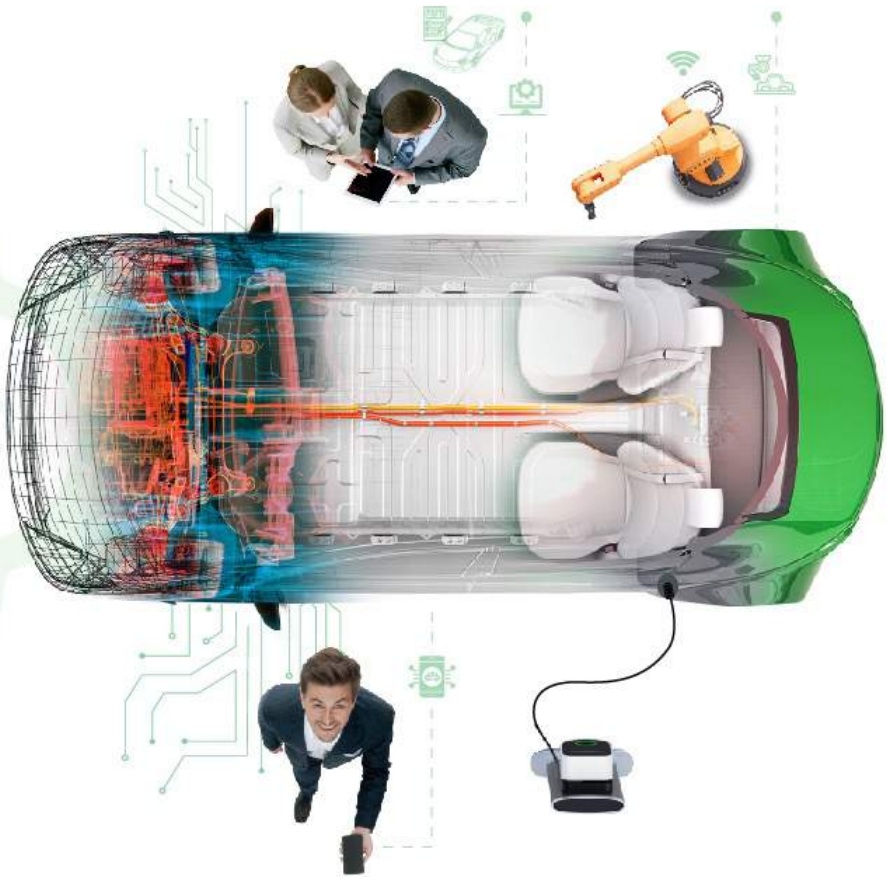
TREaD

Turnkey Research Engineering and Development of Electric Vehicles



CONTENTS

Auto OEMs increasingly seek outsourced engineering services

Advent of newer technologies, digitalization, sustainability concerns, and changing consumer preferences are leading to a rise in demand for outsourced engineering services.

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BIG NEWS NETWORK.com

Automotive engineering service providers market sees huge growth for new normal

Automotive World est. 1992

Polestar announces collaboration initiative with global suppliers to speed up development of climate-neutral car; calls for research

Newswires

Automotive engineering services market expected to reach USD 271.86 billion by 2028

Deloitte.

Outsourcing strategies are reshaping the industry and affecting both providers and clients

MarketingWeek

Record sales for electric vehicles but knowledge gaps remain

THE HINDU

EV players seek high-end engineering services

Turnkey engineering solution providers accelerate business results

More and more organizations are collaborating with capable turnkey solution providers to help meet the stringent launch time and optimize product development costs.

Challenges faced by automotive OEMs

- Limited resources with expertise in latest technologies
- Limited resources to run multiple programs simultaneously
- Existing battery electric vehicles necessitate complex integration
- High cost of innovation, especially Electric Vehicle (EV) technologies

ESP turnkey vehicle program solutions

- Experience on global projects to gain vital best practice knowledge
- Shorter and optimized timeline enabled by New Product Introduction (NPI) cycles
- Seamless and robust integration of hardware and software developed by global experts
- Variety of engagements models, LCC solution & IPs to optimize product development costs

Presenting TREaD

Tata Technologies' Turnkey Research, Engineering, and Development (TREaD) program covers the complete spectrum of solutions around full vehicle program with improved time-to-market.

Turnkey Vehicle Development Capabilities: From Concept to Launch

Over the years, we have successfully developed all types of vehicles, right from high volume to luxury & xEV to performance cars. Our deep engineering expertise in turnkey vehicle development programs makes us the preferred one-stop engineering service provider for our clients.

