QinetiQ Engine Change Capability

Presenter. **Jason Montgomery**
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QinetiQ Pty Ltd

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Agenda

1	Introduction
2	Key Operational Requirements
3	Development of the Functional Performance Specification
4	Concept development and Review
5	Engineering Challenges and Detailed Design
6	Prototype and Test And Evaluation Program
7	Production and Delivery

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Introduction

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Background

- Defence identified a need for a updated Engine Change Capability to support engine change operations for in-service and newly acquired aircraft across domestic and deployed environments.

- QinetiQ tasked by the Capability Acquisition and Sustainment Groups' (CASG) Aerospace Materiel System Program Office (AMSPO) to develop a new Engine Change Capability (ECC).

- The new ECC is required to support engine change operations across three aircraft in service with Royal Australian Air Force (RAAF).
  - AP-3C Orion
  - C-130-J30 Hercules
  - C27-J Spartan

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Background: QinetiQ Vision

“To be the chosen partner around the word for mission critical solutions, innovating for our customers’ advantage”

- The ECC Design Project is **Mission Critical** to support enduring operation of in-service RAAF Aircraft as well as an opportunity to deliver an **Innovative solution** to our customer.

QinetiQ Integrated Engineering Services (IES)

- Engineering Design, Analysis, Mechanical and Electronic Manufacturing Capability.
- Extensive experience in developing bespoke solutions to solve complex problems.

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Background

- ECC Development to be executed across 5 Phases

Contract Phase	Description of Objective
Phase 1	Development of the Functional Performance Requirements and Specifications
Phase 2i	Development of Design Concept
Phase 2ii	Detailed Design
Phase 3	Prototype Manufacture / Test and Evaluation Program
Phase 4	Development of ECC Production Data Package
Phase 5	Manufacture, Acceptance Testing and Delivery of ECC Systems

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Key Requirements

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Key Requirements

- Customer documentation identified high level requirement for ECC to consist of two primary sub systems

Lift System

- Self Propelled vehicle system used to manoeuvre ECC into alignment with target airframe.
- Required to approach aircraft in a controlled manner

Approach System

- Electrically driven attachment capable used to facilitate precise moment of suspended loads without presenting undue risk to personnel or airframes.
- Required to interface with various engines and GSE in support of in-service aircraft maintenance.

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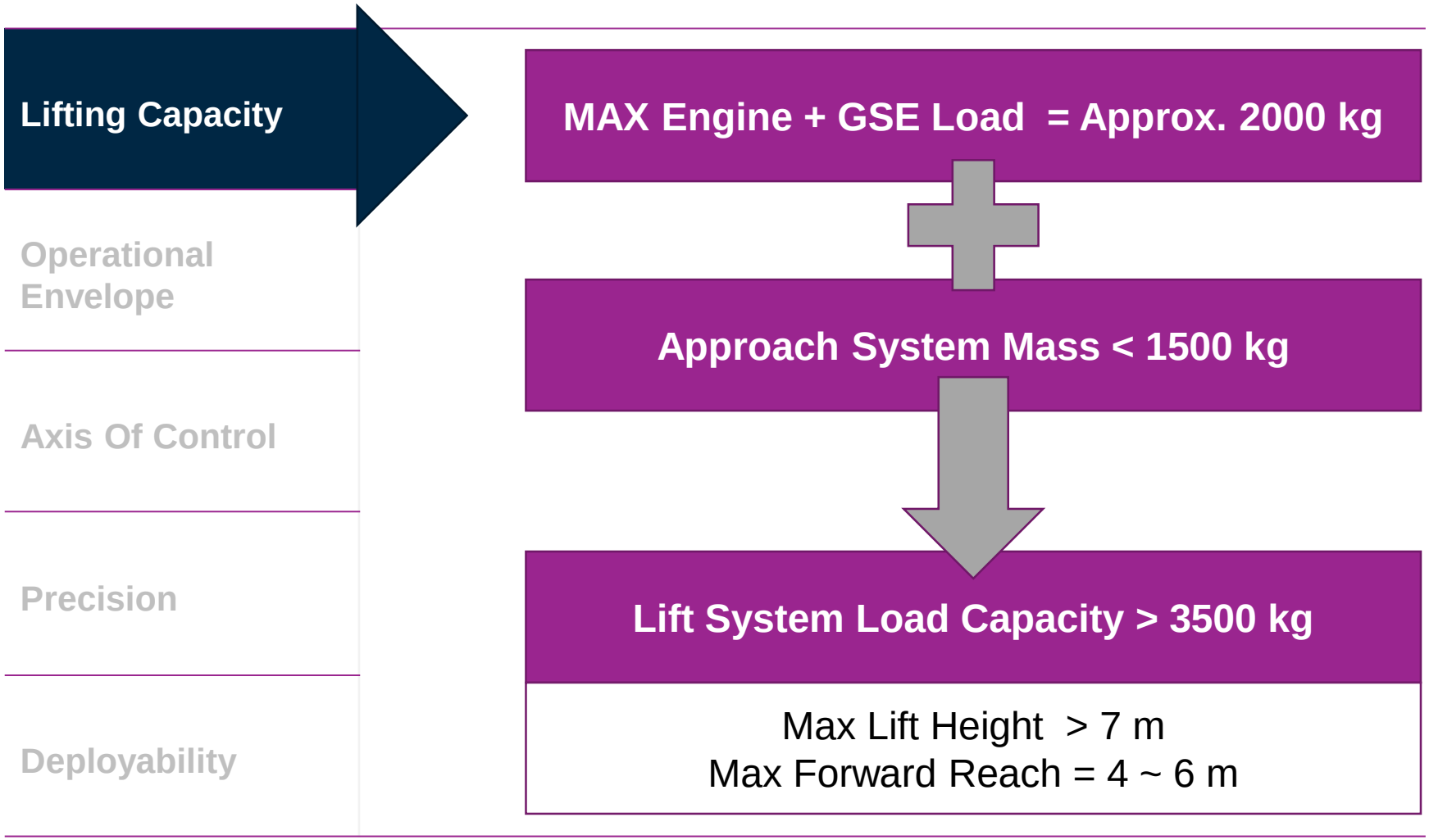
Key Requirements

Lifting Capacity
Operational Envelope
Axis Of Control
Precision
Deployability

Key Requirements



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Key Requirements

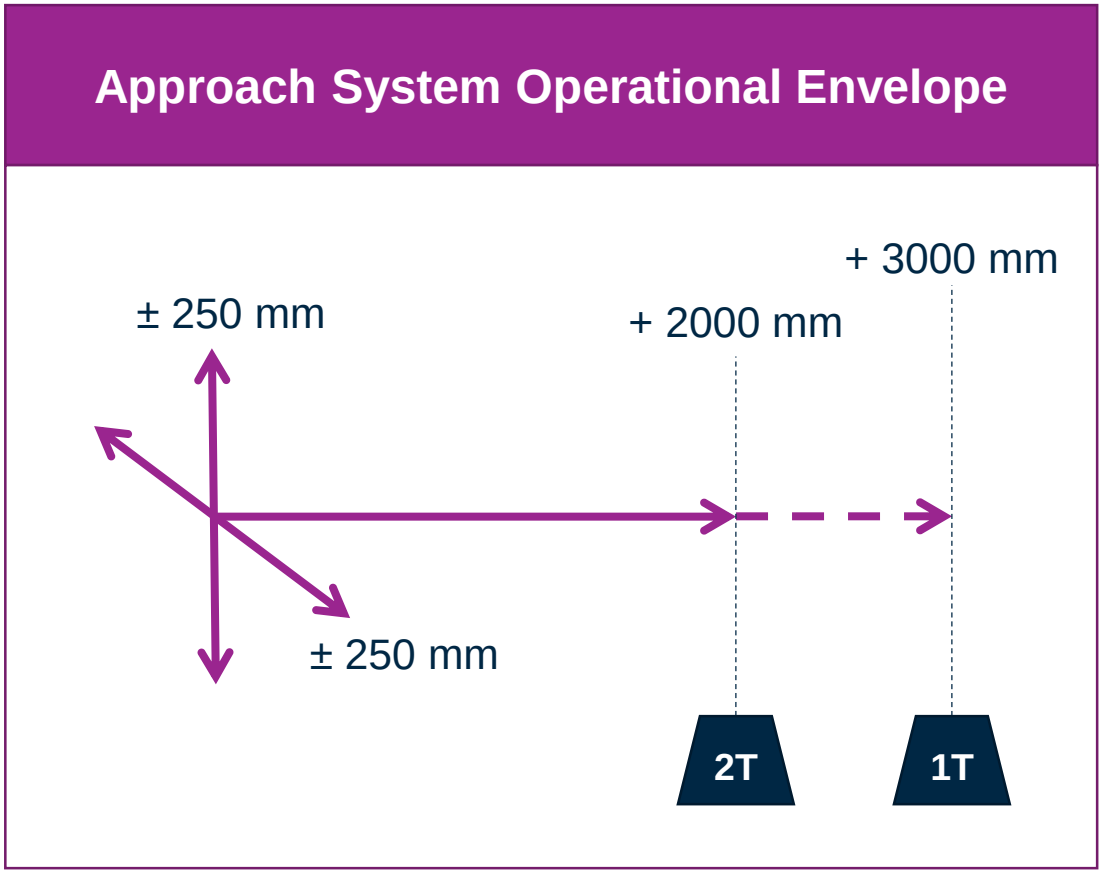
Lifting Capacity

Operational Envelope

Axis Of Control

Precision

Deployability



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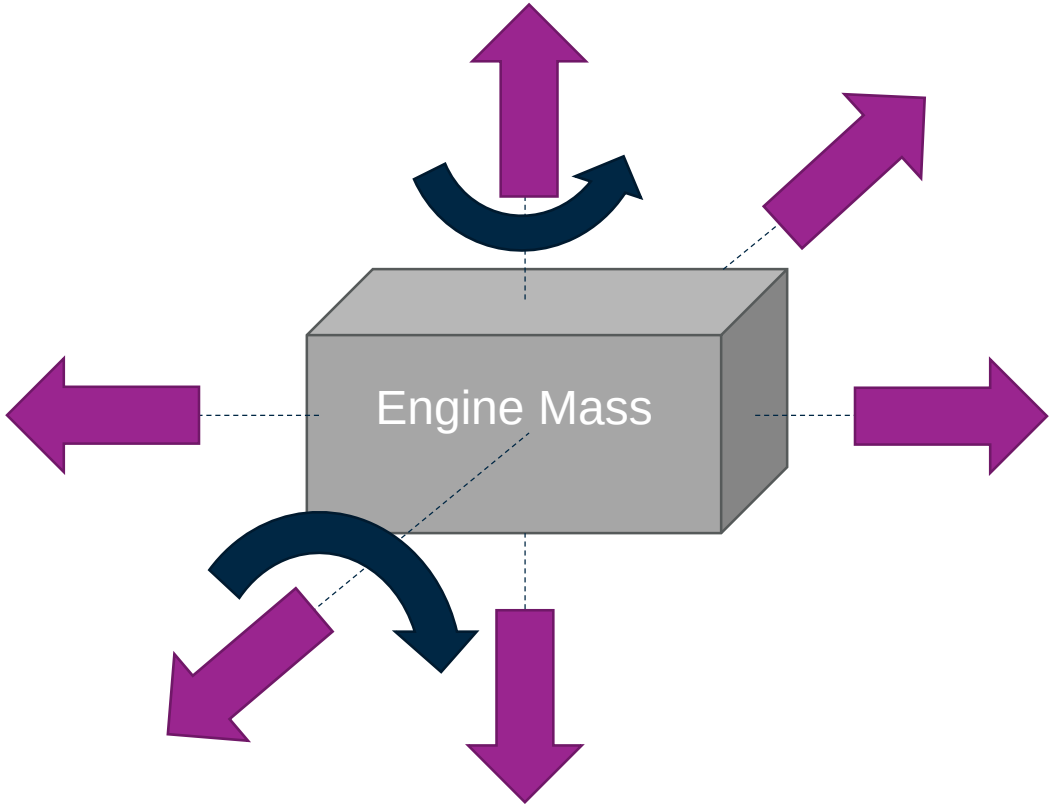

