



Facing Enclosure Design Challenges for ADAS

Find your Solution Here!

ECU

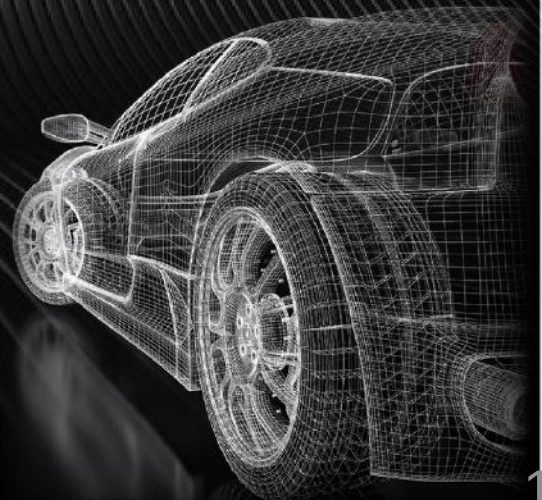
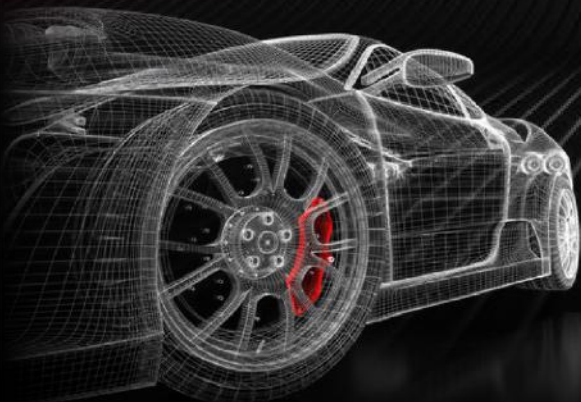
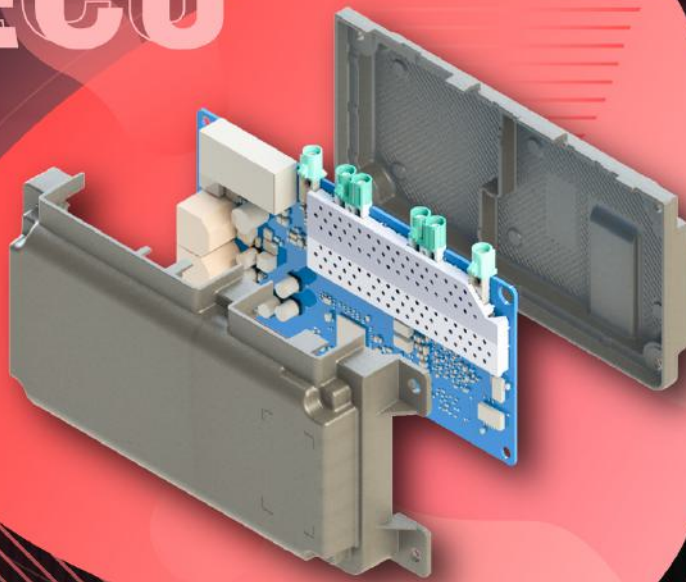
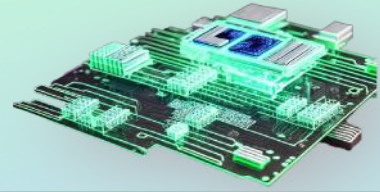


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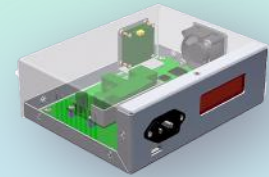
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**High-Speed Electronics :
From ADAS towards AD
(Autonomous Driving)**



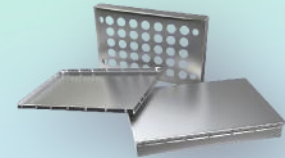
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Foreword

As automotive technology evolves,

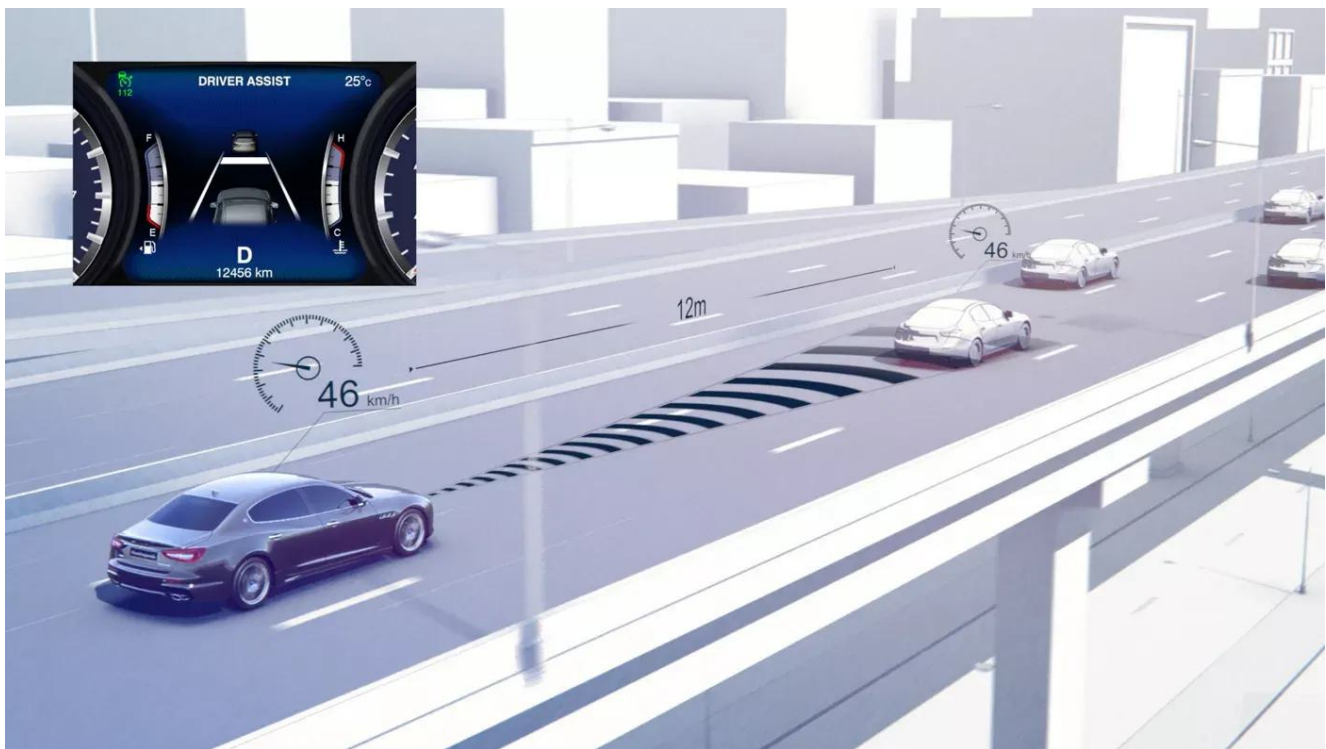
Designing enclosures for Advanced Driver Assistance Systems (ADAS) becomes increasingly complex.

