

Great Designs in

# STEEL



## Strategic Steel Application in the Acura NSX Space Frame

**Kurtis Horner**

**Honda R&D Americas, Inc.**



- Background
- Design Requirements
- Technology Selection
- Three Dimensional Hot Bending and Direct Quench (3DQ) Technology
- Summary and Conclusion



Recreating an Icon

ACURA | NSX

# NSX

New

Sports

eXperimental



1989

NSX

## Human-centered



### **Rigid & Lightweight**

- All aluminum body

### **Visibility & Stability**

- Advanced sport package

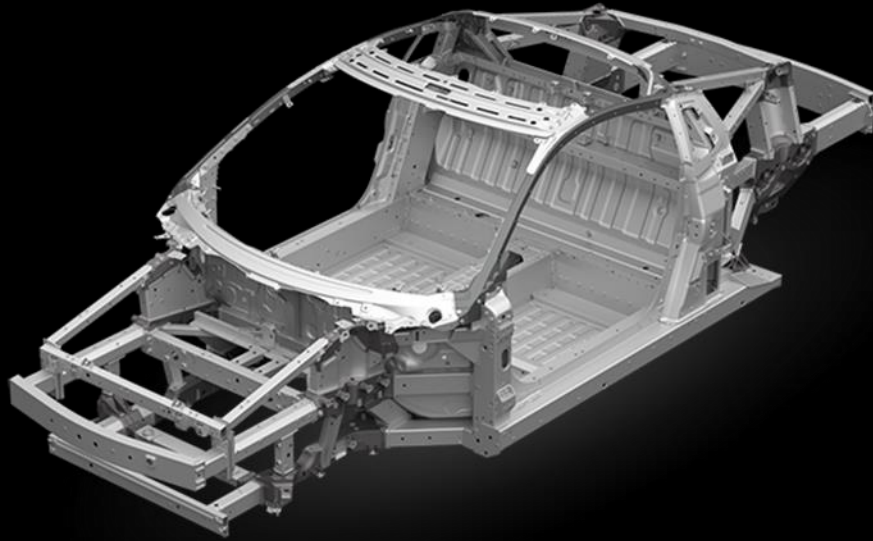
### **Quality, Reliability and Durability**

# New Sports eXperience

- Instant Acceleration ( Incredible G-feeling )
- Direct Yaw Control ( Super Handling )
- Integrated Dynamics System ( Wide Range )