3 Primary Axis + Yaw and Pitch Control

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Key Requirements

Lifting Capacity

Operational Envelope

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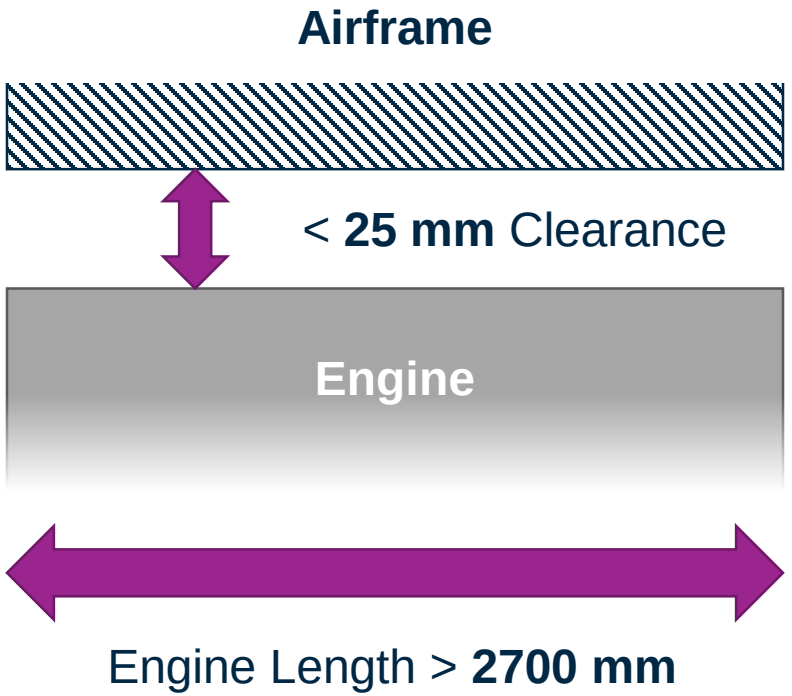
Deployability



Precision Control required to prevent collision between Engine and Airframe

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Key Requirements

Lifting Capacity

Operational Envelope

Axis Of Control

Precision

Deployability

ECC must be Air transportable by C-130J

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Key Requirements

Lifting Capacity	Loads up to 2000 kg, 7 m high, 6 m forward of ground datum
Operational Envelope	3000 x 500 x 500 mm operational volume throughout range
Axis Of Control	5 axis control required
Precision	Precision manipulation of loads at height within tight tolerances
Deployability	Air Transportable | Ruggedised for deployed environments

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Key Requirements: Design Standards

AS1418: Cranes Hoists and Winches

- AS1418.5: Mobile Cranes
- AS1418.19: Telehandlers

Additional Australian Standards

- AS4100: Steel Structures
- AS3100: Electrical Safety
- AS4024: Machine Safety and Guarding

DEF(AUST)9009A: AMTDU Air Transportability

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Development of the Functional Performance Specification

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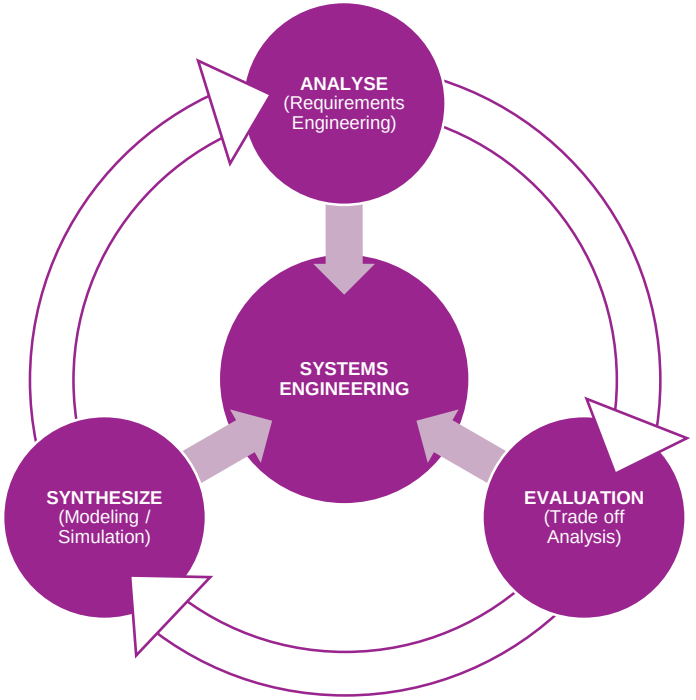
Development of the Functional Performance Specification

- QinetiQ Engaged wide stakeholder audience to inform development of approved set of Functional Performance Requirements and Specifications
  - Operational Squadrons
  - Subject Matter Experts
  - Project Representatives

- FPS Documentation developed in close consultation with stakeholder community.
  - Numerous stakeholder workshops and site visits conducted

- Continuous effort to validate FPS against key operational requirements.
  - Systems engineering tools utilised to manage requirements allocation and traceability.



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Concept Development and Review

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Concept Development and Review

- As Part of Phase two of the project, QinetiQ engineers held design workshops to generate design concepts for stakeholder review.
- In keeping with customer direction, ECC design was based on a system of systems model.

Lift System

COTS Telehandler

Approach System

???

Custom Jib Design

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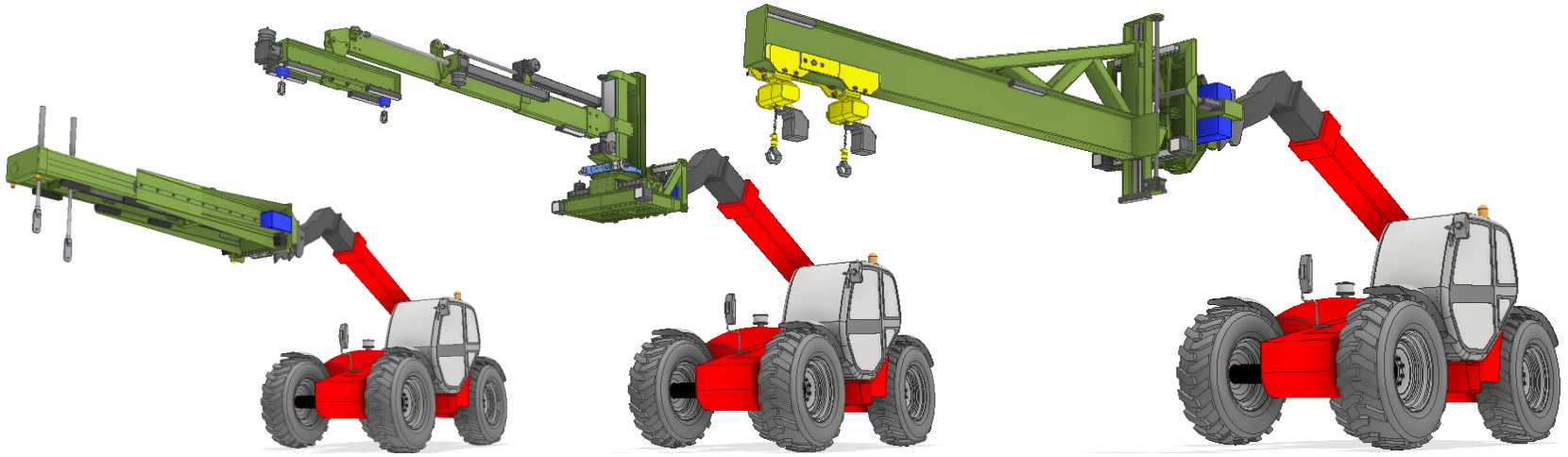
Concept Development and Review: Approach System

- Three concepts developed by ECC Engineering Design Team



- Comparative evaluation of concepts conducted to assess feasibility and compliance to customer specification.
- Outcome of concept development and analysis presented to project stakeholders at Preliminary Design Review.

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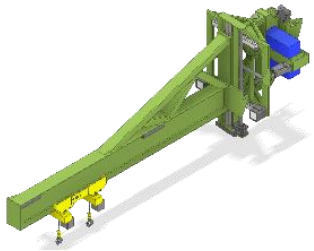
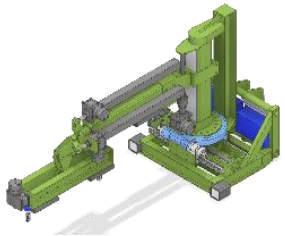
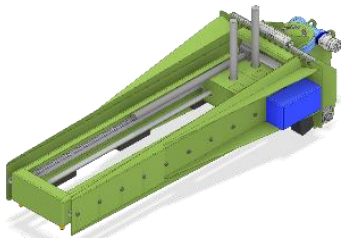
Concept Development and Review: Approach System







Concept	Rigid Beam	3 Axis Boom	Telescopic Section
X Travel	3000 mm	2030 mm	3046 mm
Y Travel	+/- 250 mm	+/- 250 mm	+/- 250 mm
Z Travel	+/- 250 mm	+/- 250 mm	+/- 250 mm
Max Deflection	9 mm	16.6 mm	2.9 mm
Size L x W x H (Compact)	4600 x 1524 x 1010 mm	1371 x 1050 x 1649 mm	3086 x 1141 x 1084 mm
Engine Pitch Control	Yes – Dual Chain Hoist	Yes – Pitch Control Beam	Yes – Dual Linear Actuators
Mass	> 1000kg	> 1000kg	> 1000kg
Complexity	Low	Medium / High	Medium

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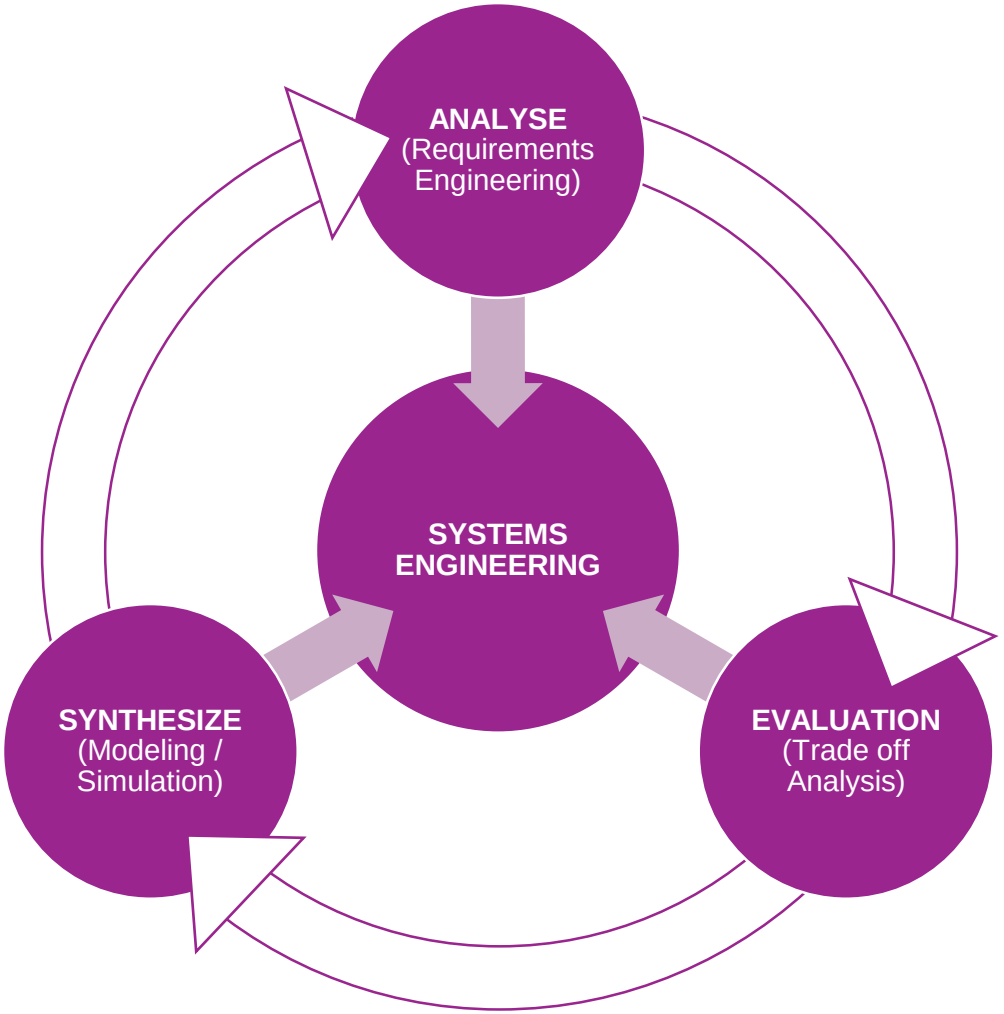
Concept Development and Review: Approach System

- Evaluation of design concepts identified the following;
  - Rigid beam offered beam structure offered most effective solution to support 3000mm forward load translation.
  - Engine pitch control best achieved through two point lift system.
  - **Best Fit solution would combine elements from all 3 concepts.**



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Concept Development and Review: Lift System

- Extensive research conducted into the ability of both In-service and COTS Telehandlers to meet Lift System requirements for the ECC;
- Manitou Telehandlers found to represent best fit solution to FPS requirements.

MANITOU
HANDLING YOUR WORLD

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Concept Development and Review: Lift System

- Of the range of platforms identified, **MT-X-1440** represented most capable platform to meet the operational requirements for the ECC Lift System.

