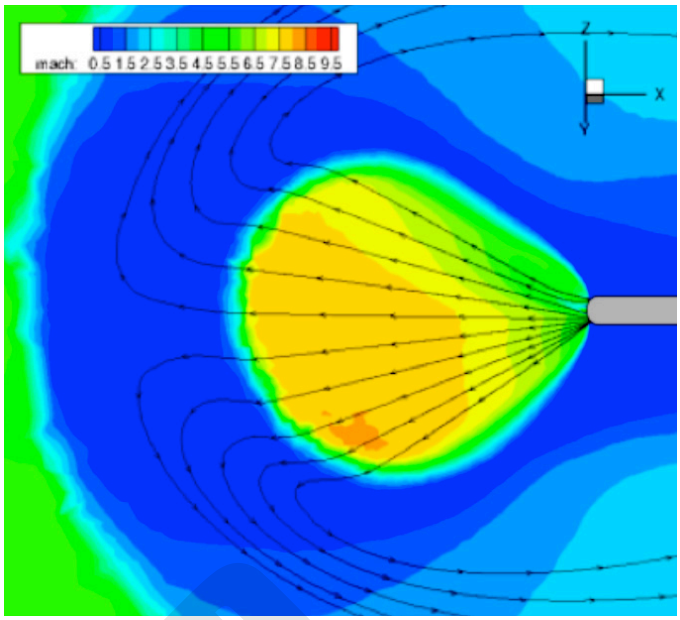
Advancement of SRP may be required to safely land large-mass payloads on the Mars surface. Because of the large gap between current Mars landing capability and that needed for Mars human exploration missions, a critical-path progression of ground-based and flight testing is required to mature SRP into a viable capability ready for Mars mission infusion.

NASA's Space Technology Mission Directorate (STMD) has initiated the Propulsive Descent Technologies (PDT) project within the Game Changing Development (GCD) Program to advance the technologies associated with Mars propulsive descent. As a capability that maps into NASA's ultimate goal of bringing

humans to Mars, technology readiness level (TRL) advancement this decade can provide mission infusion opportunities as early as the 2020s for human precursor missions. Project management leadership is provided by NASA's Johnson Space Center with technical leadership by Georgia Institute of Technology. Additional support from within NASA is provided by NASA's Langley Research Center, Ames Research Center and Marshall Space Flight Center. In addition, the Cal Tech Jet Propulsion Lab and John's Hopkins University Applied Physics Lab provide necessary capabilities to ensure success. Additional contractors supporting the project include Analytical Mechanics Association in Hampton Va., Jacobs Engineering in Houston Texas and The Aerospace Corporation in El Segundo, Calif.

NASA interest in commercial partnering has motivated the proposed PDT project implementation path to be structured as a commercial partnership with industry. Opportunities for commercial partnering were investigated in 2013 via Response for Information solicitations that have helped to inform the PDT project. The information obtained from the solicitations forms a basis for the project to pursue the potential of a government/commercial partnership that may provide flight data at Mars relevant conditions, which is applicable to human scale missions to Mars.

Additional investments by the PDT project will involve conceptual design activities and calibration of NASA's engineering prediction capabilities based on available ground and flight test data. The conceptual design effort will be focused on SRP as applied to a Mars precursor scale mission with a mass slightly lower than NASA's Orion entry vehicle. The mission design payload will be a nuclear power plant and in space resource utilization intended for delivery to the surface of Mars. Calibration of computational fluid dynamics (CFD) tools to the ground



CFD anlaysis of a representative SRP condition.

and flight test data will enable knowledge of propulsive descent obtained for specific ground and flight test conditions to be extended to future EDL designs for Mars.

The Game Changing Development (GCD) Program investigates ideas and approaches that could solve significant technological problems and revolutionize future space endeavors. GCD projects develop technologies through component and subsystem testing on Earth to prepare them for future use in space. GCD is part of NASA's Space Technology Mission Directorate.

Points of Contact:

Charles H. Campbell/NASA Johnson Space Center
Charles.H.Campbell@nasa.gov

Professor Bobby Braun/GA Tech
Robert.Braun@aerospace.gatech.edu

National Aeronautics and Space Administration

Lyndon B. Johnson Space Center
2101 NASA Parkway
Houston, TX 77058

www.nasa.gov

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