# New Sports eXperience



**Driver-centric**

**Styling**

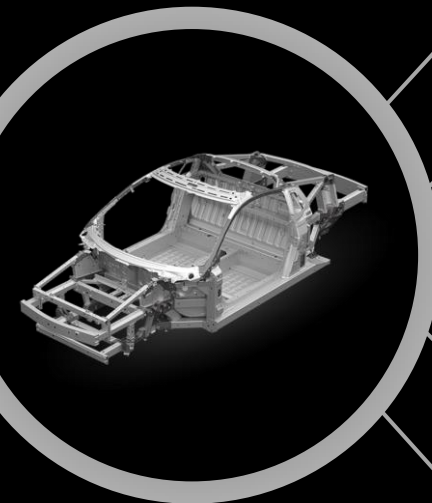
**Instant Response**

**Honda DNA**

**Precision Craftsmanship**

# New Sports eXperience

## Requirements



**Driver-centric**



- Package
- Visibility

**Styling**



- Thin A Pillar
- Sash-less Door

**Instant Response**



- High Rigidity

**Honda DNA**



- Crashworthiness
- No-Sacrifice Supercar DQR

**Precision Craftsmanship**

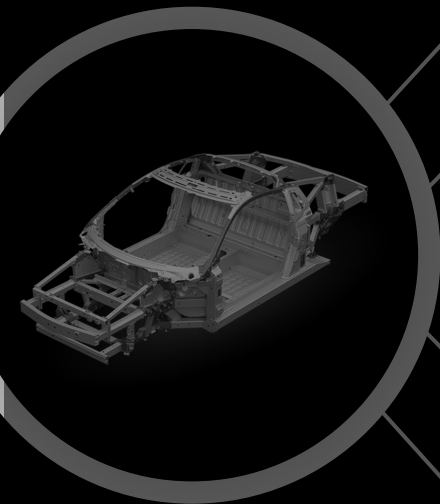


- High Accuracy
- High Efficiency



# New Sports eXperience

A Pillar Design Concept Aligned with Vehicle Concept



Driver-centric

Styling

Instant Response

Honda DNA

Precision Craftsmanship

