Advanced High-Strength Steel Technologies in the 2017 Chrysler Pacifica

Jeff Tibbenham & James Truskin
Fiat Chrysler Automobiles US LLC
The First 5 Generations

The 1st - 1984
1991-1995
1996-2000
2001-2007
2008-2016

MINIVAN HERITAGE

13.5M +
6M
14
3

UNITS SOLD CURRENT OWNERS CONSECUTIVE YEARS HIGHEST LOYALTY AWARDS J D POWER IQS

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“It will be the most technologically advanced minivan ever”. The company is spending $2 billion on engineering, design and manufacturing for the new van.

-Sergio Marchionne

Exterior Styling
2017 PACIFICA Final Design
Roof Options: 2
Cd: 0.3
Passengers: 8
Luxuriously crafted interior
Pacifica - “Why Buy” Pillars

**Versatility & Comfort**
- Multi-functional
  - 8 Passenger Seating with Stow n' Go®
  - Stow n' Go Assist®
  - Heated & Ventilated Seats
  - Heated Steering Wheel
  - Power 3rd Row

**Safety & Security**
- Comprehensive Feature Suite
  - ParkView® Rear Backup Camera
  - Surround View Camera
  - Forward Collision Warning
  - Adaptive Cruise Control
  - LaneSense® Lane Departure Warning
  - ParkSense® Parallel/Perpendicular Park Assist With Stop
  - KeySense™ Programmable Key Fob

**Technology & Entertainment**
- Industry Leading
  - 10" Seatback Touch Screens In 2nd Row
  - Blu-Ray DVD
  - Wireless & HDMI Device Connectivity
  - 7" TFT Instrument Cluster

**Design**
- Modern & Stylish
  - Tri-pane Vista View Sunroof
  - 20" Wheels
  - LED Accent Lighting
  - Rotary Style E-Shift

**Fuel Economy & Convenience**
- Efficient
  - Hybrid Technology
  - Hands Free Sliding Doors & Liftgate
  - Easy Tilt 2nd row Seats w/Child Seat Preserve
  - Stow ‘n Vac™ Integrated Vacuum
  - Capless Fuel Fill
  - Push-Button Sliding Doors
  - Keyless Enter ‘n Go™ Passive Entry / Push Button Start
All New Hybrid Technology
Most versatile and functional of any Hybrid in the market

Innovative Package
Battery in center of vehicle
- No compromise to cargo objectives
- Neutral handling effects

Class-Leading Performance

<table>
<thead>
<tr>
<th>CITY MPG</th>
<th>BATTERY</th>
<th>RANGE</th>
<th>CHARGE TIME</th>
</tr>
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<tbody>
<tr>
<td>84</td>
<td>16 kWh</td>
<td>33 mile</td>
<td>2 hrs</td>
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</table>
PACIFICA Body Structure
The Road to Success
Challenges: Pacifica BIW Design

SAFETY
- IIHS TSP+ (incl. GOOD SORB rating)
- 5* NCAP
- FMVSS Regulations

NVH
- Quietist/Best Handling Minivan
- Structural Rigidity & Isolation
- Local Stiffness

CAPABILITY
- 8 Passenger Seating
- 2nd Row Width
- 4’x8’ Plywood

WEIGHT
- >10% Mass Reduction
- Increased functional objectives

MANUFACTURING
- Current model & Pacifica manufactured on same line
- Minimize Downtime

PHEV
- Protect Interior Space
- Common Body Structure
Engineering Development Process

Voice of the Customer

Vehicle-Level Functional Objectives

Body System Functional Objectives

Design Execution

- Load Paths
- Joints
- Sections
- Materials

Rapid Concept Development (RCD)

- FCA toolset and strategic approach to BIW structure development
- Faster concept → CAE assessment loop
- Increased number of assessed concepts
Rapid Concept Development (RCD) Process

New Package

New Section Proposals

Benchmarking & Topology Optimization

Surrogate Geometry

CAE ANALYSIS

Concept 1

Concept 2...

