

# *The Skyclimber*


## **A New Way To Land A Payload On Mars**

**2007 Mars Society Conference Presentation**

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# Comparison Of Robotic Martian Type Landings



# Viking Lander

Used Thruster Beneath Lander To Land Safely On Mars

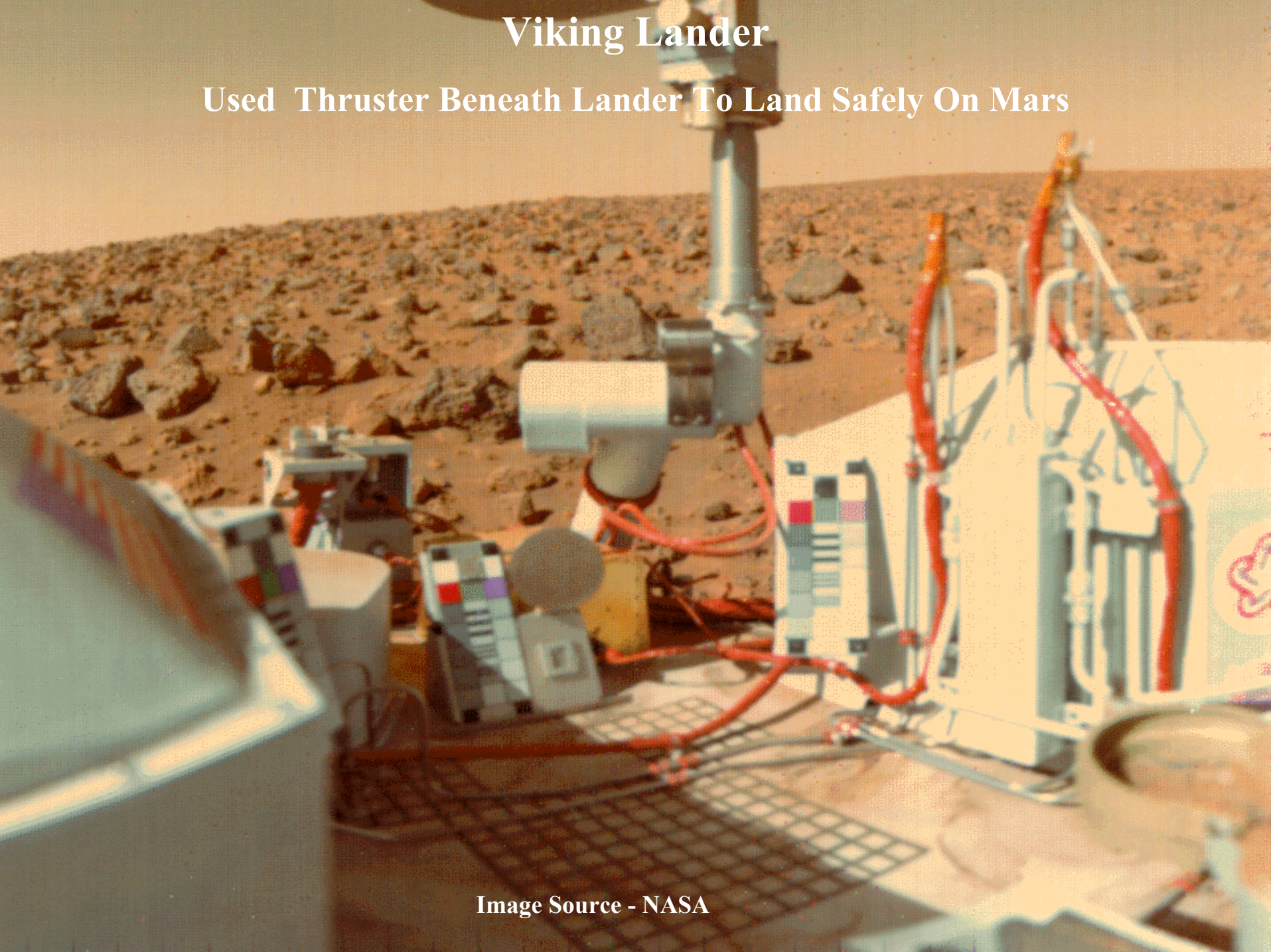


Image Source - NASA

# The Pathfinder

## New Idea For The Times – Thrusters, Airbags Drop and Roll Technique

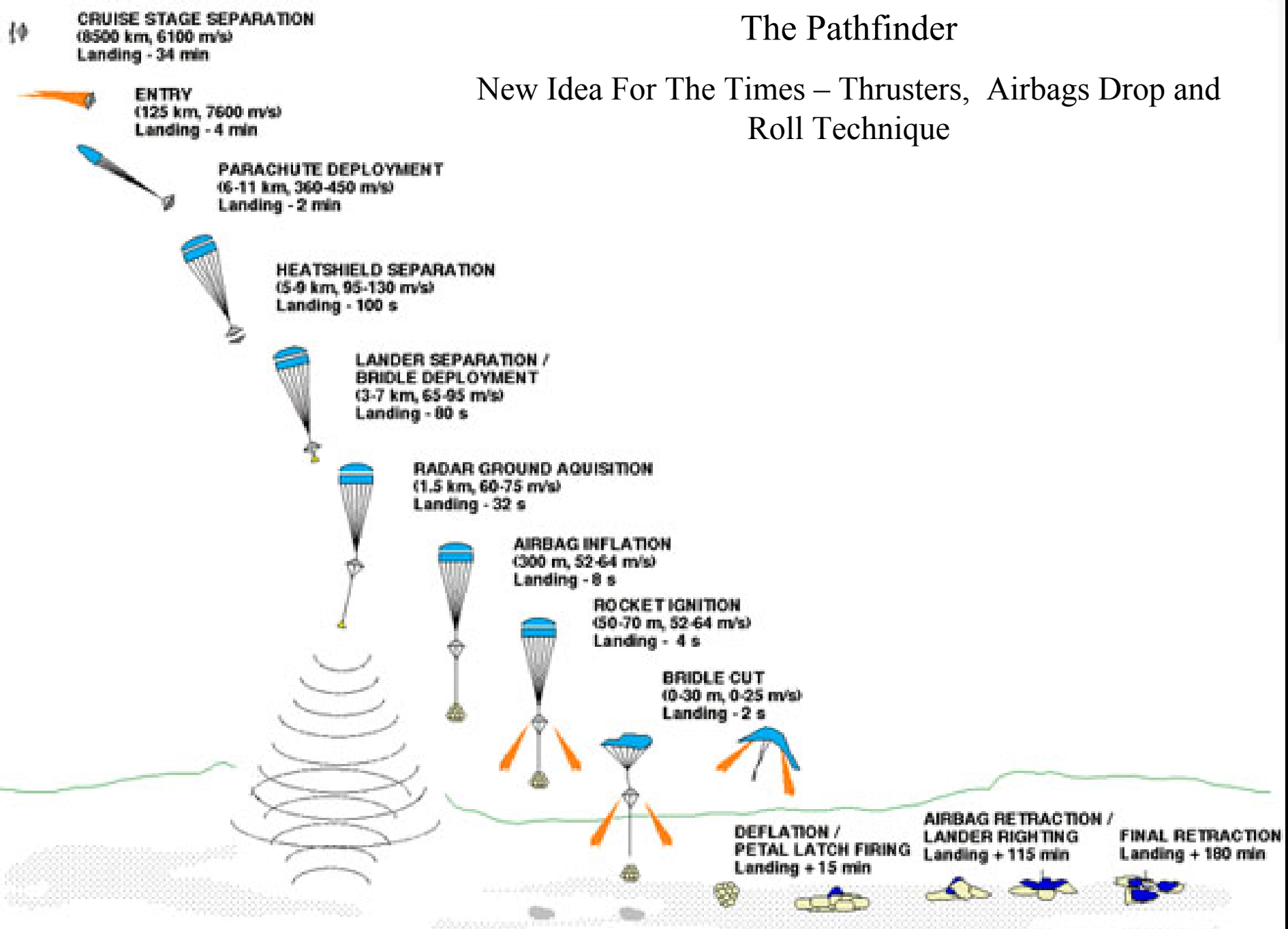


Image Source - NASA