Designing enclosures for these sophisticated systems presents a unique set of challenges that require careful consideration of materials, thermal management, and electromagnetic shielding.

Whether you're working on a new design or seeking to improve an existing one, this eBook is a resource you can turn to for expert guidance and practical solutions.

Our goal is to equip you with the knowledge needed to overcome design obstacles and deliver high-quality ADAS enclosures.

We hope the insights shared here will inspire and support your journey towards successful ADAS enclosure design.

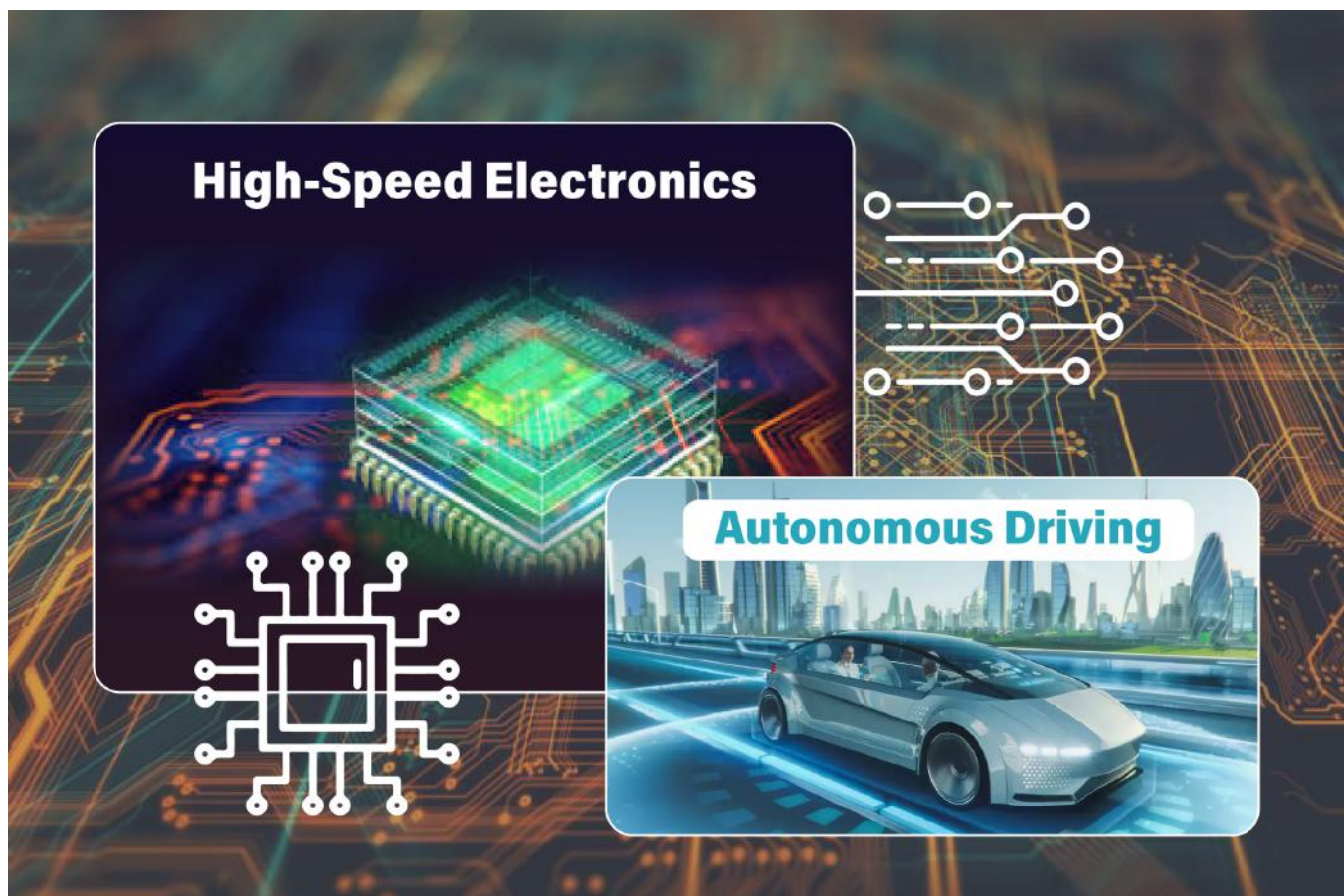


1.High-Speed Electronics : From ADAS Towards AD (Autonomous Driving)

A lot has changed in car technology over the last 50 years, and among the biggest changes is the advent of **Advanced Driver Assistance Systems (ADAS)**.

With **94% of accidents caused by human error**, ADAS has been developed to mitigate these errors by assisting or alerting drivers to potential dangers or even taking preventative actions.

Let's explore how these systems have evolved and what they mean for servicing vehicles now and into the future.

