Delivering Mechatronics for Motorsport and High-Performance Automotive Applications

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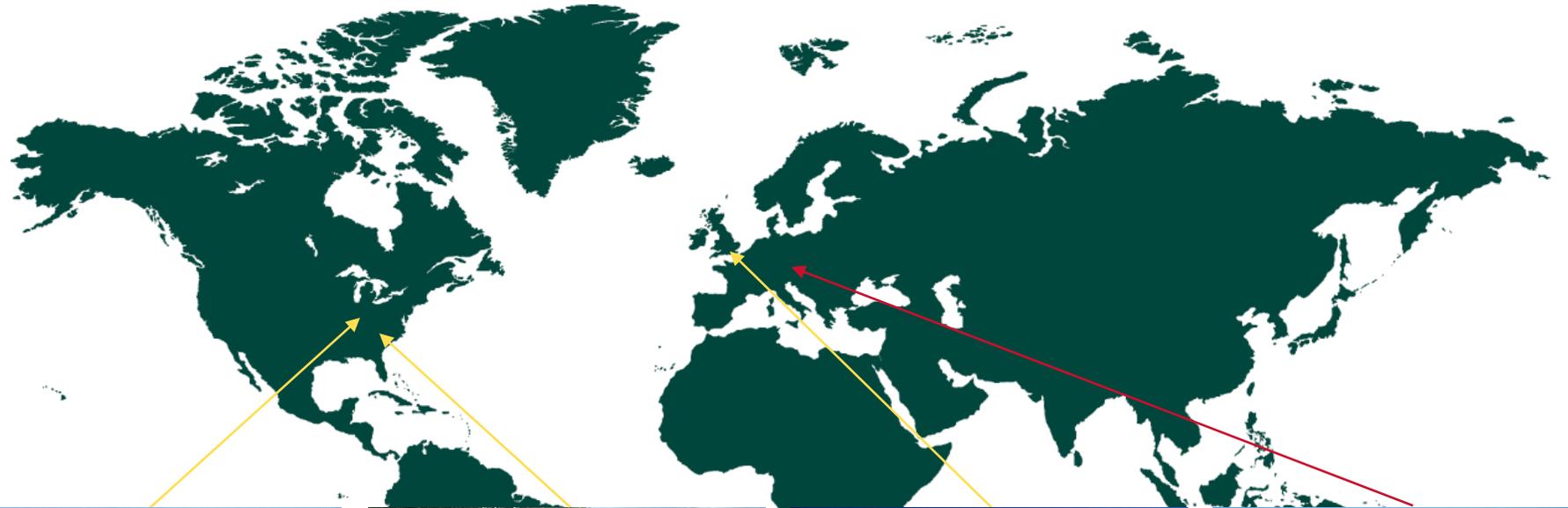2025-09-24

A global company

Design, manufacture and assembly of high-performance transmission systems

Operating in **41** global markets

70% of products are exported all over the world

Over **620** employees

4 facilities

Xtrac Indianapolis

Xtrac Mooresville

Xtrac HQ, UK

Zoerkler, Jois, Austria

BEST OF BRITISH, AMERICAN AND EUROPEAN ENGINEERING & MANUFACTURING

XTRAC
TRANSMISSION TECHNOLOGY

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Xtrac milestones & innovation

Since 1984, Xtrac's capability to consistently innovate in high-performance transmission systems has won the company numerous awards, including three Princess Royal Training Awards and two Queen's Awards for Enterprise.

2006
Supplier of first hybrid gearboxes to Zytek

2006
First diesel-powered car, the Audi R10, to win Le Mans 24 hours

2016
First Xtrac EV transmission to compete in Formula E

2020
Received Queen's Award for ILEV gearboxes

2021
World's first electric rally car with a WRX prototype powertrain finishes 3rd at Rallye Weiz in Škoda RE-X1'

2021
Supplier to new hypercar class winning team at Le Mans 24 hours

2022
Launched High Performance Mechatronics (HPM)

2023
Partnered with MiddleGround Capital to build on success

2024
Achieved two-star FIA environmental accreditation

Milestone · ICE · Hybrid · EV

2006
Supplier of first EV gearboxes to Tesla for roadster prototypes

2009
Volkswagen team with 1st diesel-powered car to win the Dakar rally

2018
Supplier of first ever all electric Aston Martin

2020
Sole supplier for hybrid 'LMDh' class of endurance racing

2021
Hybrid BTCC races in all sessions at Silverstone

2022
Delivery of GMA T.50 transmission weighing just 80kg

2022
Opening of the Xtrac Academy – 31 years since the 1st apprentice

2024
Introduced electric servo actuator (ESA) for sequential shift motorsport transmissions

2025
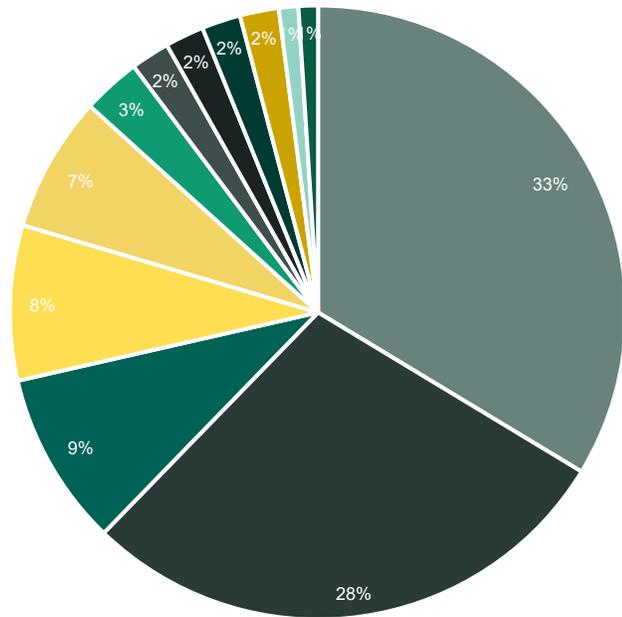Acquired Zoerkler - provider of high-quality gears and gearing solutions.

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Sectors and employees

Sales by Sector

- 33% Sports Car
- 28% HPA & Trackday
- 9%
- 8%
- 7%
- 3%
- 2% 2% 2% 2% 1% 1%

Legend:
- Sports Car
- HPA & Trackday
- Single Seater
- Stock Car
- Rally
- Industrial
- Aerospace
- E Motorsport
- F1
- Touring Car
- Motorbike
- Off Road

ICE-Hybrid-EV Sector Split

- 68% ICE
- 29% Hybrid
- 3% EV
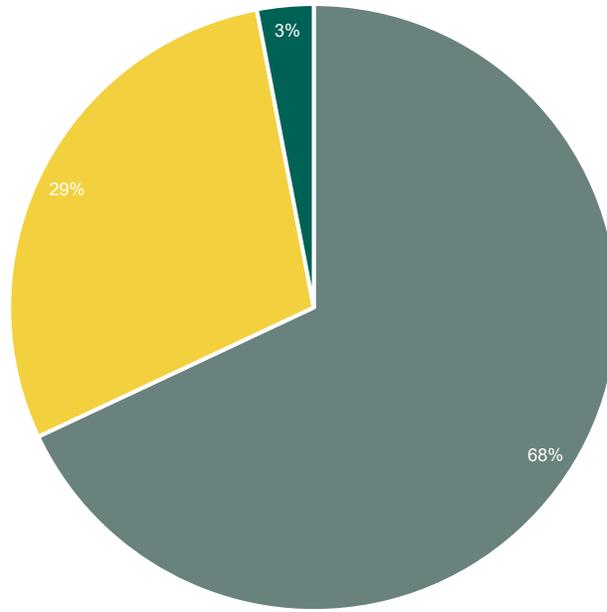
Legend:
- ICE
- Hybrid
- EV

