UNIVERSITY OF LIVERPOOL

VIRTUAL ENGINEERING CENTRE

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Supported by
Northwest REGIONAL DEVELOPMENT AGENCY
INVESTING IN englandsnorthwest
EUROPEAN REGIONAL DEVELOPMENT FUND

Background

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A new venture for the North West region of England

- **Led by the University of Liverpool**

- **£3.5m Northwest Regional Development Agency/European Regional Development Fund**

  +

- **£1.7m match from public sector partners**

- **Project Partners**

  STFC (Daresbury Laboratory)

  NWAA

  Morson Projects

  BAE Systems

  Airbus (Associate)

VEC Project

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NW of England has a high concentration of aerospace businesses serving both civil and military customers across the world.

- NW aerospace turnover - £6.3 billion
- NW aerospace employees - 48,500

The long-term business prospects for the aerospace sector are very encouraging and offer businesses excellent opportunities for growth

"23,400 new commercial aircraft required over the next 20 years, value $2.8 trillion" Airbus

NW Science Strategy identifies four regional priority areas:

Aerospace, Bio-health, Chemistry, Nuclear

NW Science Strategy Aerospace priorities are

- Composite materials, structures and manufacturing
- Virtual engineering
- Autonomous systems

Rationale

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Aerospace product development

- Increasingly more complex, globalised activity involving a world-wide supply chain
- Optimisation of new product developments is multi-disciplinary and has to encompass the entire supply chain
- Requires the secure communication of ideas, information and data with many suppliers

Product models

- Increasingly more complex permeated with uncertainty fed by evolving requirements
- Demand the integration of mechanical, electrical and software systems into a single, holistic product model
- Require linkages between requirements and behavioural data
- Require robust verification against design intention and validation against requirements

Challenges

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VEC - a “Centre of Excellence” in Virtual Engineering

- World class VE business and research
- VE education and skills development
- VE best practice demonstration

VEC – its key role for the aerospace sector

- Gateway for knowledge transfer for the aerospace sector
- Significantly improve the business performance of the aerospace sector
- Maximise companies potential for growth
- Strengthen and support integration of the supply chain

Virtual Engineering will impact product development performance

- Getting new products to market quicker
- Increasing competitiveness through reducing risk and cost
- Enabling a rapid response to customer requirements
- Providing a framework for the supply chain to work together in strong collaborations

Vision

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Significant aerospace business in NW

Technology Readiness Level 1 - 3 research at The University of Liverpool supports the development of

- A foundation for developing VE best practice

High Performance Computing (HPC) at Daresbury Laboratory

- Very high fidelity models of more complex systems
- Rapid execution of computationally intensive tasks

The VEC will:

- Build VE capabilities at Daresbury Laboratory
- Demonstrate value of VE to the aerospace supply chain
- Innovate and develop new VE tools/techniques to aid life cycle integration
- Support business development through exploitation of VE
- Develop VE educational programmes

Opportunity

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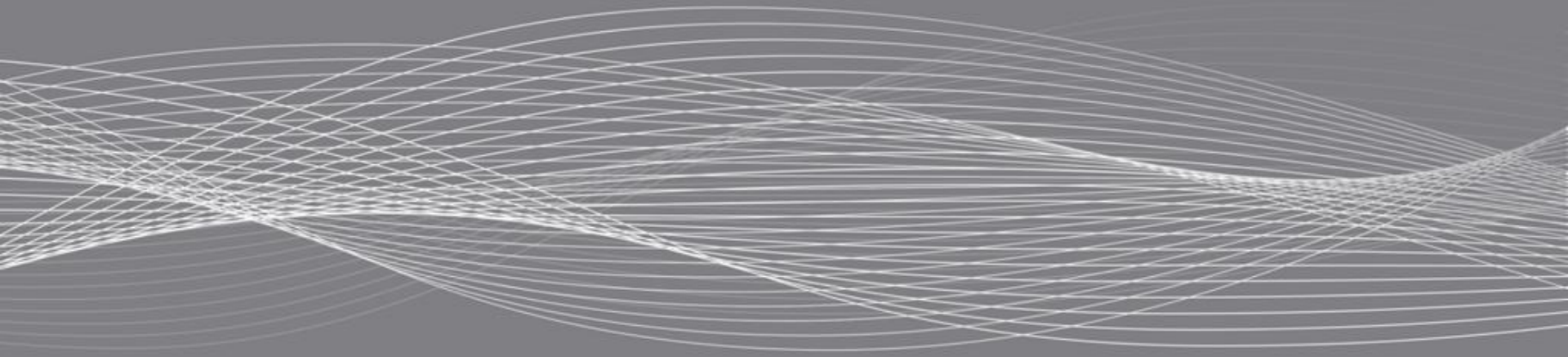

