5B Maverick Solar PV Automated Assembly & Deployment Project

LESSONS LEARNT REPORT No. 2

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Project Details

Recipient Name and website	5B https://5b.co/
Primary Contact Name	Lisa Beeren Simeon Baker-Finch
Contact Email	lisa.beeren@5b.com.au simeon.baker-finch@5b.com.au
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EXECUTIVE SUMMARY

The activity in this project is focussed around designing and implementing improvements to 5B's proprietary solar photovoltaic (PV) technology, the 5B Maverick™ (5B Maverick). This will be achieved both by automating elements of the assembly through development of the Advanced Manufacturing Pilot Line (AMPL) and automating the 5B Maverick deployment process using GPS Guided Deployment (GGD).

Key learnings in the project for this milestone are centred around the design and procurement of key components of both the AMPL and GGD developments, namely:

- the importance of considering manual assembly in designing for automation.
- the importance of early IP negotiations with procurement partners.
- the need for a range of positioning technologies to ensure accurate localisation of a vehicle in the field.

KEY LEARNINGS

Lesson Learnt No. 1 : Product optimisation for Automatic and Manual assembly techniques is not always compatible

Category: Technical

Objective: Design the 5B Maverick product for optimal assembly

Detail:

- All previous generations of the product were manually assembled
- The new generation has been designed around automated assembly (with a limited number of manual steps). For all prototypes and pre-production activities before the automated line is available, however, manual assembly will be required.
- Tasks that are straight-forward for machines are not always as easy for people (and vice versa). An example of the disconnect is aligning and inserting fasteners - human fingers are more dextrous but do not fit into small spaces.

Implications for future projects:
Due to the improved economics it enables, the majority of this product will be made using an automated assembly line. However, a proportion will always need to be made in manual assembly situations (e.g. prototyping, rework, small projects with specific product variants). This means that while the product range should ideally be optimised for automated assembly, this should not preclude it from being assembled manually.

Lesson Learnt No. 2 : Good definition of background intellectual property in commercial documents saves significant legal and commercial negotiation on terms

Category: Technical/Commercial

Objective: Engage suppliers to design and build equipment to a specification using an overarching equipment purchase agreement

Detail:

- Each piece of equipment in the AMPL program is being specified using a basic design and a set of requirements.
- When engaging with suppliers this is coupled with a Global Equipment Purchase Agreement (GEPA).
- The GEPA has been well received, however there are differences in approach to project Intellectual Property (IP) between large and smaller suppliers, with large (often multinational) suppliers having a specific stance on what project IP they will own, and smaller suppliers happy to give over all IP to the purchaser.
- Choosing a suitable supplier is a delicate balance - larger companies may have more expertise and can therefore deliver faster and more economically, but at the expense of protracted negotiations around IP.

Implications for future projects:

- For a start up / scale up, the IP concerns are greater than they would be for a larger organisation as it is the IP that the smaller company is leveraging to scale. In order to come to project level agreement with suppliers, it is expedient to expressly outline the scope background, shared and project IP and what belongs to who at the very beginning of the engagement (pre request for quotation).

Lesson Learnt No. 3 : Localisation of a semi-automated field vehicle requires multiple technologies simultaneously to achieve accurate results in a dynamic large outdoor environment.

Category: Technical

Objective: Accurate localisation of the Delta deployment machine to place each beam of 5B Mavericks on the ground at predetermined locations within a specified tolerance

Detail:

- Early investigations indicated that the semi-automated Delta machine was to use real time kinematics (RTK) guidance positioning system (GPS) as the core technology for localisation.

- Extensive in-field tests were conducted with a RTK GPS system mounted on an existing deployment vehicle across multiple sites.
- Using experimental data, it was determined that:
    - RTK GPS measured to have a variance of 20-37mm in each direction
    - Short-term averaging over 10 seconds was found to increase the accuracy of the individual readings marginally, by ~5%.
- Because of the requirement to provide positioning feedback to +/-20mm, the RTK GPS solution is not adequate for use in machine control when used alone.
- A rotary laser and a robotic total station were tested as other potential technologies to use for more accurate results.
- Rotary lasers and robotic total stations had range limitations of around 300m and 1k respectively - too short for some sites without repositioning markers and emitters
- The final solution for the guided deployment system will likely encompass a number of positioning technologies, including laser based systems to achieve the high accuracy required for placing the first beam correctly as well as RTK GPS to determine the vehicle's bearing and provide redundancy.

Implications for future projects:
For future projects, the localisation accuracy for each step needs to be determined and the appropriate technology should be used. Redundancy and multi-sensor fusion should be used to increase the reliability and accuracy of the machine operation.

A: 34 Kent Rd, Mascot, NSW, 2020, Australia **W:** 5b.co