METHOD OF ASSEMBLING A VEHICLE & INTEGRATED COMPOSITE ROOF MODULE TECHNOLOGY – PARADIGM SHIFT IN AUTOMOTIVE VEHICLE ASSEMBLY

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Abstract

This method of vehicle assembly consists of fabricating a vehicle body with floor and door openings, roof pillars defining window openings and a roof supported on the pillars, with a defined roof opening. The vehicle body is placed on a chassis. Then interior components are inserted through the opening in the roof and secured to the interior of the vehicle body. A roof module panel is placed on the roof to close the opening after the interior components have been inserted. One of the advantages of this method is that workers can assemble the vehicle without the problems of a cramped and hectic work area. Still another advantage is the reduction in cost of labor and workers compensation due to less labor required in the assembly process. Also, all interior and exterior components, including but not limited to, roof racks, skid racks, sunroof, radios, DVD players, antenna farms, decorative lining, etc. can be preassembled into the roof module panel with ease. A completely assembled roof panel can be attached to the vehicle body at the last sequential step when all interior components have been installed on the assembly line. Therefore, this method of assembling a vehicle and integrated roof module is new, efficient, and provides an economical way to assemble vehicles that will help reduce assembly time and not be labor intensive[1].

Introduction

Numerous assembly line processes for assembling vehicles are known and widely used in the automotive industry. An assembly process developed by Helmut Konig includes mounting parts and subassemblies on an assembly frame and then moving them into the vehicle body. Connections are then made between the vehicle body and the assembled parts and subassemblies. The assembly frame is adjustable and can be used for different vehicle body types[2].

Another vehicle assembly development is made up of various zones. The first zone of the assembly process is a wire leading/transfer trimming zone where components are assembled to a painted vehicle body and then inspected. The second zone is where interior components are sequentially assembled for inspection and repair. Next is an under-floor trimming zone where components are assembled, inspected and repaired. Then there is the exterior zone in which exterior components are assembled for inspection. This process of assembly developed by Norio Katsuura and Hideaki Sasaki allows for repair and elimination of defects within each zone of the assembly process[3].

The typical assembly process includes the step of mounting components and subassemblies, such as the hood, doors, fenders, roof panel, etc. on a body frame. The body is then passed through an E-coat and paint process. Next is the assembly of interior components and systems, such as seats, IP, headliner, etc., through the door side of the vehicle. This process is labor intensive, neither efficient nor ergonomic, especially the headliner installation.

One of the areas of continuous development and research is that of a more advanced method of installing and assembling parts to the vehicle so that the assembly time is reduced and efficiency and ease of use are improved. The importance of this vehicle assembly technology is that it allows designers and engineers to utilize new assembly methods and integrated roof module technology to design and build new high performance vehicles for the automotive industry.

Integrated Roof Module Technology

Integrated roof module and spoiler assembly is shown in Figure 1. It is a consolidation of the cover of the roof and the spoiler, which may house accessories such as brake lights, antennas, etc. The roof panel can combine Class A roof material such as SMC composite (Sheet Molding Compound), PET with mineral filled composite, etc. and structural roof material such as SMC Composite with higher glass loading, PET with glass fiber composite, metal etc. into one composite roof module, as shown in Figure 2. The roof panel material can be plastics, metals or a combination of the two. The roof panel can be painted offline, inline or online based on roof panel material[4].