~622 employees

- 57% Factory
- 16% Engineering
- 14% Support
- 8% Apprentices & Under Graduates
- 6% Xtrac Inc
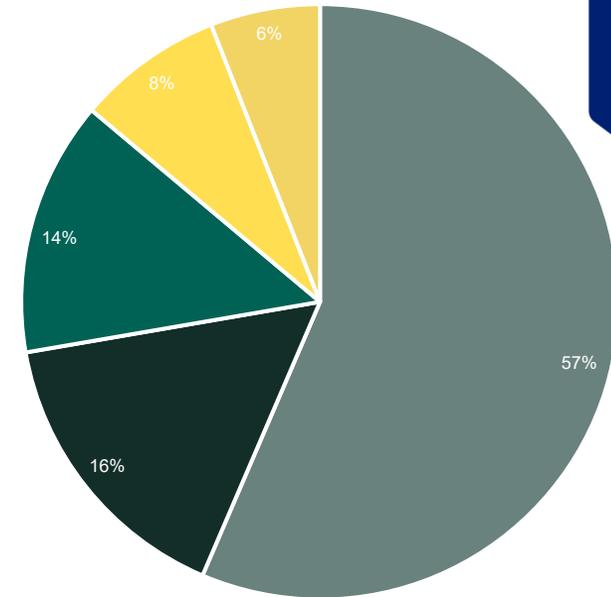
Legend:
- Factory
- Engineering
- Support
- Apprentices & Under Graduates
- Xtrac Inc

MOST LOVED WORKPLACE® Certified 2024

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Proud sole supplier to…

Since
2000 – BTCC
Expiry Year (end of)
2027
Project code
P1546

Since
2000 – IndyCar
Expiry Year (end of)
2032
Project code
P1389

Since
2009 – StockCar Brazil
Expiry Year (end of)
2035
Project code
P386/P1529

Since
2009 – Super TC2000
Expiry Year (end of)
- -
Project code
P426

Since
2015 – LMP3
Expiry Year (end of)
2029
Project code
P1152/P1415

Since
2019 – Supercars
Expiry Year (end of)
2026
Project code
P1293

Since
2021 – LMDh
Expiry Year (end of)
2032
Project code
P1359

Since
2021 – NASCAR
Expiry Year (end of)
2026
Project code
P1334

Since
2022 – RX1e
Expiry Year (end of)
N/A
Project code
P1316

Since
2023 – Formula e
Expiry Year (end of)
- -
Project code
P1382

Since
2025 – INDY NXT
Expiry Year (end of)
2035
Project code
P1414
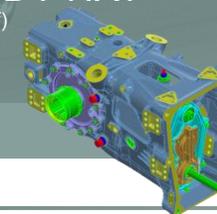
Since
2025 – LMP2
Expiry Year (end of)
2034
Project code
P1459

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Recent High Performance Automotive Project Examples

ICE

GMA T.50/T.50s/T.33
P1321, P1366 & P1402

PAGANI C9 / C10
P1370

HYBRID

AMG PROJECT ONE
P1306

CZINGER 21C
P1320 & P1385

EV

LOTUS EVIJA
P1320

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Xtrac Track Day Gearboxes

Xtrac: Tier 1 Transmission Systems

- Xtrac has a long history of supplying the mechanical gearbox hardware to high performance automotive customers, with OEMs or third parties taking responsibility to integrate and set up the gearbox, actuators and transmission control units for their vehicle.

- An increasing number of OEMs want to reduce programme risk and increase product performance by using Tier 1 transmission suppliers to do the integration work for complex transmission systems.

- Xtrac have a range of bespoke controllers and electrified actuator products, taking advantage of increased capability of vehicle electrical supplies to avoid the need for separate pneumatic or hydraulic power sources.

- Xtrac offer the system integration, software development and calibration services alongside the transmission and mechatronics hardware to provide complete transmission systems ready for vehicle integration.

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Xtrac High Performance Mechatronics (HPM)

With HPM, Xtrac supply the complete transmission system, developed in-house for automotive and motorsport applications

- Gearbox, actuators and controller hardware.

- Comprehensive software development, integration, calibration and validation services.
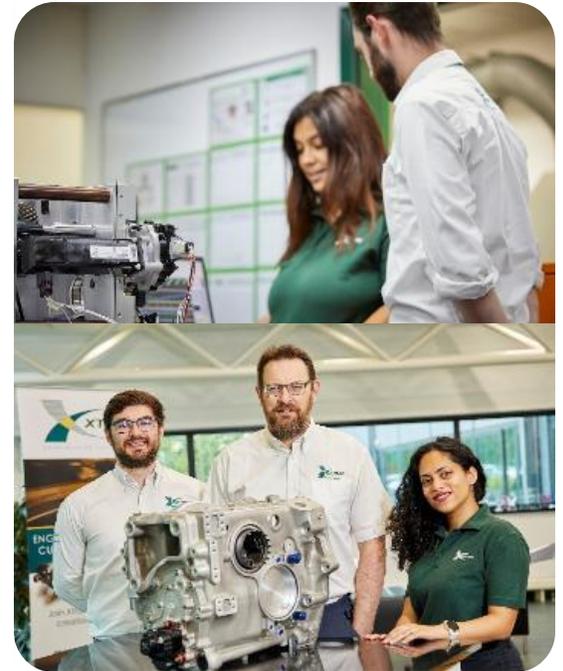
INNOVATIVE TECHNOLOGY

- Fast-acting electro-mechanical actuation (12V and 48V).

- Solutions for synchroniser, dog and Xtrac's patented IGS gear engagement.

- Road, track-day and motorsport applications.

AUTOMOTIVE STANDARDS

- Functional safety analysis and documentation.

- UDS and OBD.

- Extensive test and validation programme.

- IMDS and PPAP compliance.

MOTORSPORT PERFORMANCE

- Smart actuators for ease of powertrain integration.

- Engineering and event support.

- Proven in the most demanding competition.

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Motorsport Applications

Motorsport Gearchange Mechanism

Components:

- Fork
- Dog Ring
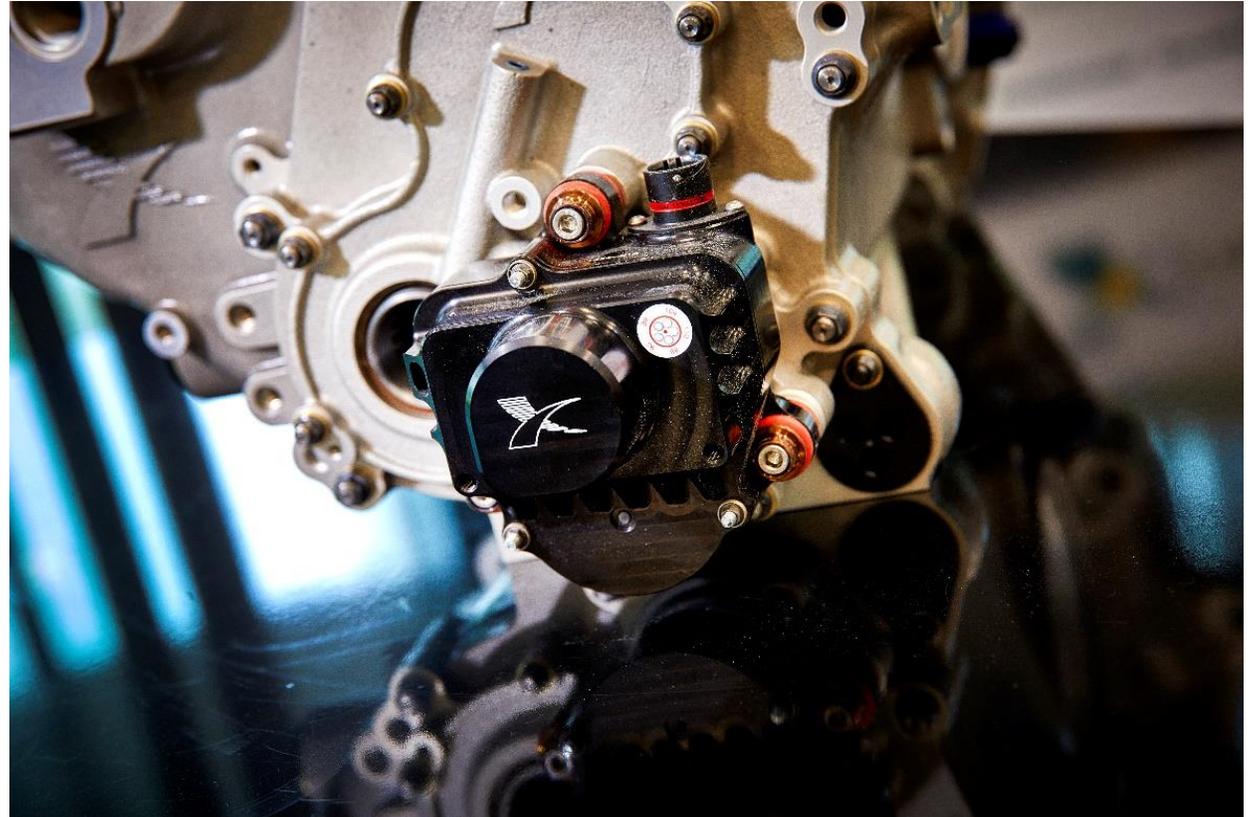- Gear
- Hub
- Shaft

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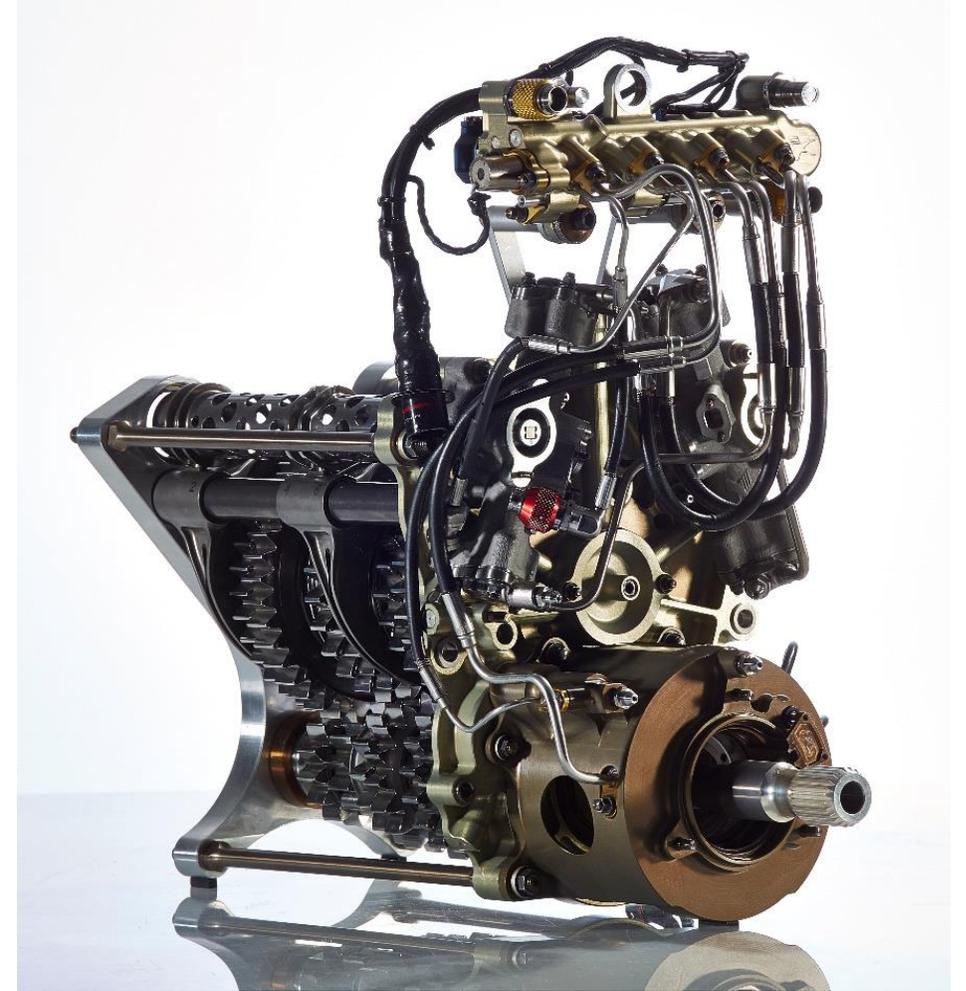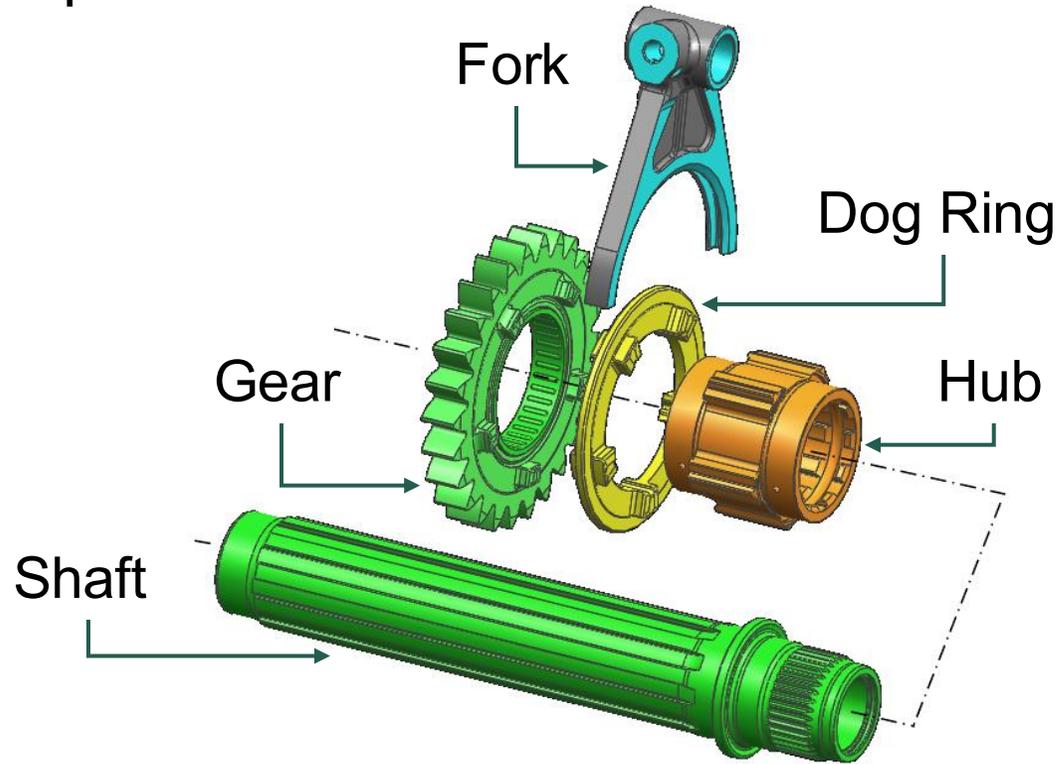
Motorsport Gearchange Actuation

