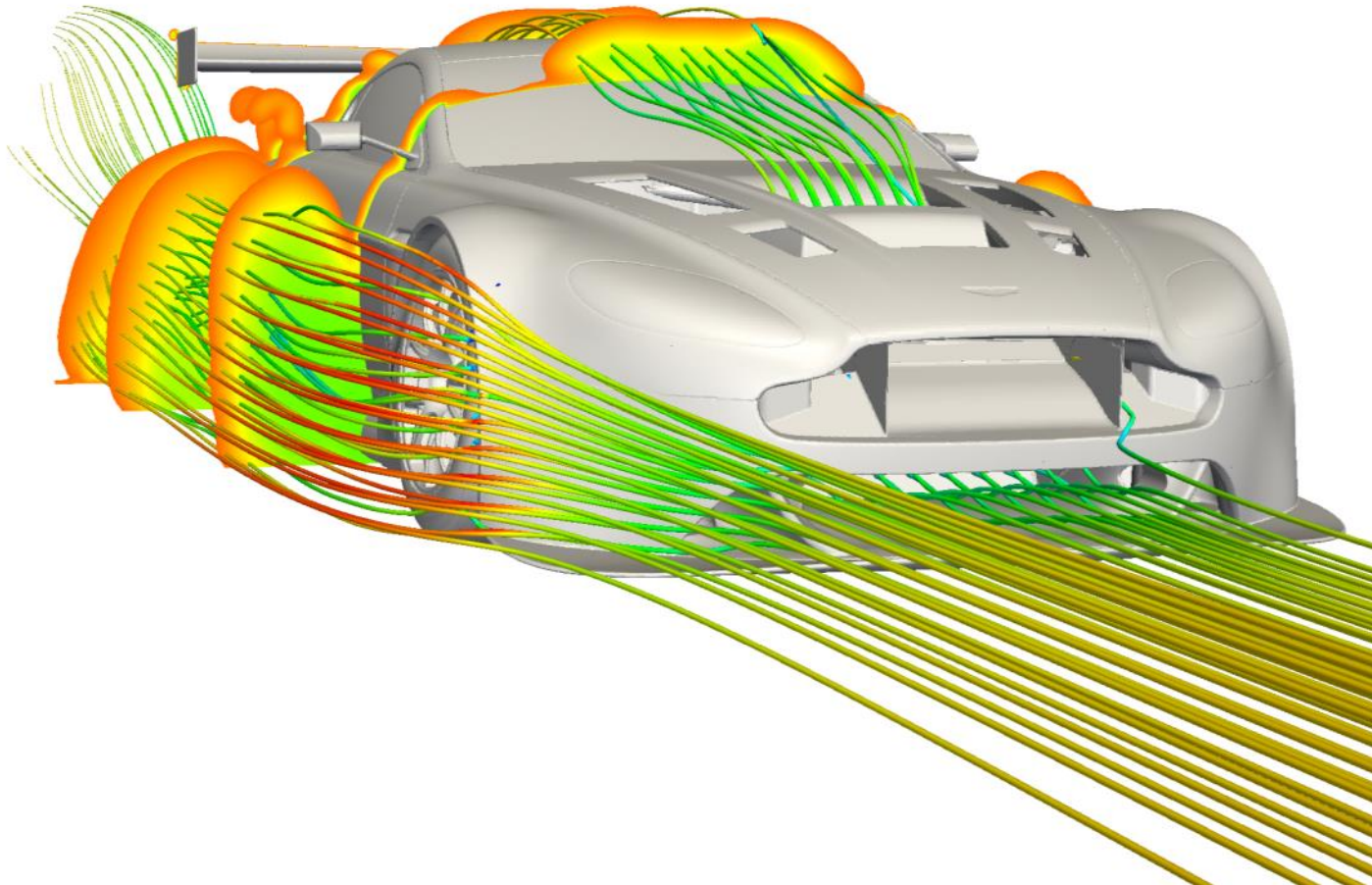




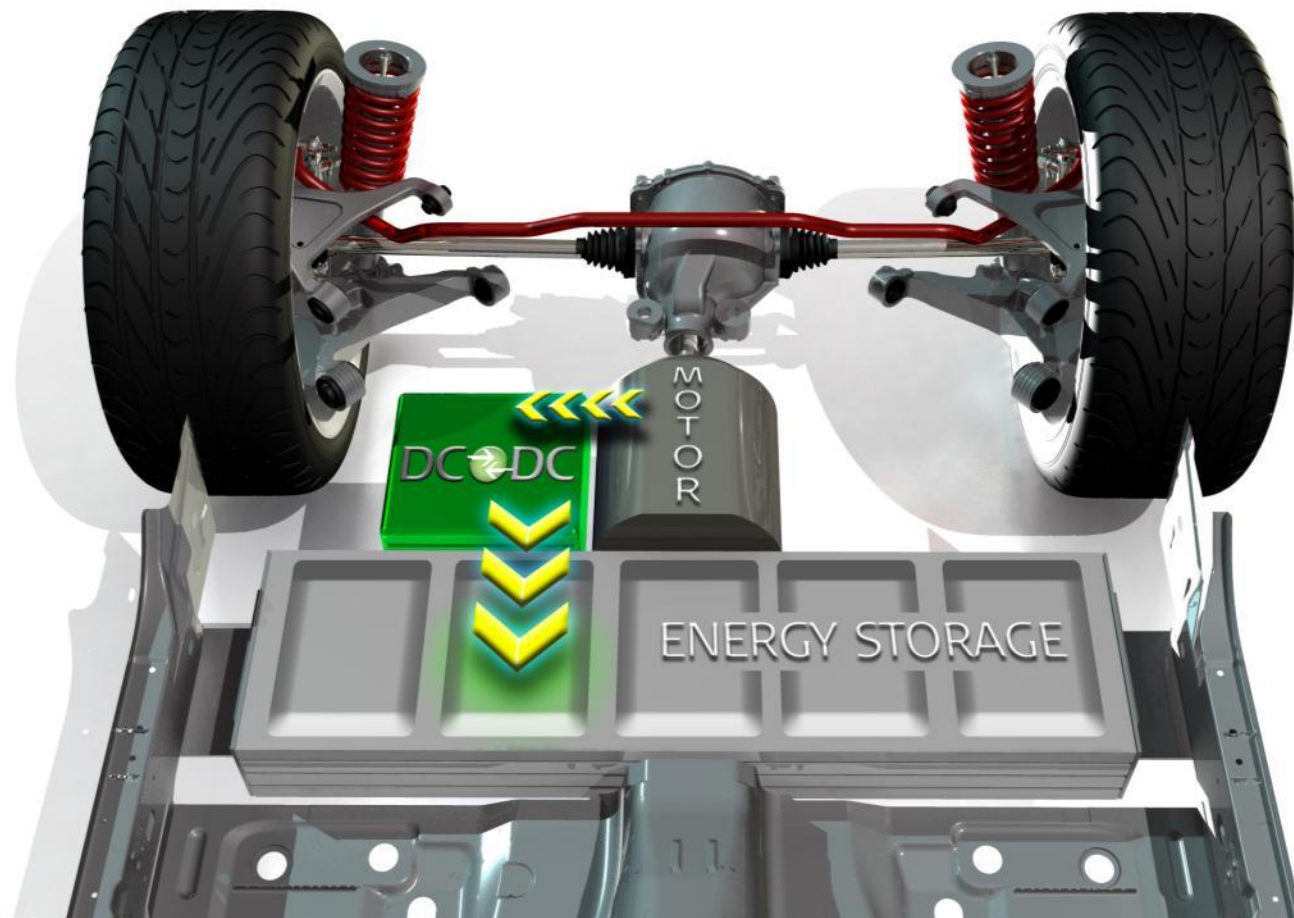
We inject excitement and  
innovation into our customers'  
products & brands