Joint Stiffness Assessment

Optimization
- Thousands of optimization runs
- Structural knowledge building
- Early mass reduction initiative

Design Development
- Detailed Design
- Material Selection

New RCD Baseline Model

New Theme
Load Path Concept Generation

Load Path Optimization

- Critical activity for efficient use of material
- Optimized structure around key packaging hard points
Pacifica BIW Design Optimization Tools

- Global Topology Optimization
  - (Loadpaths)
- Multi-Disciplinary Optimization – MDO
  - (Weight, Attribute Balancing)
- Panel Bead Optimization
  - (Local Stiffness, Mobilities)
- Weld/Adhesive Optimization
- Joint & Section Optimization
  - (Continuity)
- Sub-System & Component Topology Optimization
  - (Efficiency)
- Sub-System & Component Topology Optimization – MDO
- (Efficiency)
“Pacifica Minivan lost 250 pounds [113kg].”

“At 4,315 pounds [1876kg], the new Pacifica is 250 pounds [113kg] lighter than the outgoing Chrysler Town & Country and is the lightest minivan on the road...”
Weight Reduction Breakdown

- **FEM + BUMPERS**: -11% 
  - 64 kg

- **CLOSURES**: -22% 
  - 28 kg

- **BIW**: -12% 
  - 512 kg

**TOTAL BODY SYSTEM WEIGHT REDUCTION**: -13% (76 kg)
BIW Materials: Mild Steel Applications

Mild Steel

- YS <210 MPa
- (115kg)
- 25.4%
BIW Materials: HSS Applications

HS Steel
>210 MPa YS
(102kg)
22.6%
BIW Materials: AHSS Applications

- AHS Steel
- DP590
- TRIP690

(135kg) 29.9%
BIW Materials: UHSS Applications

AHS Steel+
DP780
(37kg) 8.2%
Hydroformed Upper Load Beam

- (2) DP780 Hydroformed tubes
- Optimized strength, stiffness and load path requirements around tight packaging

1.8 kg Saved per Vehicle
BIW Materials: Press Hardened Steel (PHS)

Press Hardened Steel
PHS1300, PQS550
(50kg) 11.1%
Front Door Ring Strategy

- 5-piece, multi material welded blank
- Eliminated insert and assembly operations
- Weight = 13.7kg per side

10kg saved per vehicle
Component Testing and Validation

B-Pillar Component Simulation Model

B-Pillar Component Validation Test
BIW Materials: Plastic Structural Inserts and Baffles

Plastic Structural Inserts & Baffles (2kg) 0.4%
BIW Materials: Other – Metal–Plastic–Metal Laminates (NVH)

Other NVH Steel (11kg) 2.4%
BIW Materials Strategy

- **Mild Steel**
  - YS <210 MPa
  - (102kg) 22.6%

- **HS Steel**
  - YS >210 MPa
  - (115kg) 25.4%

- **AHS Steel**
  - DP590 TRIP690
  - (135kg) 29.9%

- **AHS Steel+**
  - DP780
  - (37kg) 8.2%

- **Hot Stamp**
  - PHS1300, PQS550
  - (50kg) 11.1%

- **Plastic Structural Inserts**
  - (2kg) 0.4%

- **Other, NVH Steel**
  - (11kg) 2.4%

- **Hot Stamp**
  - PHS1300, PQS550
  - (50kg) 11.1%

- **AHS Steel+**
  - DP780
  - (37kg) 8.2%

- **AHS Steel**
  - DP590 TRIP690
  - (135kg) 29.9%

- **Other, NVH Steel**
  - (11kg) 2.4%

Total:

- **72%** HSS
- **2016 Town & Country**
- **50%** HSS
- **2017 Pacifica**
- **72%** HSS
CLASS-LEADING Performance Impact
Impact Development

REGULATORY

NHTSA RATING
TARGET

IIHS RATING
TARGET

TSP+

> 8500
CAE SIMULATIONS

3rd PARTY (IIHS)

> 80
FULL VEHICLE
IMPACT TESTS

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#GDIS | #SteelMatters
Frontal Impact Load Paths

Dual Impact Load Path Strategy

- AHSS Front Rails (70%)
- AHSS Front Cradle (30%)
  - Engineered detach of front cradle rear mount for increased crush space
Offensive and Defensive Structure

- Body and Chassis systems work together early in the event
- AHSS Safety cage reduces passenger compartment intrusions
Offensive Enablers

- Early engagement of body rail and chassis structure initiate lateral movement away from barrier
- Integrated bumper and UHSS Load beam system
**Defensive Enablers**