# Spirit And Opportunity Rover Landing

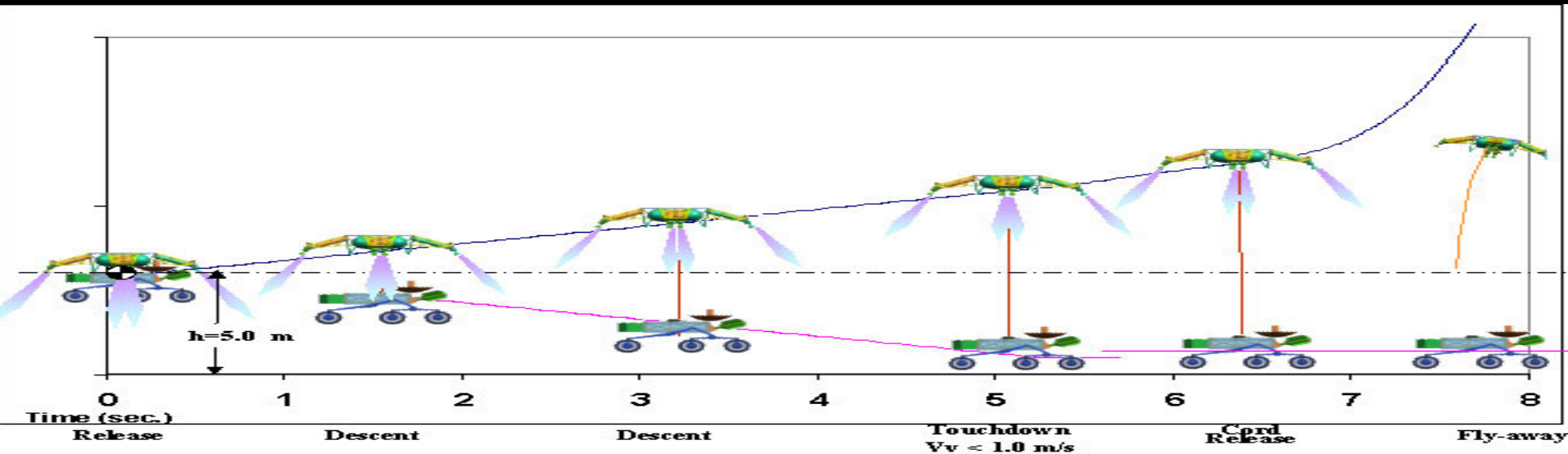
- Modified Version Of The Pathfinder Airbag Drop And Roll
- The MER Rover Airbag Drop And Roll Technique Total Mass Is At The High End Use For Landing This Way On Mars Even If You Use More Than One Parachute.