**Minimize  
Weight and View Obstructions**

**Maximize  
Interior Space and Safety**

Compact High Strength Steel Front Roof Rail

Thin A Pillar



Optimized visibility  
Low instrument panel surface  
Thin Pillar

Low Dash



# Forward Visibility



**NSX**

Standard Car

Competitor

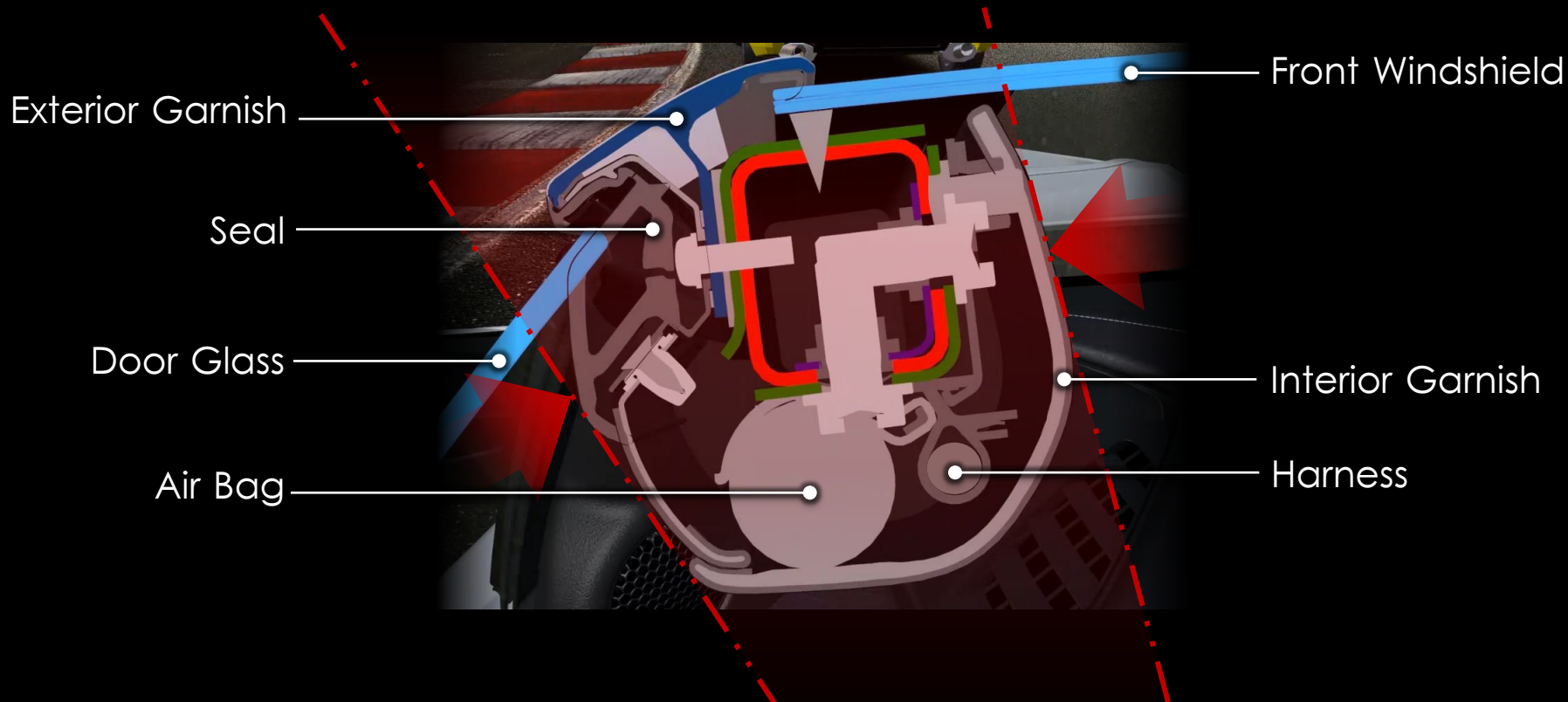
Forward Visibility

ACURA | NSX










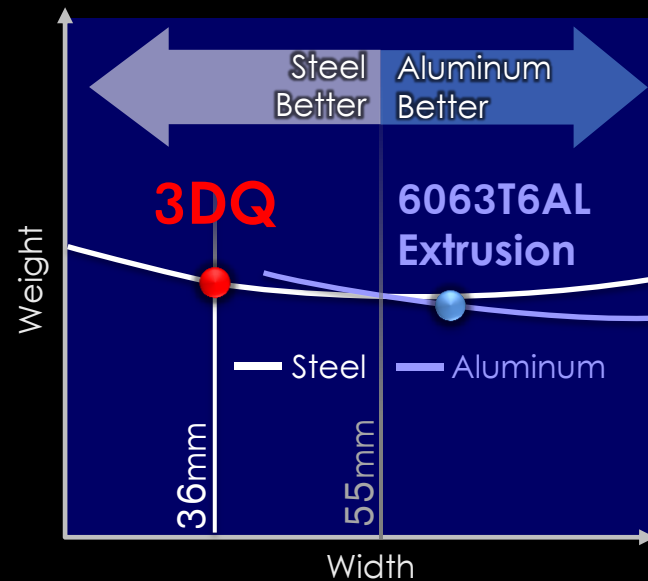
## Small design space and high accuracy requirements for surrounding part interfaces



# Correct Material in Correct Location

	PHS	Hydro-Forming	Aluminum Casting	Aluminum Extrusion	3DQ 3-D Quench
					
Performance	●	●	●	●	●
Weight	●	●	●	●	●
Pillar Size	●	●	●	●	●
Productivity	●	●	●	●	●