MT-X-1440

- **Availability**
  - Commonly used within Australian Construction Industry
- **Capability**
  - 4 Tonne Lift Capacity
  - Increased Reach
- **Suitability**
  - Air Transportable by C130

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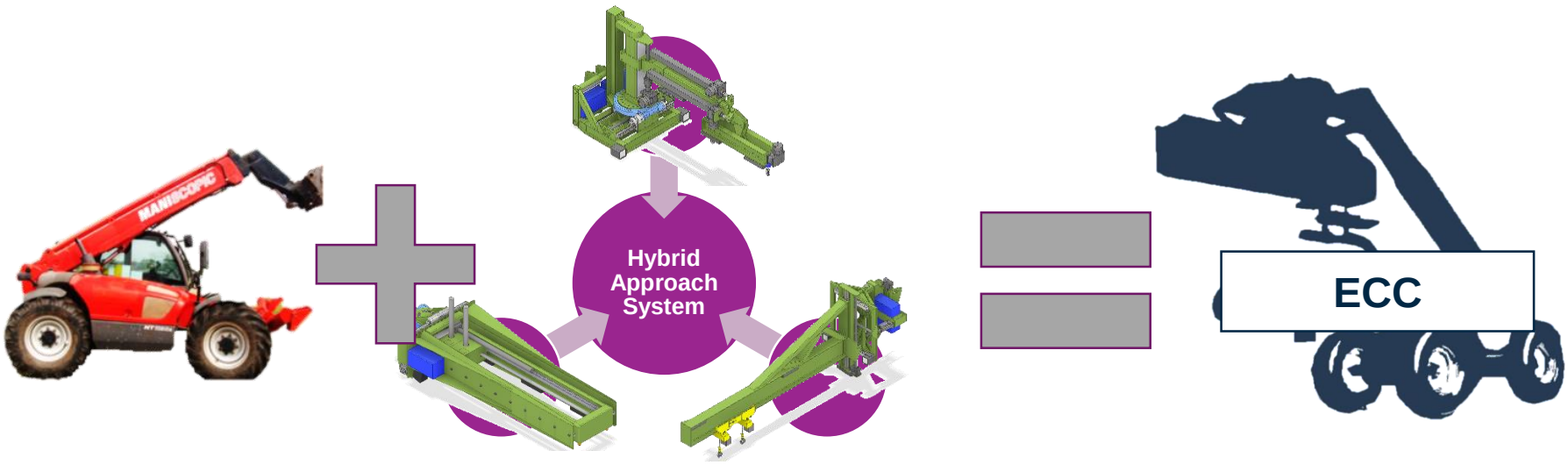
Concept Development and Review:

- Design Concepts and Telehandler presented to Stakeholder community representatives at Design Review prior to commencement of detailed design activities.



Engineering Challenges and Detailed Design

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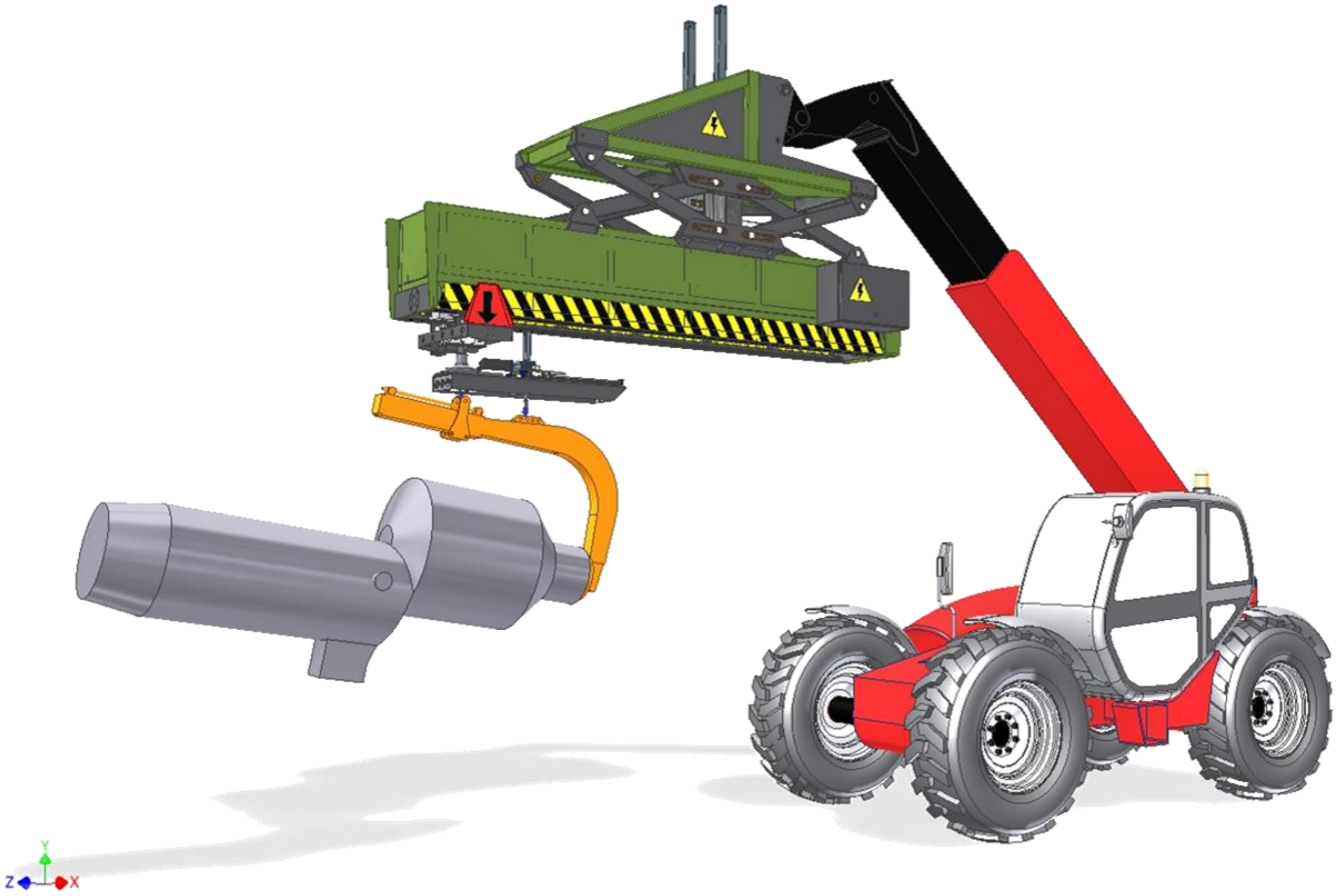
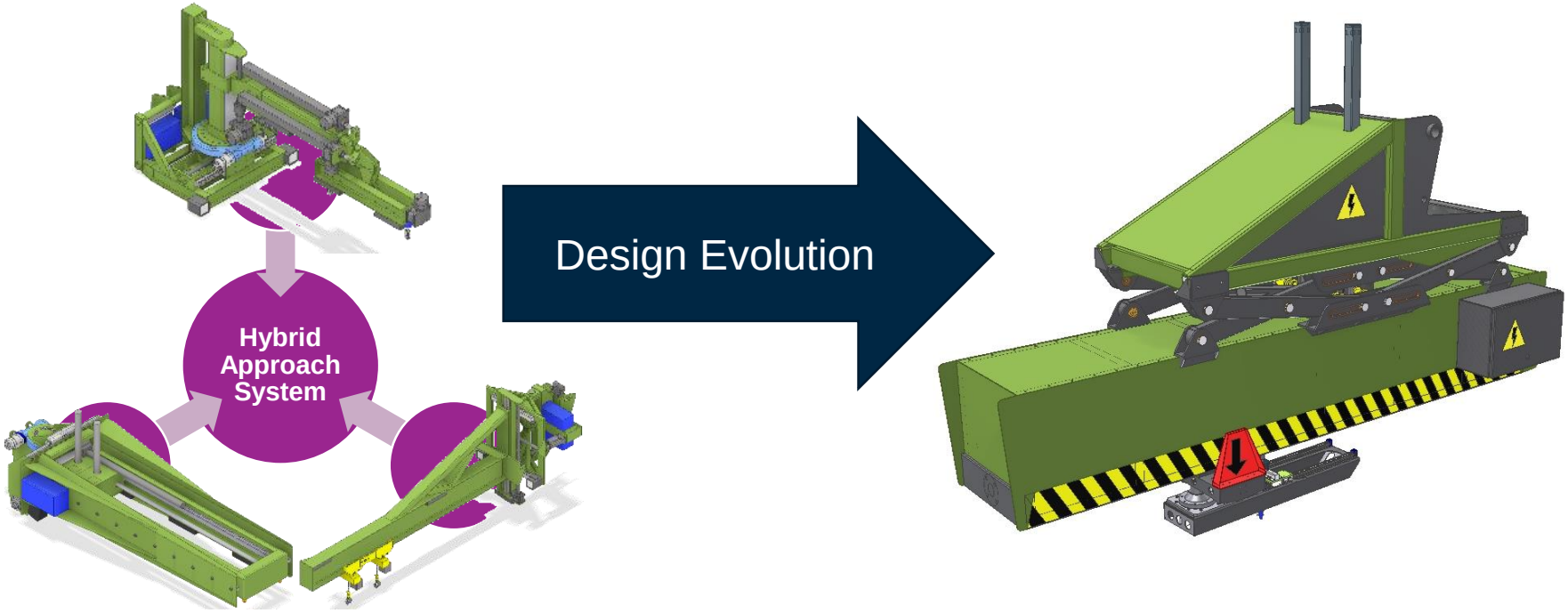
Engineering Challenges and Detailed Design

- Outcome of Detailed Design Phase



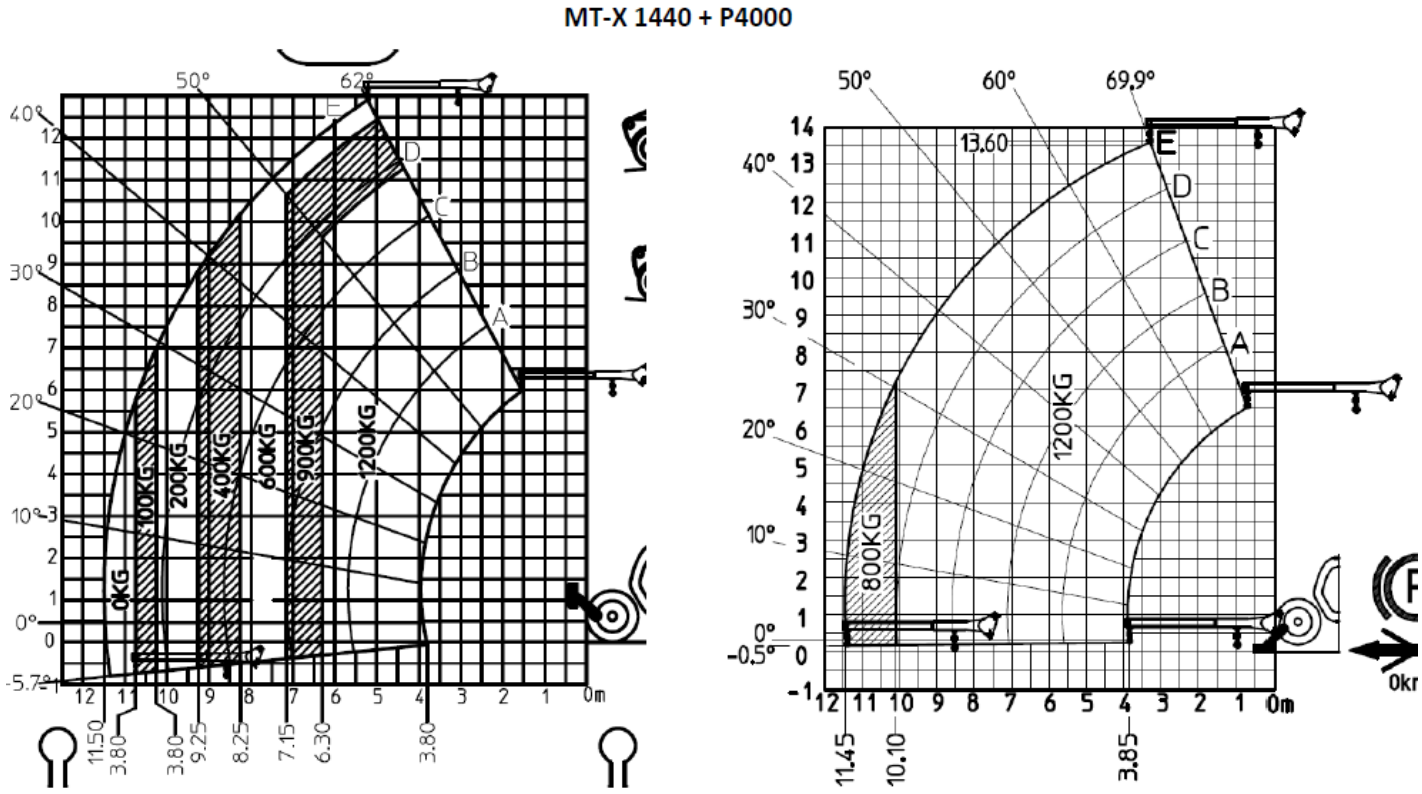
Engineering Challenges and Detailed Design



Key drivers for design evolution:

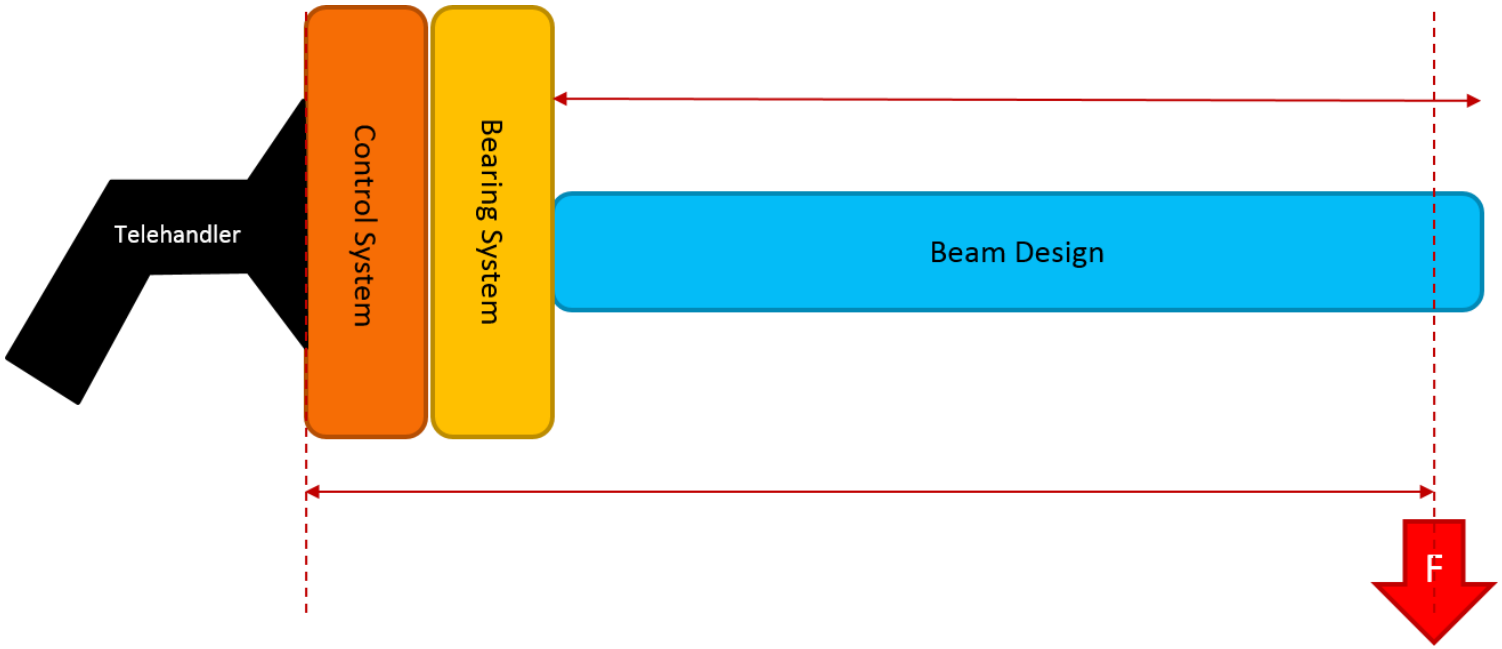
- Reduction of moment at interface between Approach System and Telehandler.
- Preservation of max possible operational envelope.

Engineering Challenges and Detailed Design



Design limit set by Telehandler ability to support moment applied at tool interface. Geometry of Cantilevered solutions incompatible with load limit.

Engineering Challenges and Detailed Design



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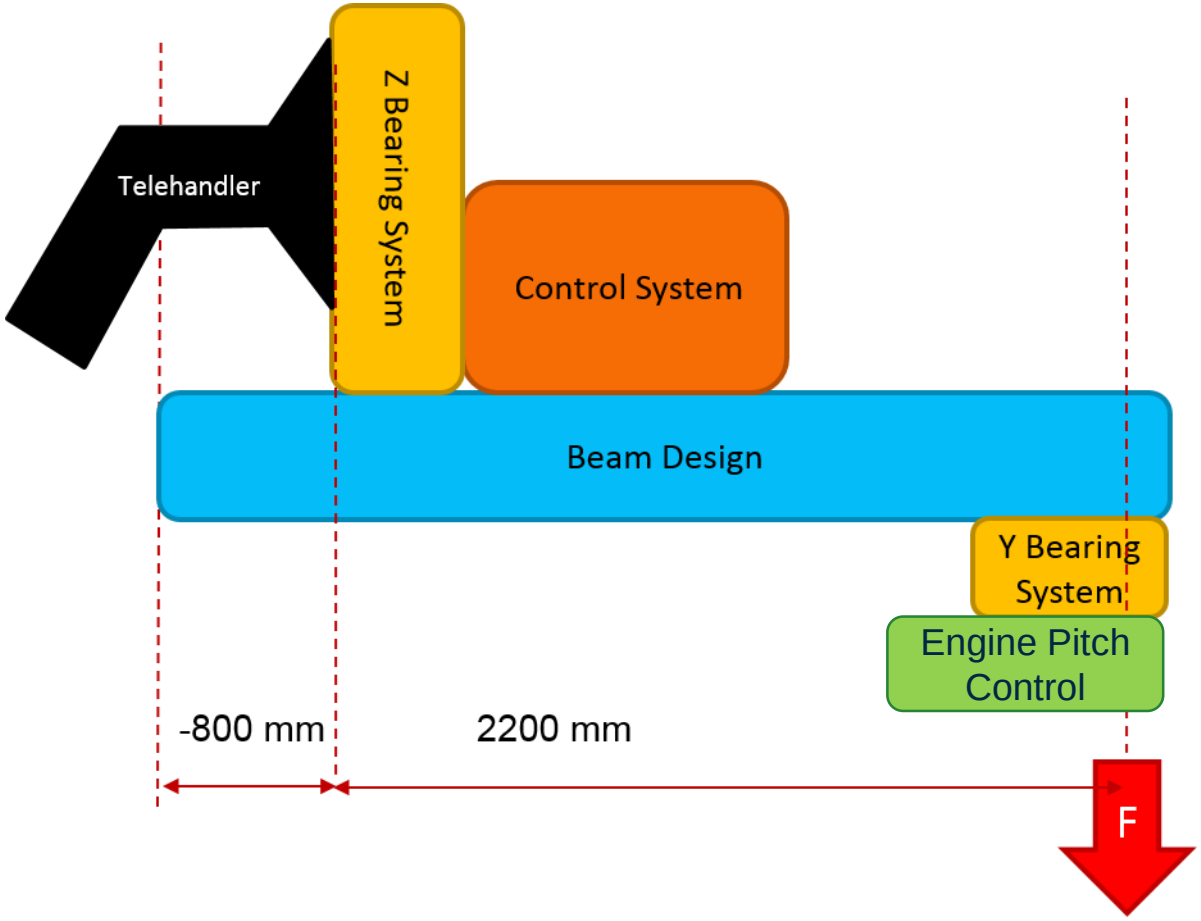

Alternative configuration developed to reduce moment applied at system interface.

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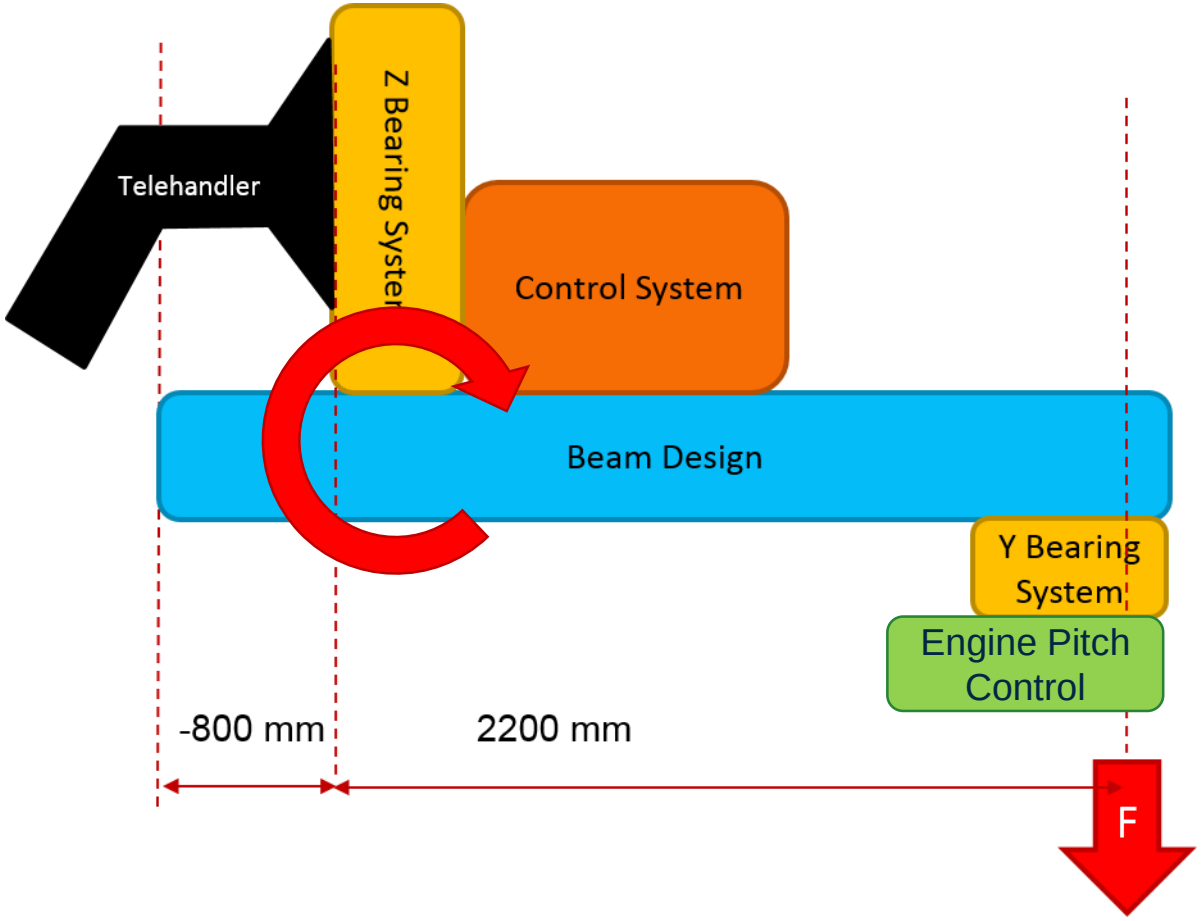
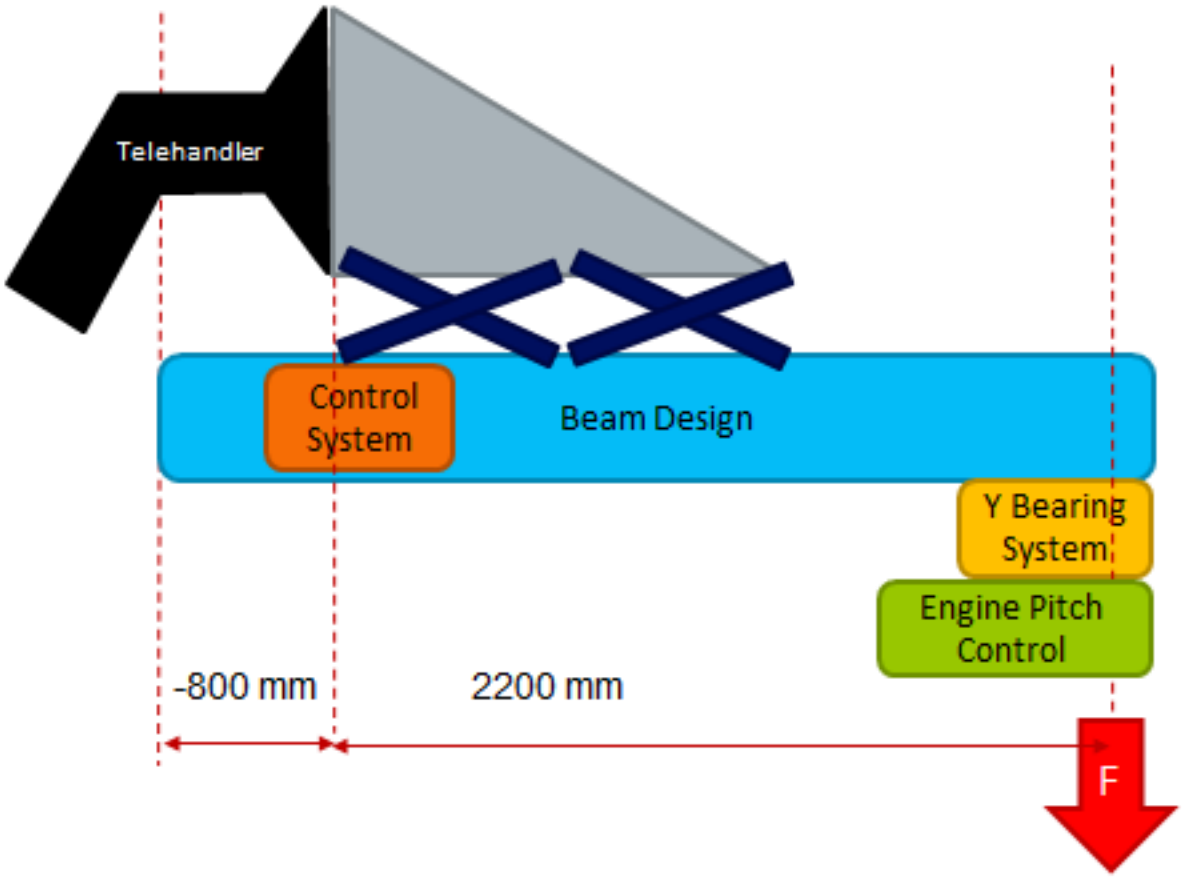
Engineering Challenges and Detailed Design