Market Definition & Product Strategy

Vehicle Engineering & Architecture & Concept Design

Detail Design & Engineering

Testing & Validation (Simulation & Test-car)

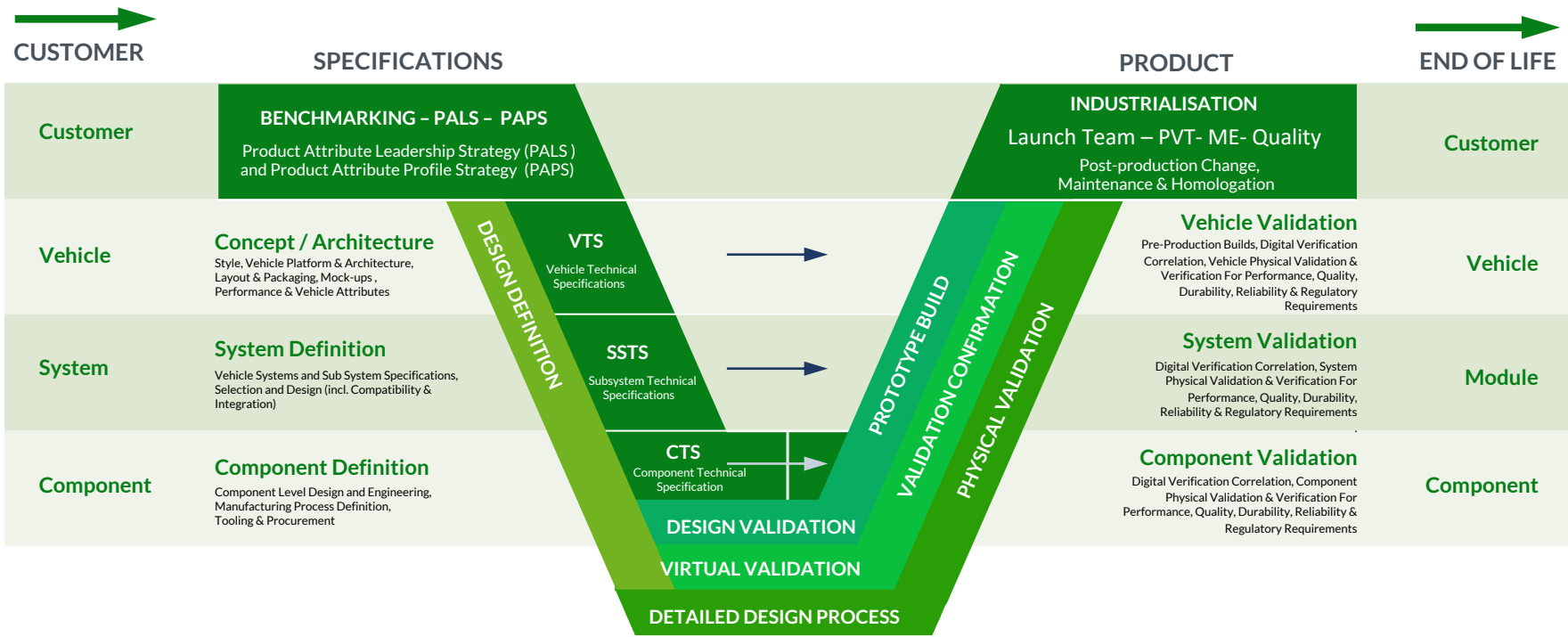
Process & Resource Planning and Industrialization

Homologation & Vehicle launch

Digital thread enablement across processes & enterprise applications

Tata Technologies' turnkey capabilities cover the entire vehicle development lifecycle

Our global expertise in turnkey vehicle development capabilities enables automakers to keep up pace with increasing digitization, automation, and EV revolution to ensure cost-effective and in-time launch.



Product Strategy	Architecture & Concept	Detail Design & Engineering	Test and Validation	Industrialisation	Launch
Product Planning, Requirements Management, System Concepts	Styling, Packaging, Mock-ups Concept Final Development Start	Product Release & Process Design Prod. & Process Verified	Process & Product Validation Prod. Certified	Start of Production, Mass Prod. Delivery & Support End of Production	Post-production Change & Maintenance

Defining the right market segment and vehicle strategy

Market definition & product strategy is the first step for a successful turnkey vehicle development, and our comprehensive R&D and benchmarking services have assisted OEMs globally in achieving it.

MARKET DEFINITION & PRODUCT STRATEGY

- Teardown & Soft Benchmarking
- Product, Cost & Performance Benchmarking
- Competitor Information; Comparative Analysis
- Governance & Legislative Landscape

TREaD — Turnkey Research Engineering and Development of Electric Vehicles

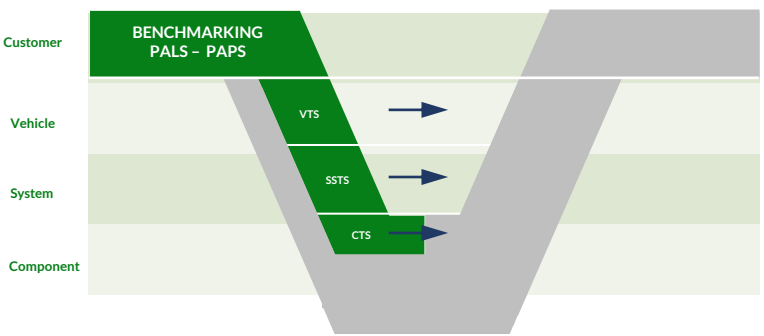
- Manufacturing strategy
- Advanced Product Design
- Functional Design
- VTS