**prodriue**



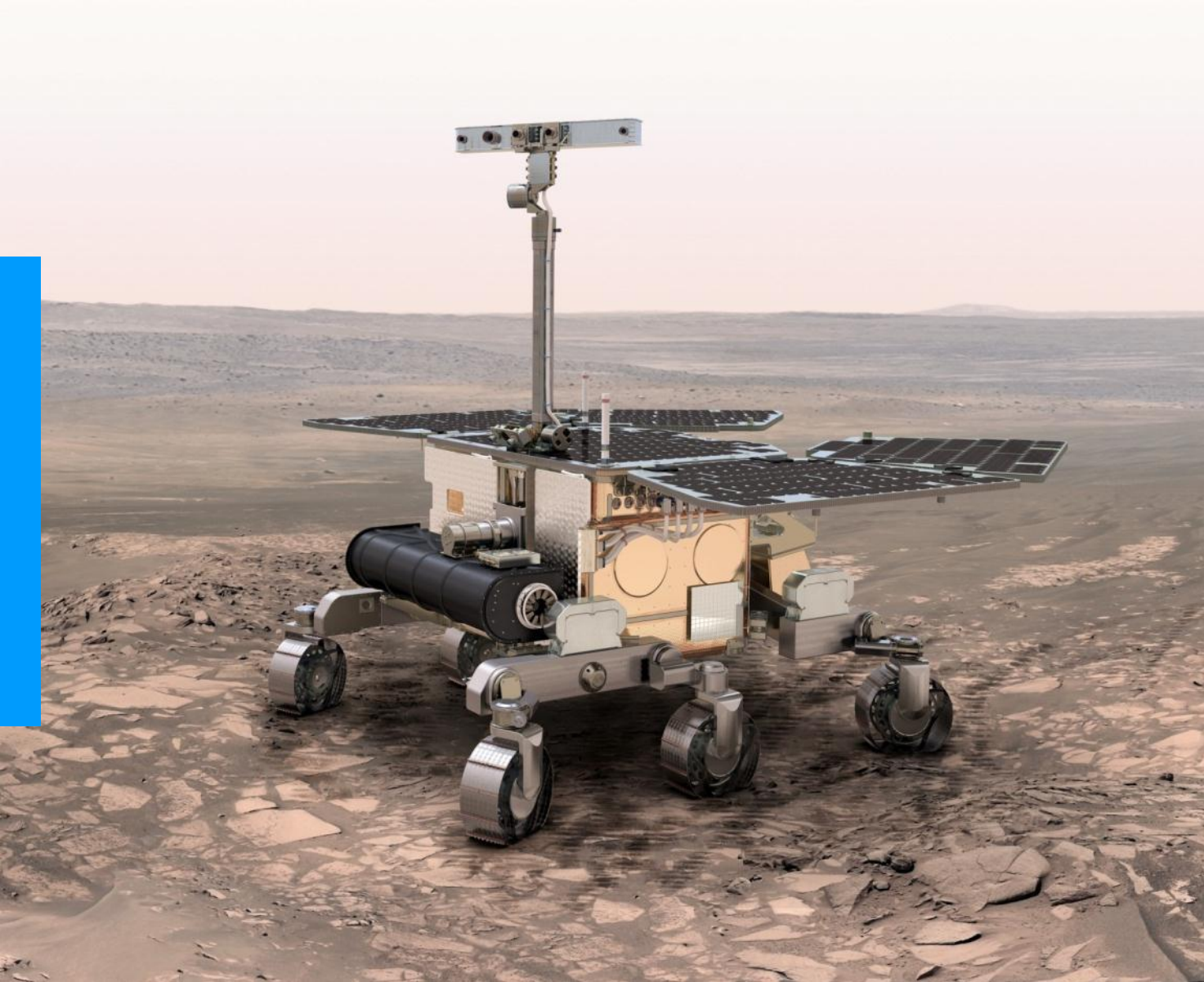
## IN MOTORSPORT

- »Aston Martin Racing
- »MINI World Rallying
- »VW Rallying
- »Vehicle design & engineering



## ON THE ROAD

- »Range Rover Autobiography Black
- »McLaren P1
- »Innovative technologies



## IN THE AIR

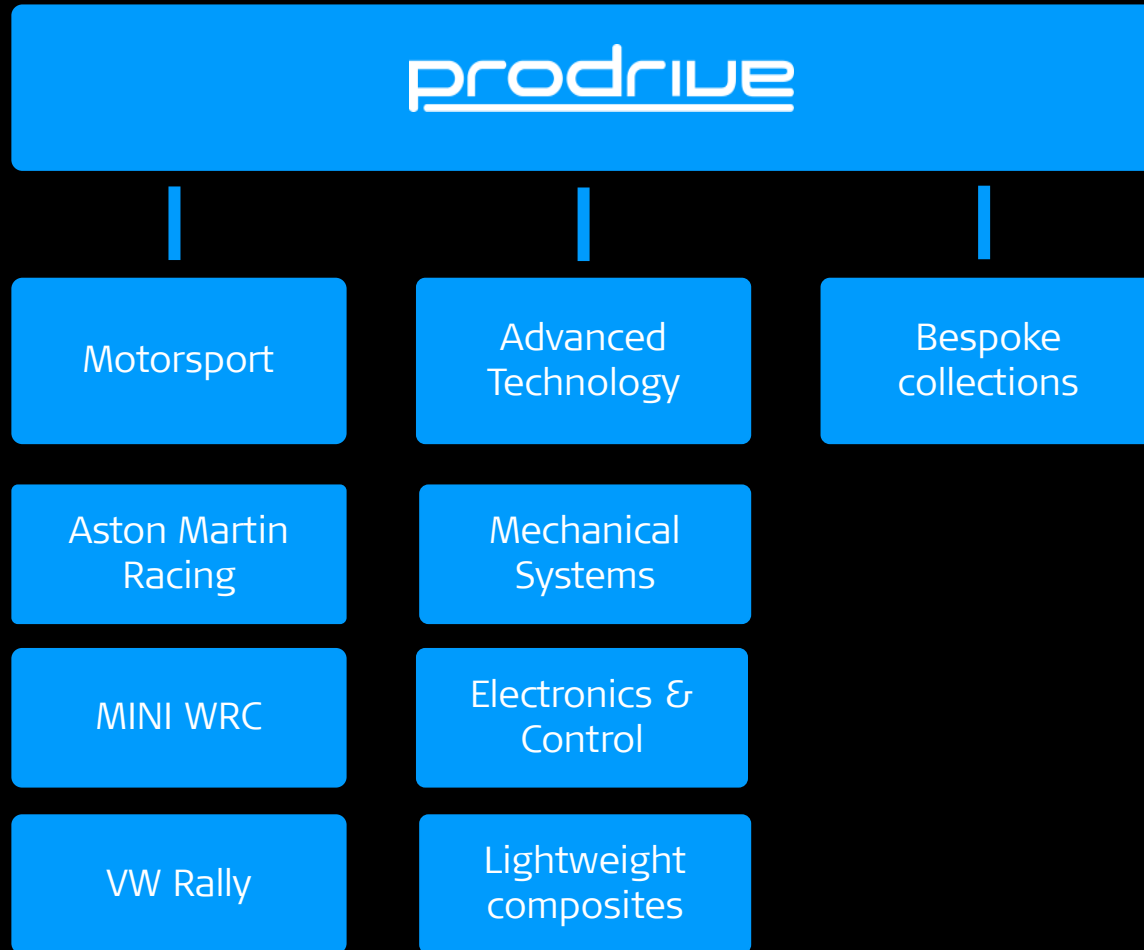
- » Boeing Dreamliner 1<sup>st</sup> class cabin
- » Mars Rover