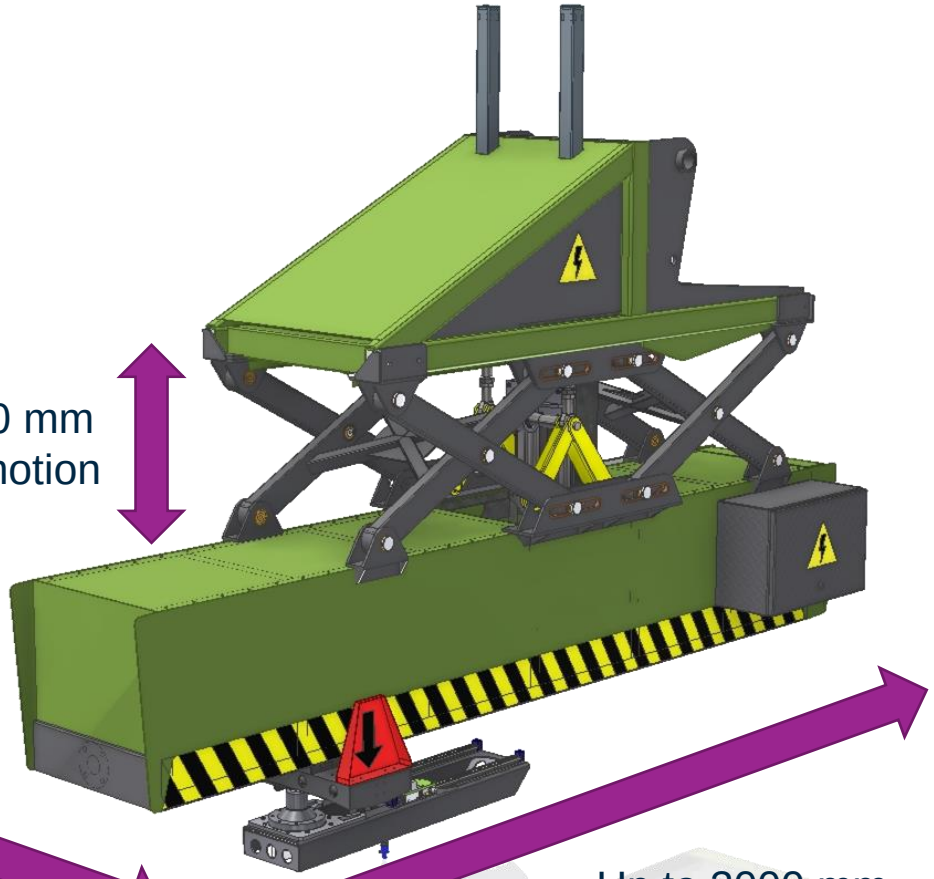
Alternative configuration still results in moment at connection point between beam and vertical motion system.

Engineering Challenges and Detailed Design



Integration of scissor lift mechanism resolved moment issue.

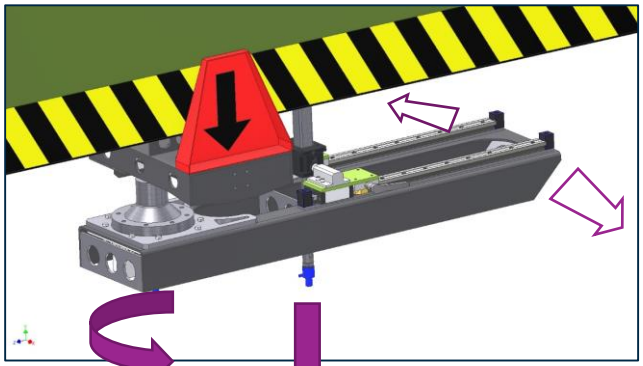
Engineering Challenges and Detailed Design



Up to 500 mm
vertical motion

+/- 250 mm
side shift

Up to 3000 mm
Forward range



100 mm Engine Pitch Control
(Enables Minimum +/- 3.5
Degree Adjustment)

+/- 5 Degree Manual Yaw
Adjustment (Braked)

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Engineering Challenges and Detailed Design

- Compliance to Australian Standards – Telehandlers

- IAW AS1418.19;

  - all telehandlers with a capacity > 3t, fitted with a Jib or Hook attachment **must** be fitted with a **Rated Capacity Limiter**; and

  - all telehandlers must be supplied with a manufacture approved **Rated Capacity Chart** for each specific attachment and load configuration.

- **Operation of a telehandler IAW conditions above without a Rated Capacity Limiter / Approved attachment load chart is not compliant to Australian Standards / WHS Legislation**

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Engineering Challenges and Detailed Design

- AS1418.19 Telehandlers - Load Chart Example

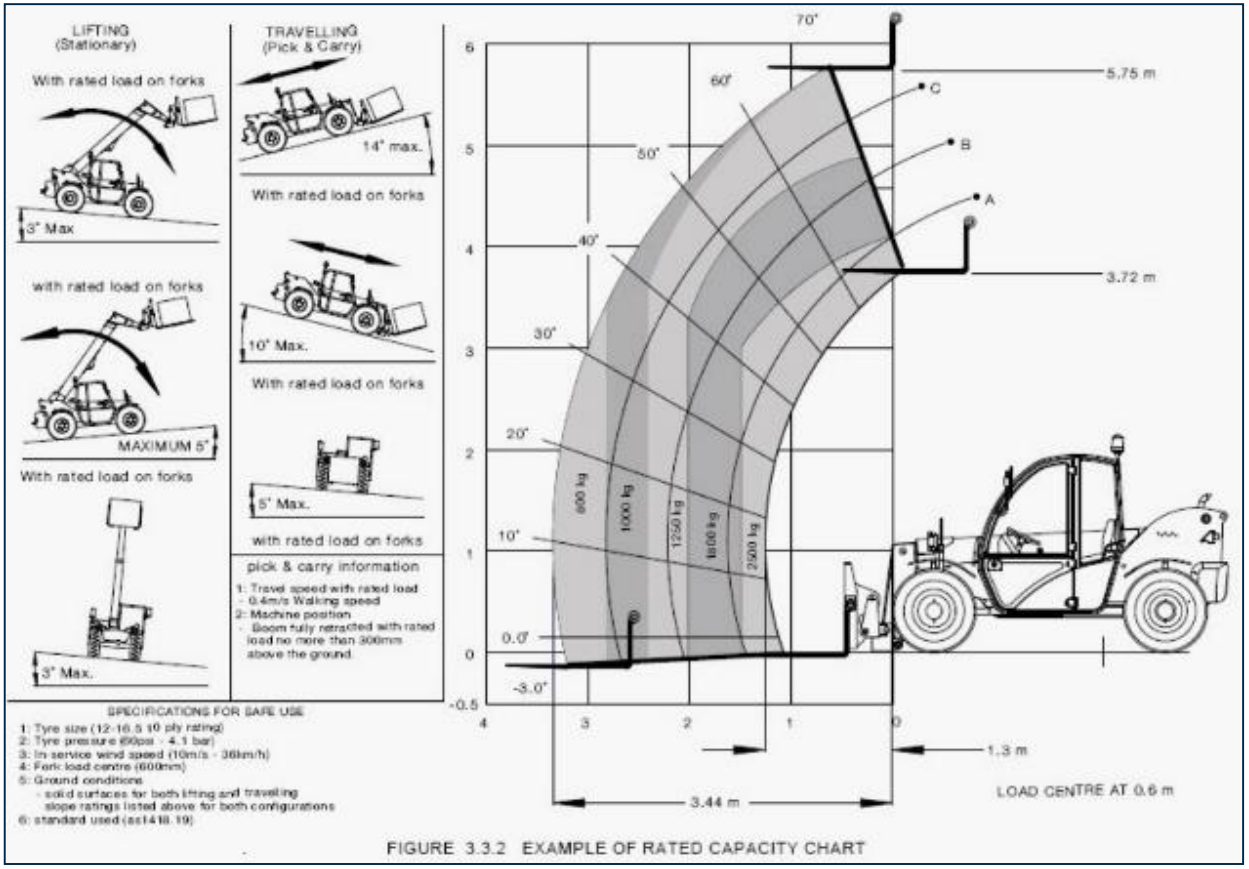
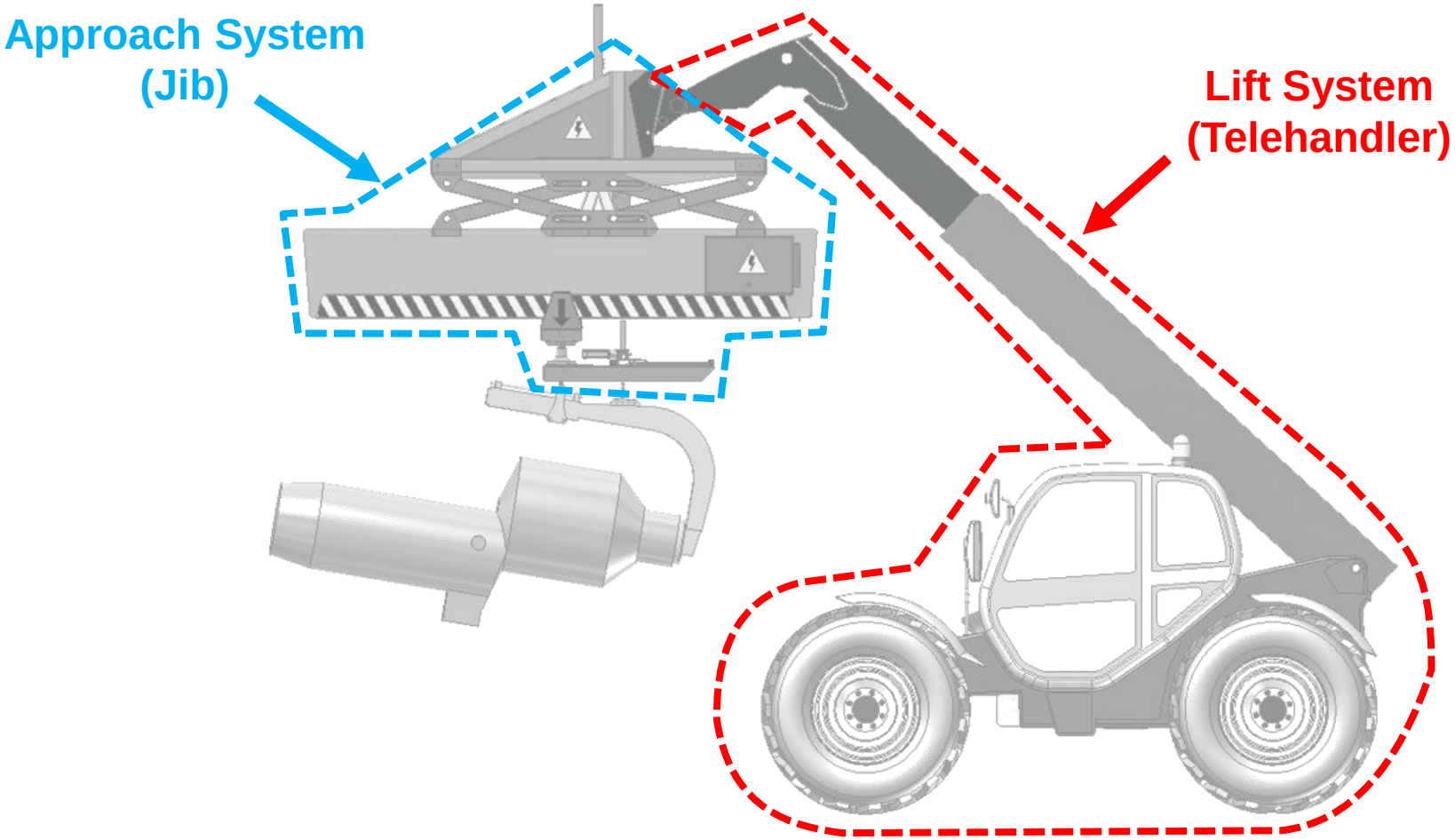