FROM CONCEPT TO DEFINITION

Dedicated ER&D center, **Axia-VAVE Centre of Excellence**, to support multiple full-vehicle programs

Defining of successful product strategy by product planners

CUSTOMER |. SPECIFICATIONS



TEARDOWN BENCHMARKING & PRE-STUDY

Comprehensive teardown, benchmarking, and should costing with focus on reduction in cost for a B segment electrical SUV of a fast-growing Southeast Asian EV startup

Result:

Targeted cost-savings

Engineering tomorrow’s EV ecosystem from digital analysis to full vehicle simulation

Concept engineering on models that are obtained through a model-based design approach forms the core of our vehicle design and architecture processes.

CONCEPT, STYLING & ARCHITECTURE

- Digital Simulation
- Concept Planning & Evaluation
- Reverse Engineering

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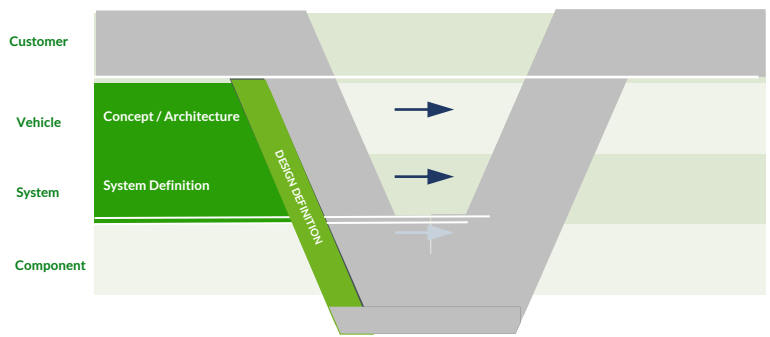
- Simultaneous Engineering
- Vehicle / Machine Attributes) Settings & Specifications
- Product Architecture

FROM CONCEPT TO ARCHITECTURE

Providing a holistic view with model-based design approach right from energy sizing to concept verification

Right performance at the right price, applying the right amount of the right material in the right place with our Proprietary ‘5R’ right-weighting approach



TURNKEY ENGINEERING DEVELOPMENT

Turnkey engineering from conception to launch of a mid-size SUV model for a renowned auto OEM based in the UK.

Result:

25% less body engineering investment

Developed 7-seat layout in 5-seat footprint

Delivering better results with 360º design expertise

Our extensive experience in end-to-end automotive design from refinement to validation, covering every step of vehicle engineering, differentiates and consolidates our reputation as a turnkey service provider

DETAIL DESIGN & ENGINEERING

- CAD Engineering
- Electrical & Embedded Systems
- 3D Surface Modeling
- Product Validation & Verification (CAE & CFD)
- Electrical Architecture
- ePowertrain Development

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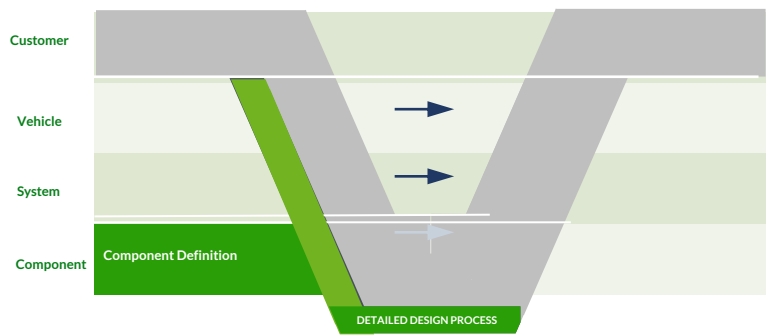
FROM DESIGN TO ENGINEERING

End-to-end design meeting all packaging and engineering targets while allowing on-schedule vehicle development

ePowertrain development: Deep domain expertise in software development and application integration



TURNKEY ENGINEERING DEVELOPMENT

Onsite/offsite program management with offsite design execution, including lightweight BIW & closures design, for a start-up advanced vehicle group