VEC Project

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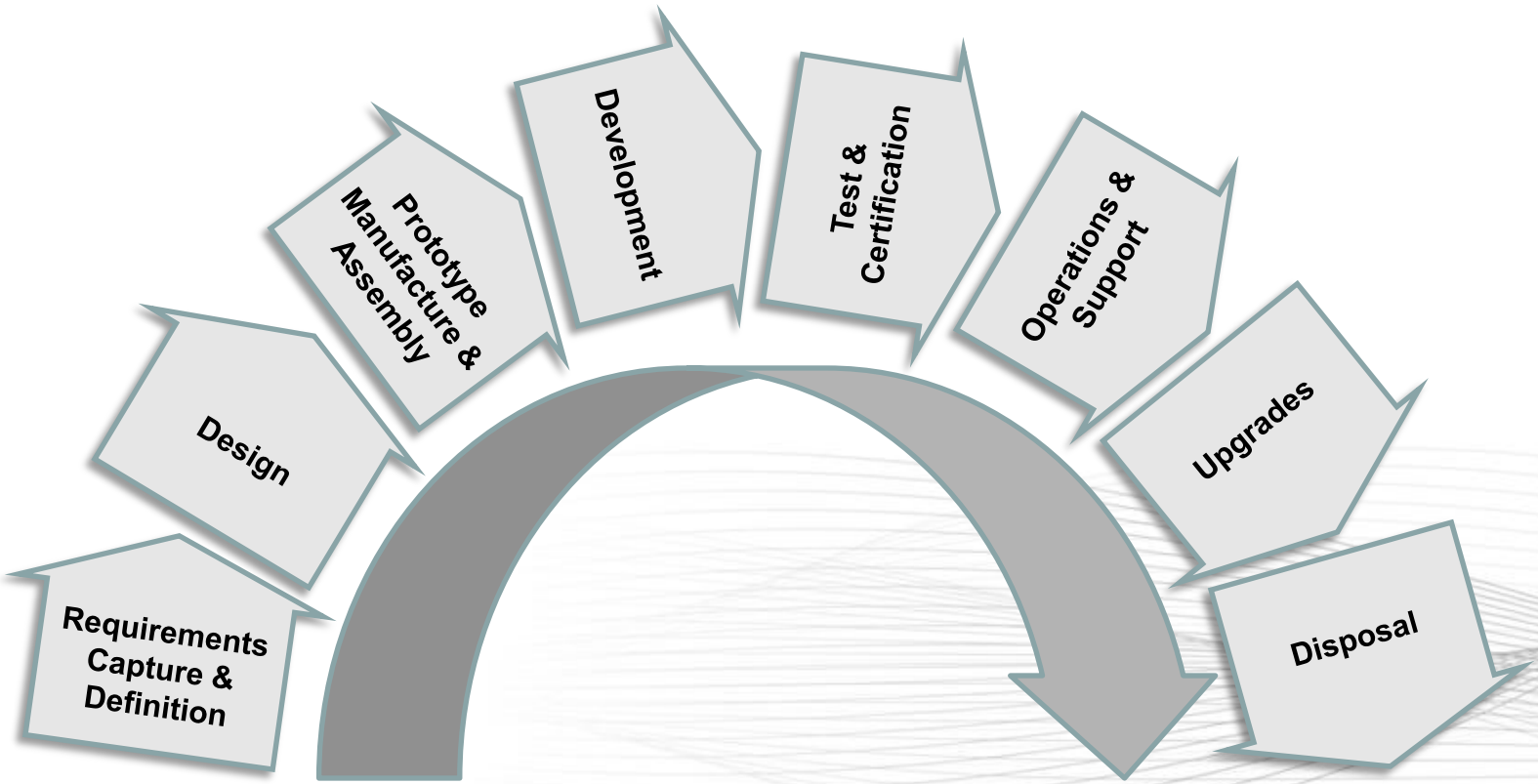
Virtual Engineering (VE) and the Product Lifecycle



Virtual Eng.