## ON THE WATER

- »Lewmar performance winches
- »Britain's Americas Cup Challenge



## PRODRIVE

- » Founded in 1984
- » 500 staff



## LOCATIONS

- » Banbury
- » Milton Keynes



## NEW HEADQUARTERS

- » 120,000 sq ft
- » Next to M40, Banbury





## MOTORSPORT ACHIEVEMENTS

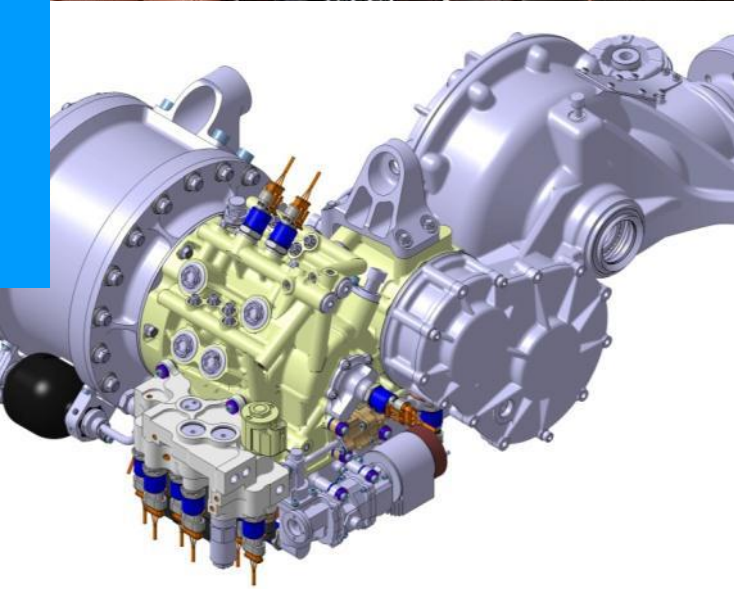
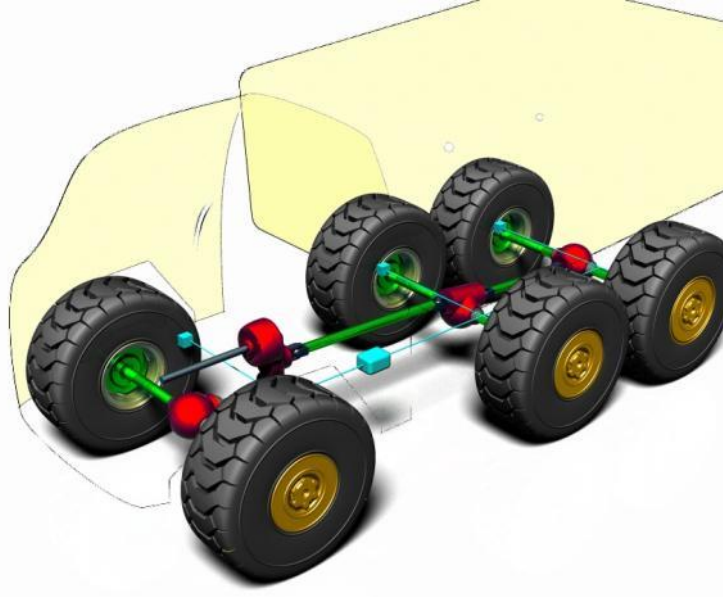
- » 1144 events:
  - 472 rallies
  - 672 races
- » 272 wins
  - 132 rallies
  - 140 races
- » 2306 car starts
- » 6 World Rally Championship titles
- » 4 Le Mans 24 Hours titles
- » 3 FIA WEC titles
- » Le Mans Series champions
- » 4 British Touring Car Championships
- » BAR F1 Team 2nd in F1 World Championship under Prodrive management





## MOTORSPORT

- » One of the largest independent, full capability motorsport organisations in the world
- » Aston Martin Racing
  - Vantage GTE
  - Vantage GT3
  - Vantage GT4
- » VW Golf SCRC
- » MINI
  - WRC
  - RRC
  - RX
- » Dakar



## ADVANCED TECHNOLOGY

» Combining our motorsport culture with robust engineering processes and quality procedures to produce solutions that enhance our clients' products and solve their technical challenges

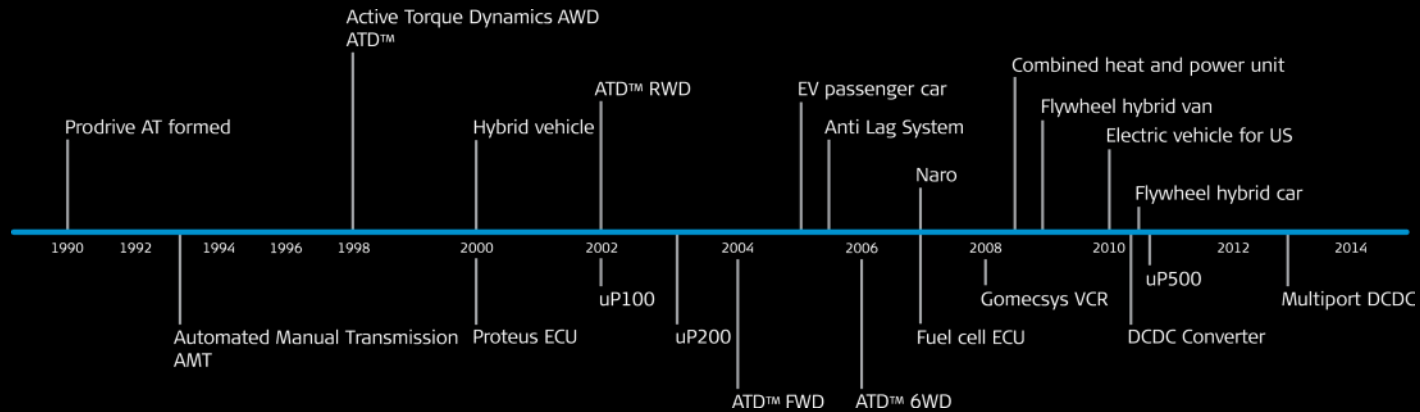
### » Sectors

- automotive
- defence
- aerospace
- marine
- power generation

### » Today's clients include

- Jaguar Land Rover
- McLaren
- Ford
- Ben Ainslie Racing
- Airbus Defence & Space

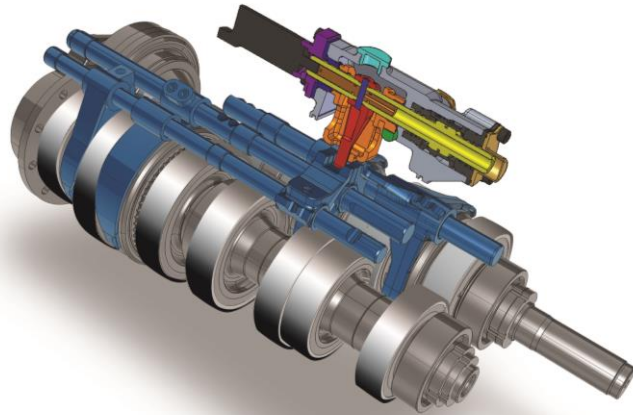
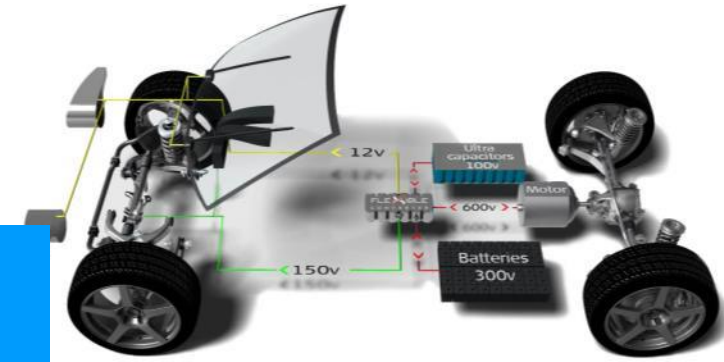




## ADVANCED TECHNOLOGY

- » Innovation & creative solutions over 20 years
- » Applying motorsport technologies to road car design
- » Providing turn-key design & supply solutions
- » Consortium approach to new IP R&D
- » Over 100 qualified engineers





## SYSTEMS ENGINEERING

### » Efficient Powertrains

- Electric & flywheel hybrids
- DC-DC converters
- Automated manual transmissions

