8/30/1999

Brainstorming Notes: Breakthrough Technologies

Class 1: Breakthrus for which the Enabling technology is either available or being worked [somewhere]/in the "pipeline", Needs to be IMPLEMENTED.

- On-orbit robotic assembly of spacecraft.
- New instrument suites for robotic spacecraft deployment that allow detection of disequilibria.
- Genomics and genetics research in space.
- Human/robotic/IT symbiot EVA systems that maximize human performance and safety. (Suits, Portable Life Support Systems (PLSS), gloves, tool sets, information management).
- Inexpensive WIDE BAND comms to enable effective telepresence - ? times existing data rates.
- "Full Court" "AUTOMATICS" – include. sensors, for safety/Health/setup/ops, to reduce, by an order of magnitude, the "standing Army"/ops costs with large improvements in safety.
- Advanced Software to enable autonomous/fault tolerant "repair" of radiation damage, allow use of inexpensive COTS electronics etc. and on-board data management and anaylsis.
- Symbolic Manipulation – sw that writes sw

Class 2: Breakthrus for which the enabling technologies are at TRL 2, requires realistic evaluations, triage and subsequent development prior to implementation.

- Biotechnologies for removing or minimizing the negative medical consequences of space exploration. (These technologies include: new prevention techniqes, new pharmaceuticals, bioengineering, genetic engineering, genomics, medical nanotechnology, autonomous medical diagnosis and treatment, robotic surgery, MEMS, new surgical materials, biomimetics, biologically inspired materials and procedures, etc.)
  - Radical biotech: 1) removing/minimizing human physiological responses to micro-ge & rad. 2) greatly enhanced immune fen. 3) remote medical treatment (pharma. genetic, eng, genomics, nanotech, out/robotic surgery.
- In situ manufacturing of indegenous or extra-Terran materials.
- Deep drilling (kilometers) capability for life detection, construction of evolutionary histories, and resource recovery.
- Carbon nanotubes, for overall weight reductions by factors of 3 to 0 on nearly all systems, also enables Mag. sais, rad. protection via non-cryo H2 storage in structures and suits, ultra-capacitor energy storage, tethers, planetary space solar and advanced TPS for aeroassist.
- Revolutionary Rocket for LEO access – PDWR [deton. in liquid fuel, factor of 40x red. in feed pump pressure, red. part count/weight, high T/W] hypermixing base ejector [3X thrust enhancement in sensible atmosphere/payload doubling], HEDM fuels [Isp to 2000 seconds], C-nanotubes [factor of 3 to 5 Dry weight red.]
- Blast Wave accelerator [INEXPENSIVE evacuated barrel with distributed sequentially detonated explosives] to place FUEL in orbit for $50/lb. Completely changes economics of FAST interplanetary transits using existing chem. propulsion and life span of maneuvering sats etc.
- A set of Revolutionary space propulsion ooptions [other than existing chemical with cheap fuel via the Blast wave accelerator-no. 4 above] – Mag. sails, Solar sails, minimagnetsphere, Thethers, SEP with cheap gun-launched fuel.

- A set of different ISRU approaches:
  - [inflatable-lined Lava tube/cavern habitats for thermal/rad. protection/weight reduction.
  - Power source alternatives to Nucs [besides planetary space solar], 150 degree F Surface Temp. swings to power compressors, Radiometric [wind/electrostatic/dust] mills, Geothermal, CO2 in-atmosphere solar pumped laser, CO2 – metal propulsion/fuel cells.
  - Bio engineered plants for planets
  - C-nanotube [non-cryo] storage of H2 produced from on-site H20 for habitats and suits (Rad Protection].
  - Direct semiconductor solar powered H2 extraction production from H20
  - Zeolite molecular sieve H20 extraction from Mars atmosphere.
- A set of Mission/Architecture level Revolutionary mass/cost reduction approaches:
  - Crew of 2 instead of 6 or more enables by IT, Married? double majors [life scientist/physician, physicist/geologist], Holographic/Virtual additional crew members for psychological support, large weight/cost downsizing.
  - For long transits, place crew in coma/hibernation, [much] reduced spacecraft weight/volume etc. [revive in preplaced/operational habita].
  - Preposition/operate [overtime – do science using] all of the infrastructure required for humans [power, Habitat, hoppers/rovers, fuel production etc.], transport via inexpensive COMMERCIAL "slowboats" developed for LEO-GEO "tug" applications, obviates need for "Magnum Boosters", vastly improves safety/mission assurance.
    - Free Form Fabrication to reduce initial fab costs
    - "Laboratories in a teacup"
    - Extended life [via planetary space solar] robotic missions

Class 3: Potential ["IFFIER"] Technological Breakthrus which may [or may not] be beyond the nominal DPT 25 year "horizon"

- Harnessing of "Zero Point Energy" [ZPE],, resulting in essentially "unlimited" energy for both terrestrial and space applications, being worked in the GRC "breakthru propulsion program".
- "Beyond human" AI, enabling Machines to "do" the discovery as well as the preplanned aspects of exploration at GREATLY reduced costs, much more knowledge/wisdom/data per dollar. Estimates of this disagree on when [ranging from 2020 to 2045] but not on if.
- Nano-technology "assemblers" for ultra-inexpensive fabrication here, there and everywhere.
- D-He3 fusion plants on moon beaming MW Energy wherever required for whatever purpose. Enabling for Interstellar propulsion.