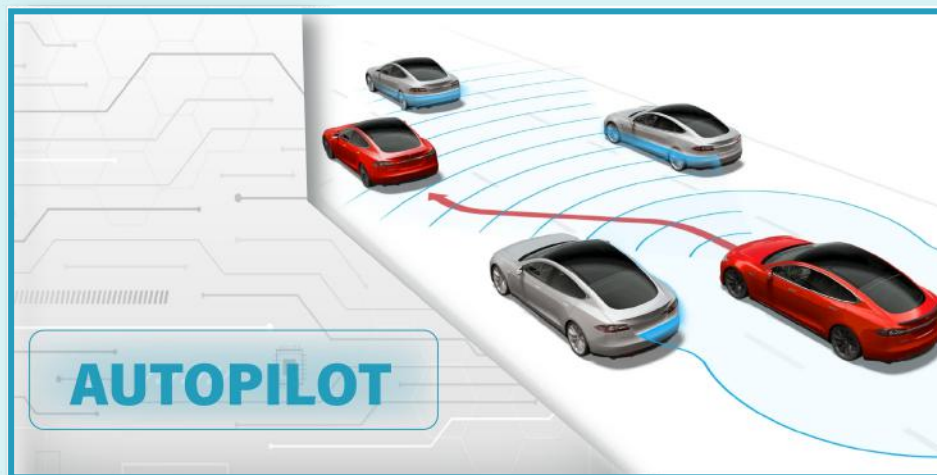


The **1970s** marked the rise of the first driver assistance systems, including electronic cruise control and early anti-lock braking systems.

Building on ABS technology, electronic stability control debuted in the **1980s**.

By the **1990s**, vehicle electronics had become more refined, paving the way for new features like night vision.

The **2000s** saw the release of lane-keeping assist, forward collision warning, backup cameras, and park assist. Surround view systems or 360° camera systems were introduced in the **2010s**, along with advanced features like driver drowsiness detection and the first single-lane highway autopilot.



Moving into the **2020s**, manufacturers are rapidly adding systems to all new vehicles. A host of advanced sensors, cameras, and more now come standard on an ever-growing range of models, from entry-level to flagship.

In many cars today, the hardware for self-driving is already in place, though some human supervision is still required.

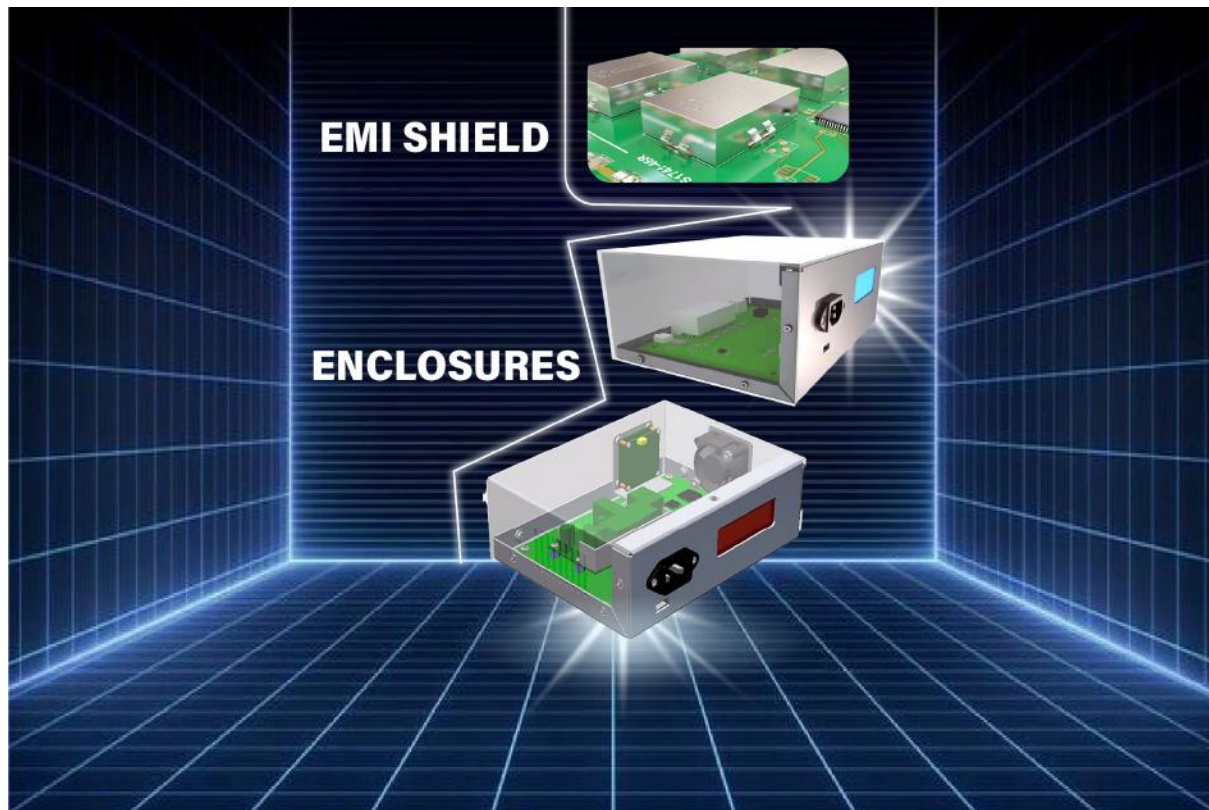
So what does all this mean for car owners and service centers?

It means fewer accidents and more peace of mind but also introduces greater complexity in auto service. It is estimated that new cars have between **50 and 100 sensors per vehicle**, so any adjustment, modification, or replacement of tires, wheel alignment, suspension, steering geometry, or windshields now likely requires recalibrating radars or cameras as well.

Accuracy is crucial because even minor sensor misalignment can result in the system misinterpreting its surroundings.

As we continue pushing toward fully autonomous vehicles, the number of sensors per car is expected to grow, promising a future of much safer and more sophisticated automotive technology.

2. Why Electronic Enclosures matters here?



Protection from Environmental Conditions: Safeguards ADAS sensors and modules from extreme temperatures, vibrations, moisture, and dust, ensuring reliable operation.

Electromagnetic Interference (EMI) Shielding: Prevents interference between **ADAS components** and other electronic systems, maintaining accurate sensor data and effective communication.