### » Chassis

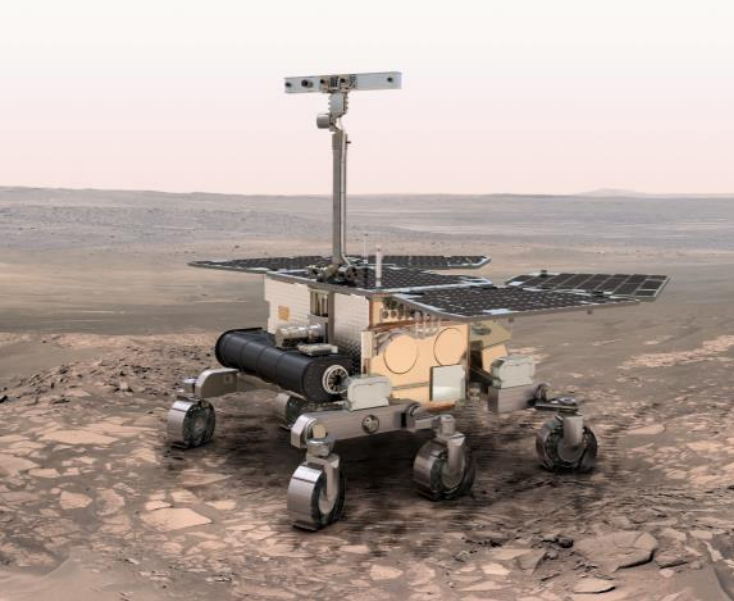
- Base chassis design
- Active driveline control – ATD

### » Interior systems

- Bespoke mechatronic systems
- Vehicle & module production

### » Active aero

- Bespoke electric and hydraulic actuation
- Module production and delivery



## LIGHTWEIGHT COMPOSITES

- » One of the largest UK plants for design & manufacture of carbon composite parts & assemblies
- » 40,000 sq ft facility
- » 180 staff
- » Sectors
  - automotive
  - aerospace
  - marine
  - motorsport
- » Today's clients
  - McLaren Automotive
  - Airbus Defence & Space
  - Bentley
  - Jaguar
  - Sikorsky



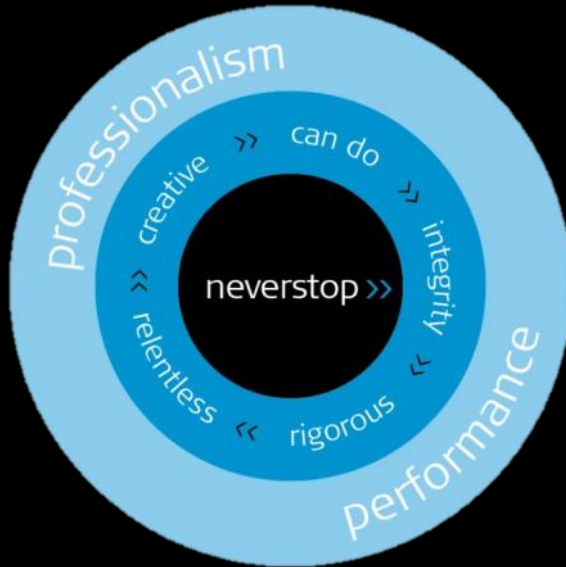


Brand &  
BESPOKE BRANDED CLOTHING  
& ACCESSORY COLLECTIONS

## BESPOKE COLLECTIONS

- » Bespoke branded clothing & accessory collections
- » Full in-house service: product design, manufacture, distribution & fulfilment
- » Sectors
  - motorsport
  - sport
  - automotive
  - drinks
  - airlines
- » Clients
  - McLaren F1
  - FIFA
  - Triumph
  - Jumeira Hotels
  - Jaguar Land Rover
  - Aston Martin

## PRODRIVE DNA



our culture professionalism  
& performance

our values can do : our attitude  
creative : how we think  
rigorous : our strive for perfection  
relentless : our commitment  
integrity : our pride

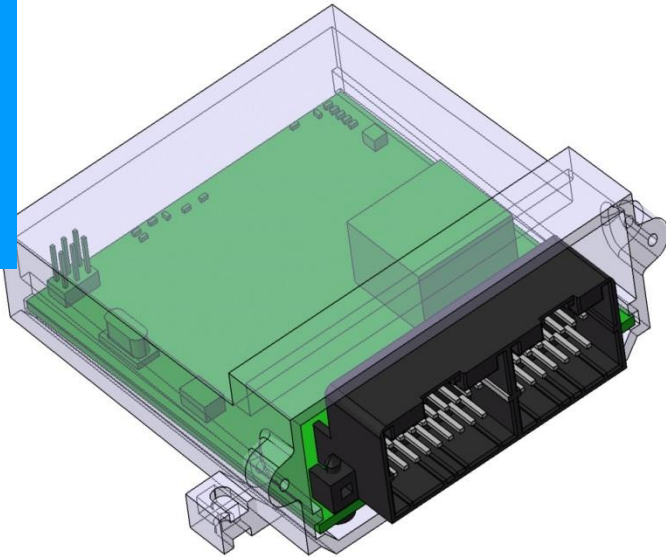
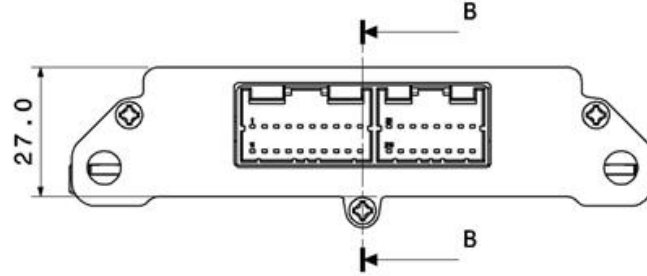
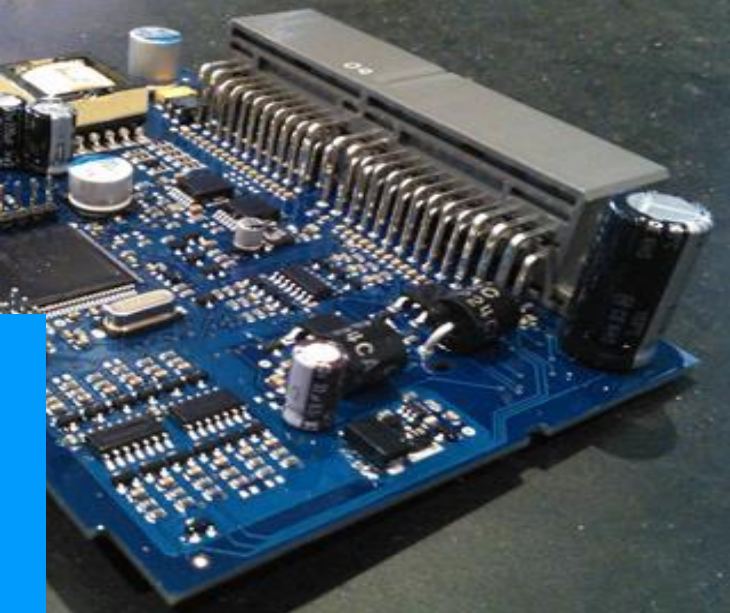
our essence neverstop >> dreaming  
innovating  
creating  
performing  
exceeding  
competing  
winning





## RANGE ROVER BLACK

- » Problem – Create higher price point for vehicle range
- » Complete turnkey solution from concept to whole lifecycle production
- » Niche luxury interior centre console:
  - Chiller
  - Table
  - Console trim
  - Side Panel
  - Armrest
- » Engineering development & programme management
- » Interior console build in Banbury
- » Production (Q4 2013)



## RANGE ROVER BLACK

- » Problem – Cost effective delivery of a unique, low volume, control module
- » Bespoke design
  - Component selection
  - Electronic circuit schematic
  - PCB layout & routing
  - Enclosure design
  - Prototype builds
  - Embedded software
- » Compliance
  - Full corporate and regulatory sign off including;
    - EMC
    - Environmental
- » Project duration
  - 9 months