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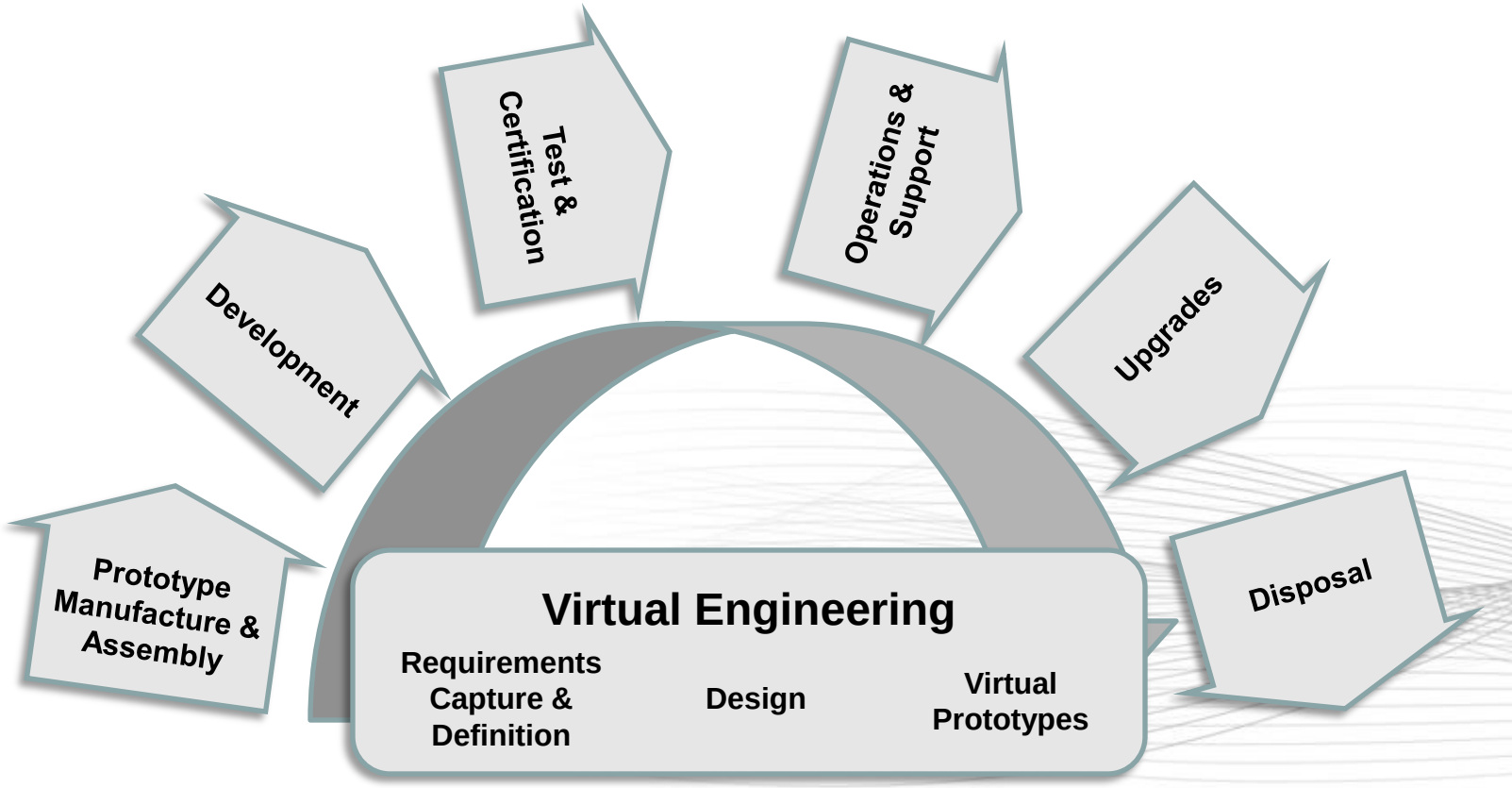
Virtual Engineering and Product Lifecycle

- VE enables an integrated approach to product and process modelling across the product life cycle to ‘join up’ the traditionally disparate and disconnected phases
- VE allows credible design decisions based on the outputs from high fidelity virtual prototypes to be made earlier in the product development process



