The new 911 Carrera Technology Workshop
Body and manufacturing
The new 911 Carrera – Agenda

1. Warm-up
2. Development
3. Body highlights
4. Production
5. Finish
The new 911 Carrera – Highlights

Design
- Exterior even more muscular and contemporary
- Even wider body

Performance & efficiency
- Optimised three-litre six-cylinder flat engine with 450 hp
- New eight-speed Porsche dual-clutch transmission (PDK)

Lighting and assistance systems
- LED matrix headlights
- Night Vision Assist
- Porsche Wet Mode

Individualisation
- Lightweight carbon roof
- Sport Design Package

Driving dynamics and driving comfort
- New Porsche Active Suspension Management
- New wheels and tyres with different dimensions (Front: 20-inch; rear: 21-inch)
- New engine mounts
The new 911 Carrera – Development weight-to-power ratio

Weight in kg

Weight-to-power ratio in kg/hp

Original 911 (1963-1973)
964 (1988-1994)
993 (1993-1998)
996 (1997-2006)
997 (2004-2012)
991 (2011-2018)
992 (2018- )
The new 911 Carrera – Agenda

1. Warm-up
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The new 911 Carrera – The eighth generation of the 911
MMB* platform
- Group modular platform
- Platform users
- Drive technologies

Product
- Systematic lightweight design
- Multimaterial body
- Innovative joining technologies

Process
- Derivatives development without prototypes
- New multi-story body manufacturing plant at brownfield site
- Methods development
- Up to nine body variants and two platforms on one production line

The new 911 Carrera – Challenges
* Modular mid-engine platform
The new 911 Carrera – Modular Mid-Engine Platform MMB

MMB platform

911

Coupé
Carrera Turbo GTX Carrera Turbo GTX

Cabrio

Targa

718

Coupé
Base GTX Base Spyder

Cabrio
Der neue 911 Carrera – Modulares Plattformkonzept
The new 911 Carrera – Agenda

1. Warm-up
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The new 911 Carrera – Reversal of the upward weight spiral

Body weight in kg

- 996 (1997-2006)
- 997 (2004-2012)
- 991 (2011-2018)
- 992 (2018 - )

Changes:
- +10% (1997-2006 to 2004-2012)
- -11% (2004-2012 to 2011-2018)
- -5% (2011-2018 to 2018 - )
The new 911 Carrera – Material concept

- Steel sheet (cold): 13% (+4%)
- Steel sheet (hot): 1% (+4%)
- Aluminium sheet: 25% (+22%)
- Extrusion profile: 991 (-37%)
- Cast aluminium: 32% (+7%)
- Cast steel: 17%
The new 911 Carrera – Development of joining technology

911 (Type 997)
- Sheet steel (cold)
- Resistance spot welding
- MAG welding
- Adhesive bonding
- Clinching

911 (Type 991)
- Steel sheet (cold)
- Steel sheet (hot)
- Aluminium sheet
- Extrusion profile
- Cast aluminium
- Cast steel
- Resistance spot welding
- MAG welding
- Adhesive bonding
- Clinching
- Semi-tubular rivets
- Flow-drilling screws
- MIG welding

911 (Type 992)
- Steel sheet (cold)
- Steel sheet (hot)
- Aluminium sheet
- Extrusion profile
- Cast aluminium
- Cast steel
- Resistance spot welding
- MAG welding
- Adhesive bonding
- Clinching
- Semi-tubular rivets
- Flow-drilling screws
- MIG welding
- Solid punch rivets
- Roller hemming
- Friction welding
The new 911 Carrera
Lightweight design of exterior side panel using aluminium

Weight reduction per vehicle

12 kg
The new 911 Carrera – Approach to the use of casting materials over time

- 997: 0%
- 991: 9%
- 992: 13%
Process optimisation

- Eliminates need for heat treatment at manufacturer
- Finished mechanical properties by input of heat in CDC process

Benefits

- Improved CO₂ footprint due to elimination of heat treatment at manufacturer
- Lower part costs
- Improved punch rivet process
Two load beams, one variant
- Lightweight coupé vehicles
- Heavy cabriolet/targa/turbo vehicles

Differentiated by wall thicknesses of the extrusion profiles with
- the same fastening points to the higher-level structure
- same joining technology to the higher-level structure

Goal
- Weight- and function-optimised structure for absorbing different levels of energy while conforming to mounting space limitations
Improvement of local dynamic transfer stiffnesses by

- optimised double-shear joints of the strut tower
- weight- and package-optimised braces concept

Goals

- Reduced rolling noise at front wheels
- Improved driving stability of front body
## The new 911 Carrera – Stiffnesses

<table>
<thead>
<tr>
<th></th>
<th>Torsion</th>
<th>Bending</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dynamic stiffness</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Body-in-white</strong></td>
<td>&gt; 53 Hz</td>
<td>&gt; 76 Hz</td>
</tr>
<tr>
<td><strong>Trimmed body</strong></td>
<td>&gt; 27 Hz</td>
<td>&gt; 29 Hz</td>
</tr>
<tr>
<td><strong>Static stiffness</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Body-in-white</strong></td>
<td>&gt; 39,000 Nm/°</td>
<td>&gt; 25,000 N/mm</td>
</tr>
</tbody>
</table>
The new 911 Carrera – Pressed part competence at Porsche
The new 911 Carrera – Universal process from design to part