## MCLAREN P1 ACTIVE AERO

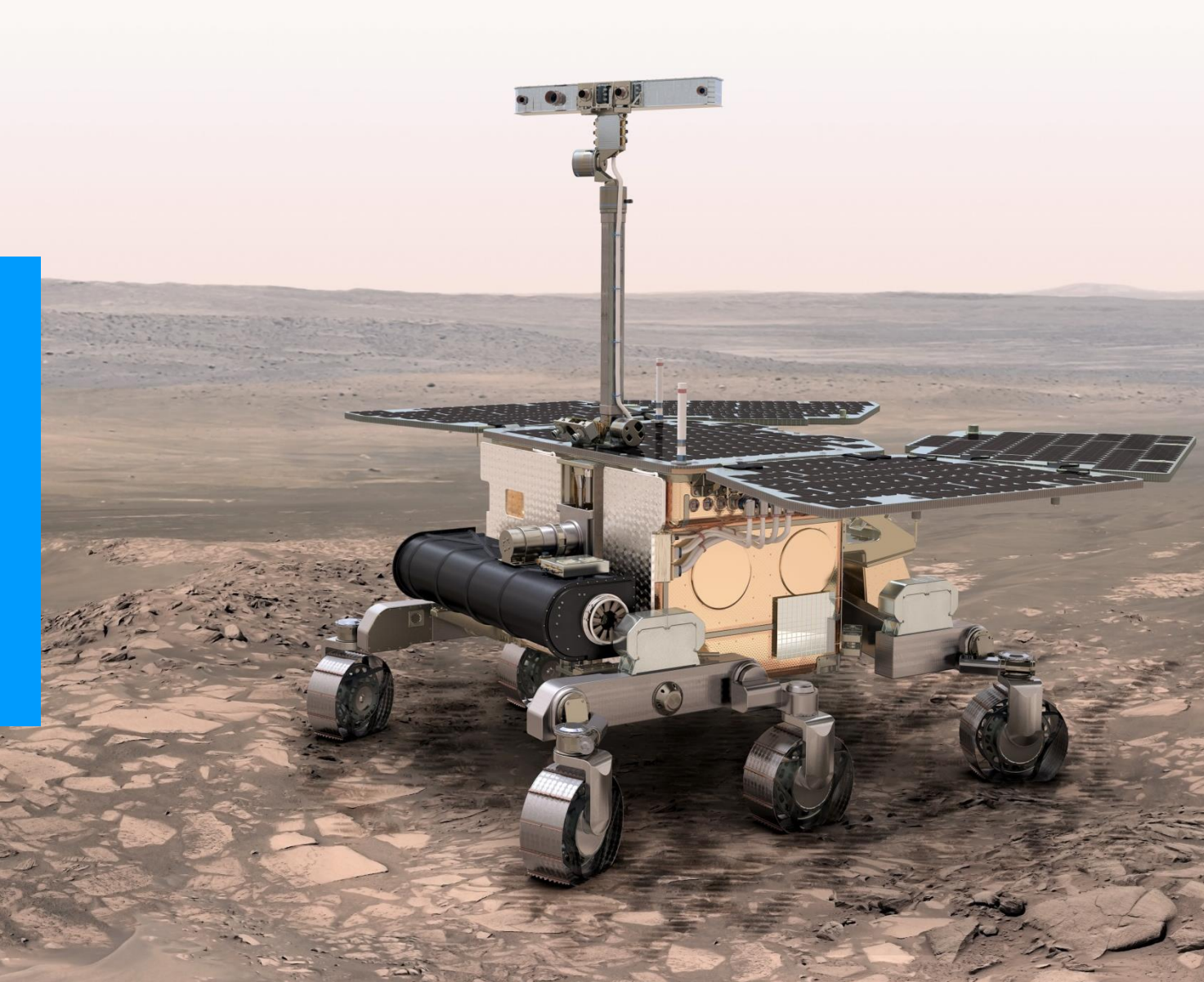
- » Problem – Aero load management for the world leading supercar.
- » Scope of Project
  - Design and manufacture of hydraulic and electrical actuation
- » What Prodrive did.
  - Design and qualification of system
  - Manufacturing methods definition
  - Deliver volume project, 7 car sets per week.



## MCLAREN P1 BODY & TRIM

- » Problem - Volume manufacture of complex, high tolerance, CFRP structure and cosmetic standards
- » Scope of Project
  - All body panel and interior package
- » What Prodrive did.
  - Design for manufacture of complex geometry
  - Tooling design
  - Manufacturing methods definition
  - Deliver volume project, 7 car sets per week.





## MARS ROVER

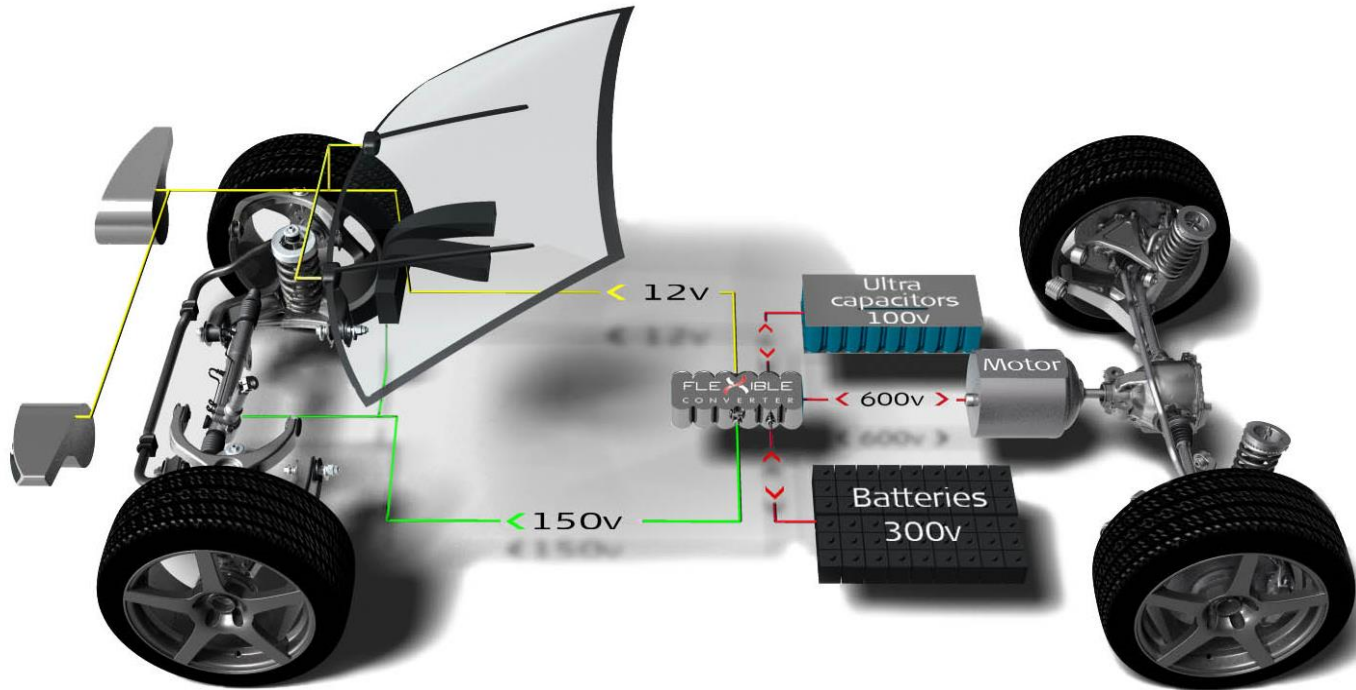
- » Problem – High tolerance multi material structure in a harsh environment.
- » Scope of Project
  - Chassis and solar arrays.
- » What Prodrive did.
  - Design for manufacture; geometric tolerance requirement.
  - Manufacturing methods definition
  - Biologically clean manufacturing facility



## AESTHETIC ACCESSORIES

- » Problem – Complicated fixing and geometry result in high cost low volume solutions.
- » Scope of Project
  - Design and develop high class vehicle accessories for volume & cost targets
- » What Prodrive did.
  - New patented technology and manufacturing process.
  - Qualified to multiple OEM criteria.
  - Established manufacturing capability and capacity to meet OEM requirements.

