5B Maverick Solar PV Automated Assembly & Deployment Project

LESSONS LEARNT REPORT No. 1

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Project Details

Recipient Name and website	5B https://5b.co/
Primary Contact Name	Lisa Beeren
Contact Email	lisa.beeren@5b.com.au
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A: 34 Kent Rd, Mascot, NSW, 2020, Australia **W:** 5b.co

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 so far are centred around the initial planning and design phase and stress the importance of:

- being aware of global supply chain issues and ensuring a continuing supply of key product components
- finalising the design of the product central to planned automation assembly before beginning the design of the automated assembly line itself
- breaking up complicated assembly processes into smaller sub-processes that can be developed independently
- completing technical prerequisites before engaging with major contractors
- being aware of intended applications of automated deployments and including subsequent operational requirements in the initial planning and design.

KEY LEARNINGS

Lesson learnt No. 1: Global supply chains and world events can rapidly alter equipment lead times

Category: Logistics

Objective: Improvement in the technology readiness of the automated 5B Maverick production and deployment

Detail:

- During early planning, estimates for lead time on equipment were received from various suppliers, which drove the initial timeline.
- Global events have shifted the marketplace for some of that equipment faster than anticipated, for example shortage of timber supplies for the building industry led to an increased uptake in roll formed steel for residential building, meaning that the queue for new roll forming machines quickly became longer from all suppliers.
- Because of this shift in delivery timing, to plan for testing of other downstream equipment, we needed to develop a strategy for sourcing beams that were as functionally equivalent as possible for the interim.
- Compounding the logistical issue of delayed machinery is the tradeoff between the steel specification that is best for the final product, the steel specification that

can be easily roll-formed and the steel specification that is readily available in the market.

- Delays to product design can exacerbate the issue - if the machine is highly dependent on a completely finished product design then delays at quotation phase can lead to much longer delays in delivery. Mitigate this by requesting quotes at the 90% design milestone for the product.
- Key learning - global forces can affect the supply chain for any equipment, including what would normally be relatively short lead time items. When planning for equipment purchase and install, ensure there is contingency in timing or alternative supply for product for testing of other equipment.

Implications for future projects:
For future projects (and for future components of this project) we would develop a risk mitigation plan for delayed production equipment sooner. We would look to place orders for the equipment as soon as we have a design that is close to complete, rather than wait, as any design changes can be absorbed during the lead time for the manufacturer to start work on the equipment. The additional cost of minor modifications to the equipment before delivery will offset the opportunity cost lost when not having the equipment running. Additionally, knowing that the equipment may be further delayed, we will ensure that there is a separate supply of the resulting parts well ahead of the machine to allow testing of downstream equipment.

Lesson learnt No. 2: Sourcing prototype parts for product design can block development of automated assembly

Category: Technical

Objective: Improvement in the technology readiness of the automated 5B Maverick production and deployment

Detail:

- Ahead of final design of any automated manufacturing and assembly equipment, having a final design and working prototype of the product the equipment will assemble is important to ensure all requirements and constraints are captured.
- This requires sourcing of parts for the prototype, often with minor variations to determine best fit for the automated assembly process. Each of these variations may need the supplier to develop tooling.
- If this was for sourcing of parts for production, the cost of the new tooling can be amortised over a significant quantity of parts, and so becomes near negligible compared to material and labour costs in production of those parts. Conversely, with a very small run for prototyping purposes, the tooling is a major cost factor in the cost per part.

- For extruded aluminium parts, there are limited facilities in Australia where these can be produced. That means that there is a cost and time penalty when sourcing new tooling and parts (long queues of other customers for extrusion companies with facility to do tooling). International supply chains can deliver faster than Australian equivalents, however are subject to logistics risk including release from port on arrival.

Implications for future projects:
For future projects where prototype parts are required, it may be advisable for first batch to be machined from the closest similar standard extrusion to receive quickly (though at greater expense) for first runs of prototype, then quickly iterating to limit the number of new extrusion tooling parts that need to be done. Similarly, negotiating with local vendors to ensure a place early in the queue as soon as a prototype has been determined to be necessary (ahead of completed part design) would ensure a timely turnaround when parts are needed.

Lesson learnt No. 3: An automated manufacturing line can be broken up into small sub-processes to allow for earlier incorporation into the commercial product

Category: Technical

Objective: Reduction in the cost of renewable energy through reductions in the cost and time required for production (AMPL) and deployment (GGD) of the 5B Maverick.

Detail:
- The early planning for the Advanced Manufacturing Pilot Line envisaged it as a monolithic system where parts went in, product came out, to be delivered as a single unit.
- Risk analysis on the various processes required suggested that some should be pulled forward for testing to ensure that they were robust. This led to breaking the system into several major sub-processes that could be developed in parallel.
- This mitigates technical risk and brings forward the timeline for several sub-processes, allowing more engineering effort to be dedicated to the processes that need it.
- A potential risk in this approach is ensuring that all sub processes interface well with each other, mitigated through systems engineering planning at specification stage.
- This approach has led to several of the stations from the assembly line having potential benefit ahead of use in the pilot line.

Implications for future projects:

For future projects, we will break down each major process into its component sub processes as early as possible, allowing the project to plan for parallelisation of development where possible.

Lesson learnt No. 4: Broad engagement with Major Contractors requires technical prerequisites to be largely complete

Category: Commercial

Objective: Improvement in the technology readiness of the automated 5B Maverick production and deployment

Detail:

- Initial planning for GPS Guided Deployment (GGD) envisaged an early engagement with Major Contractor A (MCA). Such engagement was envisaged to mainly focus on development of autonomous capabilities.
- Assessment of the actual productivity improvements from complete autonomy has revealed that the gains from implementation of complex autonomy are incremental & relatively difficult.
- The early stage of GGD equipment, site mapping and navigation specifications and concept downselection made negotiations of deliverables and scope with MCA difficult.
- Time and resources were “wasted” pursuing MCA engagement at too early a stage in the project development.

Implications for future projects: Time and resources need to be allocated at early stage gates to better define critical path work and critical development milestones. This avoids unnecessary partner engagement overheads, when prerequisites for such engagements are not in place.

Lesson learnt No. 5: GPS Guided Deployment system requirements need to account for optimal business model and operating use cases.

Category: Technical

Objective: Improvement in the technology readiness of the automated 5B Maverick production and deployment

Detail:

- Early plans for GPS Guided Deployment (GGD) envisaged a platform very similar to the existing vehicle platform that 5B currently uses. Initial project planning was based on this assumption.

- Subsequent and more thorough review of GGD system requirements revealed that the existing vehicle platform was not well suited to the GGD application and overall business requirements. For example, the high productivity of GGD leads to a strong business desire that equipment be readily and rapidly transported between sites (possibly internationally via air).
- Such system requirements, which may be a complex interaction between technical constraints and business desires, lead to a strong desire to decouple from some of the physical constraints of the existing platform.
- As a result,early project plans and work priorities have been modified to accommodate this platform change.

Implications for future projects: Full system requirements analysis needs to explicitly include assessment of the optimum business model and operating use case for any new technology development. Operations as per historical models may not take full advantage of the capabilities unleashed by new engineering developments.