

Tsiolkovsky Reusable Launch Vehicles

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Konstantin Tsiolkovsky (1857-1935) is widely regarded as the originator of the concept of spaceflight using chemical reaction engines for launch. Tsiolkovsky's original idea was for using hydrogen fuel for single stage to orbit spaceflight in which the launcher is subsequently operated as a habitation system. While this ideal for human spaceflight has proven to be basically achievable, it has been deemed to be impractical for profit driven commercial space launch operations. Over a series of recent essays I have expanded upon this long standing paradigm of Tsiolkovsky space flight, conceptually outlining a series of progressively larger parallel staged, cross feeding, heavy lift launch vehicle booster configurations, allowing hydrogen engine clusters with sufficient deep throttling capabilities to deliver ever larger and more voluminous hydrogen core stages into deep space trajectories. While the deep space payload capabilities scale nicely in such configurations, the complexity and danger of failure scale similarly.

Therefore a new paradigm in deep space, cryogenic, heavy lift launch vehicles has recently emerged, where denser methane fuel powers a fully reusable booster stage directly back to the launch site, and the Tsiolkovsky paradigm is satisfied by refuelable and reusable upper stage deep space 'spaceships'. This applies whether such a vessel is fueled by hydrogen or methane. While methane powered upper stages provide definite competitive advantages for commercial operations as well as for any deep space development missions to the surface of Mars, hydrogen as a one way upper stage fuel also possesses unique features which may be leveraged by modern space architectures. Large empty hydrogen tanks provide substantial volumes of empty space that subsequently become available for immediate human habitation if such a spacecraft has no intention of ever returning to the planet Earth, and therefore could be powered by reusable hydrogen engine cluster modules which then fly immediately back to the Earth. The purpose of this essay is to clearly state this paradigm as this new era of reusable spaceflight begins.