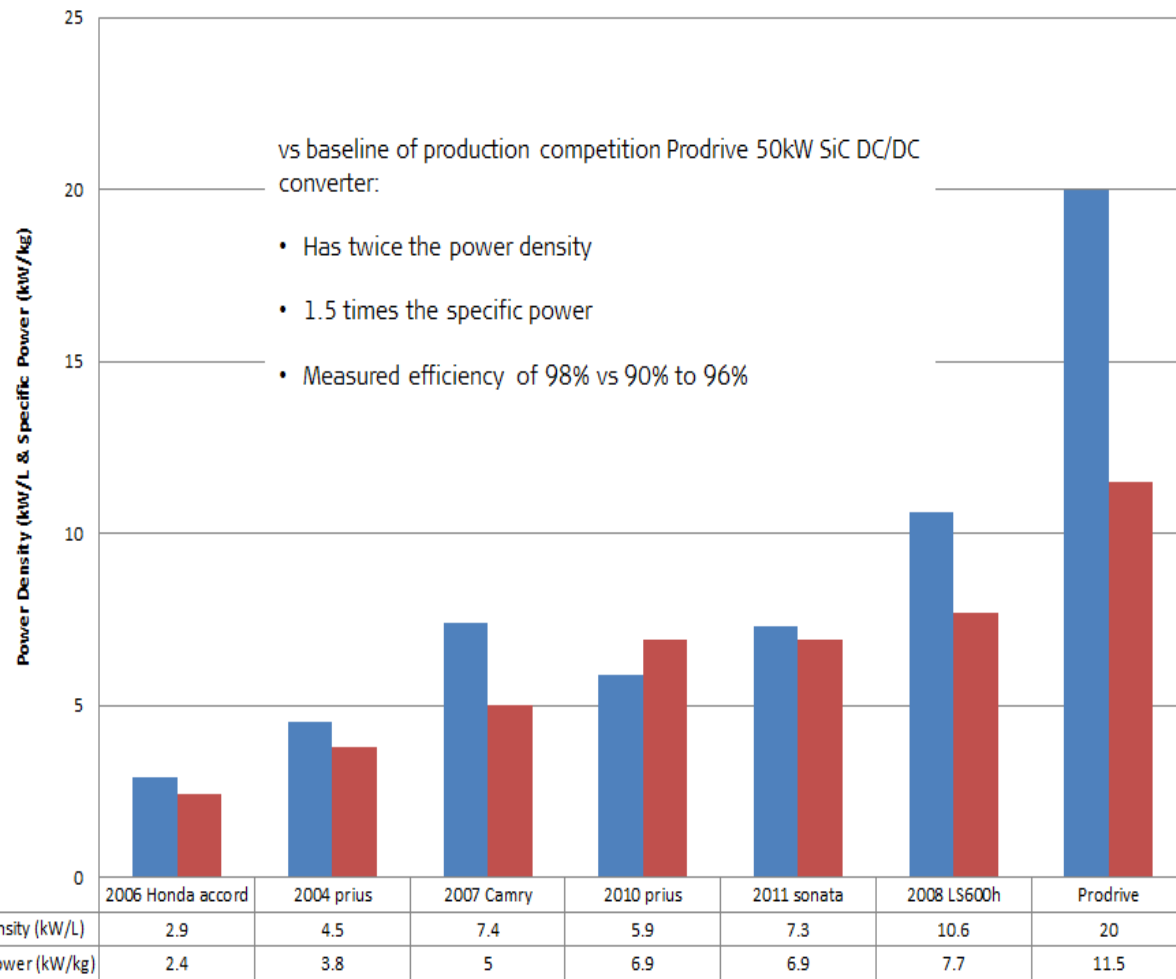




## MULTIPORT DC-DC CONVERTER

- » Problem – Multiple voltage sources on hybrid/electric vehicles
- » TSB project consortium
- » Prodrive lead partner
- » 3 year project (phase 1 & 2)
- » Silicon Carbide IGBT
- » Prodrive content
  - Converter control electronics
  - Converter control software
  - Battery pack
  - Supercap banks
- » Specification
  - 400V 40kW traction port
  - 220V 40kW battery port
  - 75-150V 25kW supercap port
  - 12V 1kW vehicle port
- » Installation on Tata Vista EV

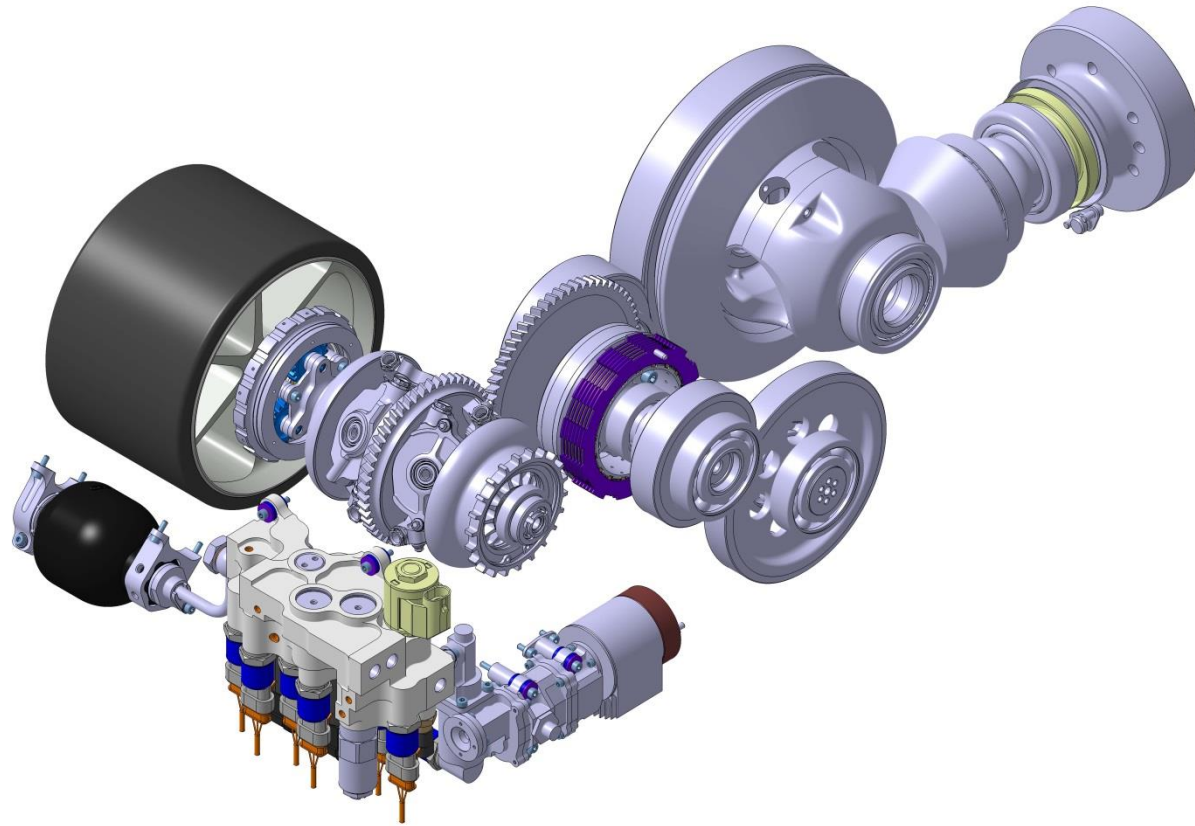
## Prodrive Multiport DC/DC vs Industry state of the art



