Modern society and scientific discovery relies heavily on communication satellites, microgravity research labs, and space telescopes – all of which require space transportation. Space launch systems have been in use since the 1950’s, however the cost remains extremely high. It costs about $10,000 USD to launch one pound of payload into low-earth orbit (LEO). Research is going into creating Reusable Launch Vehicles (RLVs) that have the potential to dramatically decrease the cost of space travel and accelerate scientific research and development. Space Shuttle Program (NASA):

- Partially re-usable, manned launch system
- Vertical take-off, horizontal landing
- 133 successful missions
- 6 orbiters built
- $450M / launch (1)
- $10k / pound to LEO (2)
- Program active from 1981-2011
- Originally designed as a “space-taxi” to deliver payload to low earth orbit. Designed to be rapidly reusable with cost per launch in the $20M range.
- Repairing hundreds of heat shield tiles and restitching the parachutes after each flight involved specialized labor and took more man-hours than expected.
- The program ended up costing more money than expected. Also considering safety concerns, the program was terminated in 2011.

Buran:
- A Russian vehicle analogous to NASA’s shuttle
- Launched only once in November 1988

Currently there are no fully reusable launch vehicles but as of today, there is no fully reusable launch vehicle available.

Space Exploration Technologies (SpaceX) is a private space company that launches satellites, resupplies the International Space Station, and might transport humans to the ISS by 2017.

- Grasshopper program began the reusability testing
- SpaceX plans to reuse the first stage of their Falcon 9 rocket by landing it vertically on a landing pad floating in the Atlantic Ocean. They will slow the first stage in it’s decent by reigniting one of the nine engines. It will then land on four legs which are deployed before touchdown.
- Recovering and reusing the first stage will lower the cost of launch since the first stage alone makes up about 3/4 of cost for the Falcon 9 rocket.
- The cost of launch for an expendable Falcon 9 is ~$61.2M USD. (5)
- Adding enough fuel and equipment to make the Falcon 9 reusable would result in 30% less total payload reaching orbit.
- The reusable Falcon 9-R (reusable model) has already carried DSCOVR to orbit and resupplied the ISS with these weight constraints.

Conclusion:
Space exploration is very expensive and will remain so until the launch vehicle can be fully reused. NASA’s Space Shuttle Program was a partial success but took too much time and money to prepare for another flight. Progress has been made in the private sector with SpaceX’s Falcon 9 rocket but as of today, there is no fully reusable launch vehicle available.