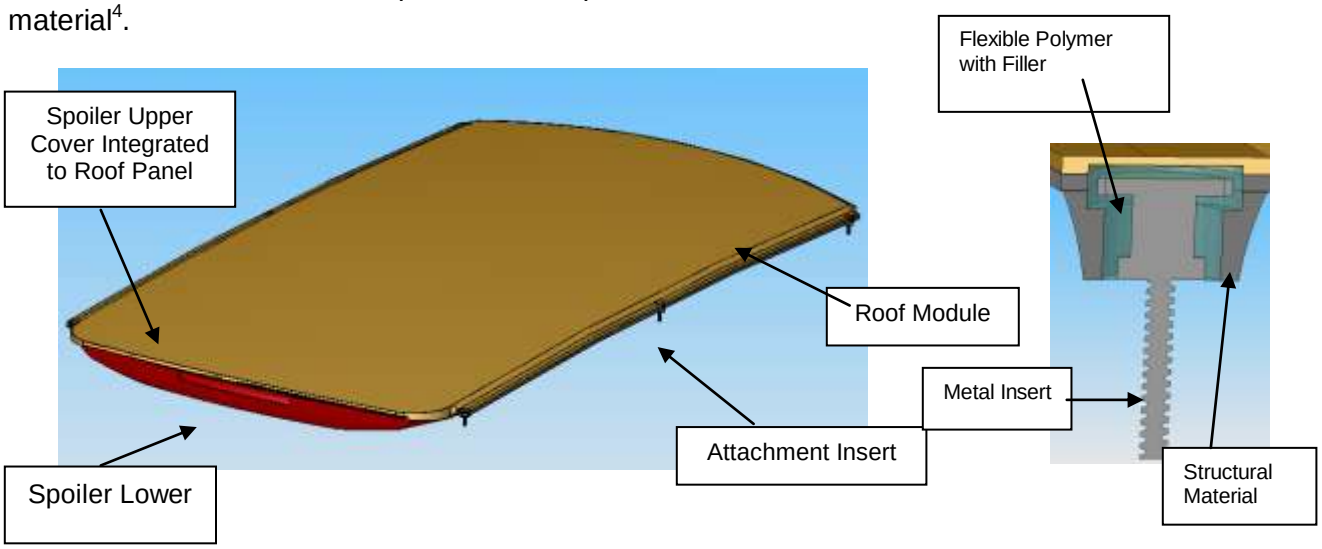


Figure 1: Integrated Roof Module and Spoiler Assembly

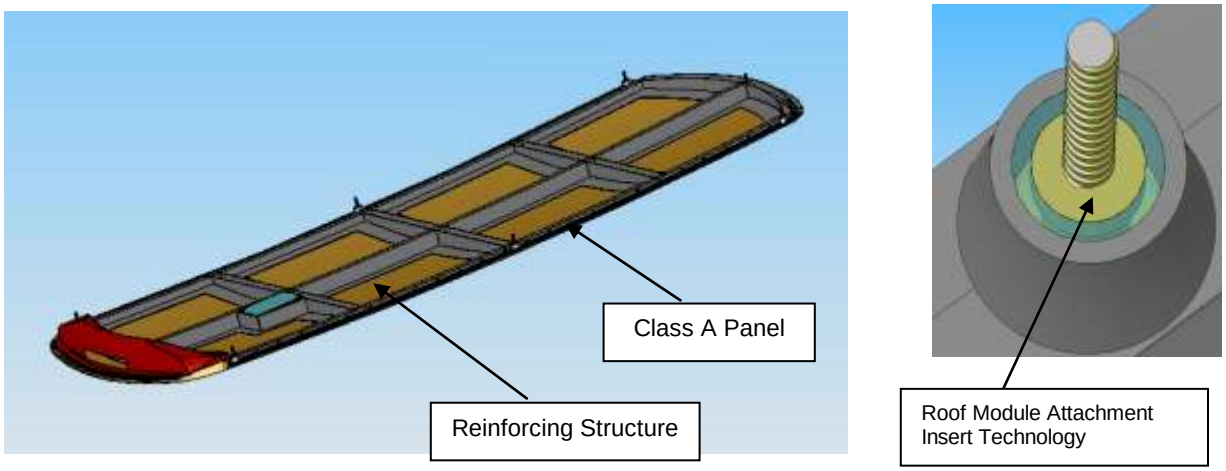
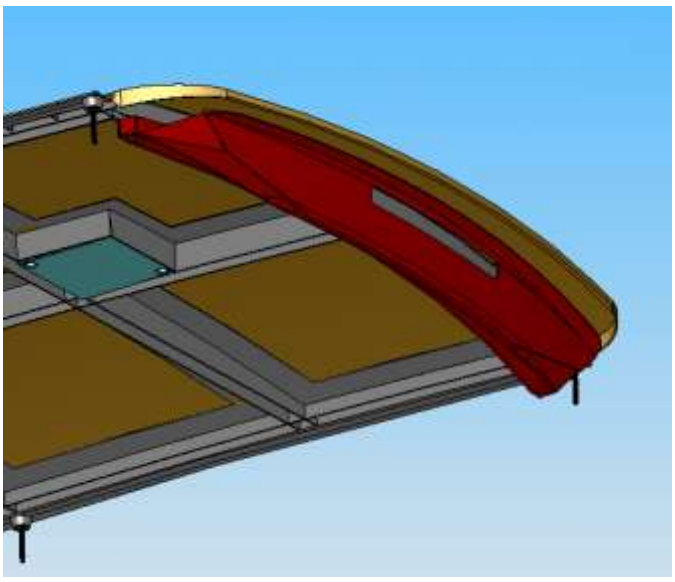
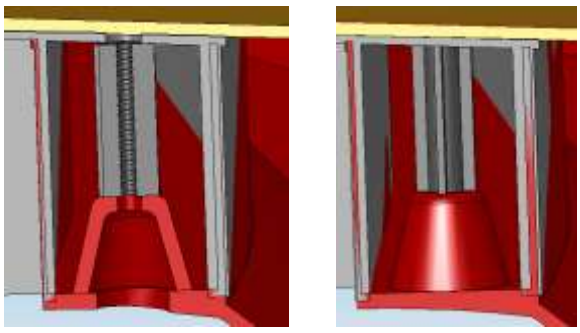