## MULTIPORT DC-DC CONVERTER

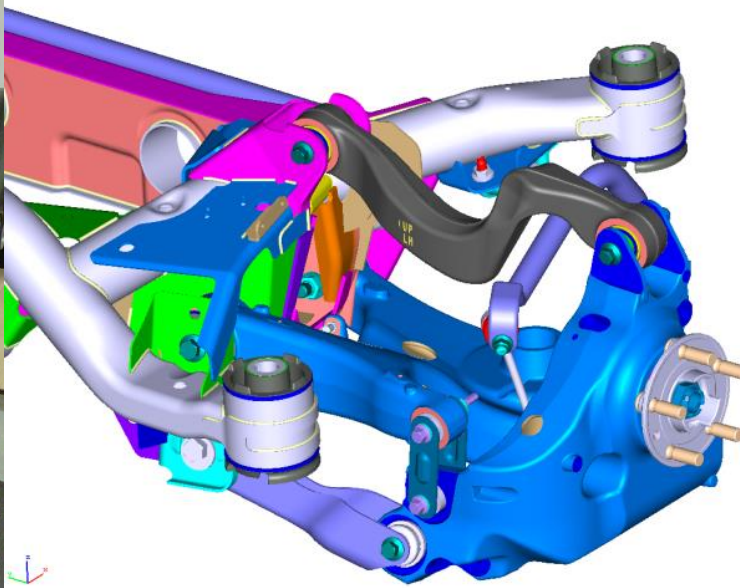
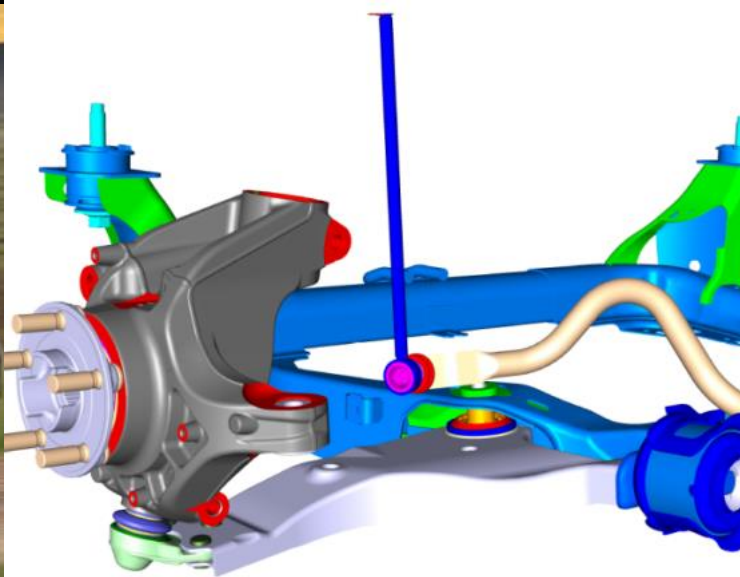
- » Phase 2
- » Develop to IR (TRL 6/7)
  - Optimise package
  - Reduce weight
  - DV programme
  - Use of AEC components
  - ISO26262 process
- » Increased specification
  - 750V 58kW traction port
  - 320V 38kW battery port
  - 75-150V 25kW supercap port
  - 12V 1kW vehicle port
- » Completion Q1 2015
  - Efficiency - 98.7%
  - Gravimetric density – 11.5kW/kg
  - Volumetric density – 20kW/L





## FLYWHEEL HYBRID

- » Problem - Improvement in NEDC without degrading performance
- » Mechanical Hybrid using a carbon flywheel and infinite CVT
- » Integrate system with minimum disruption to vehicle architecture
- » Prodrive responsibility
  - Initial simulation and target setting
  - Packaging studies
  - Vehicle integration (inc. BIW modifications and installation of flywheel system)
  - Final drive modifications
  - Electrical system design and harness manufacture
  - Supervisory control system software and hardware



## CHASSIS SYSTEM DESIGN

- » Problem - The OEM had insufficient resource
- » Scope of project
  - The Land Rover Discovery Sport Suspension system architecture was developed with a Prodrive embedded team
- » Concept to project start
  - Definition and sign off
  - Proof of concept demonstrator
  - Target setting
- » Project start to production build
  - Detailed design
  - System Integration across JLR
  - Supplier management
  - Validation
  - Release
  - Build support



## BEN AINSLIE RACING

» Problem – Britain hasn't won the Americas Cup, challenger BAR in 2017.

» Scope of project

- Hydrofoil hydraulic action
- Main sail control

» What Prodrive did

- Hydraulic system design from first principles
- Trade studies and selection.

» Prodrive key strengths

- System modelling to ensure right first time operation, early advantage.
- Speed of response and delivery.





## DRIVE LINE CONCEPT DESIGN

» Problem - The MOD required an independent critique of design

» Scope of project

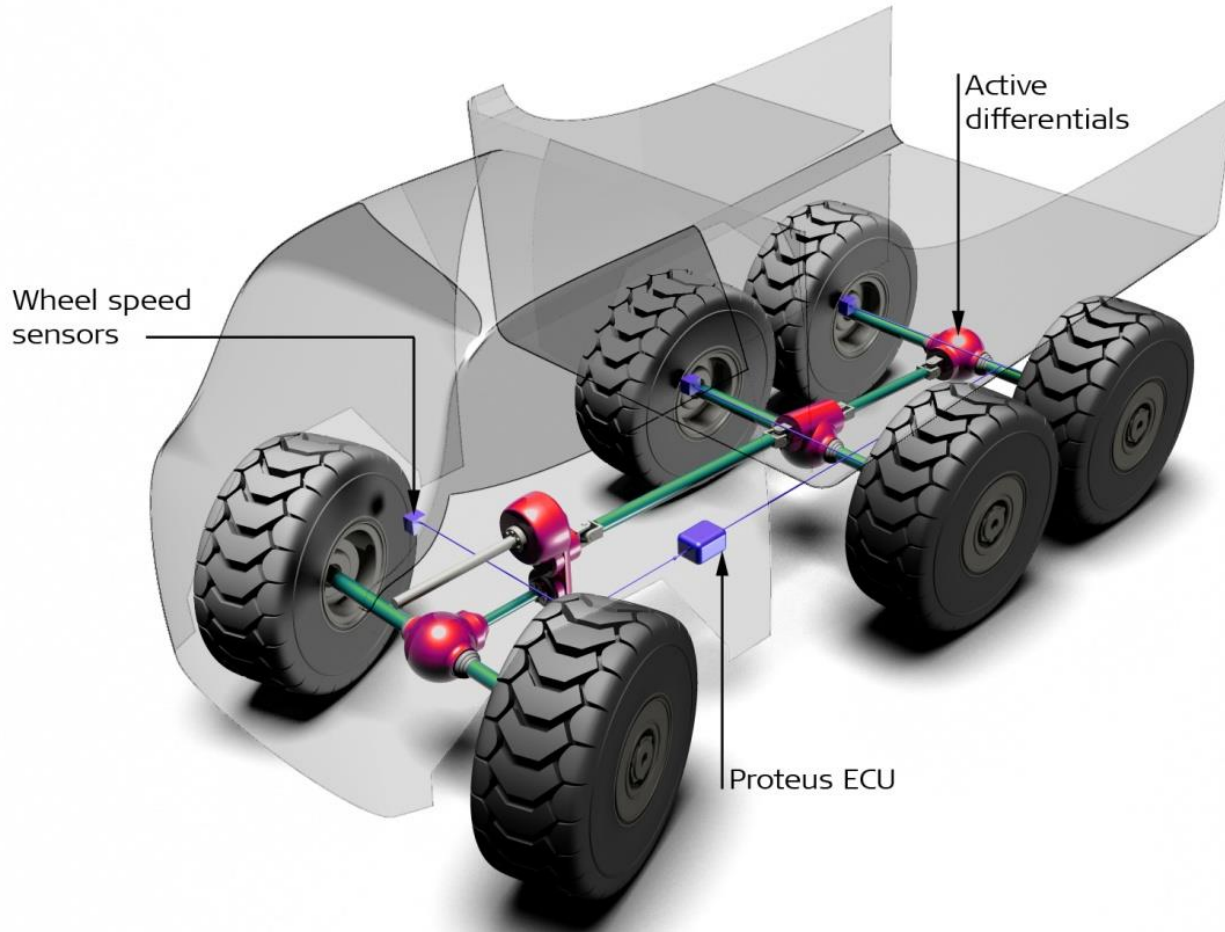
- Defence driveline concept critique for defence prime
- Unmanned aerial vehicle

