

Detroit Engineered products (DEP), is an engineering services, product development, software development, consulting and talent acquisition company. Since its inception in 1998 in Troy, USA, DEP is now a global company with footprints in Europe, China, Korea, Japan, and India. DEP uses the accelerated and transformed product development process, accomplished by utilizing our proprietary platform, DEP MeshWorks, which rapidly reduces the development time of products for all segments. The MeshWorks platform delivers tool sets that accelerate virtual validation activities associated with powertrain development across all stages for both conventional and electric powertrain.

Several tools in MeshWorks have been created with deeper understanding of the needs in a powertrain engineering team. Tools like rib addition, feature removal, model checker, fuse welding, wall thickness reduction options, design space building tools and other model assembly tools have accelerated the way engineers perform model changes for what if studies and optimization.

DEP's IC sensor (In-Cylinder) offers comprehensive portfolio of combustion analysis to the engine design and testing teams in terms of real-time gathered data and make decisions considering emissions, combustion, timing, pressure pattern, and performance parameters. This is applicable for single and multiple fuel engines.

The DEP TRIO of IC Sensor, MeshWorks tools and proven technological processes like MDO can significantly add value to Powertrain Engineering.



REVERSE ENGINEERING

Introduction

Lithium-ion battery packs, motors, inverters, power electronics components, electric drive lines and control systems are the major components of an electric vehicle.

In addition to this, the packaging of the appx. 300 Lithium-ion battery cells in a module is very critical.

Apart from these the other factors in a electric vehicle system will be common Apart for both electric and conventional vehicle.

Reverse engineering can be done to benchmark these critical systems of an electric vehicle.

Reverse Engineering (RE)

RE is the process of discovering the technological principles of a device or system through analysis of its structure, function, and operation. RE is the disassembly and re-assembly of the device, which includes document, test, analyze and report regarding the study of its function. RE is the process of taking a device, system, or program apart and analyzing its RE working in detail, usually with the intention to construct a new device, system, or program that does similar functions with improved efficiency.



Advantages of RE

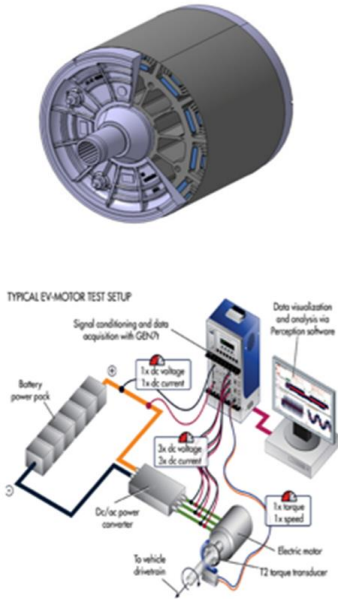
- Understand product functionality
- Understand product structure
- Identify strengths, weaknesses, and opportunities
- Determine the technology in competitive products
- Re-design to modify and improve products
- Replace old components with new ones
- Replace parts that are no longer available in market
- Create missing documentation (such as schematics and BOM)

Why RE is required for Electric Vehicles

- Growing share of EV market.
- Risks of mechanical, thermal, electrical and chemical hazards are pressing the need to choose an alternative.
- Need to create various testing methods of motor, battery and corresponding simulation practices.
- Increase in the number of concepts, geometry, chemistry, and development status of EV's battery