Optimum material selection



## Strengths

### Material Properties

- High Strength
- High Stiffness

### Productivity

- Fast maturation
- Low die investment

### Low Weight

- Hollow tubular structure

### Variable Curvature

- Conforms to styling shape



## Design Challenges

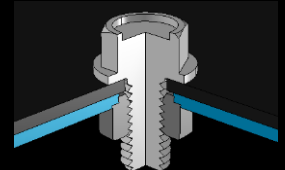
### Constant Cross Section

- Cross section can not vary with mating part requirements



### Fastening

- Laser welding
- Bolting
- Projection stud welding



### Corrosion

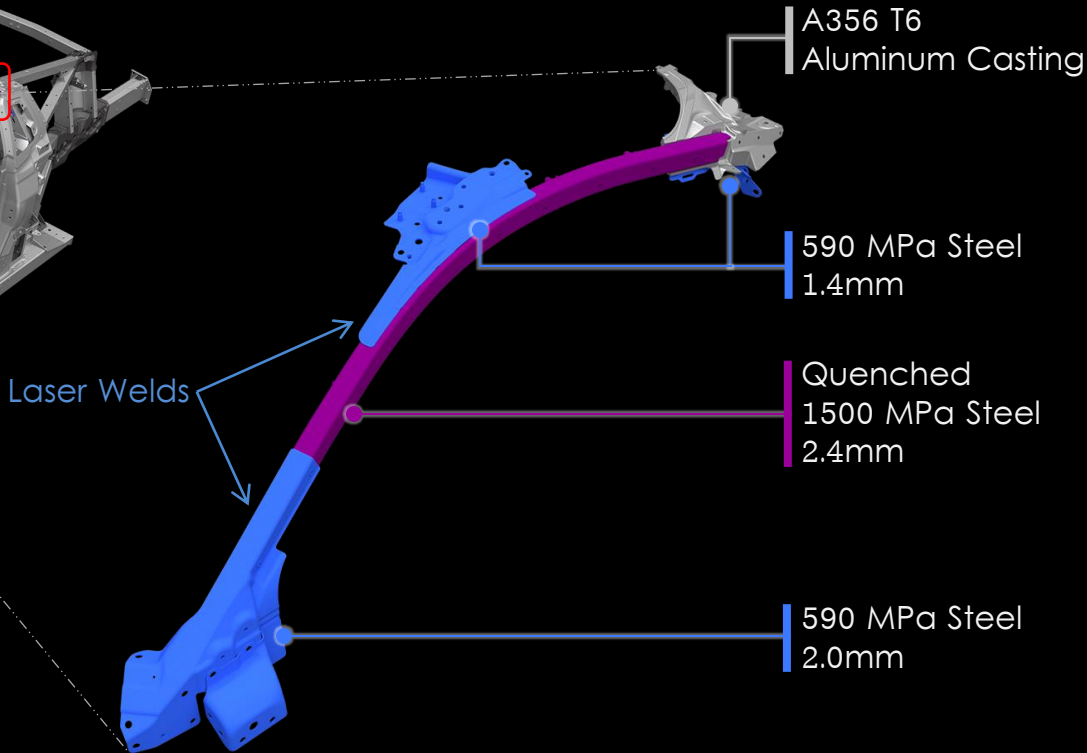
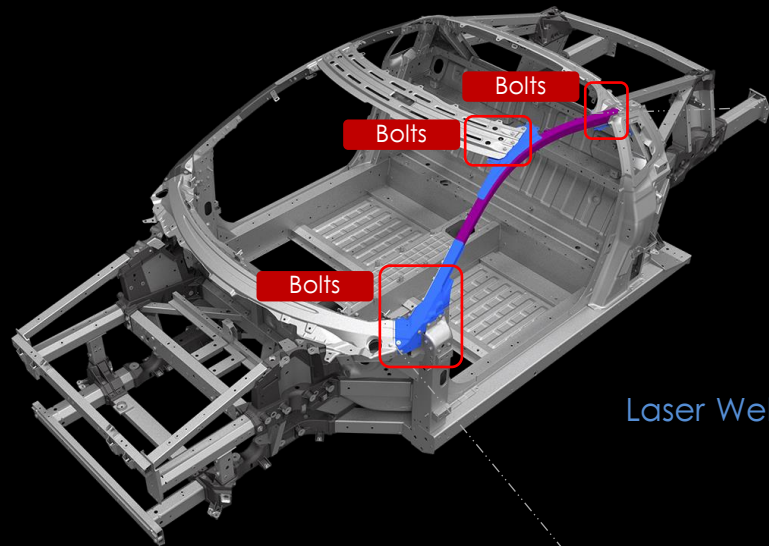
- Multi-material joining