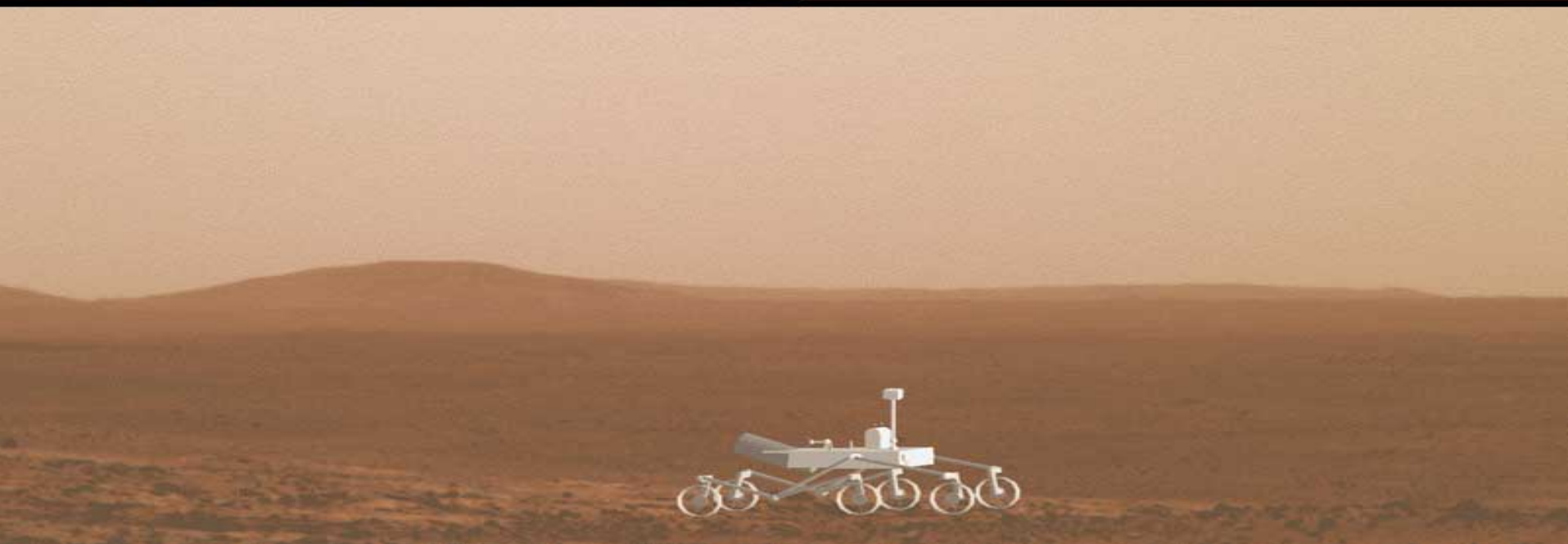
Image Source - NASA

# The Skycrane + Mars Science Laboratory (MSL)

- The NASA's Planned MSL Landing Will Be The Most Ambitious Landing Attempt On Mars Ever
- Because Of The Mass Of The MSL Rover, Over Four Times And Counting Of The Mass Of The Spirit Rover, MSL Can't Be Dropped With Airbags Without Damage So NASA Is Using A New Technique Called The Skycrane To Deploy It.
- The Skycrane Will Use Rocket Thruster To Slow It Down With At Least 240 Kilograms Of Fuel To Hover Over A Target For 8 Seconds Before Fully Deploying The MSL
- The Extra Fuel And The Mass Of The Skycrane Will Add To The Mass Of The Entire System Putting More Stress On The Supersonic Parachute And The TPS On Entry Into The Martian Atmosphere. If the MSL Mass Goes Up So Will the Skycranes Mass Have to Go up???



# The Skyclimber



# Slowing Down By Accelerating Upwards

How Do We Do It?

Simply Moving Up The Tether Line  
Towards The Parachutes During Descent  
Seconds Before Landing