- Design
- Simultaneous engineering
- Tool engineering
- Tool building
- Quality process
The new 911 Carrera – Requirements for an exterior side panel

Porsche DNA

- Aluminium
- Highly precise fit and repeatability

Dynamics

- Higher design requirement
- Increasing tool complexity
- Shorter manufacturing times and reaction times

Business requirements

- Strategic goals
- Legal requirements

Impression

- Highly precise fit and repeatability

Lightweight design
The new 911 Carrera – Technical challenge of the side panel
Example of exterior side part

- Forming force: > 1200 tonnes
- Weight of drawing tool: > 45 tonnes
- Blank holder travel: > 325 mm
- Forming precision: ±0.02 mm
- Drawing depths: up to 300 mm
The new 911 Carrera – Body manufacturing in Zuffenhausen
The new 911 Carrera – Flexible body manufacturing over four storeys

- **2nd Upper level**: Structure, Front lid, Rear lid, Doors
- **1st Upper level**: Platform, Side panels, Roof frame
- **Ground level**: Front body, Middle floor, Rear body
- **Basement**: Platform

911 Taycan
The new 911 Carrera – Flexible and innovative production systems technology

**Flexibility**
- Shared body manufacturing for 911, 718 and Taycan
- Up to nine side body variants

**Innovation**
- Energy and control technology
- Human–robot collaboration
- Digital planning tools

**Automation**
- 280 robots
- 404 m travel axis
- approx. 1,000 system components

**Conveyor technology**
- 2,200 m skid conveyor technology
- 1,500 m overhead conveyor technology
- 1,800 m chain conveyor technology
The new 911 Carrera – Porsche Group Framer

**Flexibility**
- Shared production line for 911 and 718
  - Up to nine plus two side panel variants

**Innovation**
- Implementation of highly flexible framer concept in compact construction
  - Automated part feed in “wild mix”

**Automation**
- Clamping frame transport by framer portal
  - Camera-guided roll hemming
  - Variant changeover: no cycle time loss

**Production area**
- Structures 1 and 2
The new 911 Carrera – Flexible side panel manufacturing

**Flexibility**
- Shared manufacturing island for exterior side panel of 911 and 718
- Flexibility for seven plus two side panel variants

**Innovation**
- Use of storage and retrieval machine with 18 spaces (cycle time neutral) for provision of tools
- Automated part feed in “wild mix”

**Automation**
- Fully automated changeover of tools
- Automated process monitoring (with cameras) of derivative-specific parts

**Production area**
- Exterior side panel
The new 911 Carrera – Human-robot collaboration (MRK)

**Flexibility**
- Use of innovative technologies in production applications
- Ergonomic work processes
- Working without safety fence

**Innovation**
- Human-robot collaboration
- “Grab in the box”
- Flexible component feed

**Automation**
- Heavy-duty robot with capacitive skin
- Driverless transport system (FTS) for flexible changeover of load carriers

**Production area**
- Rear body
The new 911 Carrera – Management architecture

- All data is saved from the first production step.
- Quality data, measurements and information on joints are available throughout the process chain.
- This database assures that high Porsche quality requirements are fulfilled at all times.

**Production control**

- Customer orders
- Order sequence
- Formulation
- Production orders
- Vehicle configuration document
- Quality data
- Systems messages
- Fault messages

**Shop floor**

Physical production
### The new 911 Carrera – Joining technologies in the multimaterial mix

<table>
<thead>
<tr>
<th>Joining Technology</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance spot welding</td>
<td>813 units</td>
</tr>
<tr>
<td>MAG welding</td>
<td>3.5 m</td>
</tr>
<tr>
<td>MIG welding</td>
<td>17 m</td>
</tr>
<tr>
<td>Clinching</td>
<td>527 units</td>
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<tr>
<td>Semi-tubular rivets</td>
<td>1,944 units</td>
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<tr>
<td>Flow-drilling screws</td>
<td>596 units</td>
</tr>
<tr>
<td>Adhesive bonding</td>
<td>188 m</td>
</tr>
<tr>
<td>Solid punch rivets</td>
<td>6 units</td>
</tr>
<tr>
<td>Roller hemming</td>
<td>4.8 m</td>
</tr>
<tr>
<td>Friction welding</td>
<td>116 units</td>
</tr>
</tbody>
</table>
The new 911 Carrera – Joining technology: friction welding

**Flexibility**
- Qualification of "new" method for joining high-strength steels and aluminium directly

**Innovation**
- Reduced number of individual parts by eliminating adapter parts/bridge parts
- No annoying contour due to joining element (use in functional areas like window mounts)

**Product**
- Reduced number of parts
- Eliminates seam sealing in wet area

**Application**
- Window mount flange
- Roof frame
- Rear window
The new 911 Carrera – Joining technology: roll hemming of door sill

**Flexibility**
- Qualification of method for joining aluminium side panel with hot-formed interior panel

**Innovation**
- Hemming of side panel to structure in three stages
  - No other joining technologies needed for joint

**Product**
- No annoying contour due to joining elements (seal assembly)
  - High flexibility of roll hemming head in derivative integration

**Application**
- Door sill
The new 911 Carrera – Agenda

1. Warm-up
2. Development
3. Body highlights
4. Production
5. Finish
The new 911 Carrera – Finish

- Exterior design even more muscular and contemporary
- Heightened body stiffness
- First use of MMB platform
- Lightweight design with multimaterial body structure
- Advanced development of joining technologies
- Flexible and innovative body manufacturing