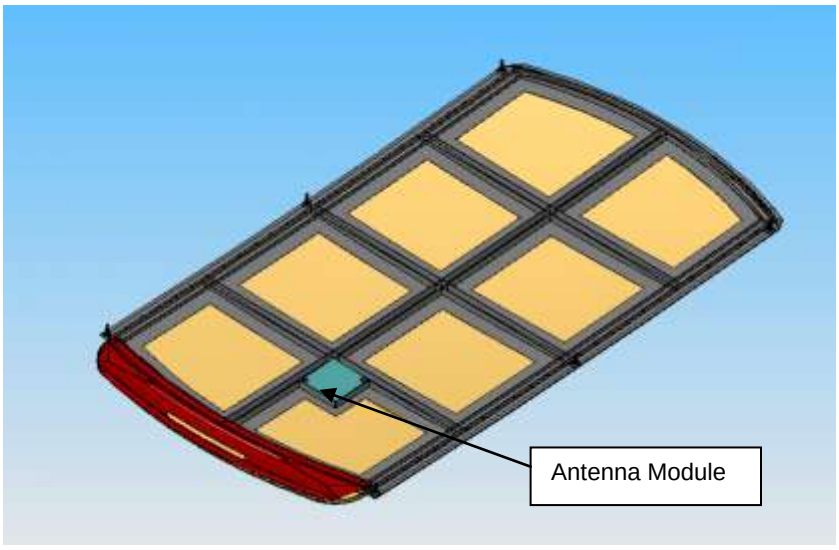
Figure 2: Roof Module Assembly with Reinforcing Structure and Attachment

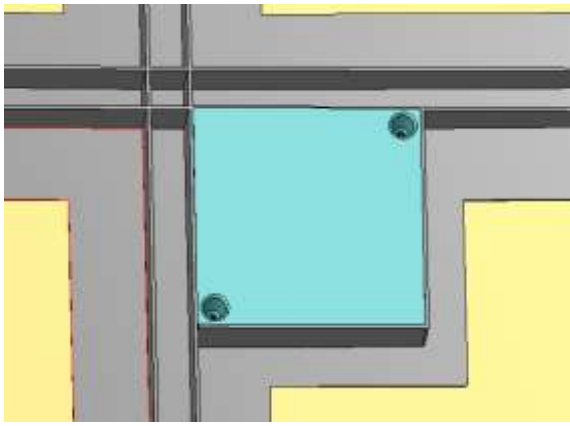


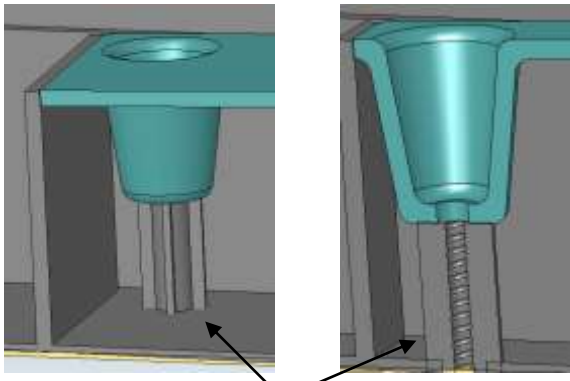


Spoiler Lower Assembly
Attachment to Roof Panel

Figure 3: Spoiler Lower Assembly Attachment to Roof Panel







Antenna Attachment to Roof Module

Figure 4: Roof Module Assembly with Integrated Antenna and Other Attachment DVDs, Lights, etc.