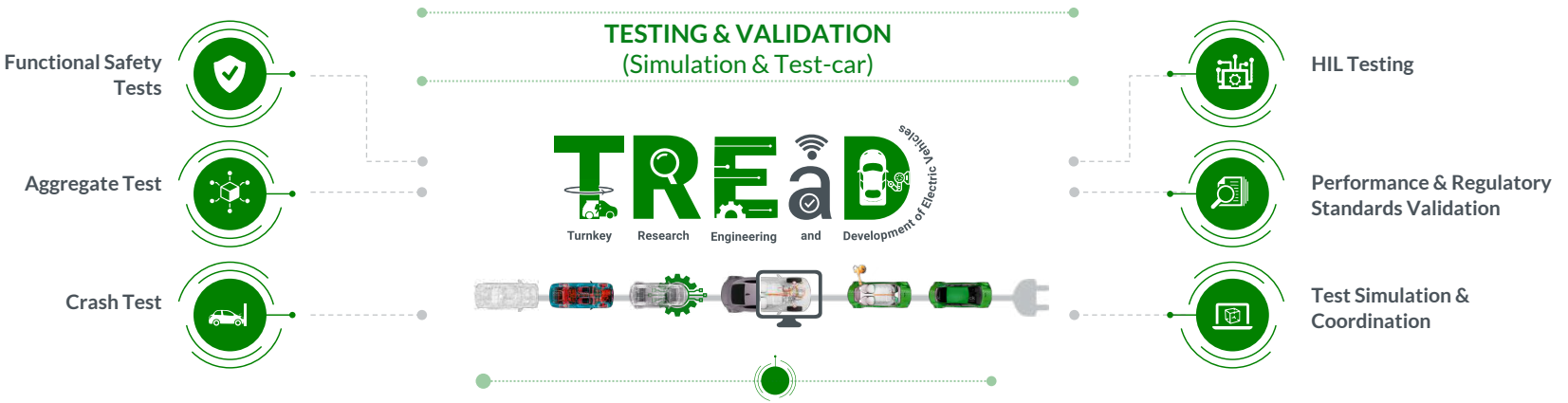
Result:

Completion of a full unibody (monocoque) aluminum structure

Established a body and closures design group

Systematic testing and validation helps reduce costly recalls

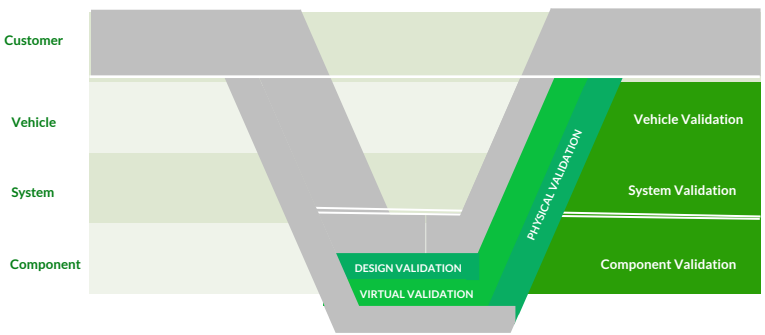
Our accurate vehicle testing and validation processes assure identification of defects during product development stages, thereby enabling best vehicle standards.



FROM TESTING TO VALIDATION

Validating top quality standards with detailed physical testing for all the vehicle's functionality

Comprehensive active & passive safety testing facilities duly backed by testing facilities and a robust partner ecosystem



DEFINED TEST STRATEGY & TEST PLANS

Analysis of the system requirement & creation of the test cases of all the connectivity system features for a leading European auto company

Result:

Quick turnaround time to market

Short time project deliverables

Manufacturing process capabilities from development to implementation

Our end-to-end vehicle manufacturing capabilities are powered by our systematic and effective pre-study, planning, tracking, and implementation methods.

PROCESS & RESOURCE PLANNING AND INDUSTRIALIZATION

- Advance Manufacturing
- SE
- Tool Design
- Part Mfg. Simulation

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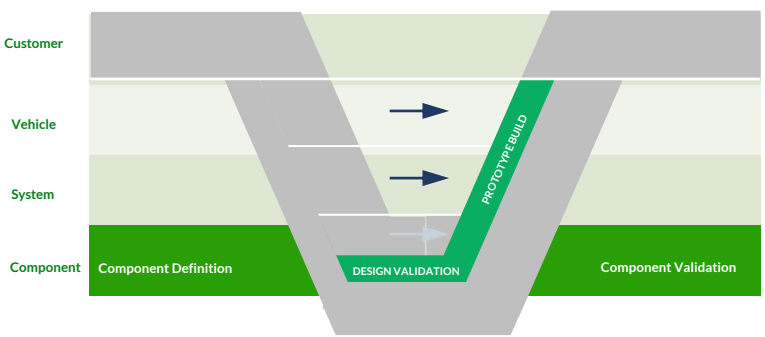
- Assembly Simulation
- Plant Simulation
- DVA
- Digital Manufacturing

FROM MANUFACTURING TO ASSEMBLY

Competence in design and building complete E/E architectures; exclusive 'platform' design capabilities

Proprietary solutions:

- AMP.IoT platform: IoT solution
- Factory Magix: MES
- FacMon: Factory monitoring & lead time improvement



MANUFACTURING EXCELLENCE

Smart factory transformation for a leading UK- based OEM

Result:

NPI reduction by 20% with digital twin

12% improvement in OEE

Ensuring successful in-time vehicle launch

Our experienced engineering and manufacturing team follows proven processes in a high-quality production environment, duly supported by a reliable supplier and distributor network.