FIGURE 3.3.2 EXAMPLE OF RATED CAPACITY CHART

Engineering Challenges and Detailed Design



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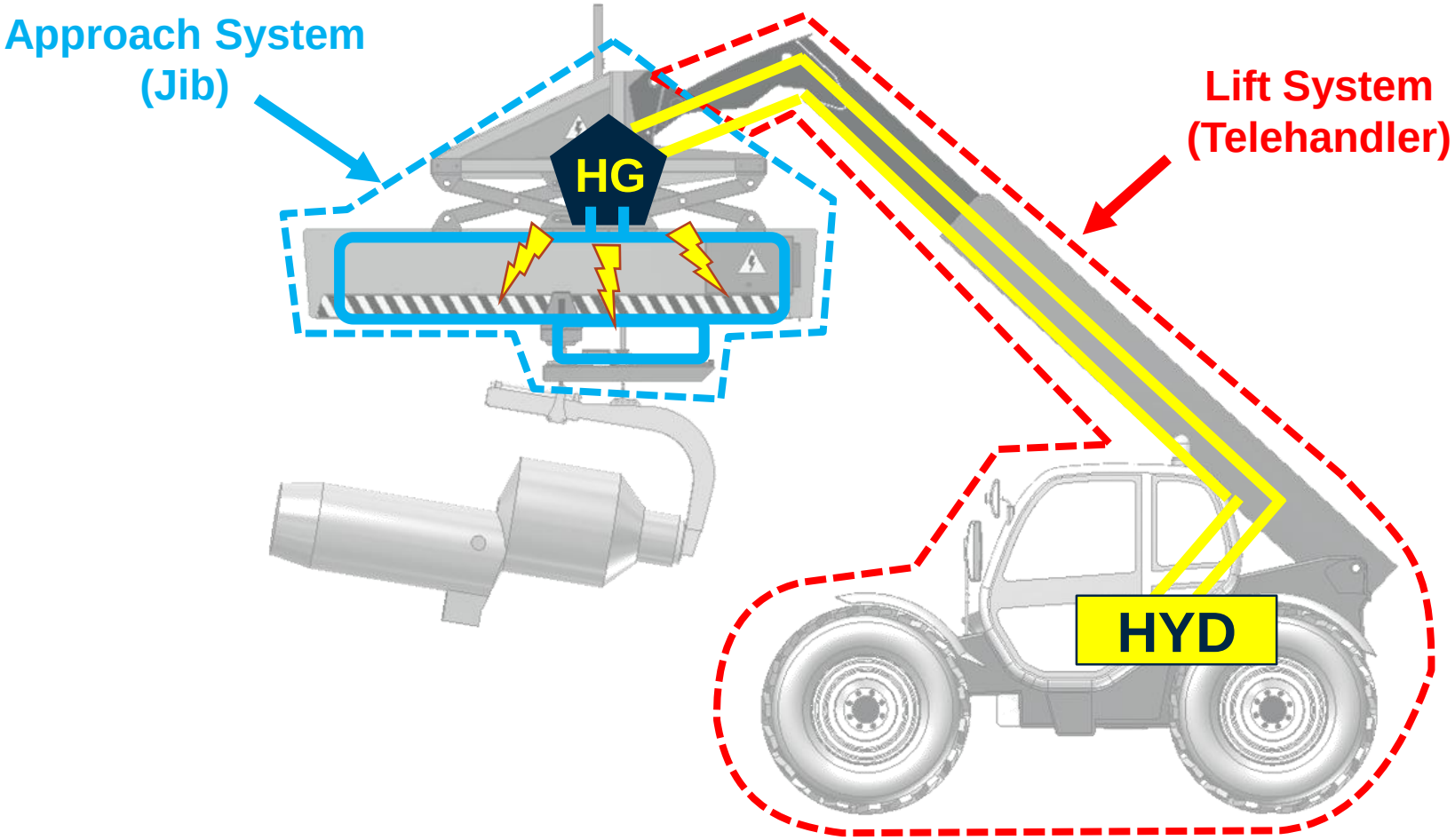
Engineering Challenges and Detailed Design



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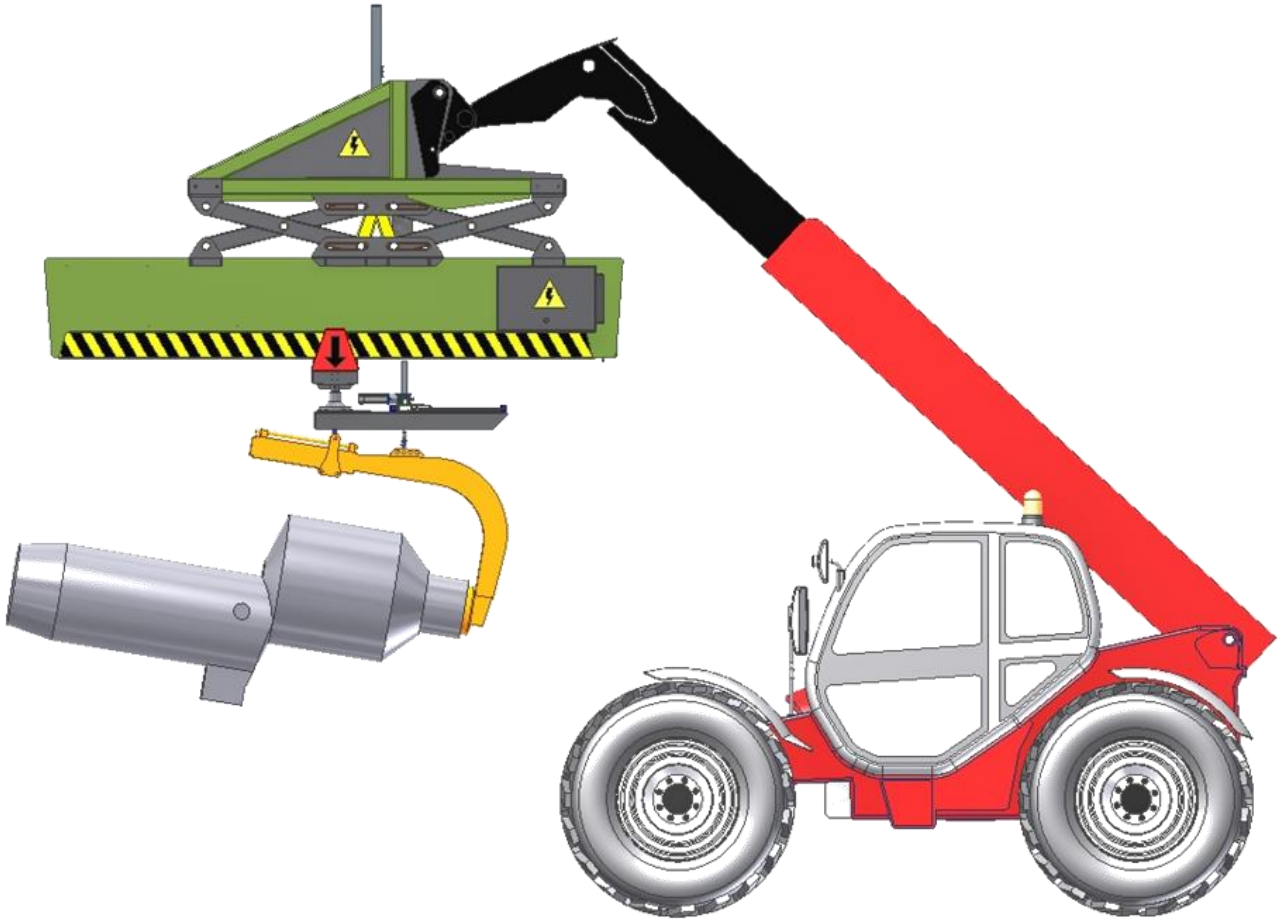

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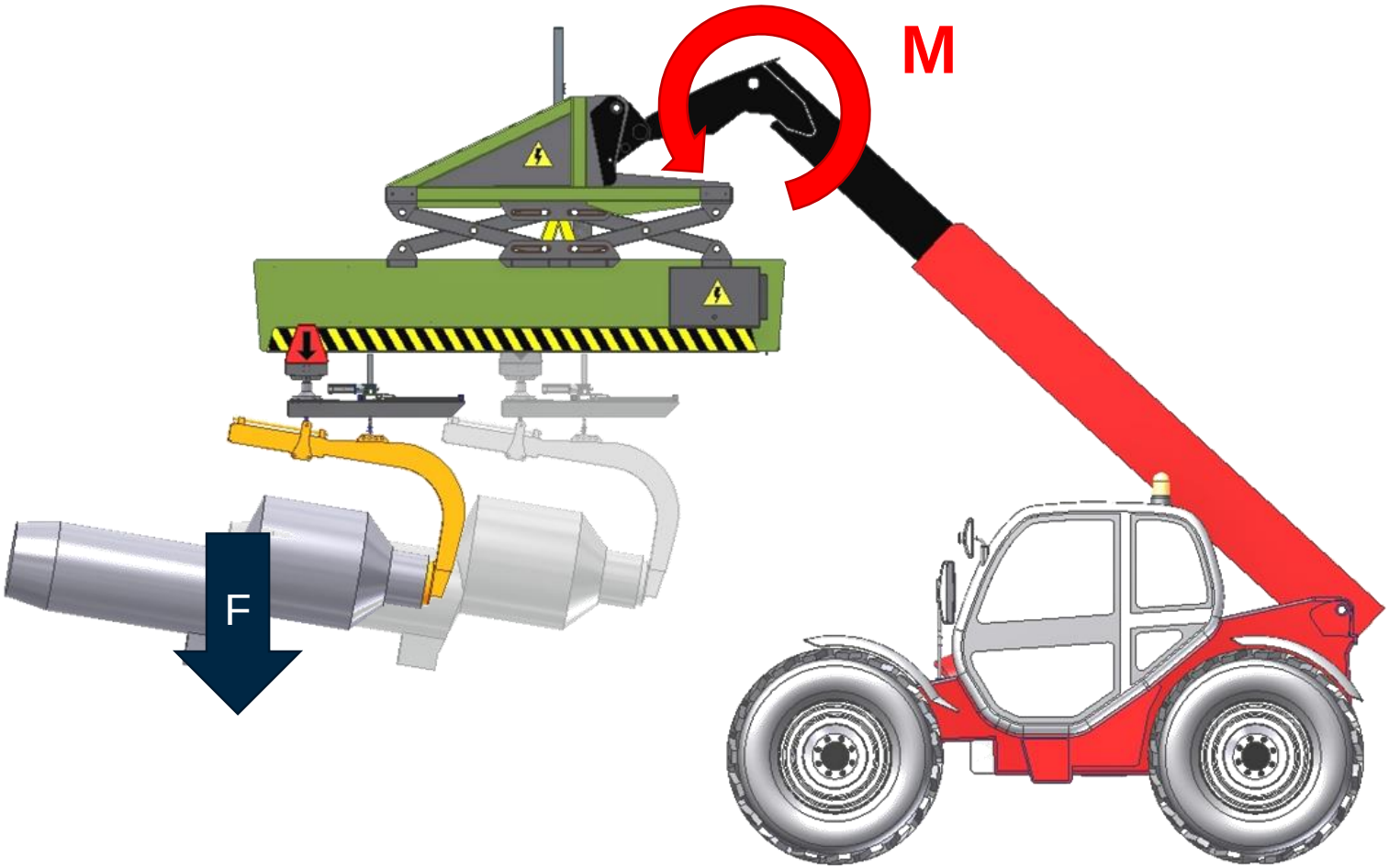
Engineering Challenges and Detailed Design