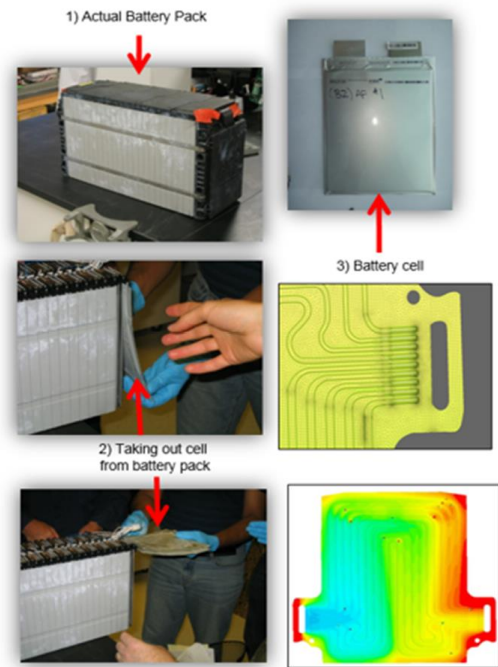
ELECTRIC MOTOR

- The motor needs to be scanned to create a CAD model of its physical structure.
- Parameters such as winding pattern, slot numbers, stator & rotor dimensions etc. can be determined from the CAD file.
- The CAD file can be used to perform electromagnetic and dynamic analysis to assess the performance characteristics of the motor.
- Various others test needs to be performed to validate and correlate all the simulated results with the actual test results.
- Motor Electrical Characteristic can be obtained from testing on the Dyno for no load
 - Stall torque and Current.
 - Free running speed, current, and efficiency.
- By gradually changing the loads using a Dyno, the motor current and speed can be changed. By taking measurement at different load cases, including stall and free running conditions, the torque speed curve can be obtained.



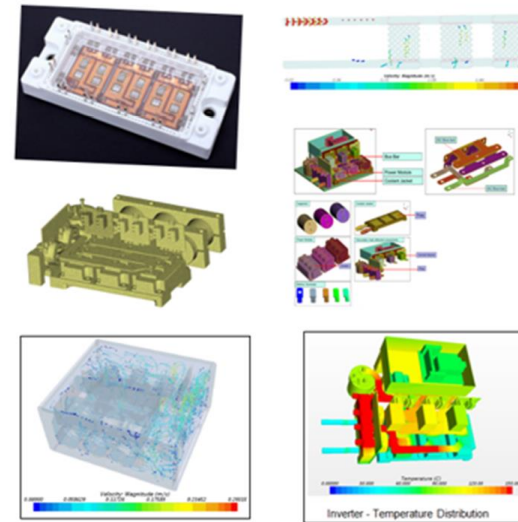
BATTERY

- A laser-scanning machine to scan battery pack and cold plate for CFD simulation is shown in figure. After scanning the micro channel cold plate, the image can be transferred into CAD using DEP MeshWorks.
- Using 3D scanning techniques we can get the space cloud points or nurb surfaces from which actual CAD model of battery cell and pack can be developed.
- CAD model can be generated for the important components. Using the electrical parameters battery simulations can be performed to predict the remaining capacity and validate the given design. These results can be used as a benchmark file.



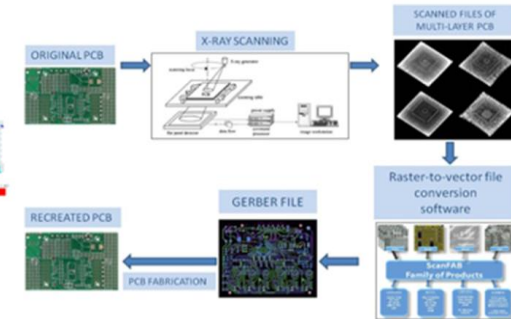
POWER INVERTERS

- Power inverters are composed of several power electronic components.
- The power switches such as IGBT, MOSFET, diodes are the main components in any power converter circuit. Understanding the characteristics and limitations of these devices is of great importance.
 - The data regarding performance characteristics of these switches can be easily obtained from their IC chip number, no additional testing is required.
 - The power loss calculations of the switches are necessary to determine the temperature tolerance of the circuit and select heat sink accordingly.
 - The structural and thermal behavior of Inverter components can be studied through reverse engineering.
 - The inverter thermal analysis is performed to estimate steady state thermal behavior using natural convection and also coolant jacket pressure drop.
 - The durability analysis is performed to get the stress levels caused by the thermal effects.



CIRCUIT DESIGN

- RE methodology depends on the circuit complexity.
- The PCB X-ray is used to display inner layer with high resolution.
- The Auto Trace tool converts bitmap image to vector file. The later can be used by circuit design tool to regenerate the original circuit schematic.
- For Microcontroller it can be more challenging as outputs don't depend on the instantaneous input.
- The PWM and speed feedback signals can be identified by monitoring the microcontroller signals in the runtime. We can also access the control methods used and Identify all system parameters.
- The signals can be by-passed at times and are overridden to trigger a fault condition to identify how the microcontroller behaves at the given scenario



DEP'S CAPABILITIES:

- 3D scanning
- Electromagnetic analysis
- Complete CAE solution
- Complete performance testing

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