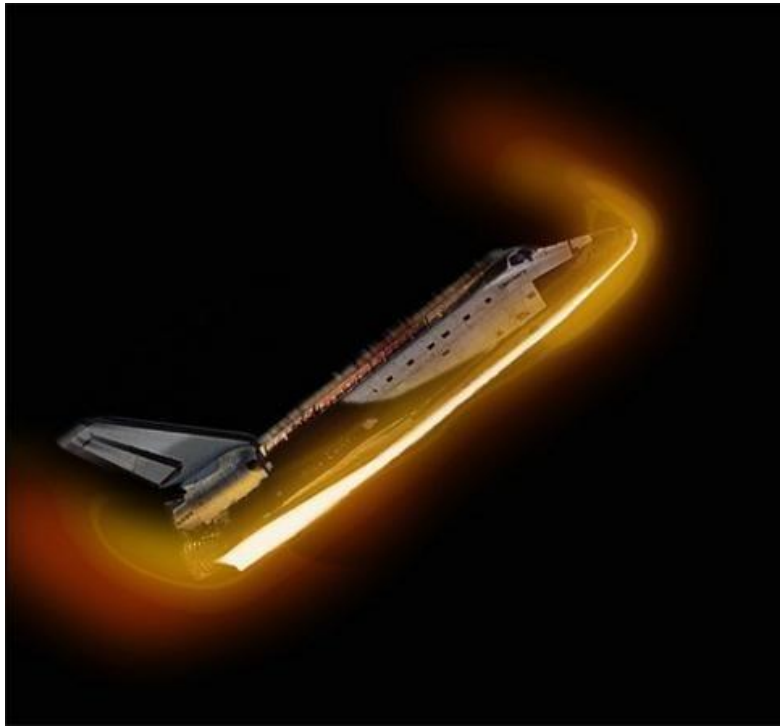
No Heat Shield

- When in orbit, a space craft is circling the Earth at around 17,500 miles per hour depending on the height of the orbit. Returning from space through Earth's atmosphere usually requires a heat shield to protect the occupants from the excessive temperatures generated as the friction of the air particles slow down the space craft. Most space craft use an ablative heat shield that flakes away as the material gets hot and carries away the heat with the little flakes. The Space Shuttle had insulating tiles that could handle the heat and prevented the heat from transferring through to the inside of the ship. All of these ships and space craft had a lot of mass and a lot of momentum that made it difficult to slow them down from orbital speed.



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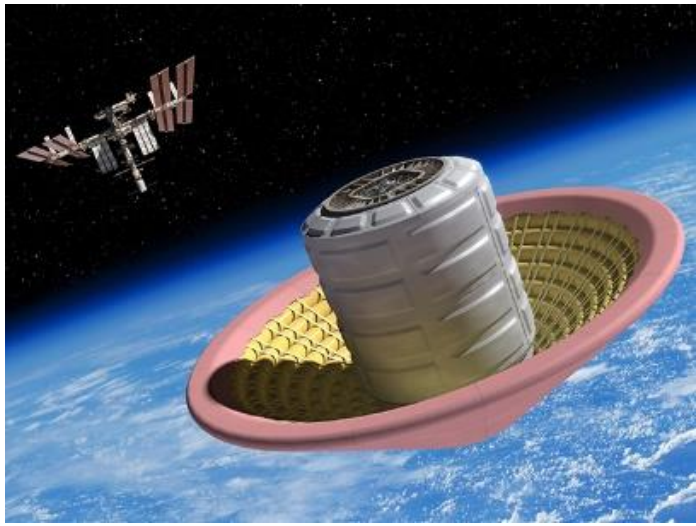
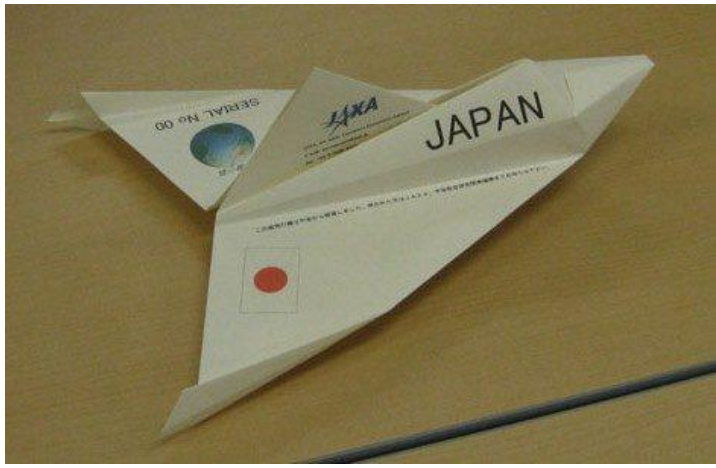
- Imagine if you had a very low mass space craft but a large surface area, it would take a smaller amount of force to slow it down. The less mass, the less force to slow its velocity. The larger the surface area, the greater the effect of the air friction. This is also how the inflatable air shield worked that was tested a few years ago.
- Several years ago Japanese researcher Dr. Shinji Suzuki suggested that a JAXA astronaut Koichi Wakata release 30 paper airplanes from the International Space Station and let them re-enter the Earth's atmosphere and expected that they would make it to the ground without burning up as they slowed down. Dr. Suzuki even demonstrated that one of the paper airplanes could survive a Mach 7 wind tunnel with minimal damage. Any one of the released paper airplanes would only have a 30% chance of landing on the ground since most of our planet is covered with water. But if one was found in a populated area, they had a phone number and address that would allow a person to contact the space agency to claim a prize. Someone must have thought the odds were too low for success out of the experiment so the airplanes were never released.
- https://www.airspacemag.com/space/the-ultimate-paper-airplane-51433308/
- http://www.nbcnews.com/id/23827045/ns/technology_and_science-space/t/paper-airplane-fly-space-earth/#.XMNYojZYahc