Requirements:

- Speed

- Weight

- Dependability

- Durability

- Power consumption

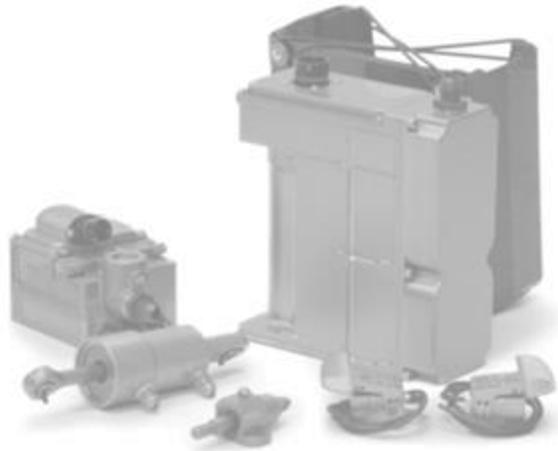**BEST OF BRITISH, AMERICAN AND EUROPEAN ENGINEERING & MANUFACTURING**

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Motorsport Gearchange Technology

2000s

Assisted Gearchange System

- Pneumatic components to automate a sequential gearbox

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Motorsport Gearchange Technology

2000s

2014

2016

P1154 & P1254 Integrated Valve Actuators

- Removes need for separate valve block and ratchet to reduce system weight
- Success in multiple endurance and touring car racing series

Motorsport Gearchange Technology
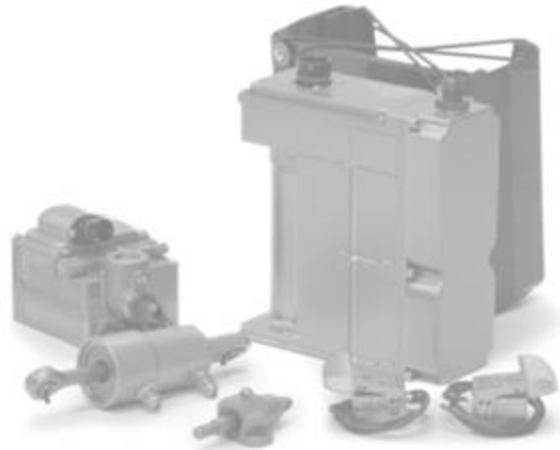
2000s   **2014**   **2016**   **2023**

P1399 Electric Servo Actuator

- Single source supply for NTT Indycar Series
- Electrically powered – no compressor needed

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P1399 Electric Servo Actuator

System approach to transmission and mechatronics
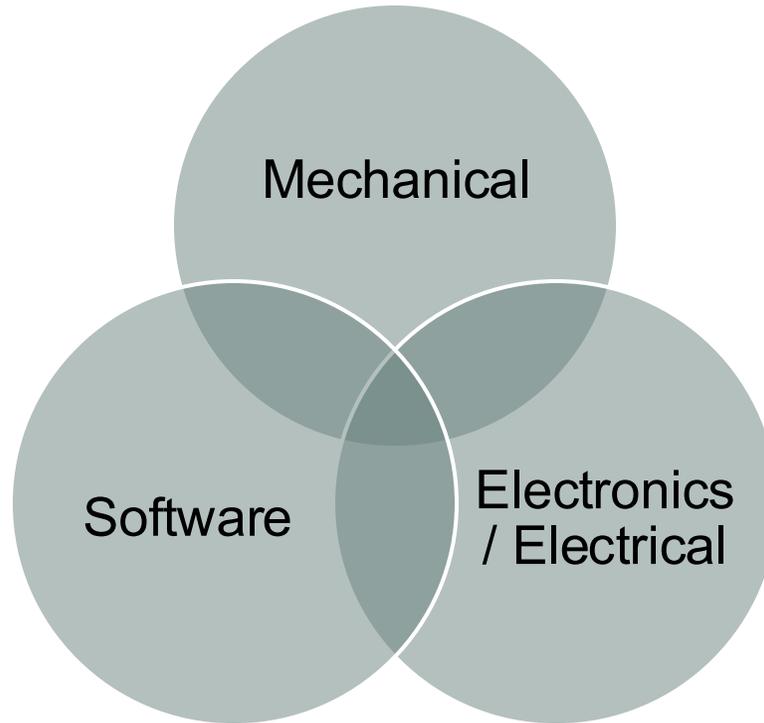
P1399 Advantages

Low system mass (indicative installation)

- P1399: 1.4kg (actuator + harness)
- Pneumatic: 2.9kg (compressor + actuator + lines)

Optimised mechanism

- Overthrow prevention and in-gear hold built into actuator
- Reduced gearchange current requirements

Extended service intervals

- Reduced wear of mechanical components extends time between major rebuilds

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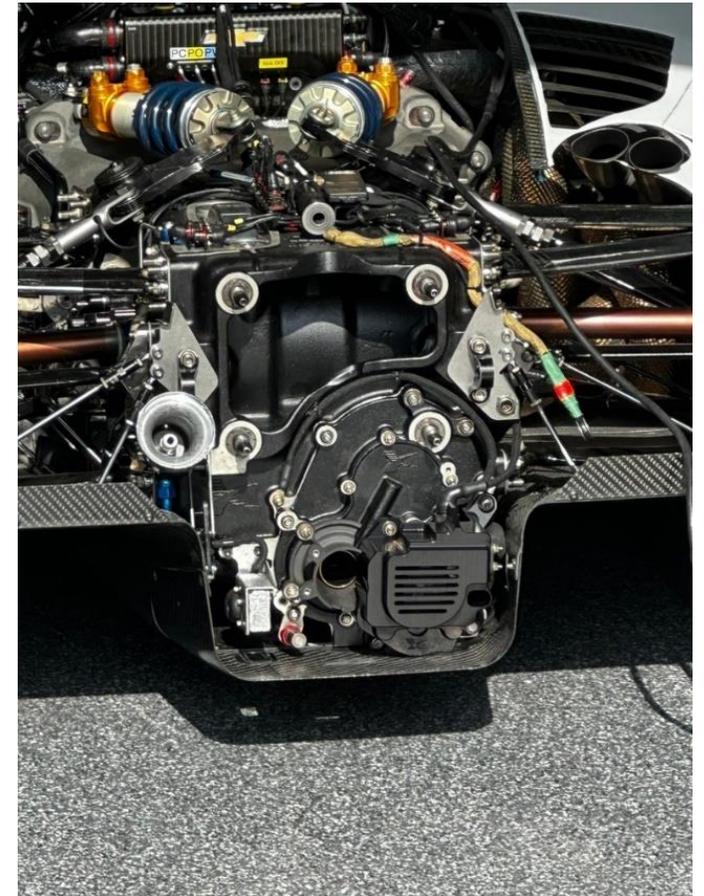
Motorsport Software Development – Task Management

Business Manger, Principal/Senior Engineers and Project manager agree upon task

JIRA for Project Tracking: Single project for all actuator. Sprints/Epics divided by project. Add all tasks.