The roof module attachment can be achieved by several methods, as shown in Figure 2 and Figure 7. The Figure 2 attachment can be molded or glued to the roof module. An insulating layer of flexible polymer, with or without filler, is molded around the metal insert. This insulating layer assists in reducing stress induced by the difference in coefficient of thermal at the mounting area. This insulating layer also assists in reducing sink marks on a Class A surface[5]. The Figure 7 roof rack attachments can be bolted or screwed down through the roof panel and vehicle frame rail[6].

Figure 3 shows spoiler lower assembly attachment to roof panel. The spoiler is attached to the roof panel by self-tapping screws. Figure 4 shows roof module assembly with integrated antenna attached by self-tapping screws. Other interior attachments such as DVD players, radio, lights, etc., can be installed to the roof module. Roof module with integrated sunroof assembly is shown in Figure 5. The roof module is designed in such a way that the sunroof module may be snapped into place with minimal effort. The roof module with integrated headliner attachment is shown in Figure 6.

The roof module and integrated roof rack attachment to frame rail is shown in Figure 7. The roof and rack assembly is characterized by a track used to receive a roof rack member. The roof rack member can be slid on the track to adjust its positioning. There is a mounting member for securing the track to the retaining elements. This is a quick method of fastening a roof rack to a roof panel[7].

The vehicle body assembly is characterized by a clamping mechanism used to clamp the edges of the roof panel to the periphery of the opening, creating a sandwiched relationship. This is an effective and quick way of fastening the roof panel onto the body of the vehicle. Therefore, it is an efficient and easy to use method of assembling the roof panel to a vehicle body[8].