Thermal Management: Manages heat generated by ADAS electronics to prevent overheating and ensure consistent performance.

Durability and Longevity: Enhances the lifespan of ADAS components by providing a robust and protective enclosure against physical impacts and environmental stressors.

Mechanical Protection: Protects ADAS systems from physical damage due to vehicle vibrations and impacts, which could affect sensor accuracy and functionality.

Accessibility for Calibration and Maintenance: Facilitates easy access for recalibration and servicing of ADAS sensors and modules to maintain system accuracy and performance.

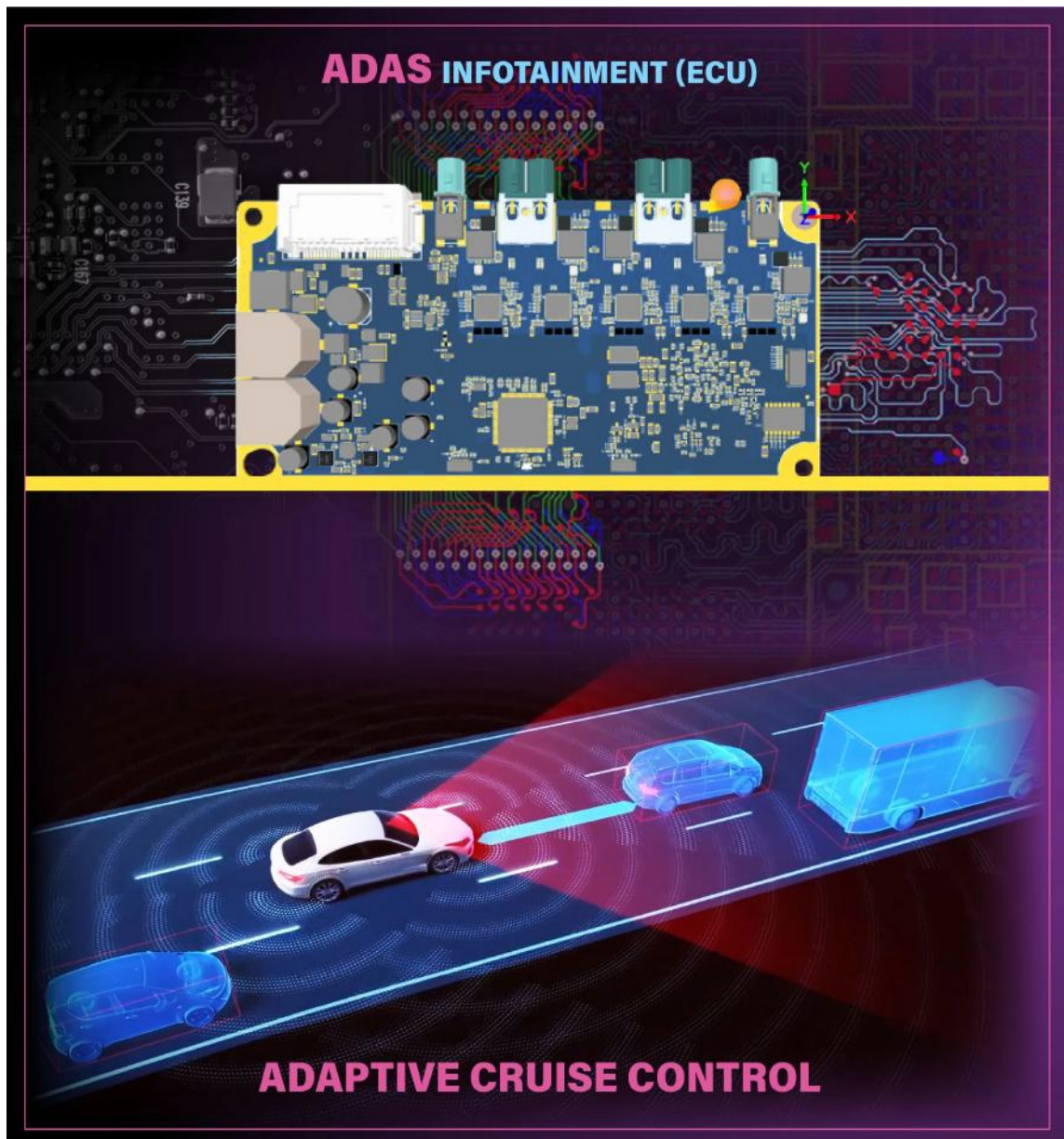
3. Key Considerations for Designing Enclosure

CONSIDERATION	SPECIFICATION
Material Selection	Use materials with high strength and thermal resistance, such as ABS with a tensile strength of 40-70 MPa.
Thermal Management	Incorporate cooling solutions, such as heat sinks, with thermal interface materials (TIMs) to manage temperatures up to 100°C.
Mechanical Integrity	Utilize shock-absorbing materials such as rubber mounts or foam inserts to mitigate mechanical stress and vibration.
Size and Space Optimization	Utilize 3D modeling and simulation to optimize the internal arrangement of components for space efficiency and minimize interference. Design custom cutouts and mounting features to accommodate specific component geometries and reduce wasted space.
Environmental Protection	Achieve IP67 or higher protection by using seals and gaskets to guard against dust and moisture.
EMI/EMC Shielding	Apply conductive coatings to meet electromagnetic interference (EMI) and electromagnetic compatibility (EMC) standards.
Accessibility	Design for easy maintenance with features like removable panels or access doors.
Regulatory Compliance	Ensure compliance with safety and flammability standards, such as UL94 V-0.
Aesthetics and Ergonomics	Create a visually appealing design that also provides user-friendly access.
Cost Efficiency	Optimize material and manufacturing costs while ensuring high quality and performance.

4. Advanced Enclosure Design for ADAS

ADAS-Infotainment Control Unit (ICU) or Infotainment ECU

- ADAS (Advanced Driver Assistance Systems) ECU (Electronic Control Unit) is the central component in modern vehicles responsible for processing data from various sensors, cameras, and radars.
- It plays a critical role in enhancing vehicle safety by enabling features like adaptive cruise control, lane-keeping assistance, and automatic emergency braking.