Sprint Planning
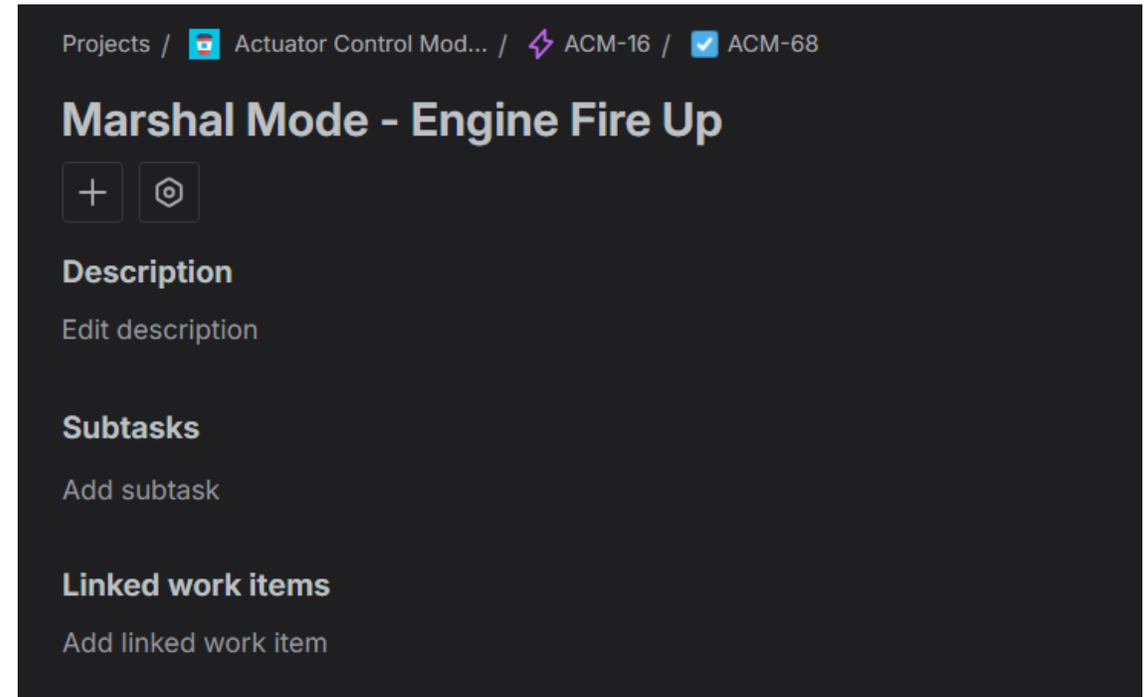
Motorsport Software Development – Simulation
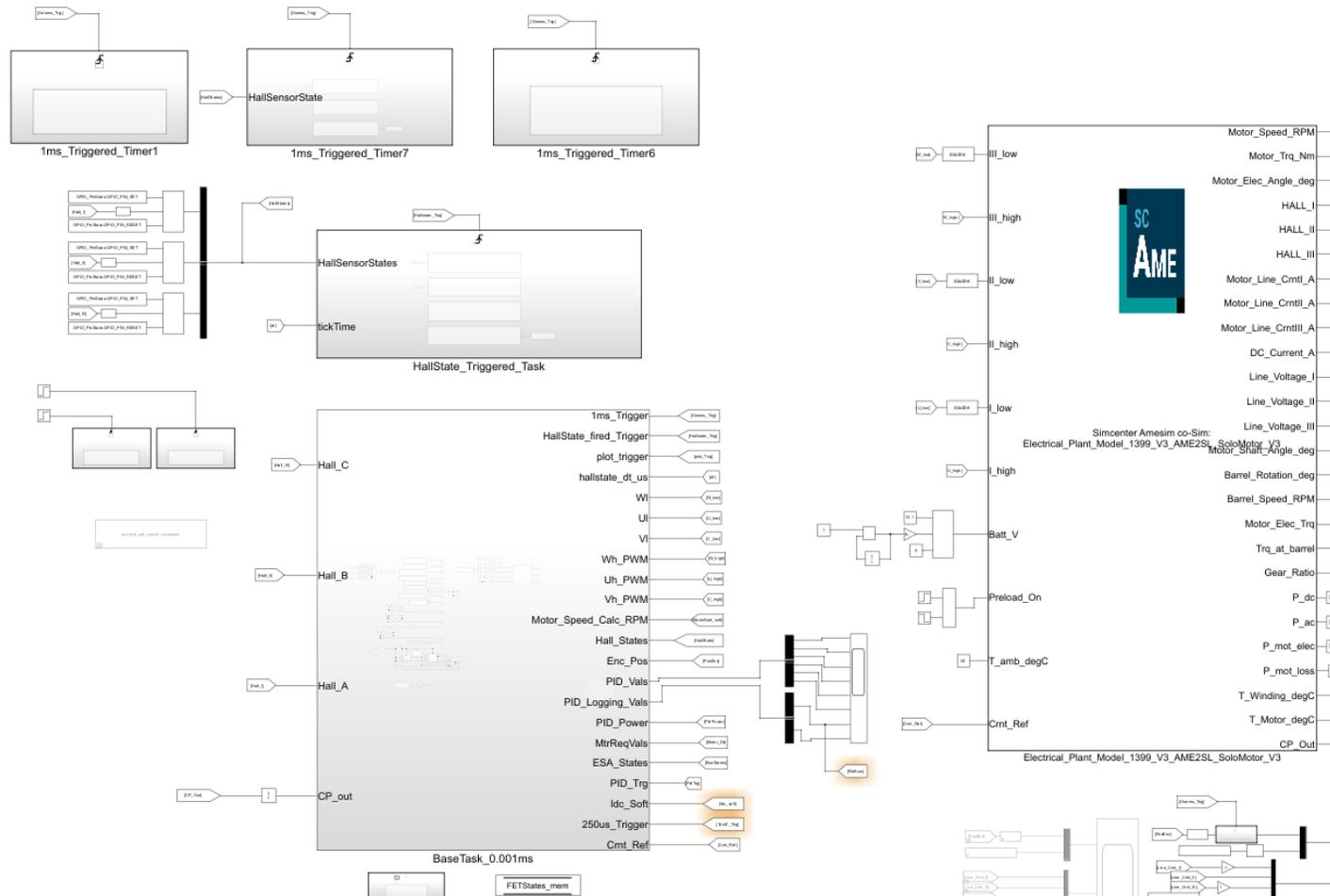
Software-In-Loop (SIL) Model Integration. Left) control logic, Right) Plant model from Amesim

Ref: XT-16754-02A - ESA Plant Model and Validation

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Motorsport Software Development – Implementation

- JIRA tied to source code version control (Enterprise GitHub)
- Feature branch from develop for selected task

Motorsport Software Development – Implementation

Development ACM-68

→ Give feedback ✕

Branches | **Commits** | Pull requests | Builds | Deployments | Feature flags | Other links