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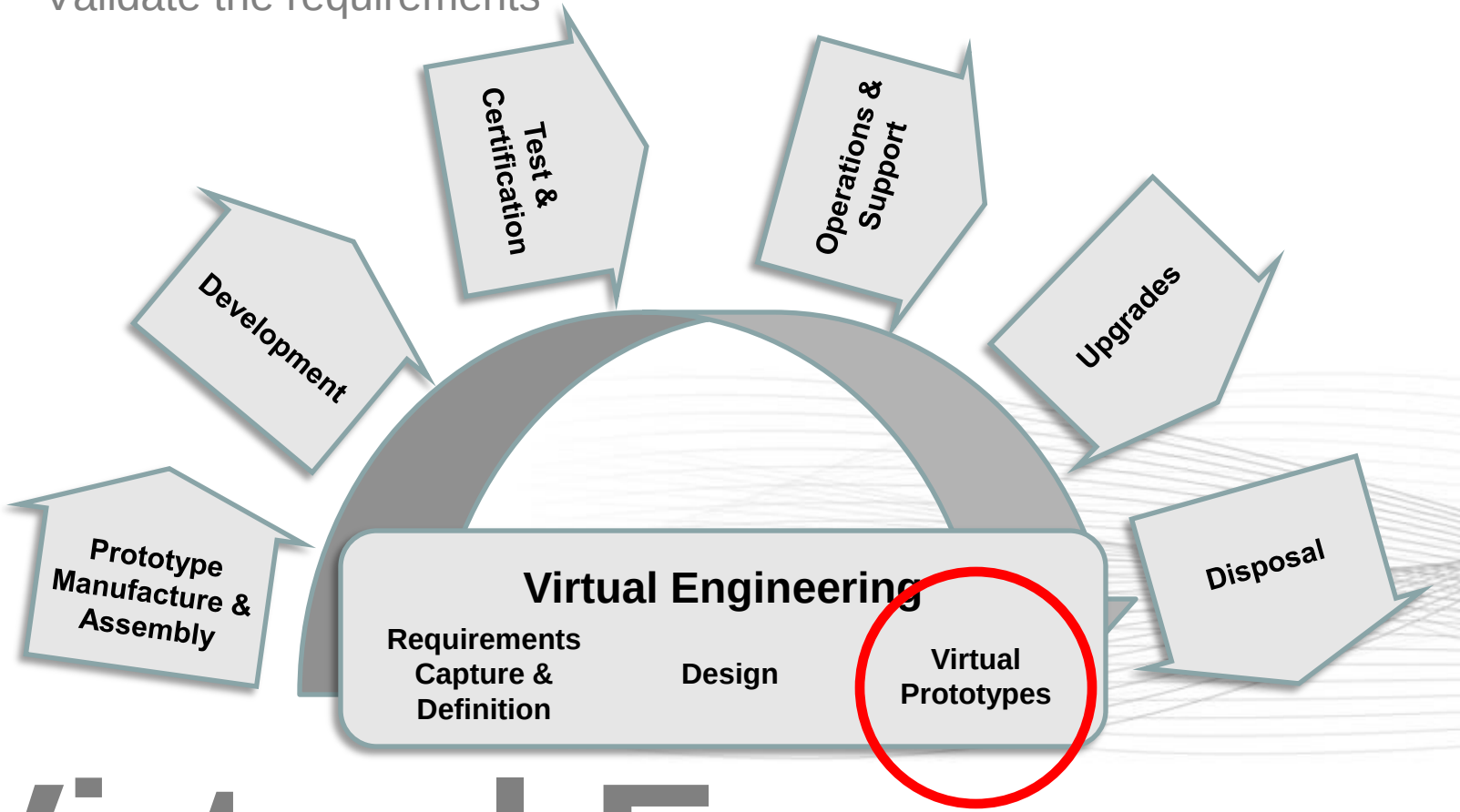
Virtual Prototypes (VPs)

Product models embedded within a synthetic environment that help:

- Demonstrate compliance with requirements
- Optimise design and development
- Validate the requirements



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VE Research at University of Liverpool

