SOUTHERN LAUNCH

Closing the loop between small satellites & timely space access

MAGIC for MATLAB EXPO 2021
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Project & Company Introduction

Southern Launch is a South Australian company that aims to be a global leader in the Space Launch Services market.

Smallsat value chain

Upstream
- Rocket manufacturing
- Satellite manufacturing

Launch services

Satellite operators

End-user applications

Markets:
- Commercial
- Consumer
- Defence
- Scientific
- Civil

Select application examples:
- Communication
- Earth observation
- Smart device connectivity
- Space exploration
- Military and navy
- Navigation and asset monitoring
Southern Launch Ranges

Orbital launch site: Whalers Way Launch Complex

*Whalers Way offers unrivalled access to high inclination launch corridors out over the Great Australian Bight from its 6km of southward facing oceanfrontage*

- 35mins by road to the regional centre Port Lincoln
- Access to the existing national transport network
- High launch window availability
- Geographically secure location
- Access to ancillary tracking and telemetry sites – Enables observation of launch through to payload separation

Suborbital launch site: Koonibba Test Range

*The southern hemisphere’s longest civilian overland rocket test range – Offering a unique opportunity for clients to develop and test rocket technologies*

- Range Head located in the western part of South Australia on Koonibba community land. Approximately 40km north west of Ceduna
- Offers unhindered flights of up to 145km into an adjoining national parks
- Enables customers to undertake specific tests of civilian and military technologies
- All approvals received to operate from key stakeholders

Key:
K – Koonibba  W – Whalers Way  A – Adelaide (HQ)
Problem Statement

- Emerging Small Satellite market
- Rocket launch is complex
  - Aerodynamics
  - Gravimetrics
  - Equations of Motion
  - Launch Operations
- It’s also strictly regulated
  - CASA
  - Australian Space Agency
  - FAA

We need a quick and accurate tool that can quickly quantify launch risks in a strict, space launch regulatory environment
Solution

- **MATLAB & ASTOS Graphical Interface & Controller (MAGIC)**

- A MATLAB based solution that does the following:
  1. Monte Carlo Simulations of Rocket Launch
  2. Streamlined Range Safety using MAGIC OOP
  3. Compliant with ASA and FAA Regulations

- Used daily by Southern Launch staff
- Under active development and support
MATLAB Benefits

• Why did we use MATLAB?
  – Industry leading
  – Well documented
  – Toolboxes
  – Unit Test Framework
  – OOP

MATLAB enables us to focus on capability development – not software development
Tools Used

- Excel
  - Data Storage System
- ASTOS
  - Simulations
- MATLAB
  - Toolboxes
MAGIC Benefits

• What does an example MAGIC output look like?
  – Individual Risk
  – Expected Casualties
  – Maximum Probable Loss

• Benefits
  – Rapidly identify risk to people
  – Advanced post processing of results
  – Model advanced complex FRMs
  – Non-standard probability distributions
Convergence Example

- Uses Information Theory to quantify how the risk profile of the Failure Response Mode (FRM) is changing
## Sensitivity Example

Relative Log Significance that each variable in Insolation (Diagonal) and 2-way Interaction (Off-Diagonal) has on Downrange

<table>
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<th>CD_Assembled</th>
<th>LaunchAzimuth</th>
<th>LaunchElevation</th>
<th>ThrustScaling</th>
<th>WindDir</th>
<th>WindMag</th>
</tr>
</thead>
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<tr>
<td>CD_Assembled</td>
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</tbody>
</table>

Legend:
- **Strong** (-4)
- **Significant** (-1.3)
- **Weak** (-1)
- **None** (-0.30103)
- **Excluded**
Sensitivity Example

Effect Each Isolated Variable has on Downrange

Commercial-in-Confidence
Conclusion

• MATLAB has enabled the creation of MAGIC
  – Capitalise on frequent launch
  – Rapid solution for Flight Safety Assessment
• MAGIC has been able to significantly advance due to the support of MathWorks Toolboxes
• MATLAB has enabled us to focus on capability development – not software development