- AHSS/UHSS-Reinforced Safety Cage
  - TWB Press Hardened door ring
- Strategic flange conditions for welds in shear and compression loading
AHSS/UHSS Rear Rail Assembly

- Optimized rear rail topology and suspension design for improved load path continuity and suspension clearance
- Optimized lateral bending mode of DP590 Rear Rail for efficient energy absorption
UHSS Safety Cage

- Press Hardened, integral A-Plr and B-Plr reinforcements
- Press hardened roof bow and front header for load transfer
- Load achieved: >4.5 x GVW
Safety Performance Summary

Crashworthiness
- Small overlap front: G
- Moderate overlap front: G
- Side: G
- Roof strength: G
- Head restraints & seats: G

CRASH AVOIDANCE & MITIGATION
With optional equipment

www.iihs.org
CLASS-LEADING Performance
Quietest and Best Handling Minivan
Multi-Ring Body Structure Concept

- Front End Module
- +Shock Tower / Plenum / Cradle
- B-Plr / C-Plr / D-Plr

D-Ring Structure Optimization

- Structural insert in Upper D-Plr
  - +1.3 Hz and **2.7 kg saved per vehicle**
  - Improved shake performance

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**NVH – Torsion Mode**

1st BIW Torsion Mode

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Town &amp; Country</th>
<th>PACIFICA w/o D-Plr Inserts</th>
<th>PACIFICA</th>
</tr>
</thead>
<tbody>
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<td></td>
<td>26.9</td>
<td>29.2</td>
<td>30.5</td>
</tr>
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</table>
Competitive Body Torsional Stiffness

Lightweight Index

Body in White Mass (kg)
Area (m$^2$) x Torsional Stiffness (kN-m/deg)

Torsion Stiffness

Torsion Stiffness (kNm/°)

- Town & Country: 22.9
Improved Body Bending Rigidity
- Continuous rail loadpaths
- Minimized upperbody breathing
- Strategic placement of modal nodes

BIW 1st Bending Mode

- Frequency (Hz)
- Town & Country: 32.2 Hz
- PACIFICA: 37.6 Hz
Improved Body Bending Rigidity

- Reduced excitation of body structure to P/T, Chassis vibration inputs
- Improved ride and shake performance
- Advanced topology-based stiffness optimization techniques targeted strategic areas for modeshape improvement
Multi-ring body structure concept

- Continuous, multi-plane ring structure
  - Bolt-in FEM-load beam braces
- Solid-mounted cradle for improved isolation, front end stiffness and vehicle dynamics
NVH – Local Attachment Stiffness

Significant stiffness improvement at key noise and vibration input points

- Engine Mounts
- Trailing Arm Attachment
It’s certainly the best minivan I’ve driven, but it might be better than a number of popular crossovers too.

James Derek Sapienza – Autos Cheat Sheet

The suite of safety features seamlessly picked up where my mirrors and windows left off, and the big V6 moved the 4,350-pound van well enough to not leave me wanting for anything when accelerating for lane changes and stop lights.

James Derek Sapienza – Autos Cheat Sheet

Riding on an all-new platform with 22 percent more high-strength steel and close to 130 meters of structural adhesives—thus boasting a 68 percent increase in stiffness—the Pacifica proved as solid as it did quiet. No squeaks or rattles and minimal wind and road noise.

Ron Kino – Motortrend

At an estimated 4,300 pounds, the Pacifica is about 250 pounds lighter than the old Town & Country. Credit the weight loss to the bump in high-strength steel, not to mention the introduction of aluminum sliding doors and an aluminum-magnesium liftgate.

Ron Kino – Motortrend

Slapping aggressive price tags on a minivan is one thing. Backing it up with best-in-class performance and functionality is another. With Pacifica, Chrysler has successfully managed to do both. And it has purposes a box into a sleek, sexy benchmark of style.

Ron Kino – Motortrend

No, minivans aren’t cool, but the 2017 Chrysler Pacifica is close.

Antuan Goodwin – Road Show by CNET

It also looks like a spaceship mated with a Ninja Turtle when viewed from straight on. This kind of funky, kind of cool look adds to the Pacifica’s curb appeal, I think.

Antuan Goodwin – Road Show by CNET

“You guys remember, ‘Get Shorty,’ right?...It’s cool driving a minivan.”

President Barack Obama – NAIAS
Thank You!
For More Information

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Presentations will be available May 22 at www.autosteel.org