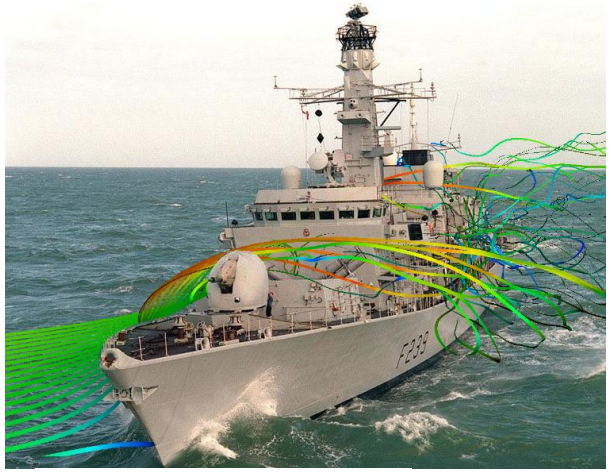
Prediction of ship-aircraft operating limits
- Modelling ship air wake, piloted simulation (MoD)

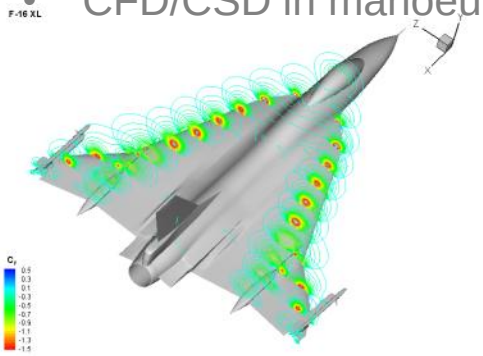
Real time pilot simulation and synthetic environments
- Linking CFD results with FLIGHTLAB (AW)

Flight control design for carefree handling qualities + proof of operational concept
- European civil tilt rotor (EC)

UAV demonstration
- With BAE Systems

Certification by analysis
- CFD/CSD in manoeuvring flight (EC)





VE Research

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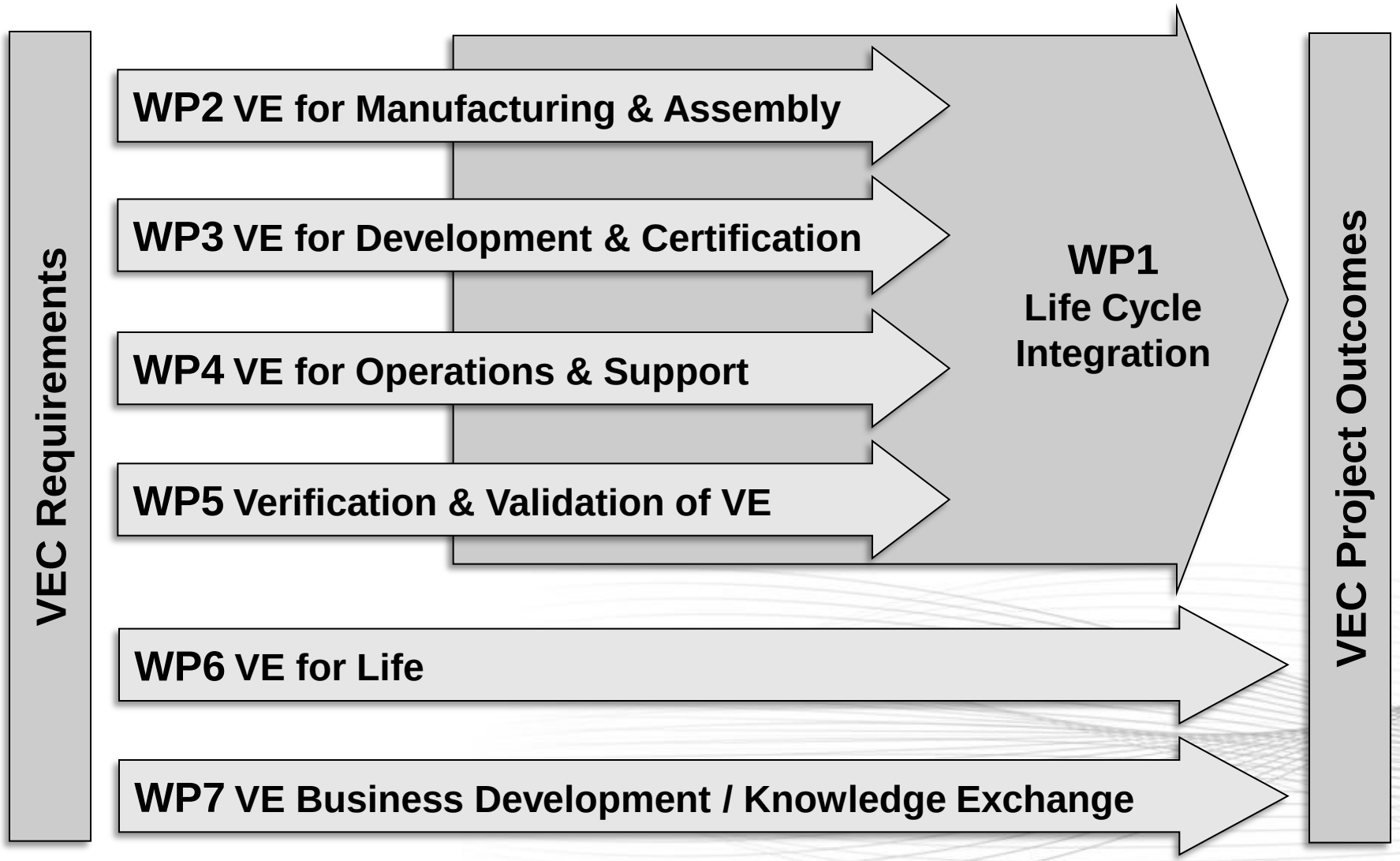

