Project BA – Notes from ELP RAL visit 30th November 2012

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Introduction by David Iron – introduction to Project BA in RAL Space Concurrent Design Facility at the end of the 10 day concept/analysis phase.

- Business case etc will be formally submitted to Govt and expect go/no go decision in about 6months. ELP and Portsmouth Grammar School (PGS) will be part of the publicity phase which starts as soon as the project is approved. Part of the Project BA website will have an education link which will lead to a website to be populated by the ELP (& PGS?). Work for the website and publicity can begin now and use photos/docs from today, but must remain confidential (others can be involve on a need-to-know basis though) until approval.
- Project BA - remote controlled drilling mission and soil analysis (scientific payload) and time capsule containing earth species data (plant, animal) and DNA in human hair samples and any associated written/photographic etc info tag from paying customers on various packages (£50-£200) or lottery customers (commercial payload)
- Project BA – an industry-academia-education partnership which will cost ~£0.5b but market research suggests filling the commercial payload will generate ~£300b revenue to cover it so therefore also to cover mission #2 to recover the drill sample and/or have another shot in the event of a disaster. Although UK Govt has upped money to ESA – this is mainly for 'inwards-facing' projects; virtually none is for 'outward-facing' science or exploration work. Procurement for parts of Project BA will be competitive.
- Objective of 10 day design phase:
    a. bring together propulsion, drill, thermal etc engineers, spacecraft designers along with project support to help plan mission including TLSP costs, risks and risk management.
    b. Mission divided into 7:
        i. lander launch (in disposable rocket),
        ii. lander cruise to Moon,
        iii. lander pole-to-pole parking orbit around Moon while landing space about the size of a tennis court is identified (just 2-3 orbits though due to bumpy gravity effects affecting orbit),
        iv. mapping and decent,
        v. deorbit burn,
        vi. horizontal decent to high window (tennis court)
        vii. landing.
    c. Rocket seems a given
    d. Lander is the focus of activity. Will have rockets (parachute landing can't be used – no atmosphere?). Expected to be about the size of 0.5Xmini-cooper. Expected to contain commercial payload, scientific payload and everything needed to support mission ie fuel, radiators, control electronics, guidance and navigation systems etc etc

Presentation by Adam Baker – Systems engineer

The systems engineer "glues" the mission together – the engineers in the room are problem solvers.

About the mission: very difficult to get to the south pole of the moon – mankind has not been there before. We've not drilled (very deep) on the moon before.

Challenges – cold, radiation, dust

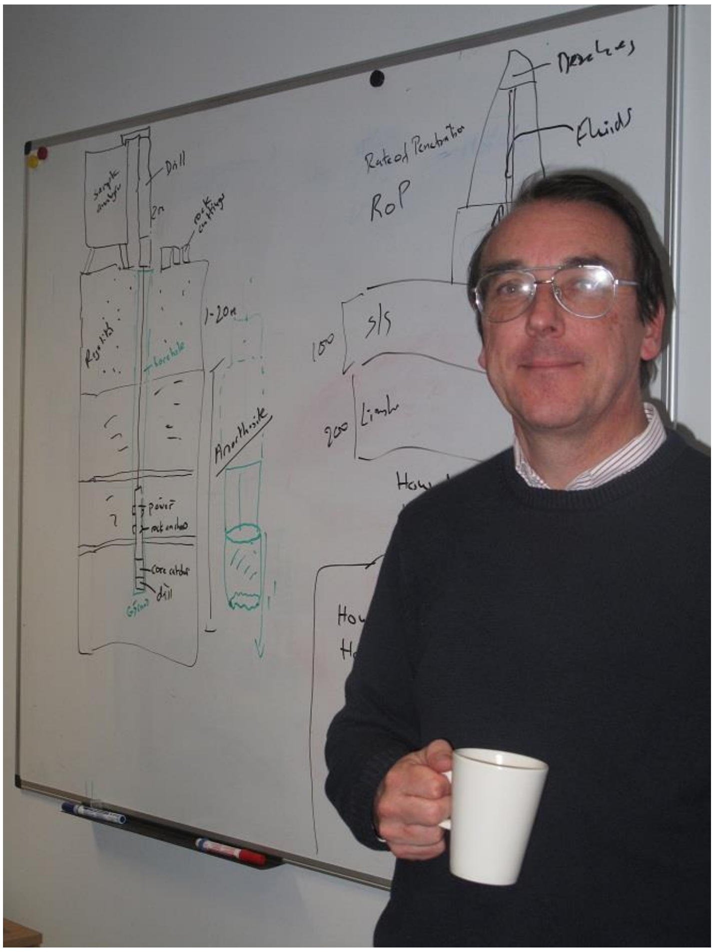
Space experts talking to non-space (drilling) experts in CDF

