

Flex Pivots

Cost, Power, mass Impacts

(contingency presentation)

Ian Pain

Flex Pivot Cost status

- **For the 18 pivots x two types the total order cost would be ~£94.5k. This represents an over-run of £81.4k on the £13.1k budgeted.**
- **The variation exceeds the BSM internal contingency .**
- **A table of costed options are listed, following slides.**
- **The best solutions are summarized as:**
 - **7. Request ESA or CPPA procure Lucas flex pivots (may be hard to arrange)**
 - no budget overrun
 - **5. Joint procurement of Lucas flex pivots with SRON (if possible)**
 - £36k overrun
 - **10. Buy Lucas optimized pivot. Power goes up to ~12mW?**
 - £55k overrun
 - **11. Buy BE systems pivots 0.15mm blades, power 12-20mW**
 - £35k overrun
 - **12. Buy BE systems pivots <0.1mm blades if available, power 4-12mW**
 - £35k overrun

Flex Pivot & Motor Choice interaction

- **Complication between ability to run at higher power dissipation and motor choice.**
 - If MPIA/PACS/Zeiss select a Cu winding rather than the baseline Al, the increase in dissipation is significant (about a factor of 5).
 - The power estimates for 2-4 mW using Lucas flexures can still contain this as the contribution from overcoming spring rate is small enough that a margin remains (or that the power dissipation would remain viable).
 - The >12mW figures contain a large spring rate contribution so would go to about **50mW** if copper windings were adopted. Thus motor availability constrains flex pivot choice.
- **Recommendation :**
 - investigate ESA or joint procurement options.
 - Only adopt a stiffer pivot (BE or Lucas) after confirming PACS motor winding type.
 - Otherwise, adopt baseline option and find money from somewhere....

SPIRE BSM Detailed Design Review

30th July 2001



Flex Pivot Option	Description	Cost	overspend on budget cost	Power	Notes
1. Budget	Original assumption.	£13.1k	0	4mW	Assumption was approx. £13k.
2. Baseline	Inconel flex pivots. Two types (chop and jiggle).	£94.5k (*)	£81.4k	2-4mW	Based on Lucas TRW quote (**). Note VAT & import duty not included - waiver would be required
3. 304 stainless	As 2, but use austenitic stainless steel.	£91.7k	£78.6k	2-4mW	Saves £1.4k per type of flex pivot. Possible better fatigue life but reduced strength (TBC)
4. 429 stainless	Uses off the shelf pivots but need to upscreen, and schedule extra vibration tests (NOT recommended)	£30.4k	£17.3k	2-4mW	HIGH risk of failure on cold vibration!! Assume upscreen by buying 4 x requirements (20 pivots x 3 @ £40) and doing 2 x extra warm vibration tests (@£2k); 2 x extra cold vibration tests (@£10k/test) with 20 extra days work (@£300/day).
5. Joint procurement	As 2, but joint procurement with another agency such as SRON,	£48.8k	£35.7k	2-4mW	£22k saving per pivot type by sharing tooling and material price. May be higher if other cost breaks occur
6. Material brokerage	As 2 but assume we could sell material to a third party broker, the original supplier or e.g. RAL	£68.9k	£55.8k	2-4mW	£12.8k saving per pivot type. Sell on of material may not work (or run into tax and duty issues)
7. ESA procurement?	Ask ESA procure the pivots for us	Nominal £13k	0	2-4mW	I have not explored this at all yet, but it would be ideal if we could do it. Allowing £13k for liaison flights etc.



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Flex Pivot Option	Description	Cost	overspend on budget cost	Power	Notes
8. Common Jiggle Pivot	switch to a single pivot type, 7010-600	£58.8k	£45.7k	>12mW	Power budget assumes aluminium windings. Saves £35.7k on material & tooling. Risetime may be compromised if motor saturates
9. Common Chop Pivot	switch to a single pivot type, 7010-800	£73.8k	£60.7k	<4mW	Major assumption - would have to be able to lightweight the design enough to take the launch loads on the lighter pivot. Unless loads reduced this does not look likely. Saves £35k less say £20k for re-engineering & increased manufacture costs
10. Common intermediate pivot	intermediate stiffness pivot to BSM specification compromise between the two.	£68.8k	£55.7k	4-12mW	Would make any light-weighting or power budget problems a trade-off. Add £6k for engineering costs. Risetime may be compromised if motor saturates
11. BE Systems Pivot. 0.1mm blade	Procure BE systems pivots. 0.1mm flexure blade. Either identical to SMEC pivots or a slightly lighter flexure (or 2 types)	£48k	£34.9k	12-20mW	Cost approx. £1k per pivot x 40 . As unit is 2mm bigger, need to re-engineer chop & jiggle stage, motor mounts and BSMs (say £8k including redesign & new prototype m/c). Power budget assumes scaling as in Dominique's note . Risetime may be compromised if motor saturates
12. BE Systems Pivot. 0.0?mm blade	As 11 but a lighter flexure if available	£48k	£34.9k	4-12mW?	Would have to confirm minimum size BE systems flexure and estimate power.
13. Spark Eroded Pivot	Special pivot, maybe developed by Zeiss	?	?	?	Cost probably at least as much as option 11
14. Smiths Industries Pivots	Maraging Steel Pivot per Smiths Industries	?	?	?	Would be a aerospace rated part. Need to determine if it works cold and calculate stiffness.