WPs

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Technical Work Packages

Using a case study approach, the VEC will develop VPs to demonstrate integrated product and process modelling in each life cycle phase

A common approach for each work package as follows:

- Create a database for an existing baseline design scenario with legacy requirements
- Create a baseline product model
- Develop a process model for populating the product model
- Develop requirements for a ‘new’ design with upgraded capability beyond the baseline
- Use the process model to populate product models with new data to examine candidate solutions to meet new requirements
- Use optimisation techniques to explore trade-offs in requirements matching
- Create a virtual prototype using the product model and associated synthetic environments
- Conduct demonstrations to a ‘virtual’ customer
- Set up VE exercises that serve as client demonstrations and educational tools
- Report, publish and promote
- Implement industrial standards and best practice into academia and vice versa (e.g. tools and techniques, processes and supply chain integration)

WPs

WP1: VE Lifecycle Integration

- The Technical Work Packages 2, 3 and 4 will develop state-of-the-art VE practice for use in each phase of the product life cycle

WP1 serves as practice integrator through:

- Establishing an integrated product and process modelling framework to support VE practice at all levels of skills and competencies throughout product life cycle
- Delivery of VEC technical outputs

WP1

WP2: VE for Manufacturing and Assembly (M&A)

- WP2 will develop a VP of a large wing structural component taken through the manufacture and assembly phase of the life cycle
- A number of mechanical and electrical sub-systems and components will be included, representative of current decentralised M&A practice
- Requirements specific to this phase will be developed and design solutions to meet these requirements explored
- The baseline product model will be enhanced to meet the upgraded M&A requirements
- This ‘upgrade’ will involve participants from the supply chain engaged in this re-optimisation and developing VE practices
- This will require the development of a collaborative framework to facilitate efficient communication and design for manufacturing and assembly optimisation by a number of different players

WP2

WP3: VE for Development and Certification

- WP3 will develop a VP of an uninhabited autonomous air system (UA^2S) that will be taken through the development and certification (D&C) phase of the life cycle
- Requirements specific to this phase will be developed and design solutions to meet these requirements explored
- The baseline product model will be enhanced to meet the D&C 'upgrade' requirements. In particular, the UA^2S will be a test bed for demonstrating a range of systems that are critical to autonomous flight and demonstrate operational benefits, e.g. observation functions
- This will involve participants from the system supply chain engaged in UA^2S technology development and VE practices
- Real time piloted simulation will be used where appropriate as a virtual flight test facility
- The impact of different levels of modelling fidelity will be assessed, both on the system functionality and the efficiency of the optimisation

WP3

WP4: VE for Operations and Support

- WP4 will develop a VP of an air system that will be taken through the operations and support (O&S) phase of the life cycle
- Requirements specific to this phase will be developed and design solutions to meet these requirements explored
- The baseline product model will be enhanced to meet the O&S ‘upgrade’ performance requirements
- Activities will involve high-fidelity, whole vehicle, modelling drawing data from state of the art computational aero-elastic and flight dynamics modelling
- Real time piloted simulation will be used where appropriate as a virtual flight test facility
- Representation of multiple players in the synthetic environment in which the VP will operate, thus creating the capability to address a broader range of system functionality/performance questions