∨ ▦ Xtrac-Controls/1399A-ESA (GitHub)   Show all files

Author	Commit	Message	Date	Files
RP	178e24	ACM-68 MISRA-C 2025 Use labs instead of …	20 days ago	1 file
RP	085fe7	ACM-68 Allow for higher limits during distur…	21 days ago	1 file
RP	6d979d	ACM-68 If less than 10 mV from target, set …	21 days ago	1 file
RP	8bfe11	ACM-68 Don't allow for PID correction withi…	21 days ago	1 file
RP	03cc89	ACM-68 Abs for activating disturbance rejec…	28 days ago	1 file
RP	b06888	ACM-68 MISRA-C 2025 updates.	30 days ago	2 files
RP	4fb61a	ACM-68 Refactor the PID sum limits.	about 1 month ago	1 file
RP	ec66ac	ACM-68 Ignore all limits during disturbance …	about 1 month ago	1 file

Development ACM-68

→ Give feedback ✕

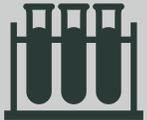Branches | Commits | Pull requests | Builds | Deployments | Feature flags | Other links

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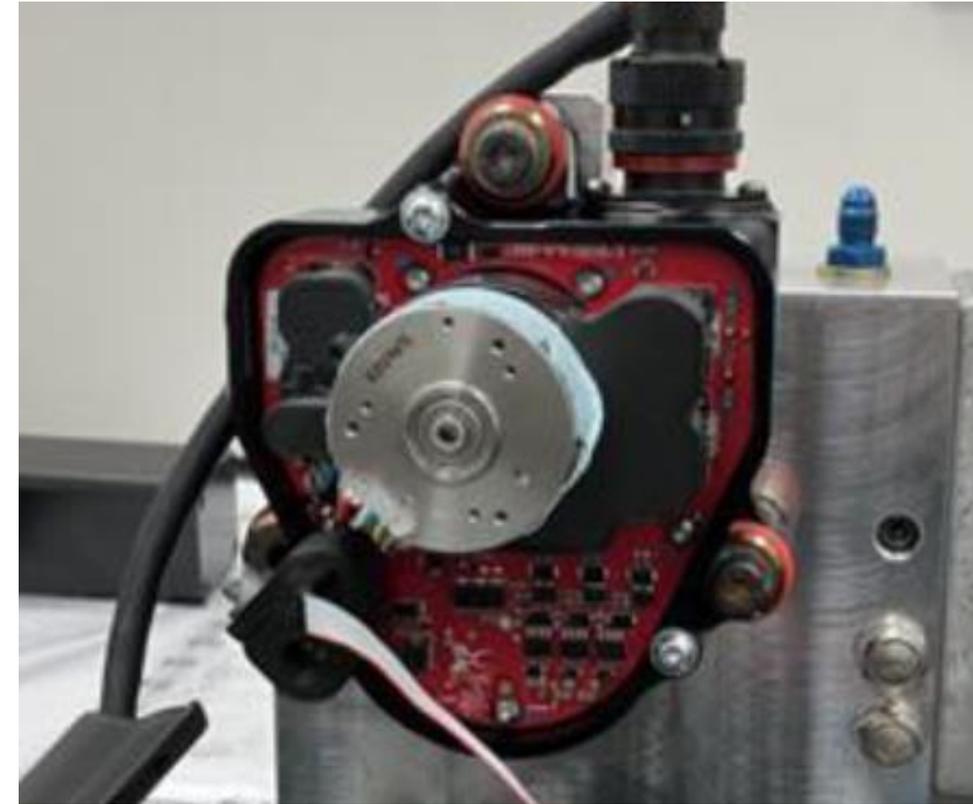| Branch	Pull request	Action
⑂ feature/ACM-68-Marshal-Mode-Engine-Fire-Up		Create pull request

Motorsport Software Development – Feature Testing

✓ Test plan specific to feature being implemented

Tested on physical system (Benchtop Testing)

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Motorsport Software Development – Feature Testing

- Feature to Develop pull request

Motorsport Software Development – Release Candidate Generation

Create branch releases/vM.mm.pp.00 branch from develop.

Run release build to generate build artefact. Commit and tag as release.

MISRA C 2025 with C/C++Test By Parasoft. Commit.

Push branch and tags to remote.
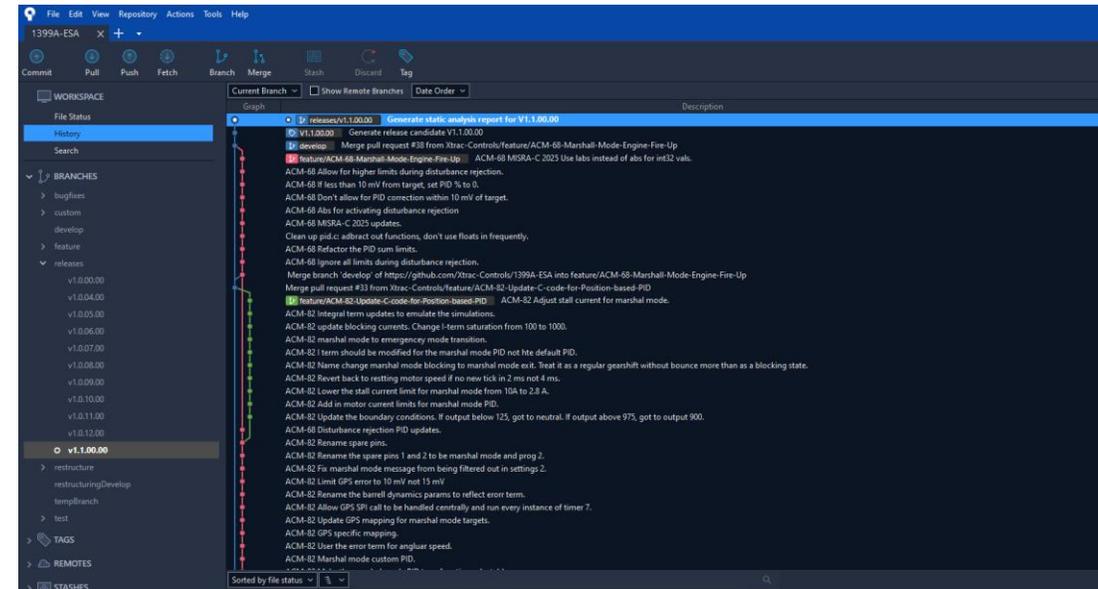
Motorsport Software Development – Flywheel Rig
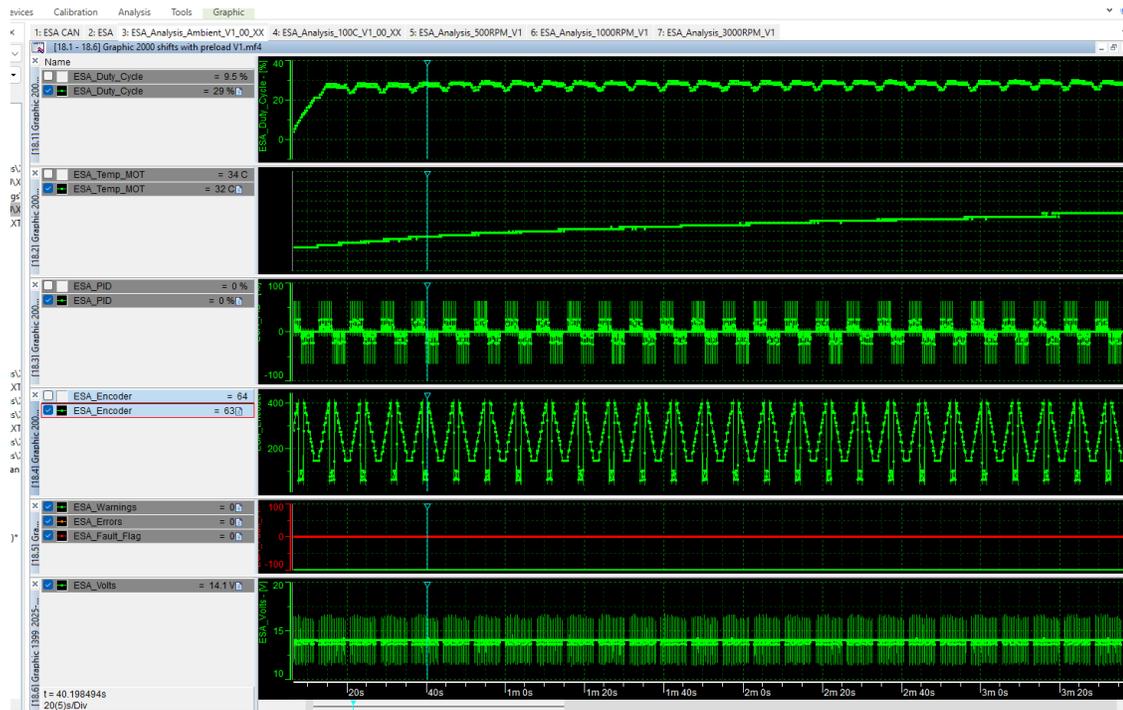
Flywheel representing barrel inertia