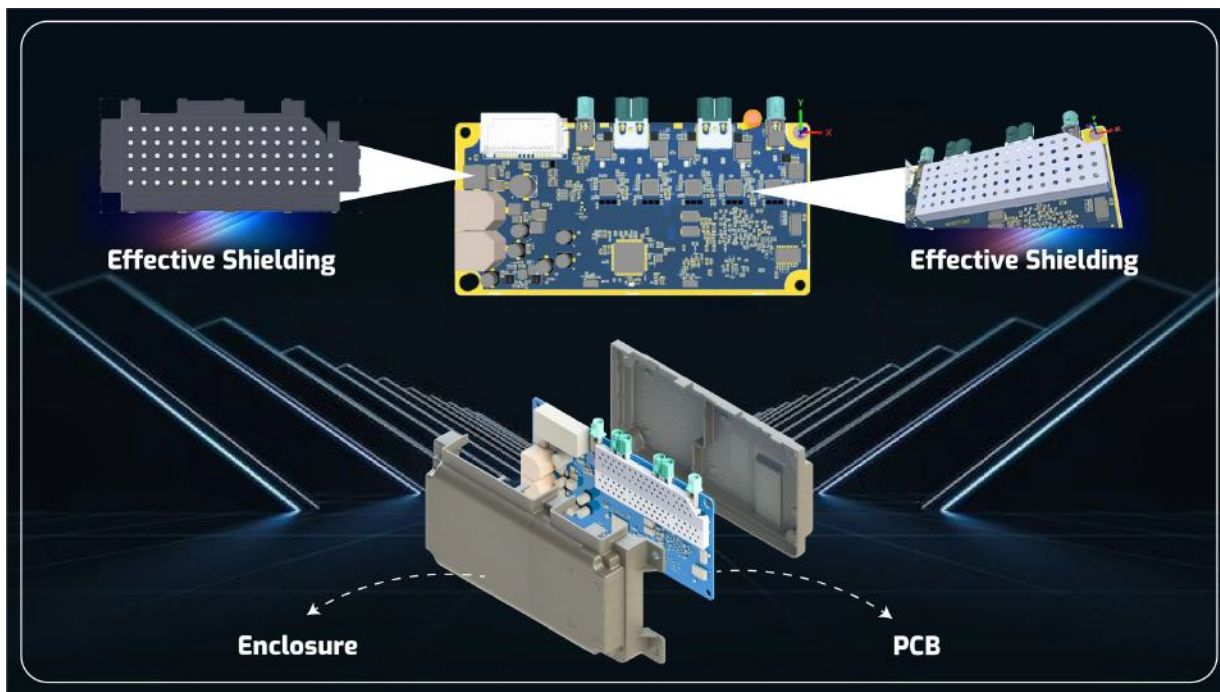
a) Enclosure Design for ECU

Designing an enclosure for a ECU demands meticulous **material selection**, advanced manufacturing techniques like **CNC machining or die casting**, and precision surface finishing such as anodizing or powder coating for durability and aesthetic appeal.

With an iterative design approach, incorporating environmental considerations and ensuring regulatory compliance, the enclosure guarantees optimal protection for the ECU, the vehicular "brain," upholding the highest standards of safety and reliability crucial for automotive applications.



b) Top Challenges in Enclosure Design for ECUs

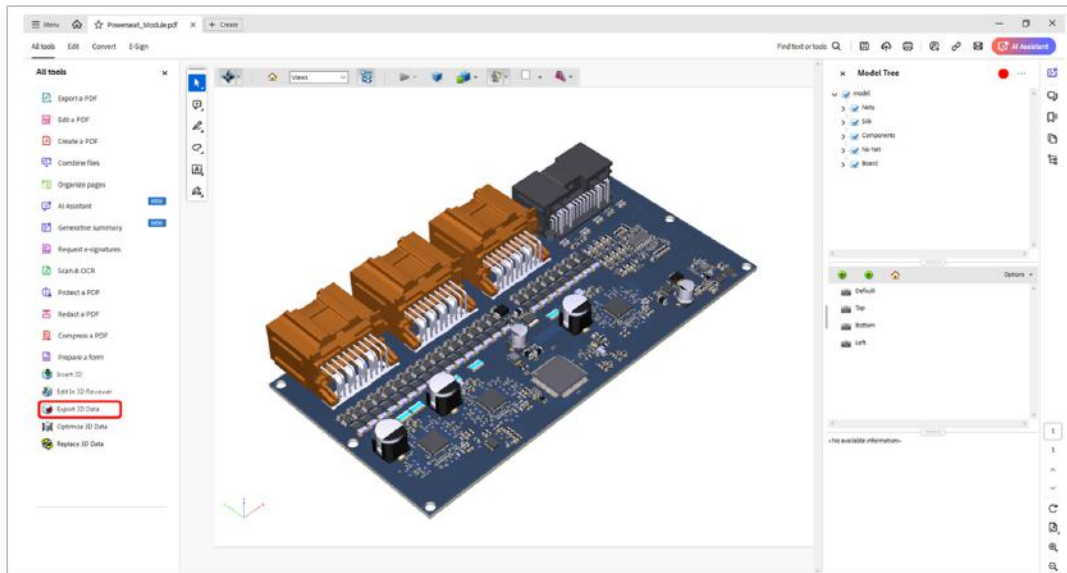


- Integrating the PCB layout into the enclosure design efficiently.
- Finding materials that are both strong and resistant to physical impacts, chemicals, and heat.
- Choosing materials that offer high shielding effectiveness, conductivity, and anti-corrosion properties while being lightweight and durable.
- Ensuring the enclosure can effectively protect the ECU from dust, moisture, and other contaminants.
- Designing the enclosure to efficiently manage and dissipate heat, especially from high-heat components like processors.
- Optimizing the design to fit power and signal connectors, SD card ports, and to accommodate different assembly parts.
- Balancing material and manufacturing costs with performance and durability needs.
- Designing the enclosure to allow easy access for maintenance and ensuring user-friendly features.