VEHICLE LAUNCH & HOMOLOGATION

- Supplier Management
- Product Packaging and Finishing
- Perceived Quality & Optical Quality
- Homologation Schedule

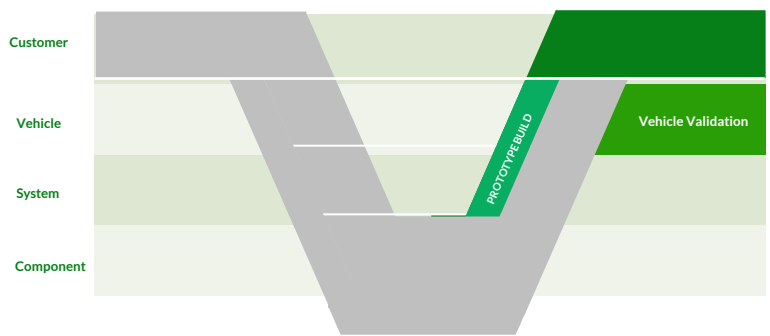
TREaD — Turnkey Research Engineering and Development of Electric Vehicles

- Issues Management
- Type Approvals Documentation & Certification
- Execution & Monitoring of Pre-homologation Test
- Ongoing Manufacturing Optimization

FROM LAUNCH TO MARKET

Enabling cost-effective and in-time launch of e-vehicle into the market

Best-in-market competence in global EV launch programs



IN-TIME VEHICLE BUILD & LAUNCH

End-to-end build & launch of the first hybrid vehicle for a Sweden-based premium car manufacturer

Result:

On-time delivery; surpassed all quality targets

Delivery of top-hat engineering services

Building the right foundation with an organized NPI approach

Our product development efforts are focused on developing systematic, concurrent, and iterative engineering methods involved in getting a new product into the market from an idea to end-of-life.

Tata Technologies' NPI approach:

Our **New Product Introduction (NPI) approach** encompasses all the activities and processes involved in defining, developing, and launching a new or improved product into the market. The **New Product Development (NPD)** proposition is a digital subsection of the NPI and encapsulates the product definition from concept to making it manufacture-ready.

NPI

Product Strategy	Architecture & Concept	Detail Design & Engineering	Test and Validation	Industrialization	Launch
• Product Planning • Requirements Management • System Concepts	• Styling • Packaging • Mock-ups	• Product Release • Process Design • Prod. & Process Verified	• Process & Product Validation • Prod. Certified	• Start of Production • Mass Prod. Delivery & Support • End of Production	• Post-production Change & Maintenance

Benefits realized through our NPI solutions

- Better tracking of progress
- Improved quality
- Faster time to market
- Holistic approach
- Better flexibility
- Better integration
- Reduced issues at gateways
- Control of project phase overlaps

Product Data Management (PDM):

Tata Technologies' PDM expertise acts as a bridge between the Enterprise Resource Planning (ERP) system and the Computer Aided Design (CAD) system. This enables delivery improvements in cost, quality, and time whilst mitigating risks, leading to improved customer satisfaction and retention.

TTL Pulse platform provides robust process and KPI data to facilitate delivery - gate to gate

PULSE

The Tata Technologies engineering framework is powered by Pulse, our agile task management & support platform that reduces the NPI cycle through the application of an effective tracking and implementation method.

Digital thread enablement across processes & enterprise applications

Our enterprise solutions help OEMs address production-specific challenges and accelerate their digital transformation journey, while integrating the digital thread across the entire lifecycle.

Product Engineering & Innovation

- Consulting and Business Process Re-engineering – Digital Twin & Thread
- Implementation & Integration
- Modernization, Upgrade & Migration
- AMS
- Knowledge-based Engg.

Digital Manufacturing

- MES Scan & Consulting
- MES Implementation & Upgrade
- Production Systems Integration
- Mfg. Analytics & Plant Monitoring
- Mfg. Infrastructure Consulting & Support

Digital Enterprise Solutions

- Enterprise Scan & Supply Chain Consulting
- ERP Implementation & Migration
- System Integration
- Application Development & Maintenance
- Integrated Supply Chain Solutions