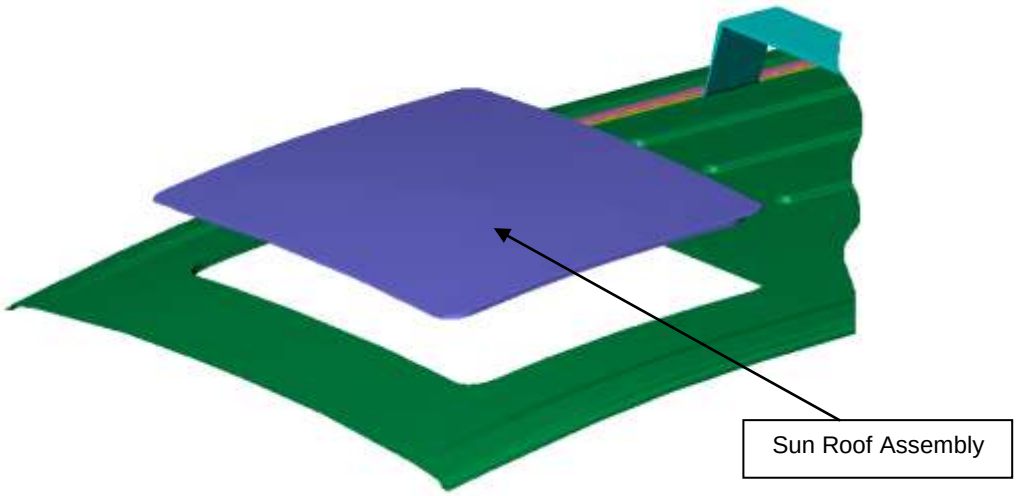


Figure 5: Roof Module with Integrated Sun Roof Assembly

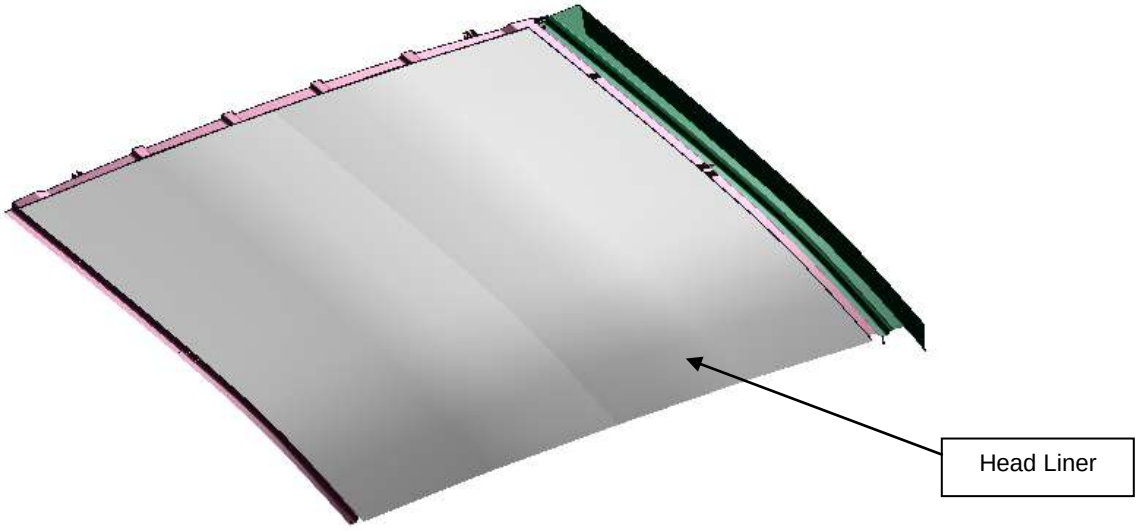


Figure 6: Roof Module with Integrated Head Liner

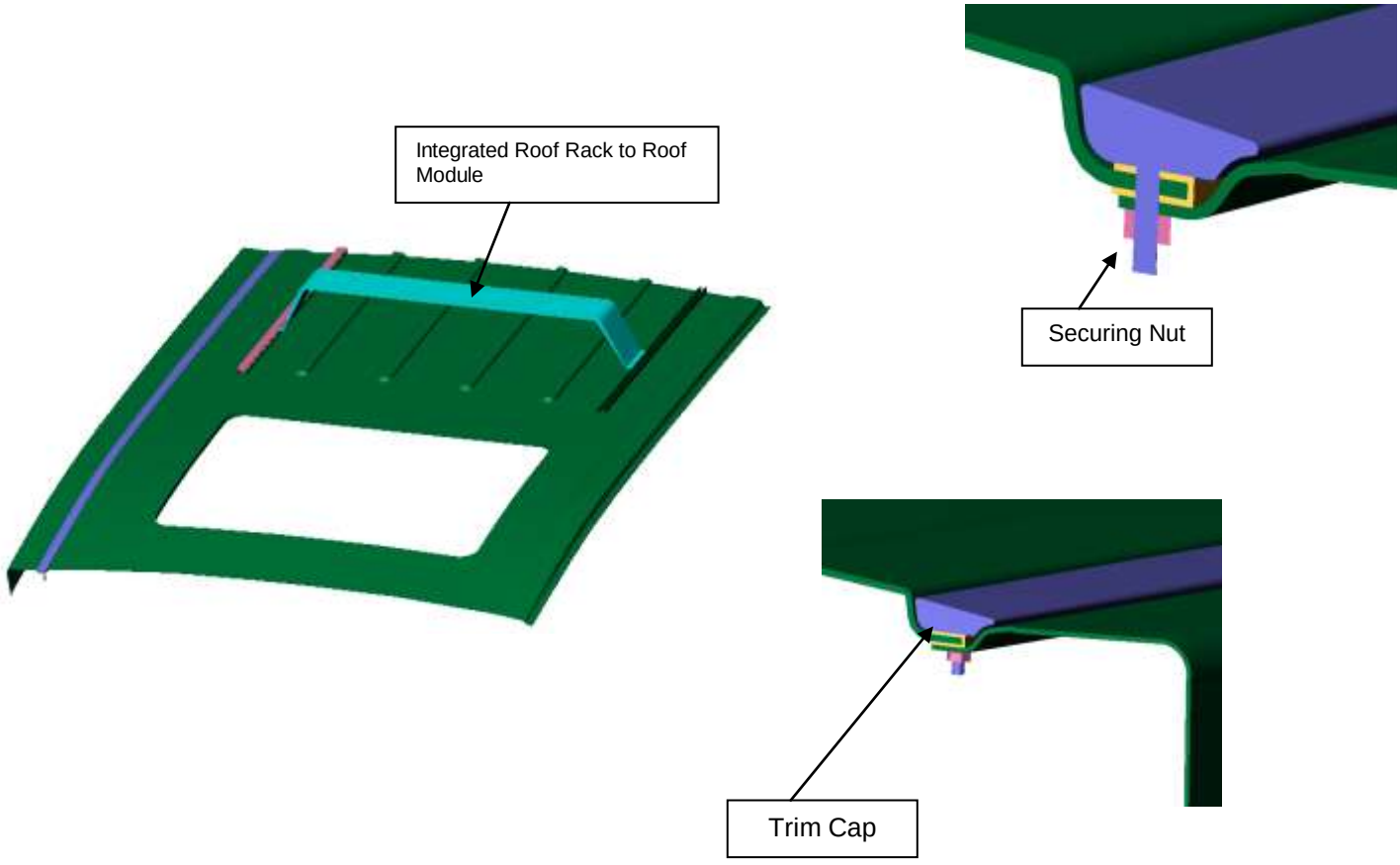


Figure 7: Roof Module and Integrated Roof Rack Attachment to Frame Rail

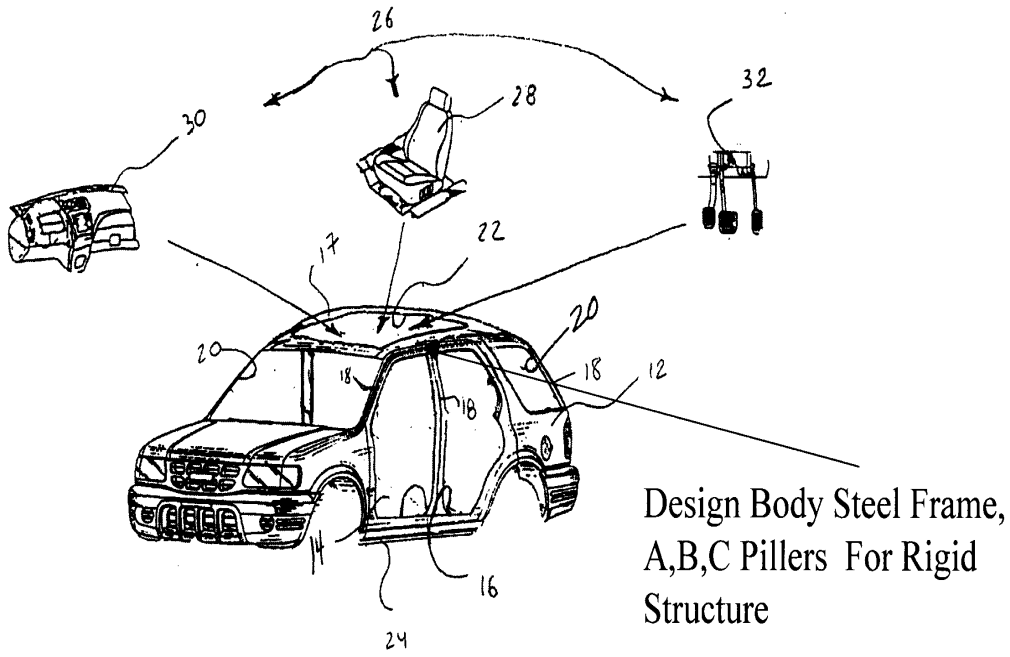


Figure 8: Schematic View Showing Assembly Of Interior Components Through The Roof Opening

Method of Assembling a Vehicle

A method of assembling a vehicle is comprised of several sequential steps. The first step includes fabricating a vehicle body having a floor, door openings, roof pillars, roof frame with roof opening, etc. The next step is placing the body on the vehicle chassis. Once the body is secured, then the doors are attached to the body of the vehicle. The next step is E-coating the body. The process of E-coating is widely specified by automotive OEMs for body and underbody corrosion protection on steel components. This process may help to preserve the underlying material by improving its resistance to environmental degradation, including corrosion and erosion.

Upon the completion of the E-coating process of the vehicle body, the next step is to paint the vehicle body. The body of the vehicle is run through painting booths on the assembly line. The next step is to install interior components, such as seats, instrument panels, center consoles, etc., through the roof opening, as shown in Figure 8. The roof module interior components include items such as clocks, DVD players, antenna farms, decorative linings, lights, headliners, etc. The exterior components, which include roof racks, skid racks, sunroof, etc., are installed on the roof module. The next step includes placing the roof module onto the roof opening and fastening it to the vehicle body, as shown in Figure 7.

The advantages of the method of assembling a vehicle and integrated roof module can be readily appreciated by comparing this method with the currently used method of assembling vehicles in the automotive industry. Present assembly methods tend to be labor intensive, not

cost effective, not ergonomic for installation and time consuming because all interior components, including seats, instrument panel, head liners, etc., are installed through the door opening before the vehicle is ready to leave the assembly line[9]. Assembly of common components, such as tires, windshield, etc., is not discussed in this paper.

Conclusion

An integrated roof module and spoiler system can be manufactured and assembled on a vehicle body in an efficient process. This new method of assembling a vehicle will provide an efficient and economical way to assemble vehicles that will help reduce assembly time, not be labor intensive, be ergonomic for installation and cost effective. The method of assembling a vehicle and integrated roof module is a paradigm shift in automotive vehicle assembly technology.

Acknowledgments

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