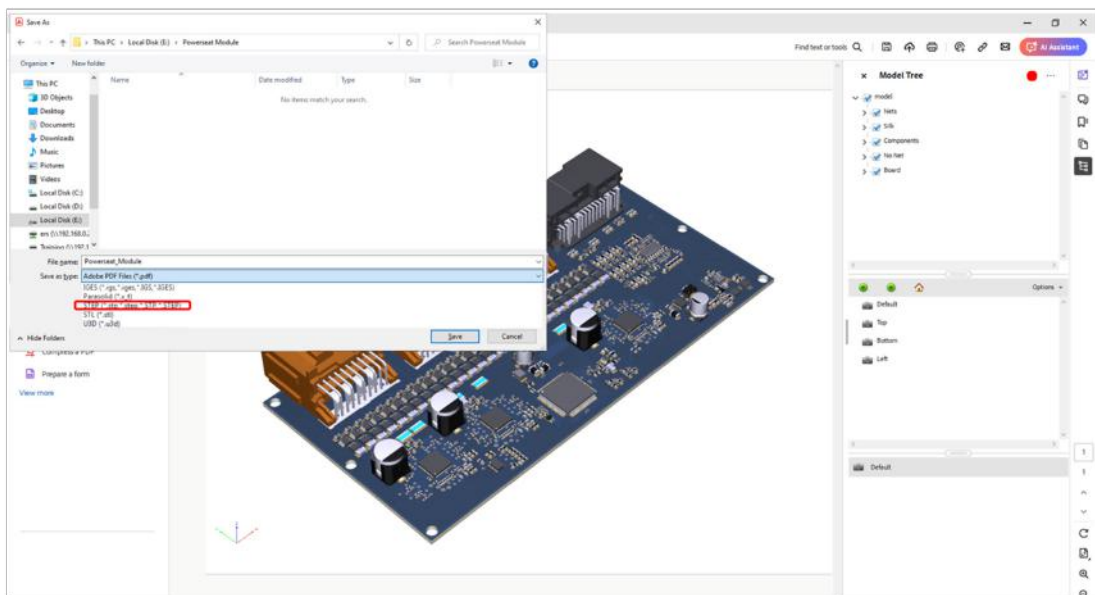
c) How to Overcome the Challenges?

Step-1: Requirements-Analysis

- Use the "STEP" file to guarantee that the PCB fits exactly within the designed space of the enclosure.



- Use the cut-out details to create openings in the enclosure for connectors, cables, and other components. These cut-outs must be accurately placed to avoid misalignment and to provide easy access to external connections.
- Ensure that no components, connectors, or mechanical features are placed within the defined keep-out areas.



Step-2: Material Selection

The (Plastic- ABS-Acrylonitrile Butadiene Styrene) is chosen for its combination of high strength, thermal stability, regulatory compliance, and lightweight properties, ensuring reliable protection and performance of the ECU in harsh automotive environments.



FACTOR	TECHNICAL VALUES OF ABS	REQUIREMENT
Strength	Tensile Strength: 40 - 70 MPa	Withstand mechanical stresses and impacts without cracking or deforming.
Weight	Density: 1.04 - 1.06 g/cm ³	Lightweight to contribute to vehicle efficiency
Regulatory Compliance	UL94 V-0 Flammability Rating	Meet automotive industry standards for safety
Thermal Performance	Heat Deflection Temperature (HDT): ~90 - 100°C	endure high temperatures without degrading or warping.
Safety	Dielectric Strength: ~20 kV/mm	Non-conductive, prevent electrical shorts.
EMI/EMC Shielding	Shielding Effectiveness	Typically enhanced with conductive coatings
Compatibility Requirements	Corrosion Resistance: High, compatible	resistant to galvanic corrosion and compatible with other materials
Elastic Requirements	Modulus of Elasticity: ~2.1 - 2.4 GPa	offer flexibility to absorb shocks
Aesthetical & Acoustical Requirements	Easy to mold for aesthetic purposes	Visually appealing finish and good noise reduction

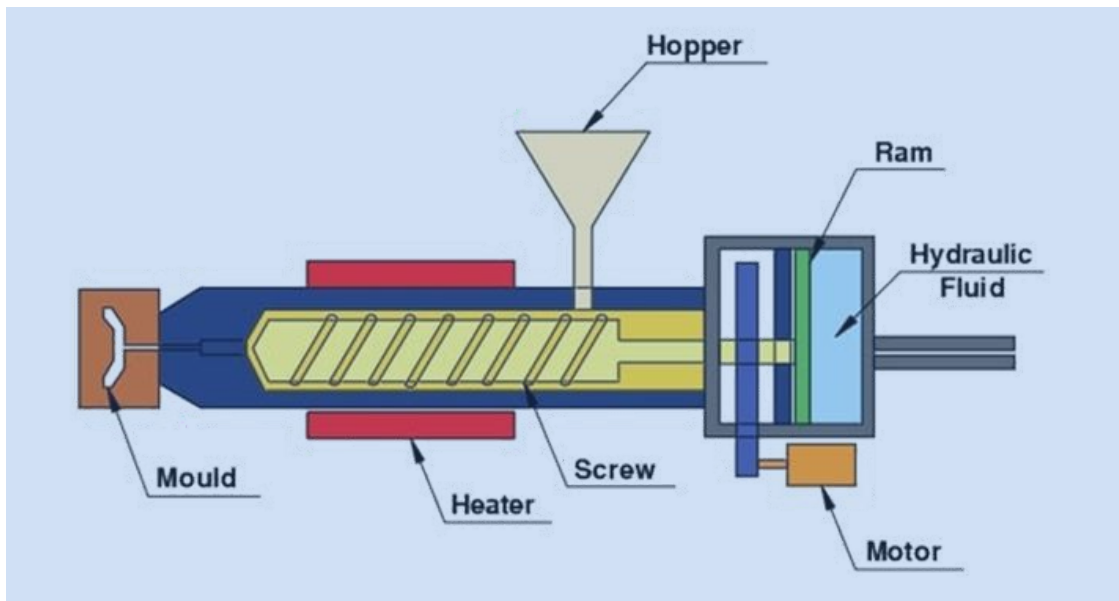
Step-3: Manufacturing Selection

Following factors are considered during the selection of manufacturing process

- Tight tolerance manufacturing
- Excellent repeatability
- Fast cycle time
- Cost effectiveness



Effective manufacturing process for this enclosure design is **Injection Molding**



Step-4: Initial Sketches – Enclosure Shape & Size Plan

Rough initial sketches are drawn with the details related to cutout for input & output connectors, compartment for battery.