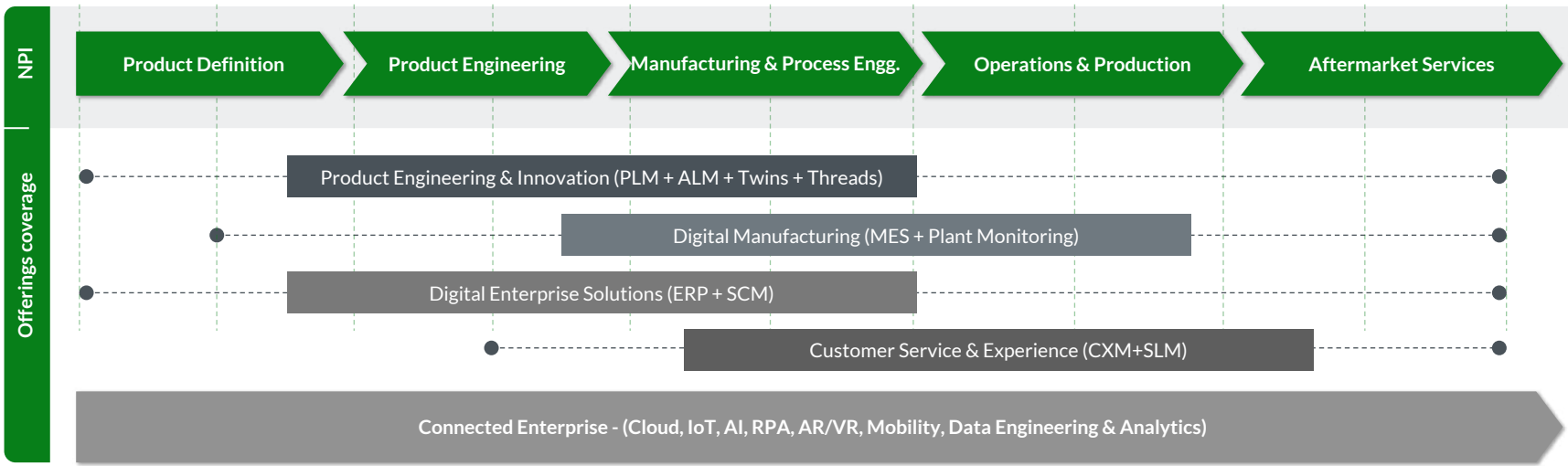
Customer Experience Management

- 360-degree customer management
- Dealer Mgmt. System Implementation & Global Roll-out
- Campaigns & Call-center Mgmt.
- Advanced Analytics
- Mobility

Connected Enterprise

- Cloud Solutions
- Data Engineering & Analytics
- Artificial Intelligence
- Robotic Process Automation
- IoT/Industrial IoT
- AR/VR

TTL POV AND SERVICE OFFERING GROUPS



Strong partner ecosystem for customized requirements

We have forged valuable alliances throughout the product engineering, lifecycle, and digital services value chain, which help OEMs connect business solutions to the exact needs of customers.

PRODUCT BENCHMARKING

Association with various industry-leading testing organizations to carry out R&D, benchmarking, and product-related testing, analysis, and evaluation at our dedicated in-house benchmarking and testing facility, AXIA.

TESTING & VALIDATION LABS

Collaboration with various leading global lab and testing facilities across the EV development value chain, ranging from advanced benchmarking lab, battery testing labs, and other test technology set-up, to pre-launch & product finish lab.

PRODUCT VALUECHAIN PARTNERS

Extensive network of technology & channel partners across the globe that help fulfill the exact go-to-market requirements across the end-to-end manufacturing ecosystem of EVs.

LOGILITY

Solution Partner PLM | SIEMENS | Platinum Smart Expert Channel

VALUE SOLUTIONS PLATINUM PARTNER DASSAULT SYSTEMES

ptc

AUTODESK. Gold Partner

Our turnkey product development capabilities set us apart

We are differentiated by our extensive real-world knowledge and continued reliability to ensure shorter time-to-market and better customer experience through our single-window accelerated automotive solutions.

- **Turnkey vehicle development capabilities help OEMs save time & costs**
- **Global presence & diverse resource pool to deliver turnkey product programs**
- **Established framework & tools based on our expertise to reduce development time**
- **Comprehensive product management capabilities to realize better CX**
- **Extensive experience in delivering successful turnkey vehicle development programs**
- **Globally Distributed Execution Model (GDEM) to ensure a balanced approach**

Turnkey concept to launch in world-class duration

Turnkey support for the first electric vehicle manufactured by a new generation auto OEM in China, ensuring project delivery from concept to a validation vehicle in accelerated time-frame, leveraging our own IP and vehicle modular platforms

Turnkey EV development program execution in shorter time

Turnkey electric-vehicle development from concept to launch for a leading next-gen Southeast Asian automotive manufacturer, helping the company achieve its goal of launching electric vehicles in shorter time.

zinnov™ ZONES 2021 | ER&D SERVICES

Zinnov Zones has positioned Tata Technologies:

- As the **Global Leader** in Zinnov Zones Global ER&D Services Ratings 2021 for 5th year in a row
- **1st amongst all India-based Automotive ER&D ESPs** for the third consecutive year

"Tata Technologies has consolidated its leadership position in the global ER&D space, consistently over the years, backed by its scalable offerings across the product design and the manufacturing value chain."

- Sidhant Rastogi,
Managing Partner and Global Head, Zinnov

Accelerate your e-mobility goals with Tata Technologies TREaD

TREaD enables cost-effective vehicle development program in record time while maintaining the best-in-class quality standards throughout the product lifecycle.