» What Prodrive did

- Performed critique and evaluation of novel driveline concept
- Recommended improvements
- Defined efficiency & targets
- Devised concept layouts
- Delivered detailed report

» Prodrive key strengths

- Peripheral understanding of driveline and transmission
- Utilising material and manufacture processes to achieve very challenging performance



## DRIVE LINE CONCEPT DESIGN

» Problem – Enhanced safety & functionality

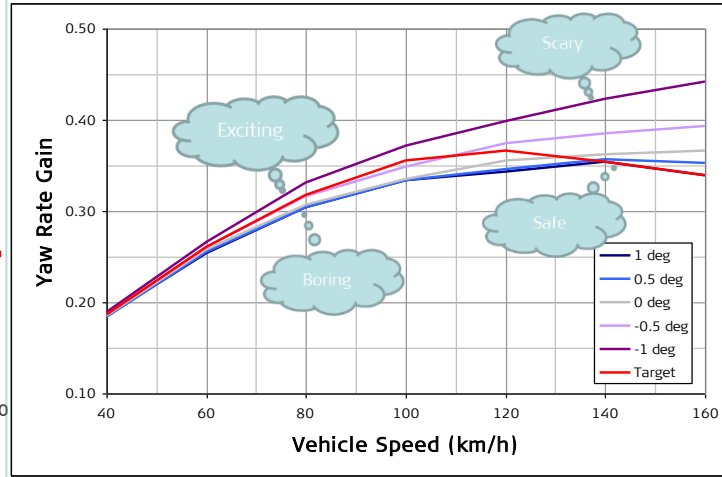
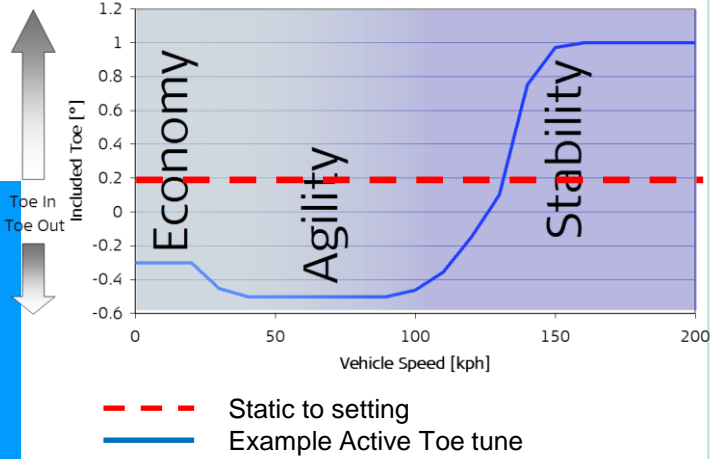
» Scope of project

- Active Torque Dynamics System for off-highway 6 wheel quarry vehicle
- Focus on traction and steering improvement
- Mitigate traction as necessary to ensure steering response
- Improve brake performance by cross-axle coupling
- Improve vehicle safety through reduced reliance on operator skill

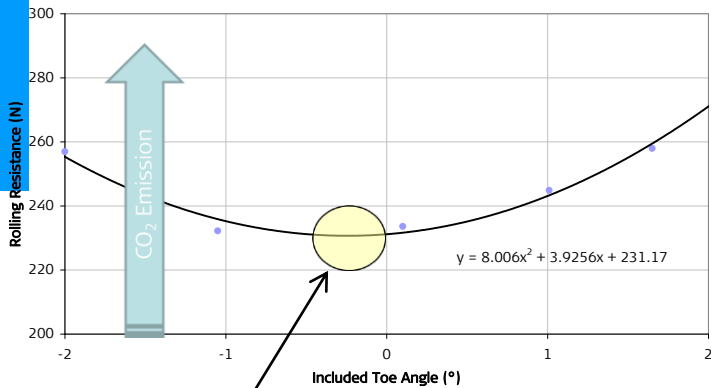
» What Prodrive did

- Sensitive conversion of existing vehicle to achieve a technology demonstrator
- Use and control of existing locking differentials
- Developed vehicle demonstrations
- Development of control strategy and electrical design
- Calibration and demonstration

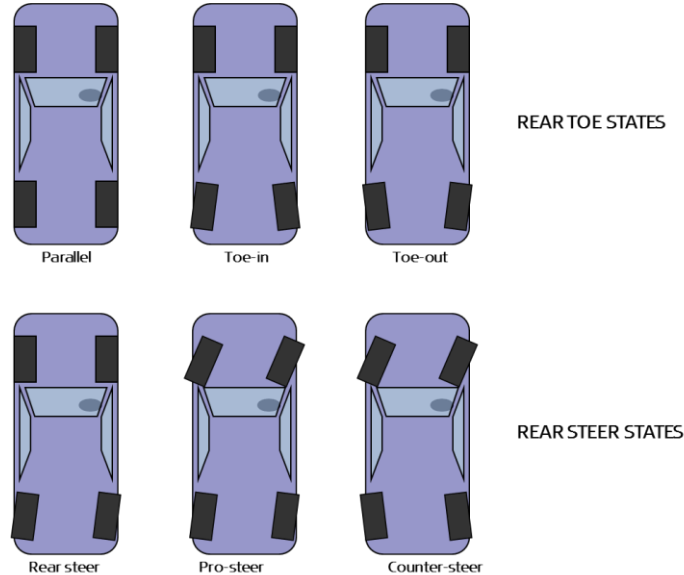
Toe Angle vs. Speed Map



Corrected Friction Force



Indicates toe angle that achieves best CO<sub>2</sub> performance

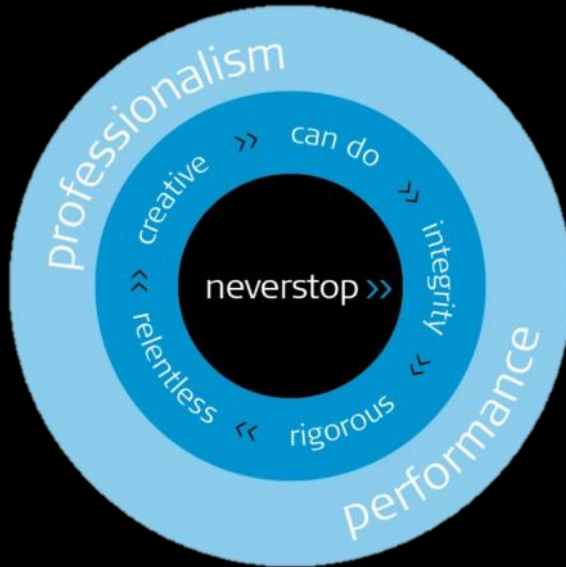


## VEHICLE PERFORMANCE

- » Problem - Enhance functionality of simple rear suspension, small on-cost & reduce CO<sub>2</sub>
- » Scope of project
  - Identify concept requirements
  - Develop and manufacture a system demonstrator
  - Demonstrate functionality
- » What Prodrive did
  - Developed a prototype and fitted to existing car
  - Specified actuation and measurement system
  - Developed the control logic and system
  - Calibration and demonstration
  - Technical reporting



## PRODRIVE DNA



our culture professionalism  
& performance

our values can do : our attitude  
creative : how we think  
rigorous : our strive for perfection  
relentless : our commitment  
integrity : our pride

our essence neverstop >> dreaming  
innovating  
creating  
performing  
exceeding  
competing  
winning