Pneumatic actuator driving a pin to emulate engine preload

Up/Down shift analogue shifts

2000 shifts ambient

2000 shifts 100 C

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Motorsport Software Development – Spin Rig

Representative Cluster

Repeated Up/Down shift sequences at

500 RPM
1000 PRM
3000 RPM
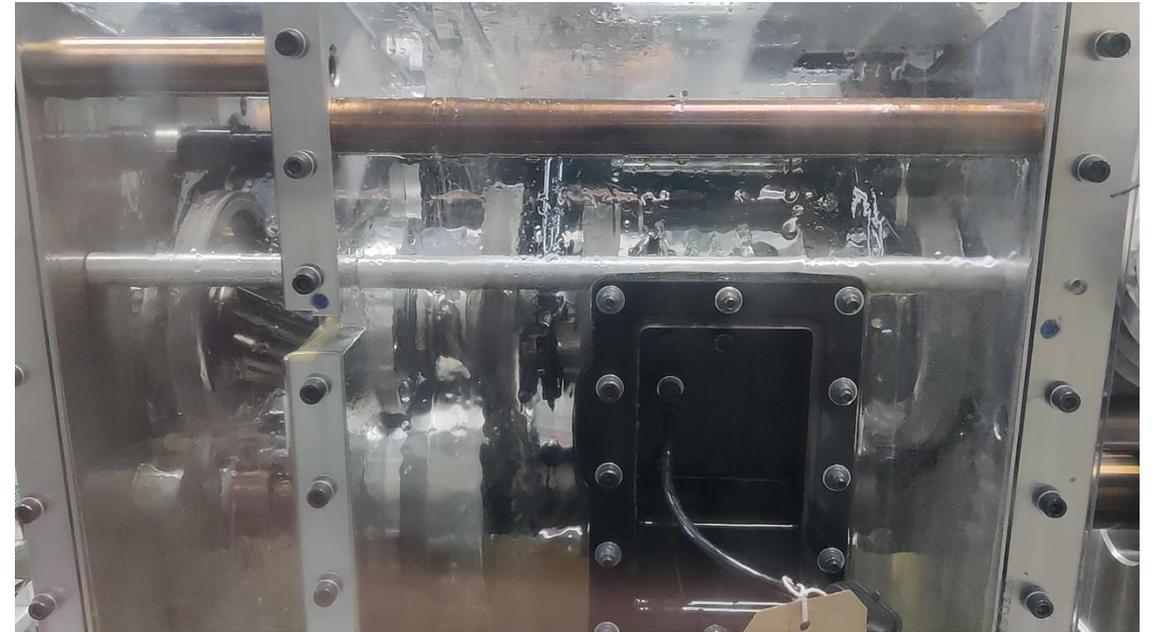
Motorsport Software Development – Additional Testing

- Tested for thermal, shock and vibration and endurance
- Single Vehicle Test
- Multi Vehicle Test
- Full Grid Rollout

https://paddockeye.ie/indy-500-open-test-set-for-april-23-24/

Motorsport Software Development – 1399 On Track

- Successfully completed two seasons in Indycar

- Racing in GT3 and off-road championships

- Innovative engineering recognised by Louis Schwitzer Award from SAE

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1399 – Future Development

- Barrell stall detection

- Marshal mode: neutral between gears

- CD/CI pipeline: New Eagle collaboration

- Processor and hardware updates

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HPA Applications

High Performance Automotive Requirements

Further requirements for:

- Safety

- Comfort / driveability

- Automotive quality systems

- Additional sensors, with redundancy
- Use of synchronisers rather than dog engagement
- Extended verification and validation

High Performance Automotive Capabilities

- In-house control software engineering and calibration
- Systems engineering
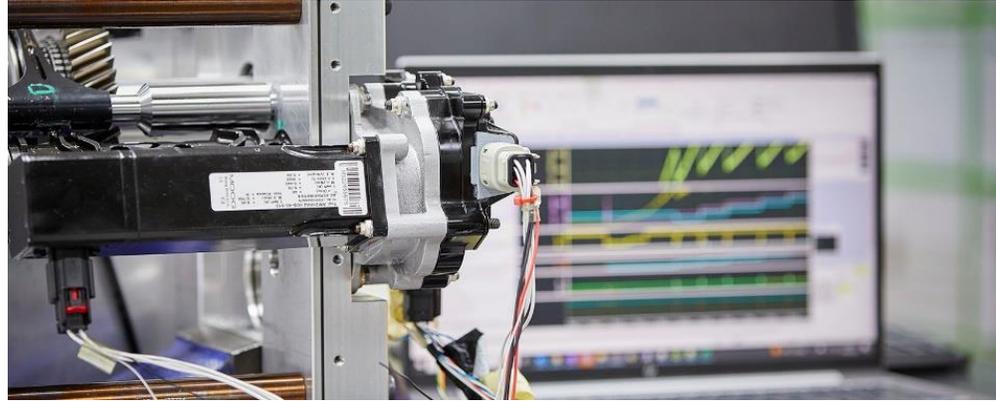
- Model and simulation based development
- Advanced transmission rig testing capability

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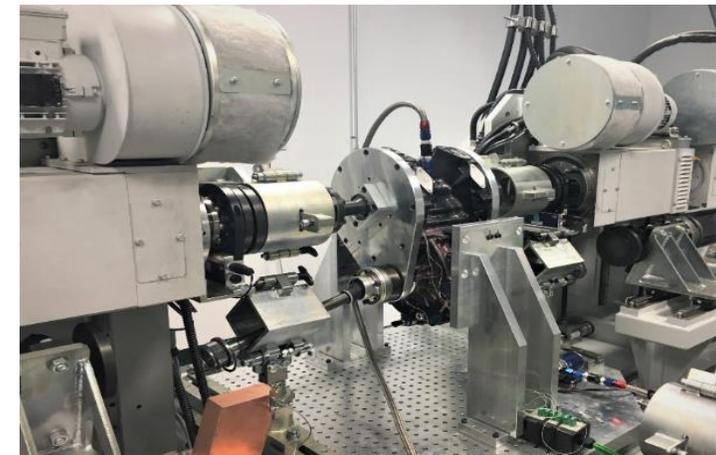
Hypercar Transmission