- Enclosure Size (Length x Width)
- Overall Height of the Enclosure
- Battery compartment
- Cutouts requirements
- Mounting techniques
- Keep-out zones

Step-5: 3D modeling in the CAD tool

The process begins with creating detailed sketches of the initial concept. These sketches capture the essential design elements, providing a visual roadmap for the **3D modeling** phase.

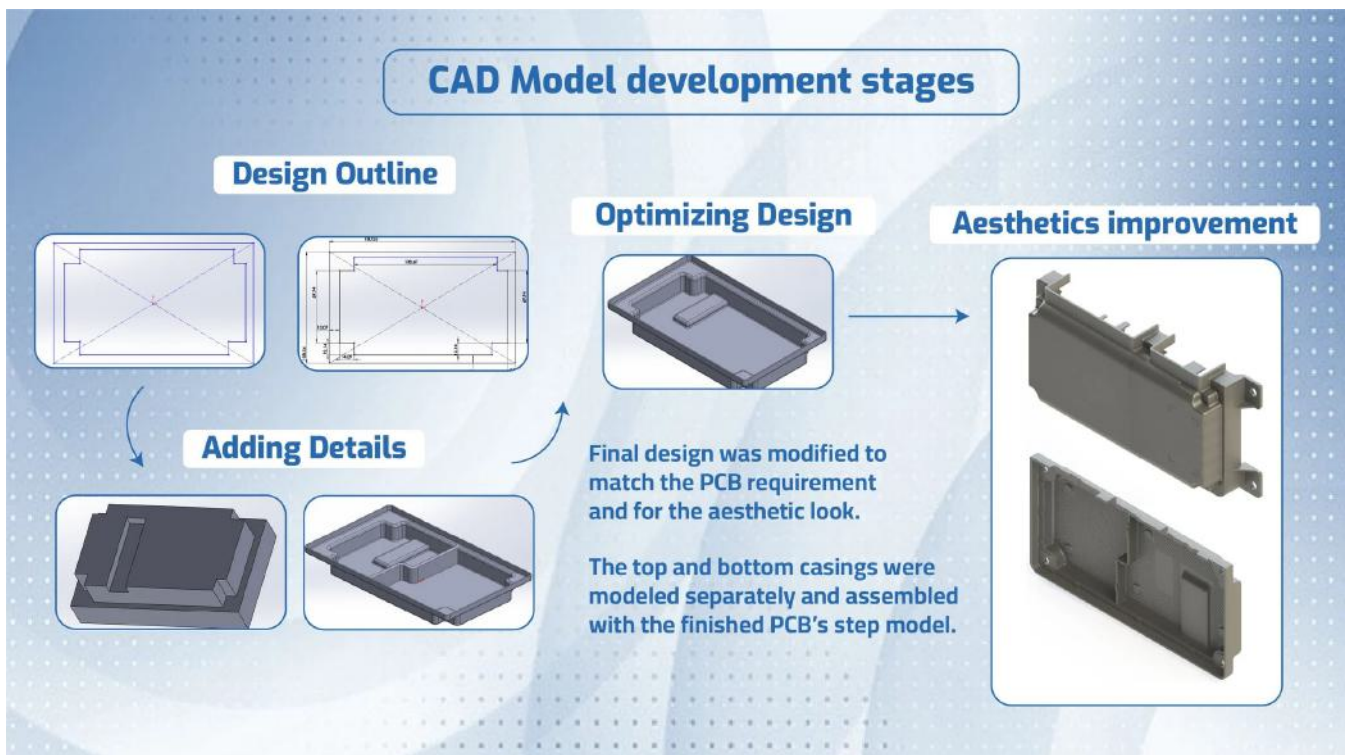
The sketches serve as a foundation, outlining the dimensions, key features, and overall layout of the product.

Once the sketch details are finalized, the next step is to translate them into a digital format using CAD tools.

This phase involves building a precise **3D model of the design**, where every component is modeled with accuracy.

After the 3D model is complete, the focus shifts to optimizing the design.