T=1  
V=3.69 m/s  
19.51 m/s

T=2

7.38 m/s

11.07 m/s

T=3

14.76 m/s

T=4

18.45 m/s

T=5

22.14 m/s

T=6

1.06 m/s

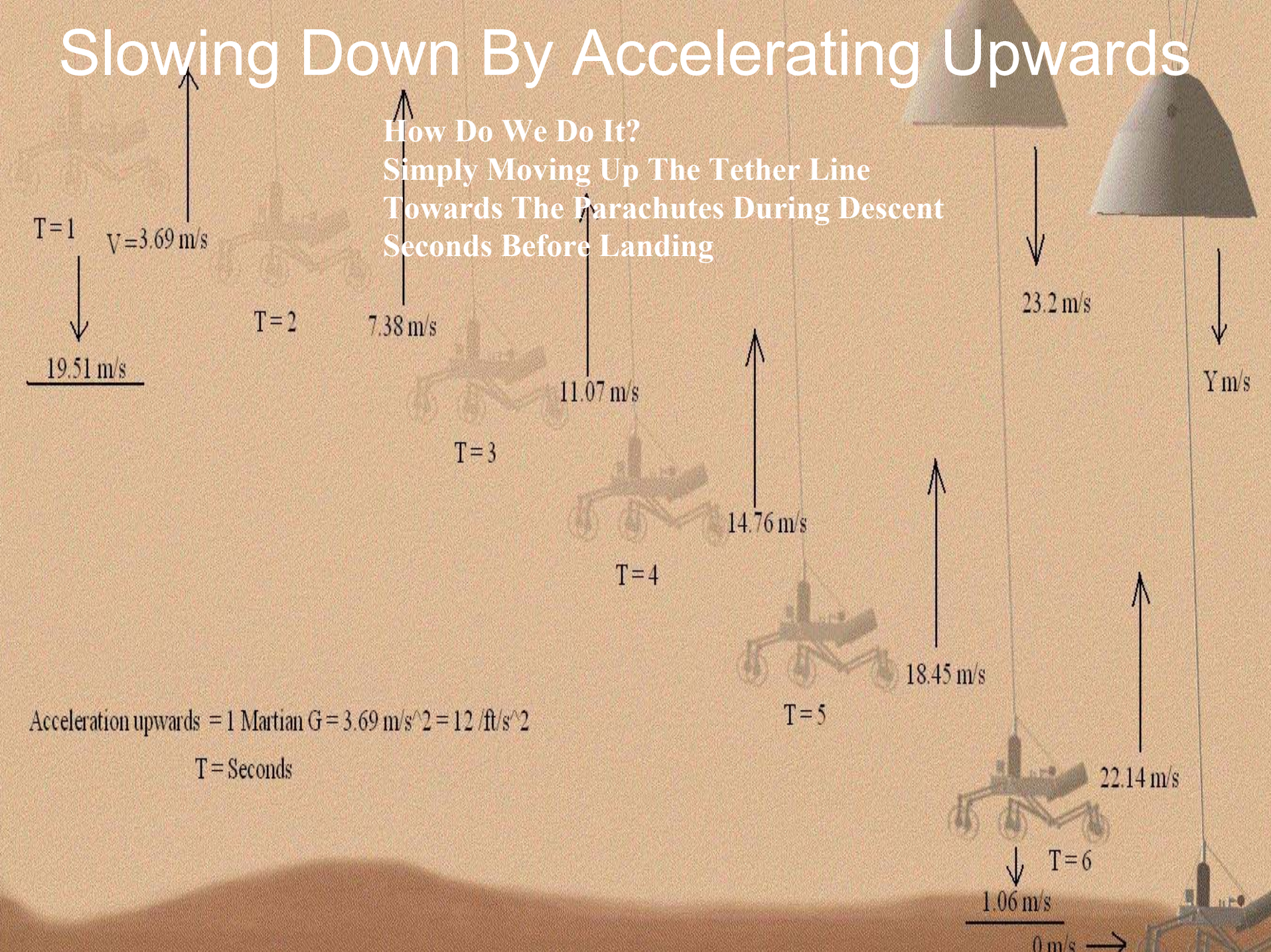
0 m/s

23.2 m/s

Y m/s

Acceleration upwards = 1 Martian G =  $3.69 \text{ m/s}^2 = 12 \text{ ft/s}^2$

T = Seconds



Example of adding a recoil device to lower the power needs of accelerating up the tether line - most of the initial load of the rover / robotic craft / cargo / etc. will be on the recoiled device - surgical tubing stretched short of its elastic limit

Rigid composite material - high bending moment, similar to sport fishing pole

Recoil device - surgical tubing affixed to composite material

Spider line -(tether-line) moves freely through the surgical tubing

Used to distribute and stabilize the load attached to the rigid composite material