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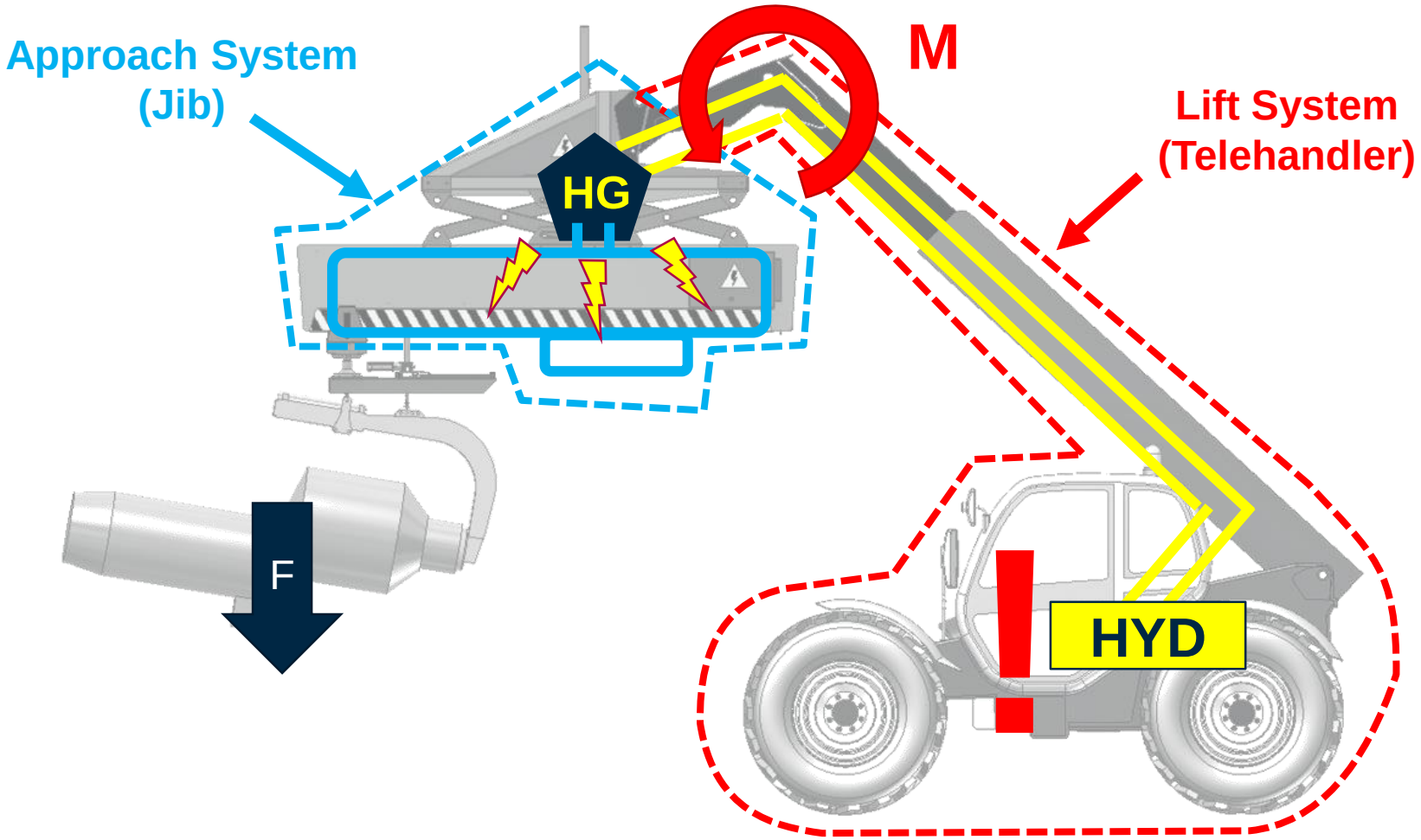
Engineering Challenges and Detailed Design



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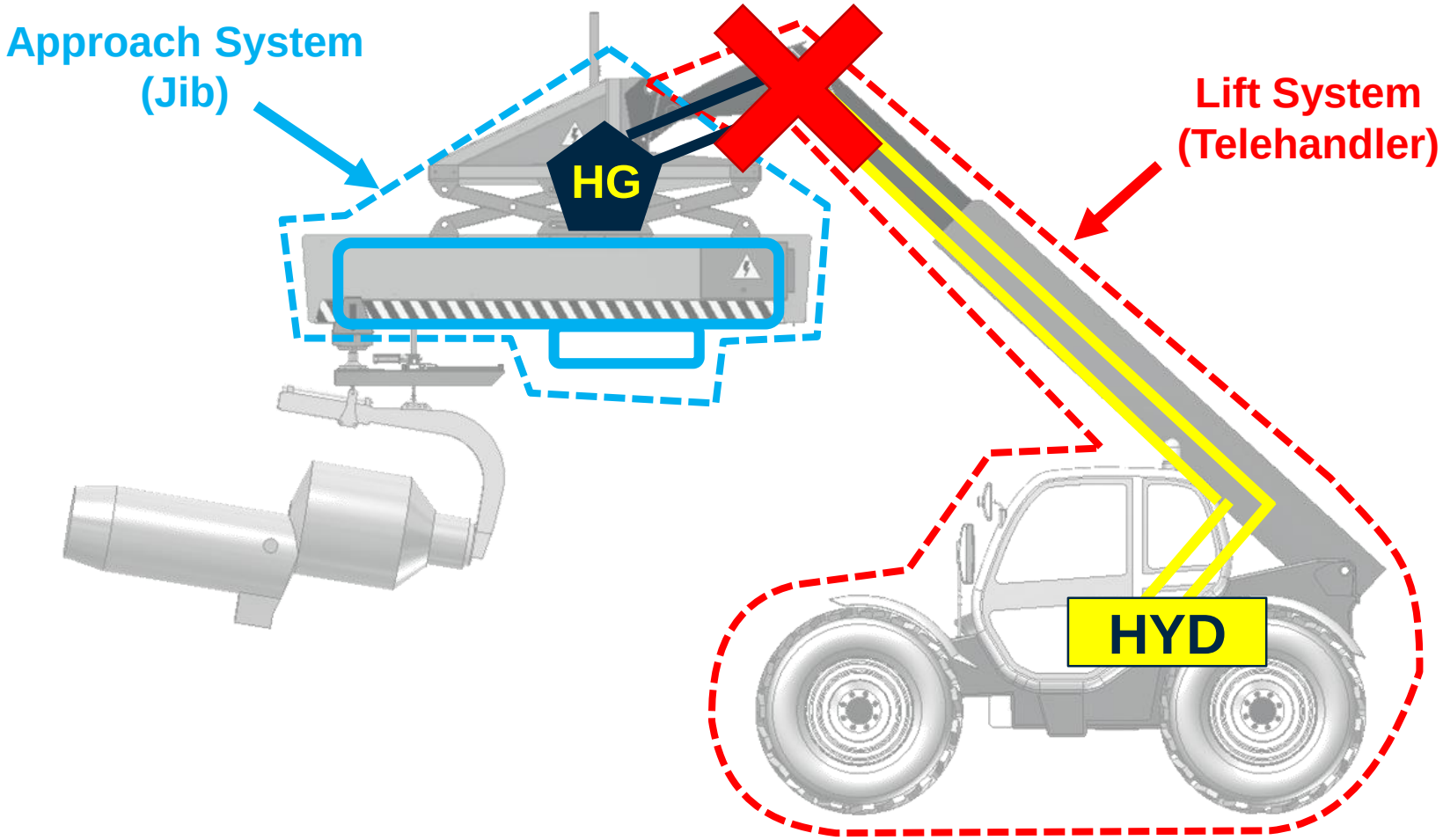
Engineering Challenges and Detailed Design



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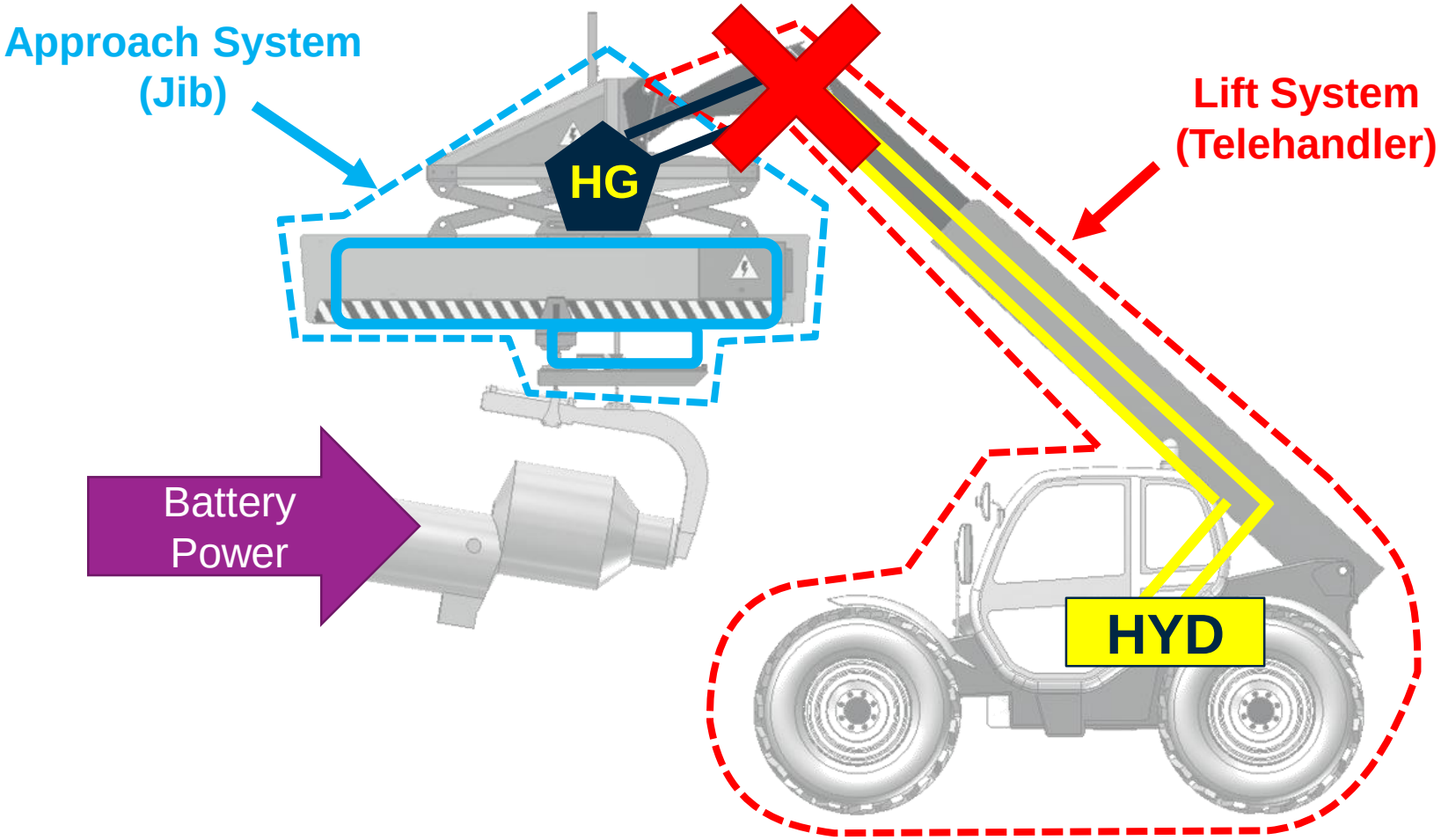
Engineering Challenges and Detailed Design



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Prototype and T&E

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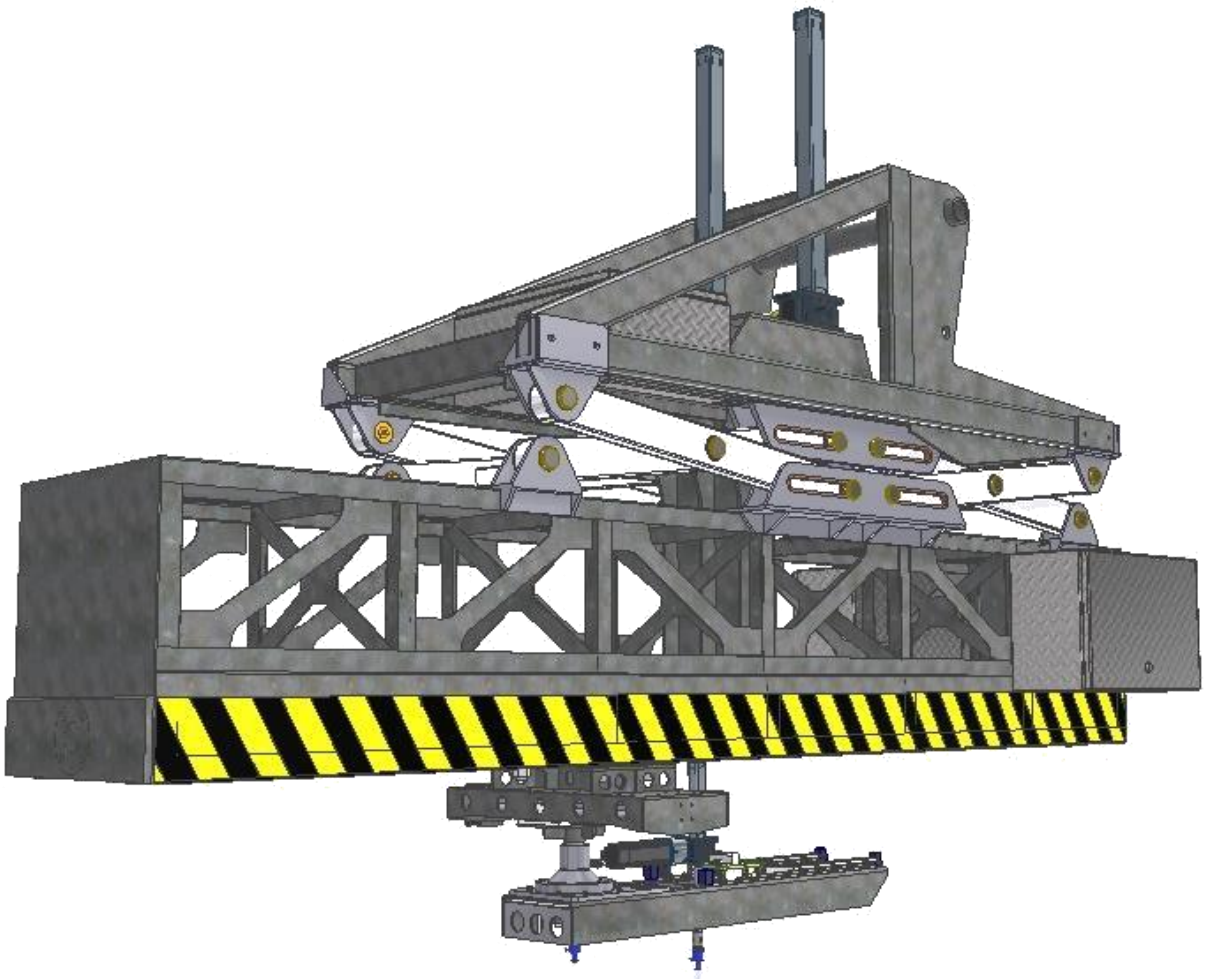
Prototype and T&E

