NASA PRIZE CONCEPT (2009)

Title of Challenge: Wriggly space ratchet

Note this is two closely linked challenges

Objectives
(a) Develop a space propulsion system based on rolling, unrolling, bending etc. where the linear motion is a result of repeated rotative motions. ie The controlled exchange of angular and linear momentum.
(b) Recruit 'high-school' minds to the application of basic physical mechanics, and engineering where the limits of exploration are really in their own minds.
(c) Use serious science and engineering (as epitomised by NASA) to engage with the geek community of romantic wannabe space inventors.

Description:
This challenge is predicated on the ability for a massive flexibly jointed structure to exchange angular and linear momentum and in this way work it's way through space without an external reaction. (The reactive forces are generated by inertia... ...the changing geometrical configuration giving changing reactive vectors.) A simple illustration of the asymmetric use of inertia is at http://vulpeculox.net/misc/kinky.htm. The motion of such critters would be rather curious like those microscopic worms found in ponds.

From an engineering point of view we might think of robotic arms, motors and control paraphernalia or a heat sensitive material that deformed according to whether it was facing the sun or away from it. It is possible to imagine a craft with 'bimetallic wings' that always gymnastically flipped itself towards the sun - or away - or at an angle.

There are three very important points to note
1 The method is only applicable in space
2 The idea of completely novel propulsion systems, autonomous long-distance craft, with fascinating and 'romantic' visible action will appeal to anyone who until now has just read science fiction.
3 There are huge numbers of possible configurations. Ideal for getting lots of separate people to investigate.

Implementation:
There would be two separate challenges:
- Creating a simulation of a propulsor that could visit all eight vertexes of a cube.
- The other for a solar-powered actuation mechanism.

ie. the materials science part would be divorced from the gymnastic shenanigans bit.

The simulation would need to be kick-started by providing a basic physics engine and CAD system with starter components such as masses, hinges, actuators and actuator control programming. This could then be used as-is by any individual or group, or used as a starting point for more sophisticated components or soft-body simulation.

There are three very important points to note
1 PC computing power makes such simulation open to anybody with imagination.
2 The complexity of the gymnastics is like Lego for the mind. People who get involved will be constructing complex models. Therefore to succeed they will be pretty clever

people (or that sort of latent talent that gets hooked on an idea and is then strongly motivated to do study the technical background.)

3 This is the sort of thing that all true geeks would like to have a go at: Applied cleverness in their own time, a prize, no limits - plus the irresistible romance of inventing space travel. Those that aren't geeks will still be keen to see weird critters lolloping off to visit far parts of 'space' with NASA on the side. It's one of those things that looks good on TV.

Determining the winners

The simulation requires flying the course of the vertexes of a cube and might the be assessed on total power to weight ratio and time taken. The engineering competition might usefully be split into articulated and flexible methods (see end note) then evaluated on published criteria related to established space engineering metrics such as reliability, longevity. Being a first attempt we'd expect a lot of marks for potential.

Rewards

Recognition and a monetary token. It would be fairly safe to say that many of the people getting involved in the simulation would forgo prize money for a week swapping sketches to the engineering entrants at a gathering. On the basis that this competition is the first in the field I would suggest a number of smaller prizes eg [picks number] $5000 for most this, best that, lightest the other and so on.

Format

- For the simulation NASA would need to provide a basic demonstration running on a simulator plus a populist video etc to grab the imagination.
- The engineering competition would probably require some working prototype and detailed documentary description.

Timeframe: About a year perhaps.

Type of competitors

- The simulation would be very much aimed at the general geek.
- The engineering competition is probably something for established research groups.

What area of NASA's work does this challenge address?

- Space travel
- Popular *technical* engagement with space research
- Popular *understanding* that NASA is about very clever people pushing back boundaries.

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End note: What happens when say a helical worm that curls/uncurls according to temperature painted black and white in progressive 160-degree arcs is left 'stationary' in space illuminated by sunlight? Nobody knows - but we can be sure it won't stay still - Something's got to happen - now the challenge is to find out what, understand the phenomenon and harness it.