How long?

What are the risks?

Conversations with engineers

1. **Phil Bustin – drilling engineer**



- Nothing on earth suits.
- Proposal – completely new 'dry, self cleaning/emptying drilling' method to drill <50cm lengths of 5-6cm soil (more like rock) core down to a depth of 100m down from the surface using a derrick which is controlled, operated and maintained by the lander using its little arm.
- Experiments will be performed as the drill goes down
- Problems to solve:
    - near the surface it is dusty – needs to be able to drill without the hole collapsing so a telescopic-style liner will be used to line it. No idea how deep the dusty layer will be. Needs to be able to clear the hole of the dusty material and also is it collapses
    - when rock is reached, needs to be able to bring up rock cuttings and put them somewhere on surface (I'll have 100m of core - that's a lot of material to manage).
    - How thick are the different rock layers going to be - Anorthosite was mentioned – what are the issues with that? (Chris thinks very hard rock, prompting the question from us – would different bits need to be swapped in from a capability perspective)
    - How do I drill?
    - How do I clean the hole?
    - What if I get stuck?
    - How do I get torque?
    - How much power do I need?
    - What redundancy is needed to cater for wear and tear?

2. **Wayne – spacecraft CAD designer**
   - Uses info provided by rest of team (esp propulsion engineer and thermal engineers) to start working out size and shape of lander. Also to ensure its balanced, stable on landing and whilst unloading, setting up drilling, doing soil analysis etc. Also design of arm, solar panels, radiators, guidance system hw and sw etc
   - Important to keep the design balanced – 3-8m between legs
3. **Christine – propulsion engineer**
   - Chooses engines for each part of mission, preferring COTS over brand new etc. Works out fuel types required, coolants, Helium gas needed to pump fuel etc
   - Spreadsheet to model the calculations for each component eg fuel tanks
   - Mentioned that the calculations are not constant during descent – gravity
   - Key thing is to use standard components where available to reduce risk
   - Investigation / prototyping
   - 1 month cruise – 6 months science on surface with the possibility of 24 months if extended operation is possible
4. **Adam Baker – system engineer**
   - Pulls all engineering together in big spreadsheet. Considers mission details and its impact on engineering etc. Also on how to bring back sample. Also on how to handle and where to park time capsule (not near rig or slag heap or rockets etc)
5. **Alan Dowen – thermal engineer**
   - Chooses a/c and radiators required to support/protect electronics and payloads during each of part of mission (delivery, orbit, on surface).
   - Constrained to certain power budget for instruments
   - Goldilocks analogy used – equipment needs to be at the right temperature - Electronics work best at room temperature.
   - Will need to have solar panels and radiators all the way around the lander because due to orbit, all surfaces will be exposed to hot (when facing sun +750) and cold (when away from sun – 750) over time. At any given time ?? there will be a cold side of lander where no sun its too cold; on the hot side too hot. Only cold fuel (no nice warm drilling fluids etc) so considers geometry of heat distribution surfaces, heat pipes, materials etc to help to do this
6. **Sef – project support - costs**
   - Support for 6m-2year mission but with capacity to extend if lander carries on operating. ESTRACK coms for earth-led remote control of lander/derrick etc