Revised Beam Design

Optimized for In-House Manufacture



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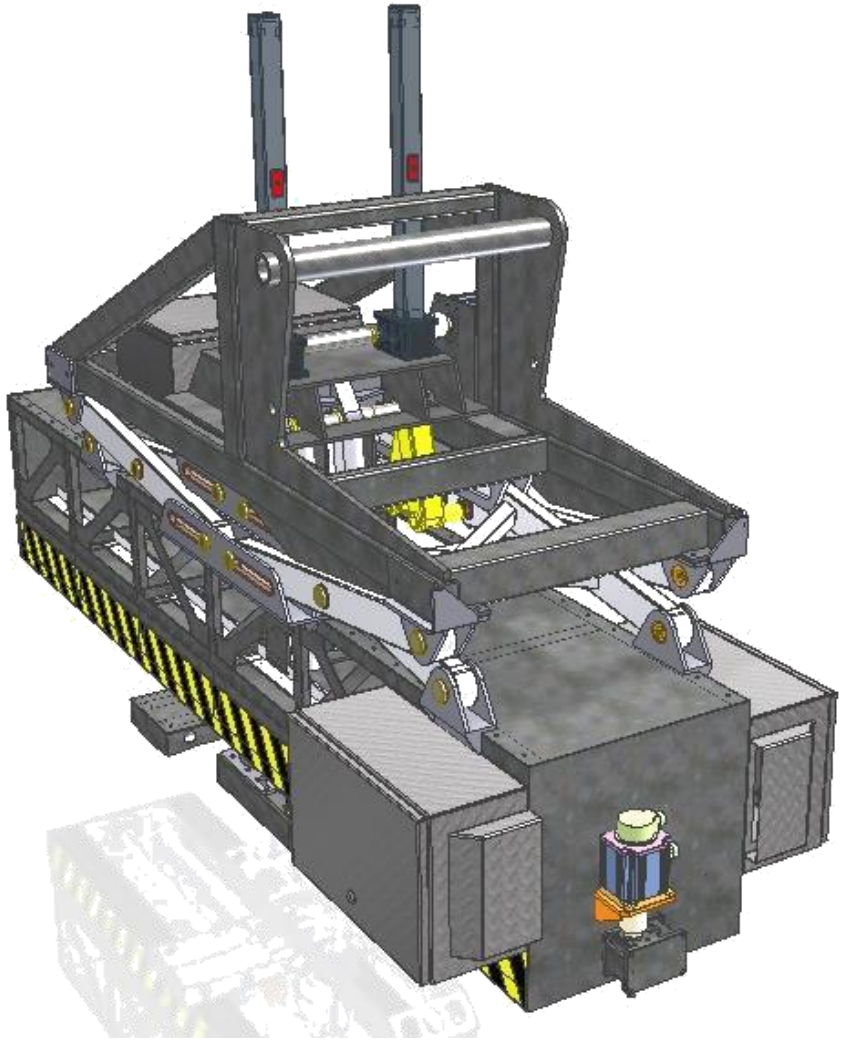
Prototype and T&E



- Open Design to Simplify T&E Access
- Ready for Integration with Manitou
- Fully functional onboard Control System

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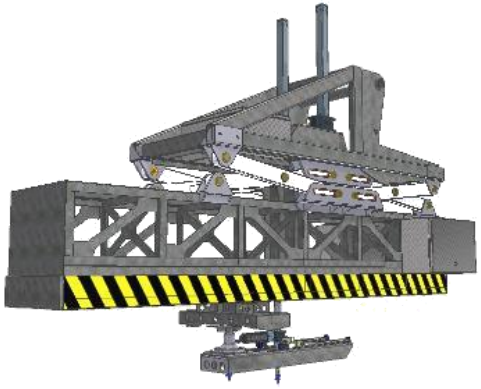
Prototype and T&E



Approach System Testing

Integration Testing

Lift System Testing

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Production and Delivery

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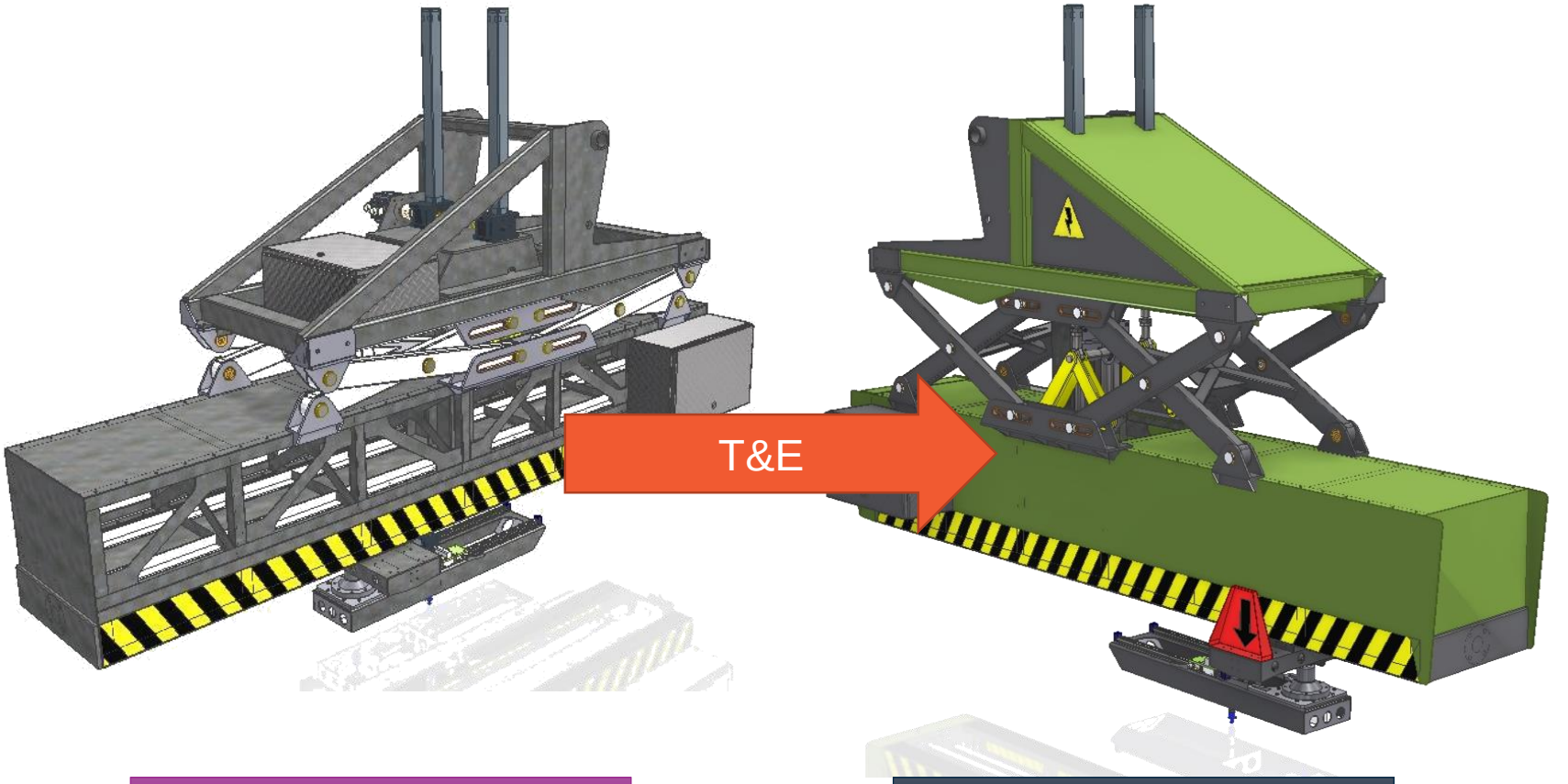
Production and Delivery



Prototype

Production

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Production and Delivery

- ECC Development to be executed across 5 Phases

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Prototype Testing

Prototype

To be built at QinetiQ Integrated Engineering Services

To be validated through Test program

QinetiQ Australia, Manitou and NTP Forklifts are partnering to deliver ECC Lift System compliant to the requirements of DEF(AUST)9009A

Production

Production Models to be built following prototype validation

First Article Acceptance Testing and Delivery

Provision of ongoing support through LOT

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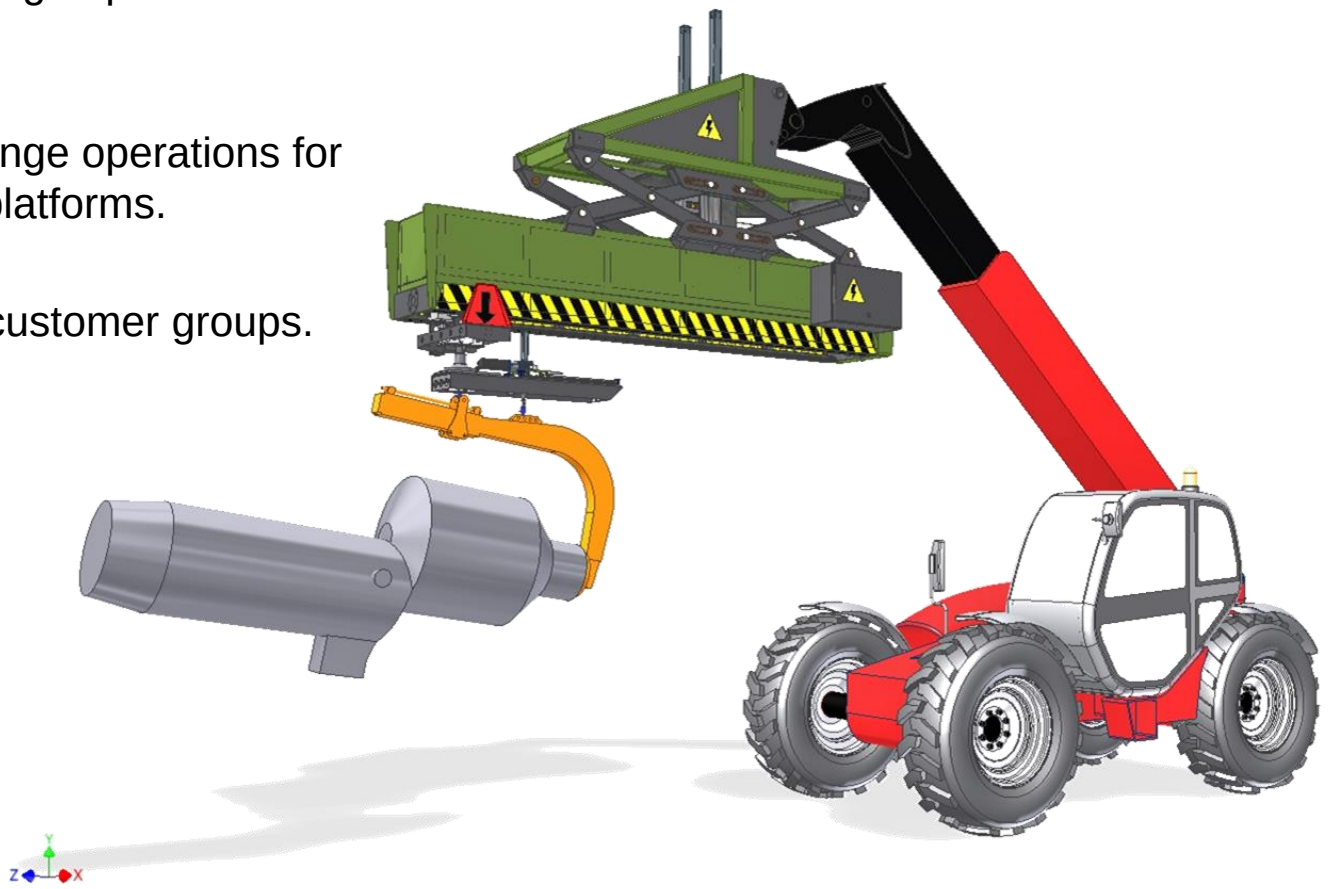
Production and Delivery

- Additional Employment Opportunities;
  - Support to engine change operations for Rotary Wing Aircraft.
  - Support to engine change operations for next generation land platforms.
  - Support to additional customer groups.

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QUESTIONS?

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