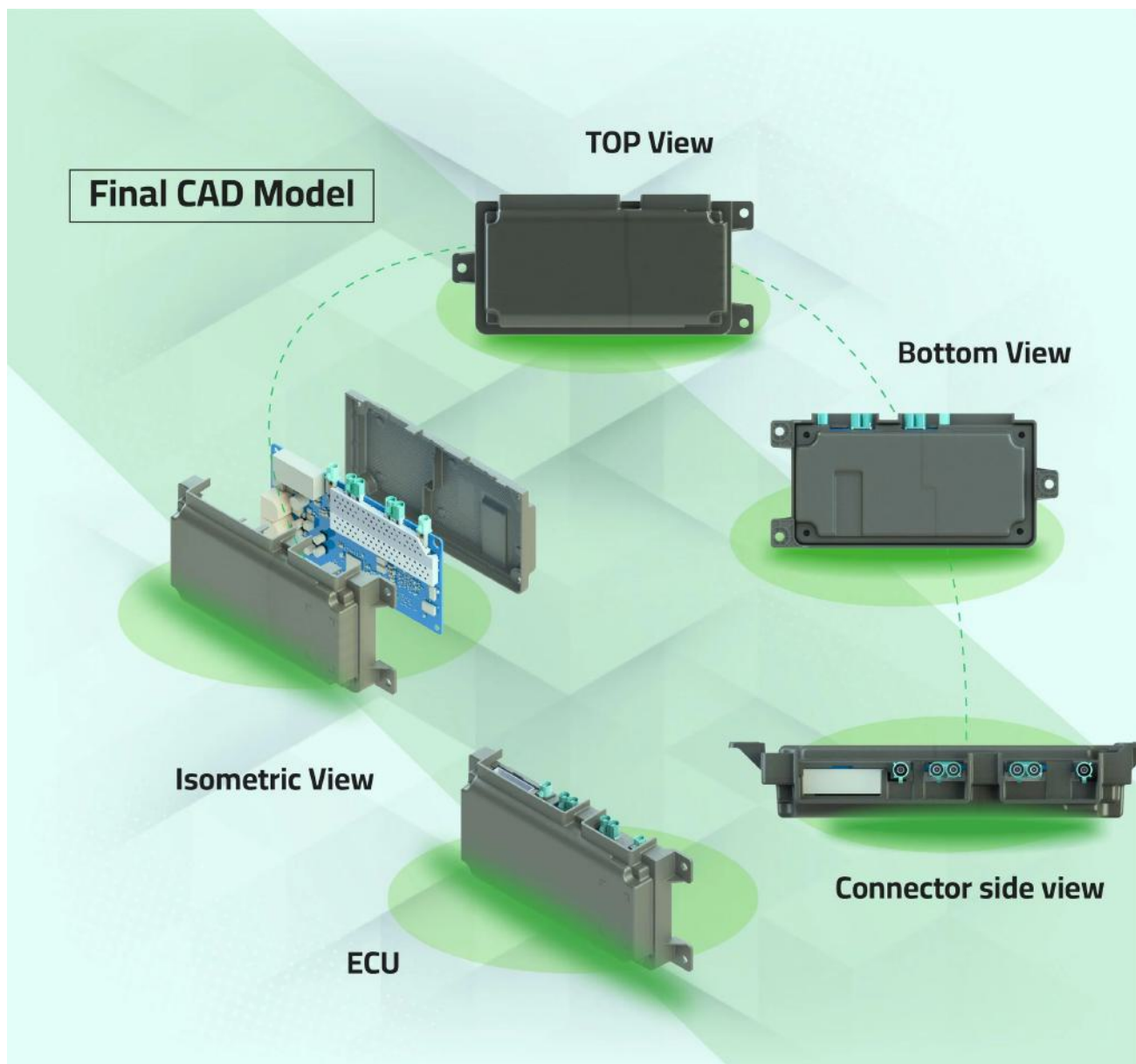
From the initial sketch to the final optimized design, every step is documented and refined. This continuous development ensures that the CAD model evolves into a robust representation of the final product, ready for manufacturing.



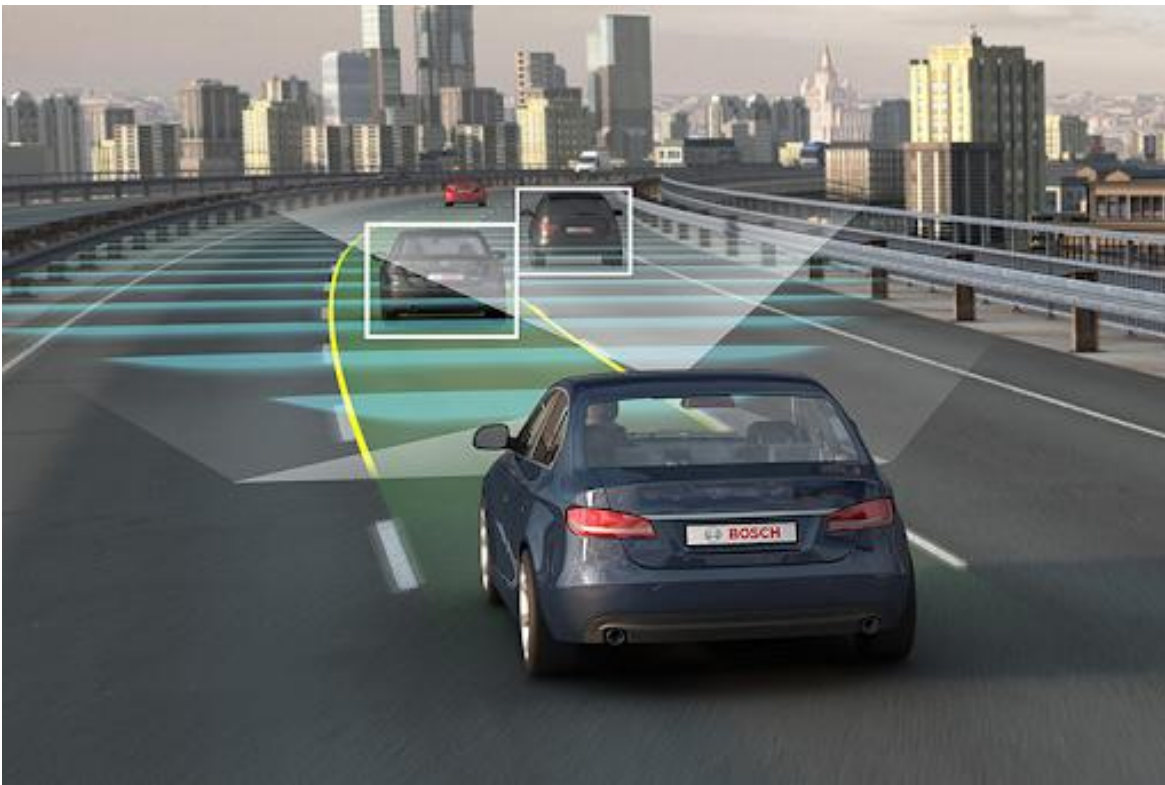
Step 6- Results

Final design was modified to match the PCB requirement and for the aesthetic look.

The top and bottom casings were modeled separately and assembled with the finished PCB's step model.



Summary



In this ebook, we've talked about how to handle the challenges of designing enclosures for ADAS.

You need strong materials to make enclosures last, seal them well to keep dust and moisture out, and block interference to keep systems running smoothly.

We've also discussed how to save space, manage heat, and follow the necessary rules.

Use these simple tips to solve problems in your projects.

By doing so, you can make your ADAS designs better and more reliable.

The solutions are here for you to use and succeed.

To discover more insights, visit our services page. <https://gighz.net/engineering-cad-design-services/>