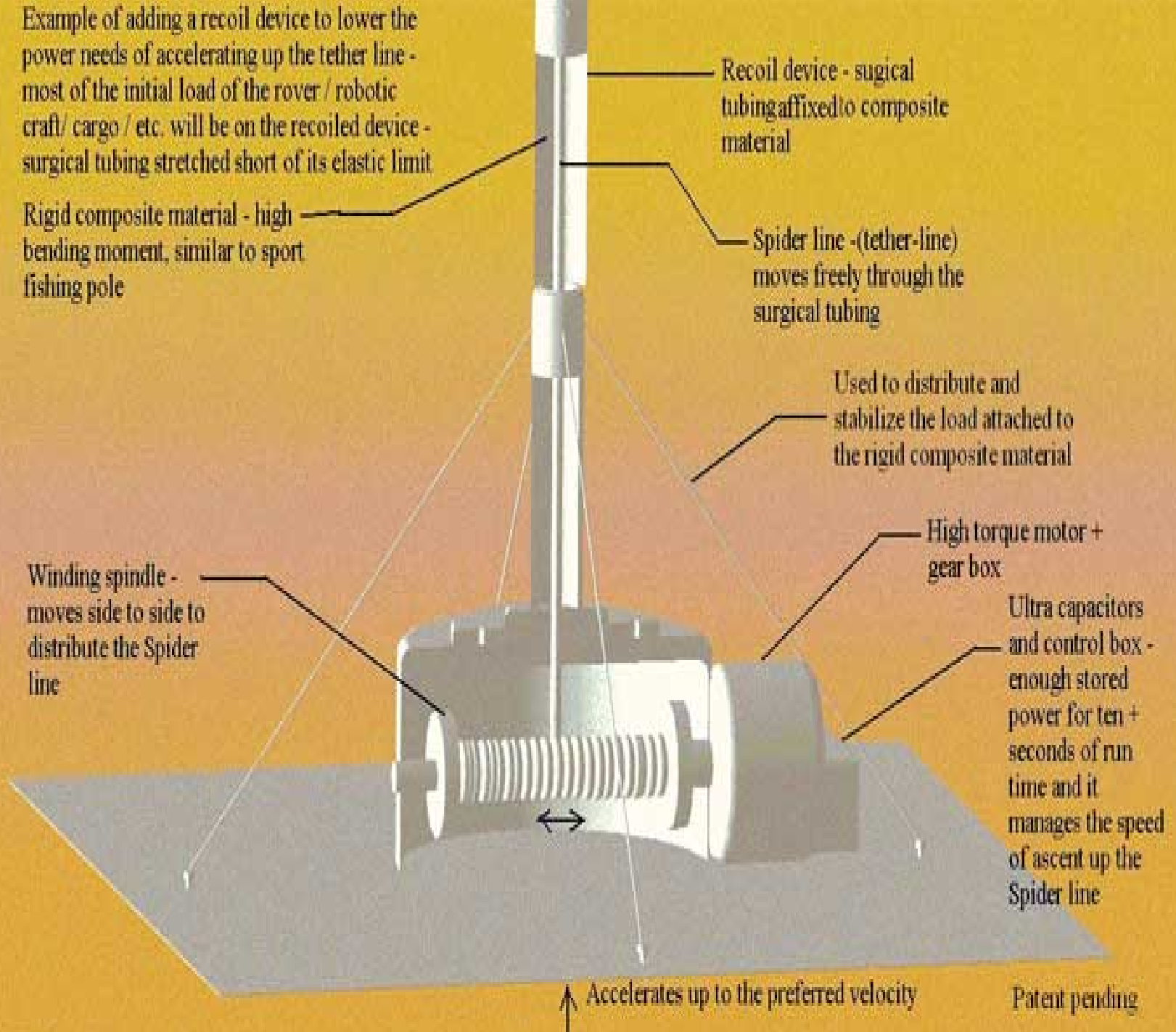
High torque motor + gear box

Winding spindle - moves side to side to distribute the Spider line

Ultra capacitors and control box - enough stored power for ten + seconds of run time and it manages the speed of ascent up the Spider line