Realizing turnkey product development ambitions across geographies through best-in-class

....engineering, and digital solutions, coupled with our deep mechanical expertise

Accelerated time-to-market

Systematic go-to-market strategy and NPI framework for accelerated product development to successfully enable concept to launch in accelerated time-frame

eVMP™

Electric Vehicle Modular Platform™

OEMs can accelerate their mobility journey with the Tata Technologies' eVMP™, a fully scalable EV platform, with a wide range of features, which is built to power the next generation of electric vehicles worldwide

Improved program cost-efficiency

OEMS can optimize their development costs related to turnkey development, model year, and homologation programs by 2-8%.

Elevated customer experience

Execute multiple vehicle programs simultaneously to engineer and launch new-age mobility solutions across geographies

Turnkey program for a leading Chinese auto OEM

Turnkey support from definition to release for the OEM's first Electric Vehicle (EV), which was manufactured in record time

TURNKEY VEHICLE SUPPORT, INCLUDING:

- Full vehicle Computer-aided Engineering
- Complete Body Architecture (Alu)
- Complete Upper body (Alu)
- Door and Closures (Alu)
- Complete Exterior
- AME, System Engineering, Joinery Data Base Build
- Program Management
- Electrical e-test
- Connected Car Architecture & Test
- Battery Swap Development
- PLM Strategy and Implementation
- Prototype Build and Test Support
- Functional Safety

IMPACT

World-class time-to-market
Executed initial product definition to product release in accelerated time

PROJECT HIGHLIGHT

Patented "quick swap" battery system devised & developed by Tata Technologies

"Tata Technologies, our partner of choice, was able to pool in experts and teams from China, India, UK and Romania to help us deliver our first finished product, an all-aluminum SUV that broke lightweight index benchmarks and was delivered in record time from a blank page to a validation vehicle in world-class duration."

- Vice President,
Vehicle Engineering, Chinese OEM

Turnkey vehicle development program for a next-gen Southeast Asian EV start-up

End-to-end Electric Vehicle (EV) development in record time, powered by our eVMP™ R&D initiative and experienced global talent pool

TURNKEY VEHICLE DESIGN & DEVELOPMENT, INCLUDING:

1 End-to-End Research & Benchmarking

- Teardown & Soft Benchmarking
- Product, Cost
- Performance Benchmarking
- Should Costing
- Product & Cost planning

2 Concept, Styling, Engineering, Design & Vehicle Architecture

- Platform Design & Ips
- Digital Simulation
- 3D Surface Modeling
- Right-weighting
- Automotive Open System Architecture (Autosar)
- Electrical & Embedded Systems
- Telematics
- Model-based Design Approach
- e-powertrain Development

3 Testing & Validation

- Functional Safety Tests
- HIL Testing
- Prototype Build

4 Manufacturing Process & Resource Planning

- Quality Proving
- Digital Manufacturing
- Body and Chassis Development
- Target Based Sizing
- Parts Development
- Complete EE Integration

5 Vehicle Launch

- New Product Introduction (NPI)
- Product Packaging and Finishing
- Post-production Change & Maintenance

6 Homologation

- Model Year Refresh/Development
- Homologation Schedule
- Type Approvals Documentation & Certification

IMPACT

Launch of electric vehicles in record time:
Application of our IP eVMP™ helped the company achieve its goal of EV launch in record time

PROJECT HIGHLIGHT

Application of Tata Technologies' IP eVMP™, a fully scalable EV platform, built to power the next generation of EVs and accelerate e-mobility worldwide.

"We are very happy to cooperate with Tata Technologies and look forward to the success of VinFast EVs. In collaborating with Tata's team of experienced engineers with excellent technical qualifications, VinFast can achieve its goal of launching electric vehicles in record time. With the vision to drive the movement of global smart EV revolution, this cooperation will help VinFast EVs win the trust of customers across global markets. We strongly believe this strategic partnership will help VinFast realize our pioneering position in the global electric vehicle industry."

