The Economics of Space

It was noted that during the Apollo program, in which the United States sent men to the moon, that even if there were piles of gold bricks ready to be picked up by the astronauts, it still would not have paid for the cost of the mission. The costs of space travel have been enormous, and many have questioned the value of going into space. Cost is why the Apollo missions were ended, it demanded too many resources that could be used elsewhere. We made the space shuttle to see if having a reusable spacecraft could bring the costs down. Even though the space shuttle was a very successful venture, it was still prohibitively expensive to go to the moon again.

The economics of space travel and the benefits of it are not well understood by the general population. While space travel is exciting and wonderful, and stirs the imagination, it is the practical realities of economics which determines what actually happens. Costs and benefits of space travel have followed a path of stagnation after the U.S. government stopped the Apollo program and then grounded the shuttle fleet. What would make space travel worthwhile? Is there something out there valuable enough for us to pay these enormous costs? Will space travel become cheap enough for anyone to travel there? What is in our future? Colonies on the moon? How about Mars, Ceres, or Europa? **Main Question** How will the current advances in space technology and engineering change our economy in the short run, and in the long run, and what will this mean for jobs, scarcity of metals, manufacturing, new materials, and travel?

I. Economics of Space
   - A. Introduction, background
     - i. Historical reasons for space exploration
     - ii. The Gravity Well
     - iii. The Space Race
     - iv. Satellites and Space Probes
       1. Communication
       2. Exploration
       3. Scientific data gathering
   - B. Costs and Barriers to Space Exploration and Exploitation
     - i. Current rocket technology limitations and costs
       1. Cost per gram to get something into orbit
       2. Materiel technology
          - a. Heat shields
          - b. Radiation shields
          - c. Micro meteorites
       3. Rocket propulsion and rocket fuels
       4. Can we reach nearby stars with current tech?
       5. Light speed lag
          - a. delays in communications hampers remote drone exploration
       6. Space junk
     - ii. Health effects of space and microgravity
       1. Sleeping and biological functions
       2. Muscle atrophy and decay of other human organs
       3. Solar and Cosmic Radiation
       4. Recycled air
       5. Fresh food?
       6. Artificial gravity
       7. Long term health – can we survive in space?
     - iii. Psychological effects
       1. Isolation

2. Cramped spaces
3. Getting along in extreme conditions

C. Benefits and Profits to Space Exploration and Exploitation
   i. Jobs
      1. Spaceship construction
      2. Piloting, navigation, mission control
      3. Cargo and payload handling
      4. Space tourism
         a. Hotels and casinos in space
         b. Visiting the wonders of the solar system
      5. Moon and asteroid mining
      6. Space manufacturing
   ii. Technological advances
      1. Rapid worldwide Communication
      2. Global positioning systems
      3. New rocket technologies being developed
         a. SpaceX
         b. Blue Origin
         c. Space Launch System
   iii. Science!
      1. Studying Earths systems
         a. Gravity
         b. Weather
            i. Climate change
         c. Magnetic Anomalies
            i. Pole shift
      2. Study the Sun
      3. Study the solar system
   iv. Manufacturing
      1. Asteroid mining
      2. Can space manufacturing be profitable?
      3. Can we make new materials in space?
   v. Exploration and Colonization
      1. Moon
      2. Mars
      3. Ceres (Largest asteroid in belt, mostly ice water)
      4. Terraforming – is it worth it?
   vi. Future space technology, and how it could change all of the equations
      1. Ion propulsion
      2. Solar sails
      3. Alcubierre drive (warp drive)

D. Analysis – Is it worth it in the short run, in the long run?
   i. Applying a cost versus benefit analysis
   ii. Is this a racial imperative?

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2. Papers should be 10-12 pages in length in Times New Roman or Ariel 12 point font, double spaced, pages numbered, cover page optional, references on last page (as per APA notation), 1 inch borders on top/bottom and left/right, stapled (no covers or binders). Be sure to include name and period.
3. Please type all work on a computer.