↑ Accelerates up to the preferred velocity

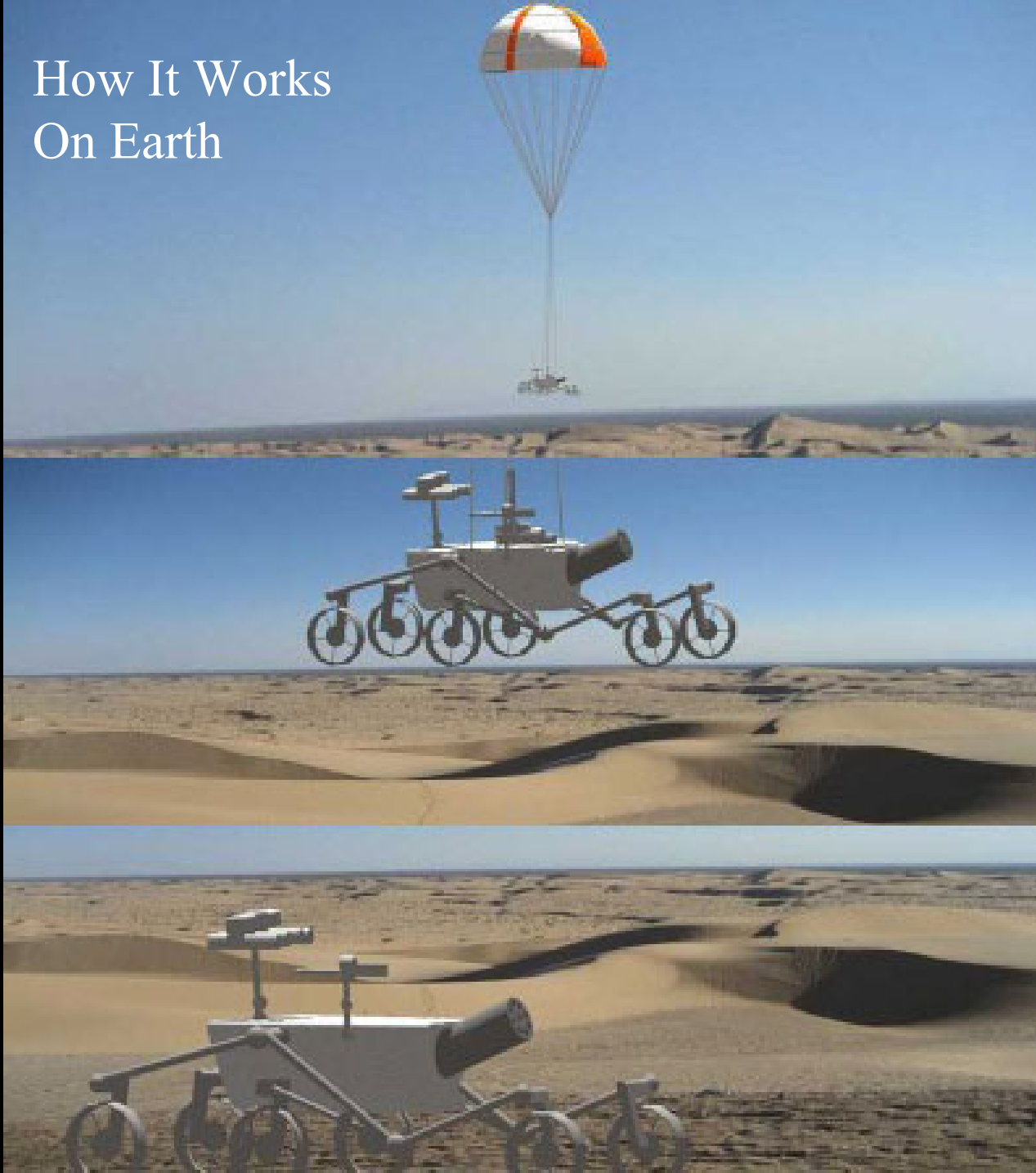
Patent pending



# How can we stop

- The density of the Martian air at the datum is  $2.79E-5$  slugs/ft<sup>3</sup> at -30 C and is approximately 1 percent of what it is on Earth. Earth's air density is .00237 slugs/cu ft at sea level at 58 f. As a result, the difference between the Martian and Earth's air density and the power produced from the wind is much less on Mars than it is on Earth. Using
- $P = 1/2 C_d \rho A V^3$
- Parachute where  $P$  = power,  $C_d$  = Coefficient of drag,  $\rho$  = density of the air,  $A$  = surface area, and  $V$  = velocity.
- $F = P/V$
- As a result using three 134 ft subsonic parachutes (same size that is used on the solid rocket boosters but made out of much lighter material) the Skyclimber + MSL speed for descent before impact would be less than 70 k/hr = 43.09 mph = 63.2 ft/s at the nominal temperature and atmospheric pressure range at the Martian datum Using The Current Mass Predictions For The MSL.