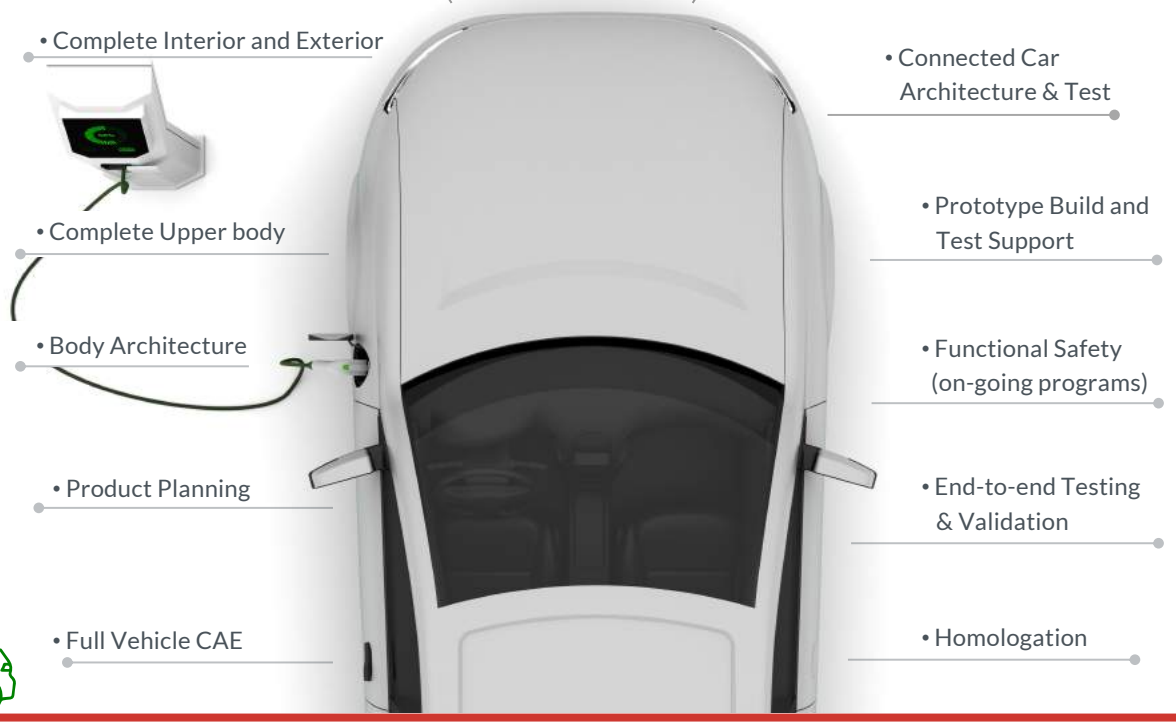
- Vingroup Vice-Chair & VinFast Global CEO

Turnkey development of a replacement SUV model for a UK-based automotive giant

Full external ownership from conception to production launch of a replacement mid-size SUV model, leveraged by our dedicated Global Delivery Model

TURNKEY VEHICLE DESIGN & DEVELOPMENT, INCLUDING:

- Quality Proving
- Supply-Chain Management
- Complete Interior and Exterior
- Connected Car Architecture & Test
- Complete Upper body
- Prototype Build and Test Support
- Body Architecture
- Functional Safety (on-going programs)
- Product Planning
- End-to-end Testing & Validation
- Full Vehicle CAE
- Homologation



IMPACT

- **On-time delivery** of the project
- Achieved **body engineering investment was 25% less** than if done in-house
- Successful development of a 7-seat layout in a typical 5-seat footprint
- Surpassed quality targets with the resultant vehicle

PROJECT HIGHLIGHT

Leveraged Tata Technologies' dedicated Global Delivery Model (GDM) to deliver the project

"Everything you can see and everything you can touch has been executed by Tata Technologies."

- Chief Program Engineer,
UK-based automotive giant

Why Tata Technologies

Analyst Recognition

zinnov™ ZONES 2021 | ER&D SERVICES

Tata Technologies has been positioned in the 'Leadership Zone' in the Zinnov Zones Global ER&D services report for four consecutive years. Zinnov has positioned Tata Technologies as 1st amongst all India- based Automotive ER&D ESPs for the second consecutive year.

Company of the Year 2020

Industries Served

- Automotive
- Aerospace
- Industrial Heavy Machinery
- Industrials

Partner Ecosystem

Tata Technologies has forged extremely valuable alliances throughout the Product Engineering, Product Life Cycle Management and Digital Services for manufacturing industry. Simply put, the strength of our alliances helps you connect your business solutions to the needs of your customers. That's better for you, better for your customers. Tata Technologies is proud of our key alliances.

ptc · Microsoft · SAP · LOGILITY · SIEMENS · DASSAULT SYSTEMES · salesforce · ORACLE

Commitment to Business Excellence

Tata Technologies has adopted the Tata Business Excellence Model (TBEM) as an organizational improvement methodology to achieve excellence in the way it runs its business and manages the operations. TBEM ensures focus on critical aspects of the business including Leadership, Strategy, Customer, Workforce and Processes and these are assessed for process maturity as well as competitive outcomes that they deliver. The Company achieved a score of 553 in the last formally conducted TBEM assessment and was positioned under the 'Emerging Industry Leader' category. From Quality Management system perspective, the Company has adopted globally recognized standards across its key delivery centers to establish its enterprise-level Quality Management System(QMS) and Information Security Management System(ISMS).

AS 9100D | ISO 27001: 2013 | ISO 9001:2015

TATA TECHNOLOGIES

TATA

Reach out to us at marketing@tatatechnologies.com
to learn more about

TREaD
Turnkey Research Engineering and Development of Electric Vehicles

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Engineering a ***better world***