WP4

WP5: VE for Verification and Validation

- WP5 will develop a framework for verification and validation (V&V) of VE and VPs, drawing from current Research Council funded activities at the University of Liverpool
- Verification implies a match of functionality and performance with the design specification
- Validation implies a match of functionality and performance with the requirements
- This Work Package will draw on the outputs of Work Packages 2, 3 and 4, alongside current academic research, to support the V&V framework development

WP5

WP6: VE for Life

WP6 will develop a series of VE educational modules, using the activities in Work Packages 1-5, to form the core of a postgraduate taught programme in VE

WP6

WP7: VE for Business

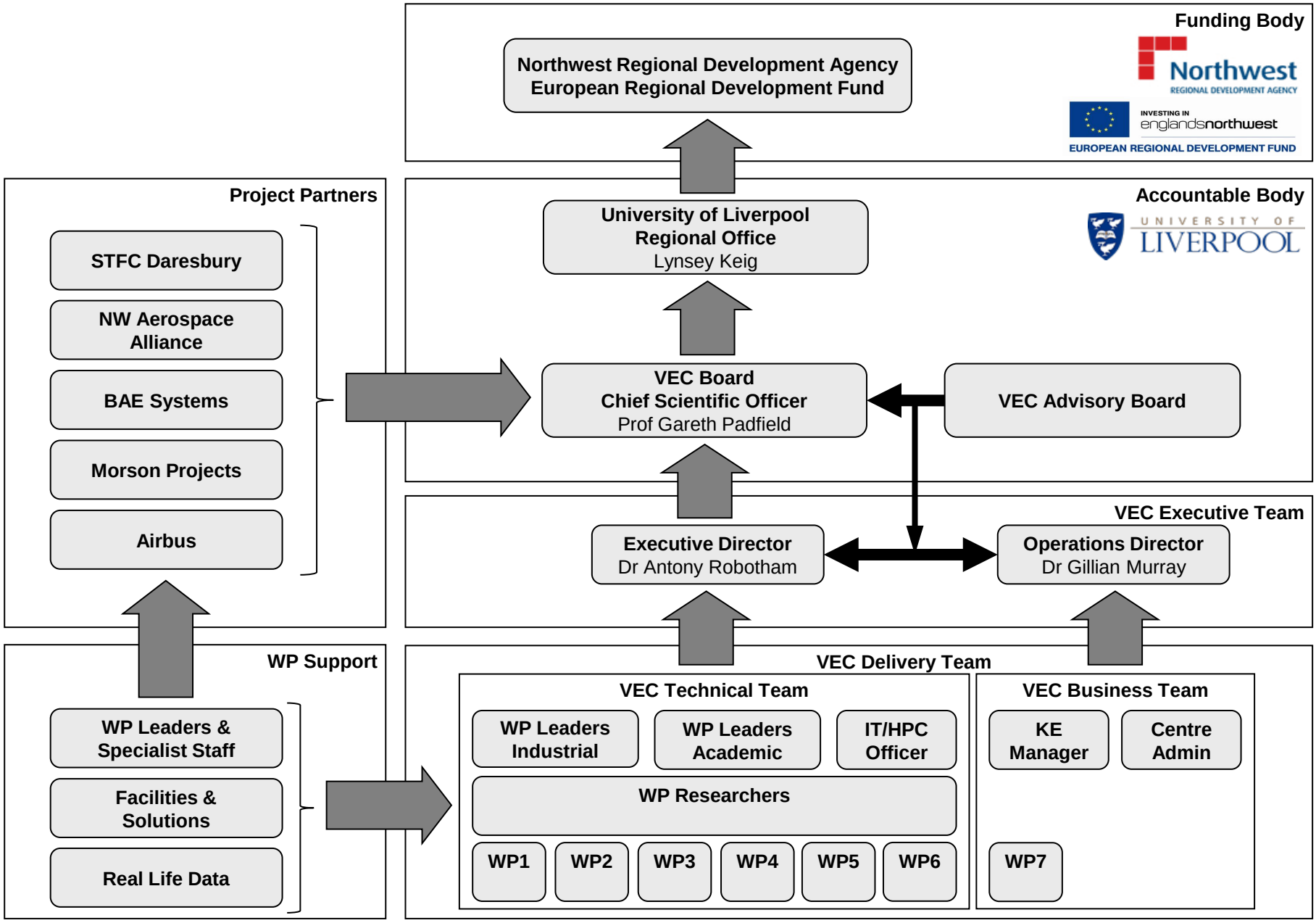
The business team activity will integrate with the technical work through:

- Undertaking needs and demands studies (assessing the requirements of the customer)
- Developing a baseline business plan/case for the Centre with strategic operational options to drive the VEC towards sustainability
- VEC promotion, undertaking industry awareness through VE workshops and briefings and driving forward a targeted programme of company assists which will demonstrate benefits of VE to the supply chain whilst monitoring and reporting current VE practice and problems in the supply chain
- Working alongside the Northwest Aerospace Alliance on the planning, delivery and quality of supply chain events
- Facilitating and promoting a strong culture of collaboration and partnering combined with high levels of productivity and customer orientation
- Reassessing customer requirements following VE promotion activities and company assists
- Upgrading the business plan and developing the business case for future sustainability.
- Securing future commercial & business opportunity pipeline to sustain the VEC
- Developing dissemination pathways for the work of the VEC including web based publicity and promotional material

WP7

PROJECT X00860PR: VIRTUAL ENGINEERING CENTRE

PROJECT ORGANISATION



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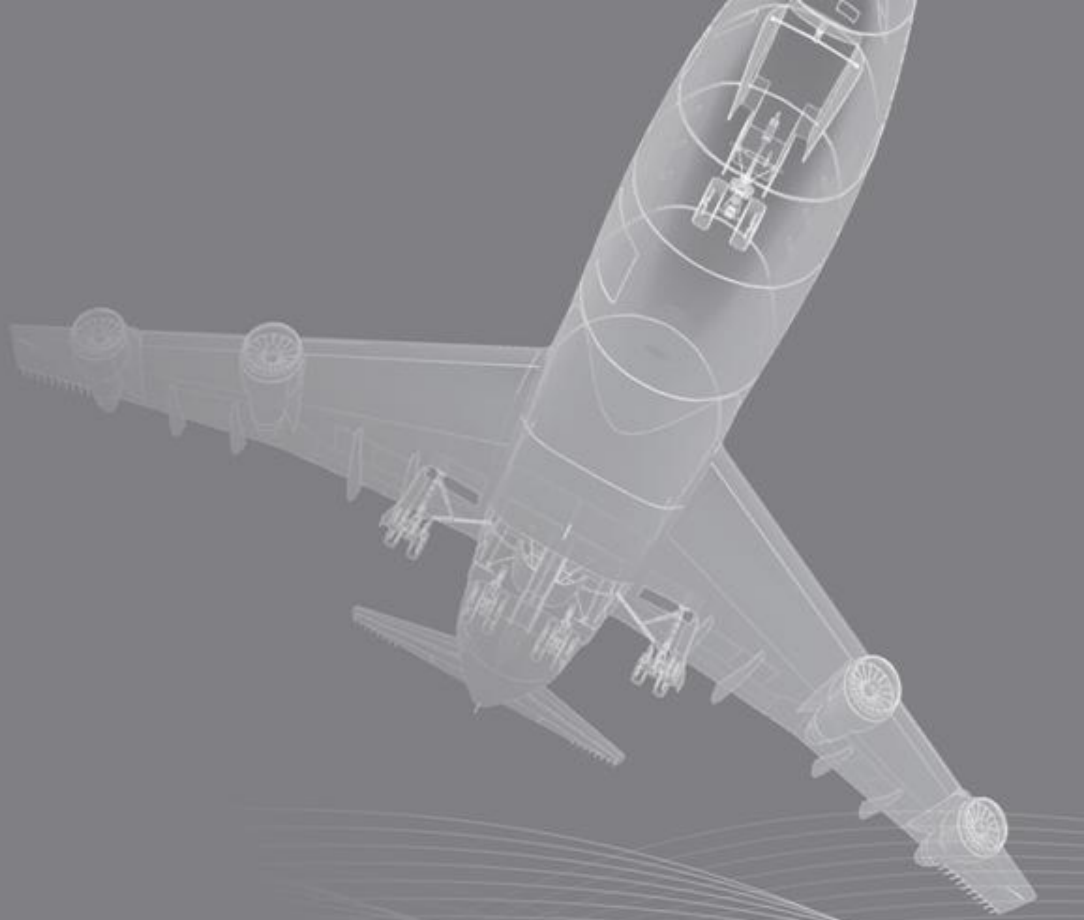

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