# How It Works On Earth

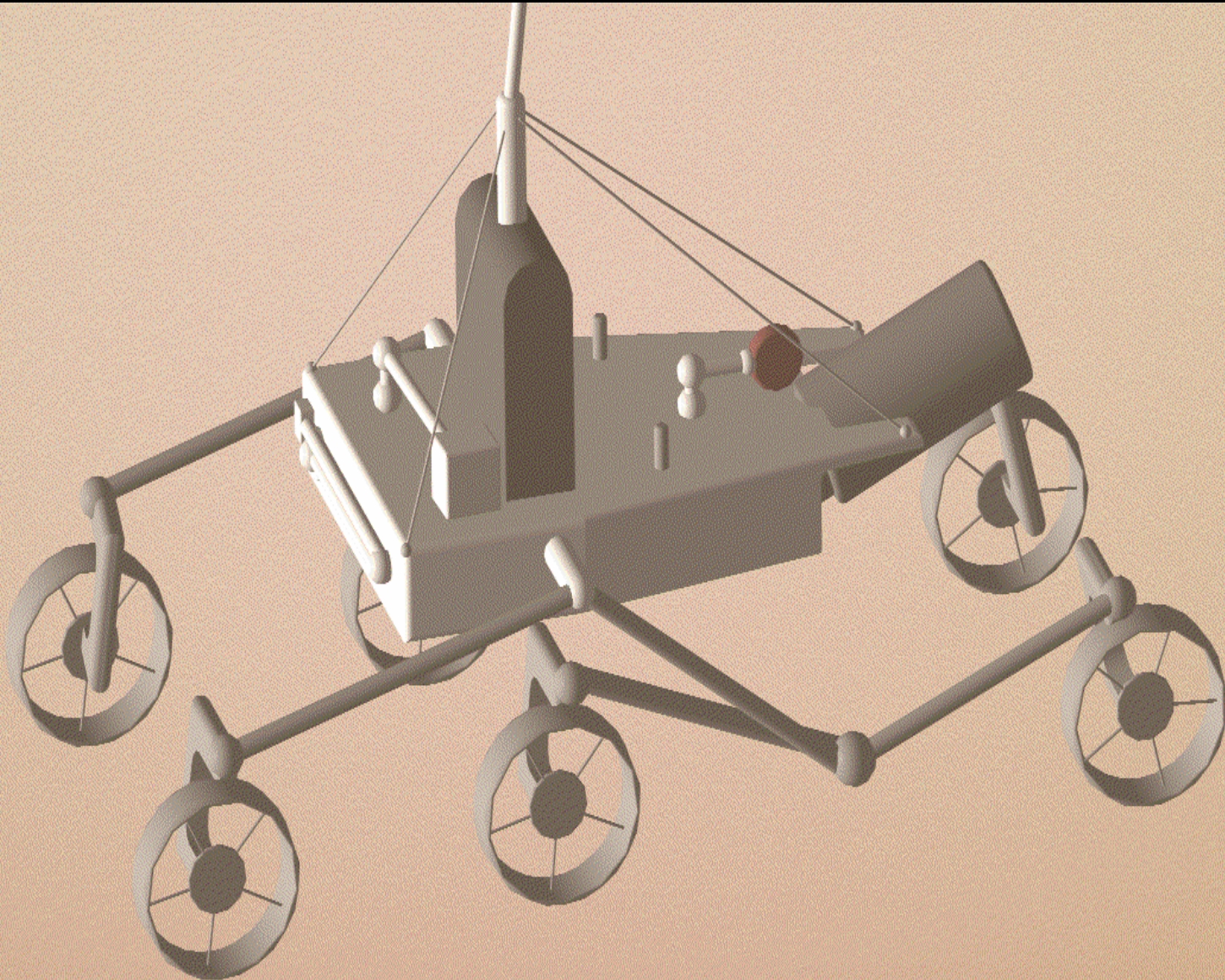


## Total mass Of The Skycrane =??? + Propellant Mass???

- Skyclimber – Total Mass May Be 100 Kilograms Or more Lighter Than The Skycranes Using Today Current Mass Prediction. That includes three large sub-sonic parachutes, electric motor, ultra capacitors, winding device
- Lightweight Retractable Wings Deployed After It Reaches Sub-sonic Speed For Guidance To Landing Site Will Help Steer It To Its final Destination
- The Retractable Wings Will Add Horizontal Guidance At Subsonic Speeds But Doesn't Provide Enough Lift To Lift the MSL And Canopy!!!
- Why Travel Over 200 Million Kilometers Then End Up Landing Somewhere You Don't Want To Land???



# Distribution of the load, recoil devices, etc.



# *Skyclimber Animation*

Double Click On Bottom Image  
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