Inflatable air Shield



JAXA origami airplane

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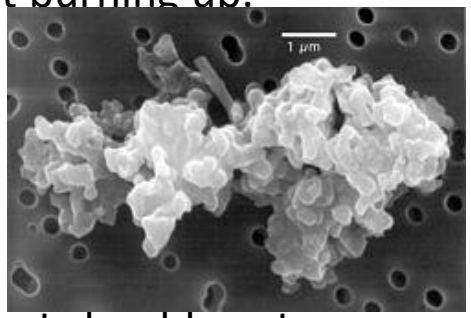
Supporting research:

- NASA has been collecting cosmic dust that falls through the atmosphere since the 1980's. The NASA WB-57 high flying aircraft has flown with sticky material on retractable surfaces of the plane and has returned pieces of cosmic dust stuck to the sticky surface. This is proof that it is already possible with very tiny, light weight particles and relatively large surface area to come through the atmosphere without burning up.
- https://www.stripes.com/news/nasa-plane-collects-dust-really-tiny-cosmic-dust-1.39530
- https://curator.jsc.nasa.gov/dust/
- https://www.wired.com/2012/08/nasa-perseid-meteor-flights/
- http://www.elementsmagazine.org/archives/e12_3/e12_3_dep_cosmoelements.pdf
- I am certain that there will be skepticism about whether this will work. The whole argument should center on the amount of frictional force from the air it will take to change the velocity of the 'satellite' as it comes through the atmosphere. Imagine a canon shooting confetti. Even though the gun powder might make it exit the muzzle at Mach 1, the paper pieces would slow down quickly and fall to the ground. Even though a bullet or canon ball may get hot from the air friction as it travels through the air, the paper pieces might only be singed from the ignition of the gun powder because it takes so little frictional force to slow them down.
- Despite the paper airplane experiment not occurring, I am convinced it is still a great idea but I would like better odds of getting real data for an orbital speed payload returning to the ground without a heat shield.



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Problem:

- Develop an air foil that would allow a 200 gram electronic package (battery included) to be slowed down by the atmosphere without burning up.
- Develop an electronic payload that would allow tracking and maybe data acquisition from the time of release to the time it might land (could be a long time--like a year or more).
- This package should utilize ham radio frequency 437MHz to send a ping on a regular basis so it can be tracked easily from the ground.
- Sunlight sensor could help to only send a signal when it is getting power from the sun
- NORAD can track some items in space depending on the cross sectional area and reflectance
- 437 MHz---Antenna size—6.42”
- Tips: consider
  - a maple tree seed pod and how it helicopters down to the ground
  - Different paper airplane designs
  - Toys that fly and flutter to the ground
  - What kind of materials would you use?
  - How big of an object can NORAD track in space? Would they be willing to assist with tracking? It will have a different visiblity in different orientations.
  - Assume that it may be deployed similar to how the Lightsail 2 was deployed from the second stage of a rocket.
  - https://www.theverge.com/2019/7/7/20683623/lightsail-bill-nye-planetary-society-satellite-earth-update

- Suggested teams:

2-3 people developing the air foil and materials, 2-3 people developing the electronics package, 2 people developing the power, need someone with a ham radio license—not very difficult.

Application:

- If we proved this could work on Earth, would this be a viable method of dropping many small probes to the surface of Mars without heat shields and scattering them over a large segment of the planet and retrieving lots of data points from many locations?
- Could this be a way of getting high altitude atmospheric data from the region between a space craft orbit and the high altitude balloons since there may be significant linger time in the upper regions?

Thoughts on testing

- Place your electronics in the freezer and see how it works.
- Place your electronics in a vacuum jar and see how it functions. Is it able to dissipate its own heat over time? Are any of the components damaged by the vacuum?
- Drop your project from a high tower or building. Is it able to slow the package down enough to not be damaged?
- Lift your project with a drone over a big field and drop your project from the drone's highest elevation. How long does it drop before there is enough force from the air surface to start slowing it down? What happens with different orientations when dropped?
- There are a few schools who may be able to drop their project from a weather balloon. Some of these balloons can go as high as 100,000 feet where the air is very thin and the project would reach at least Mach 1 as it begins to fall. This would be a good test to see how both the airfoil and the electronics behave in the near vacuum of that altitude—temperature, radiation, air pressure. Although dropping from the balloon is a great beginning for testing it in space, it still doesn't test how it will behave at re-entering the atmosphere at 17,500 mph. The only way I can think of testing this is to put it at the top of a rocket. I'm not sure how we will get some of these designs on top of a rocket yet but I am working this one step at a time.
- I expect some of you may have some better ideas and methods of testing. Try them!