Cutting edge specifications:

- 7-speed semi-sequential gearbox
- Single clutch, synchromesh
- Twin barrel
- 48V electrically powered actuators
- Sub-100ms shifts
- Extensive use of 3D printed structures

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HPM Solutions: Road Car Programme Case Study

Xtrac synchronised AMT for road-going low-volume hybrid hypercar, with complete set of Xtrac HPM transmission mechatronics hardware

Differential actuator

Clutch specification, testing and characterisation

Clutch actuator

Wiring harness

Transmission control unit

Gearchange actuator

Software

Base software, L1 functionality, L2 safety and application calibration
UDS and OBD2 (J1979) software for US and Worldwide

Model-based software development

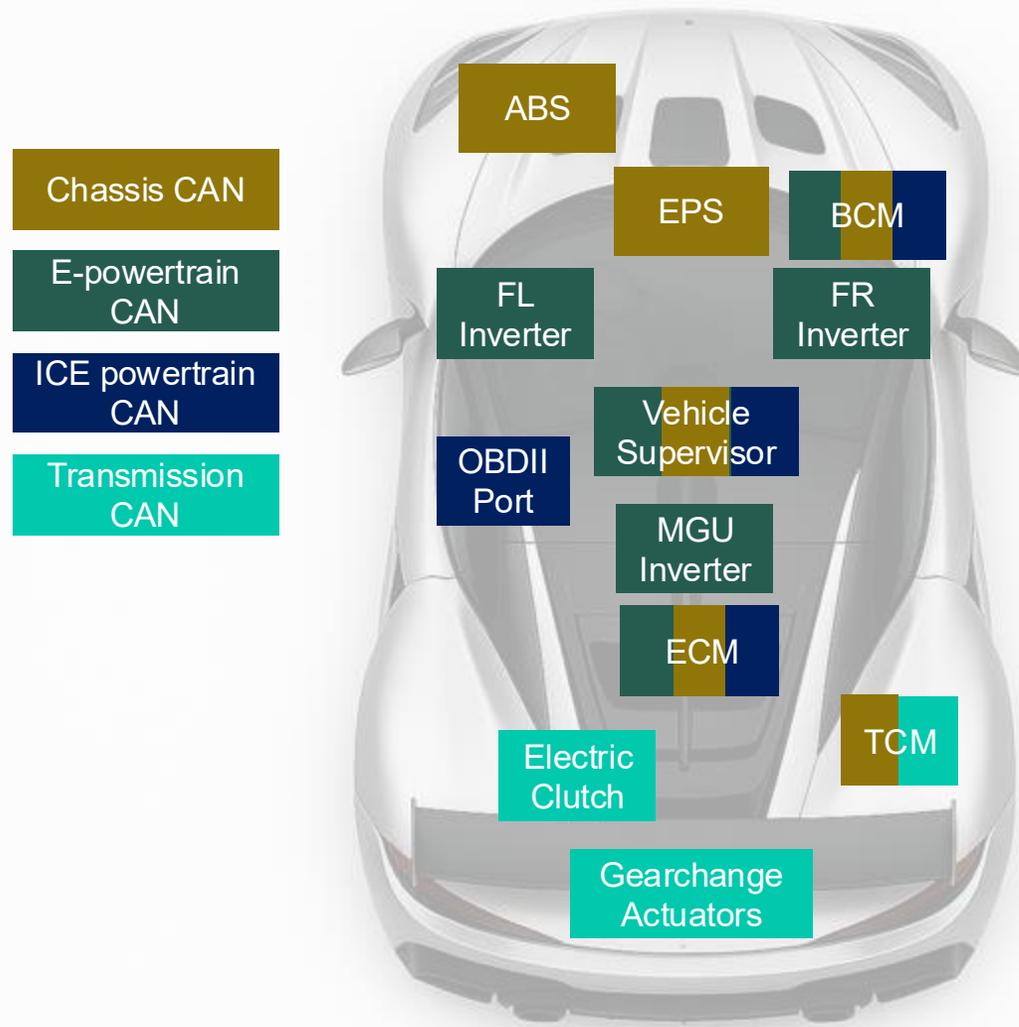V-model approach with traceability from requirements through software implementation to sign-off test

eTAS

VECTOR

Xtrac engineering services for calibration, verification and validation, and vehicle engineering support
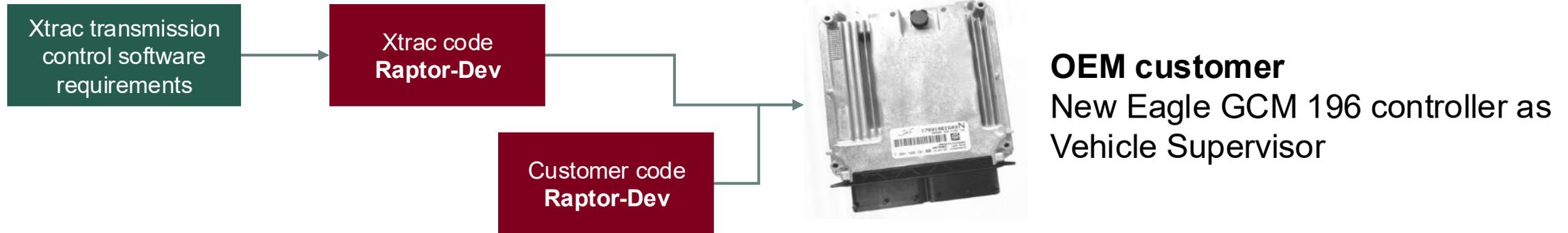
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HPM Solutions: Road Car Programme Case Study

Chassis CAN

E-powertrain CAN

ICE powertrain CAN

Transmission CAN

ABS

EPS

BCM

FL Inverter

FR Inverter

Vehicle Supervisor

OBDII Port

MGU Inverter

ECM

TCM

Electric Clutch

Gearchange Actuators

- ▪ Transmission control software coordinates torque demand during gear change

- ▪ Hybrid powertrain controlled by Vehicle Supervisor
  - Front e-machines
  - Motor-generator unit on engine crank
  - Internal combustion engine

- ▪ Optimum solution is to move transmission control torque profiling module from TCM to Vehicle Supervisor to reduce latency

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HPM Solutions: Road Car Programme Case Study

Xtrac transmission control software requirements → Xtrac code **Raptor-Dev**

Customer code **Raptor-Dev**

OEM customer
New Eagle GCM 196 controller as Vehicle Supervisor

Implementation

- Looked at linking Xtrac transmission control software to build with the Raptor code via a Simulink S-function – challenges to integrate the parameters in the build process
- Chosen solution was to port certain modules from the Xtrac code directly into the VSM's Raptor Simulink codebase

Benefits of this approach

- OEM customer gains flexibility to adjust shift feel (torque off / on ramps and shift times) within limits:
  - Part of the brand identity
  - Faster iteration during development
- VSM takes full responsibility for direction of travel and shift paddle handling
  - Simplifies functional safety goals

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Race to Road… and Back

- Application of quality standards

- Using software to deliver improvements and features

- Use of simulation to understand and optimise the complete system

- Verifying and characterising system performance on test rigs before going to vehicles

Questions?

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