### Part Accuracy

- Assembly sequence
- Manufacturing process

Steel substructure separately e-coated to prevent corrosion

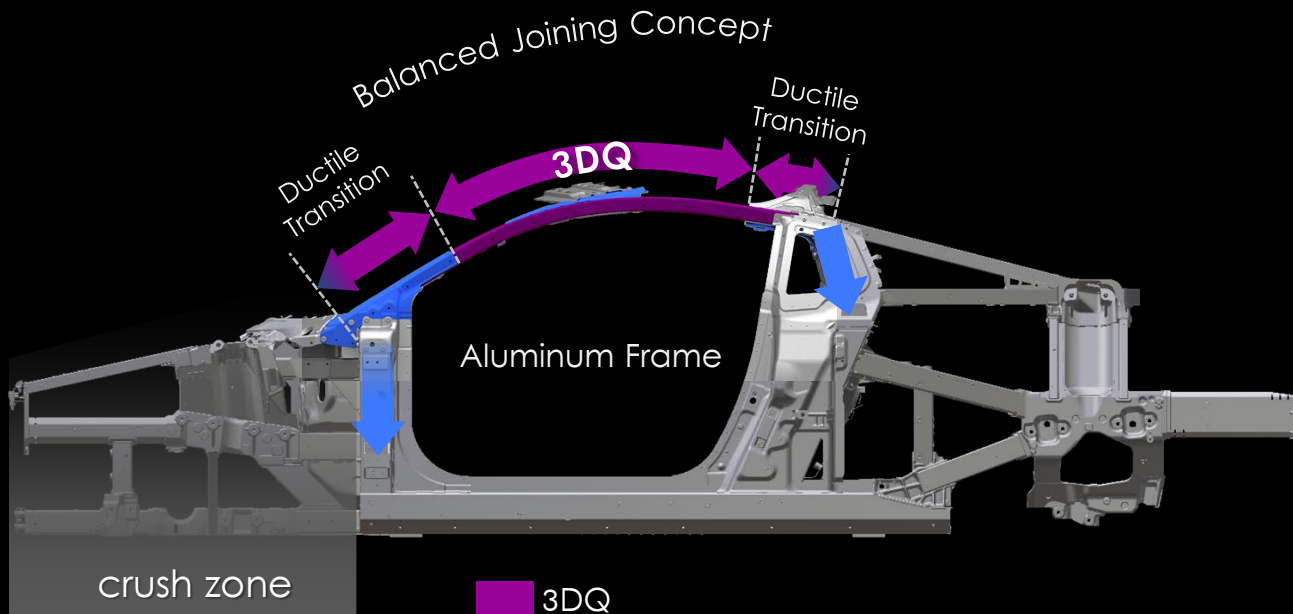
Sheet metal stampings transition to A-pillar structure





## Mechanical Joining Strategy

- Joining Location
- Optimize joint strength for each attachment



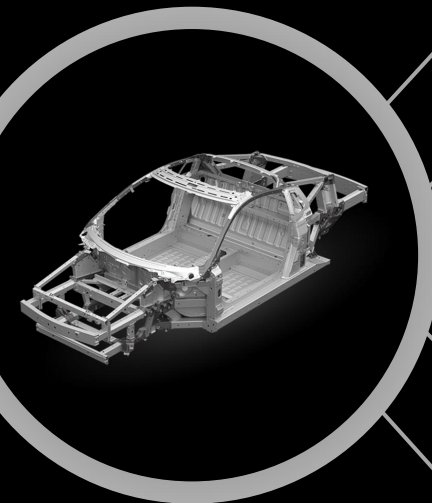


## NSX meets NCAP world test mode standard, hybrid protection, and Honda safety commitment

	Mode	Target	Achievement (In-House Results)
<b>US NCAP</b>	OVERALL	5 ★	5 ★
	Front Collision	4 ★	4 ★
	Side Collision	5 ★	5 ★
	Roll over	5 ★	5 ★
<b>EU NCAP (Collision Modes)*</b>	OVERALL	5 ★	5 ★
	Front Collision	≥ 13.0 pts	13.8 pts
	Side Collision	≥ 14.0 pts	16.0 pts
<b>Other</b>	Roof Crush	FMVSS 216	OK
	Pedestrian	GTR9 Regulation	OK
<b>Honda Safety Commitment</b>	SUV Side Impact	Cabin Integrity, Hybrid Protection	OK
	Side Pole at IPU location		OK
	Car to Car (50kph) NSX vs MDX SUV		OK (CAE)

\* ISOFIX, ISA, LDW, & AEB features are not applied

# New Sports eXperience



**Driver-centric**



## Requirements

- Package
- Visibility

**Styling**



- Thin A Pillar
- Sash-less Door

**Instant Response**



- High Rigidity

**Honda DNA**

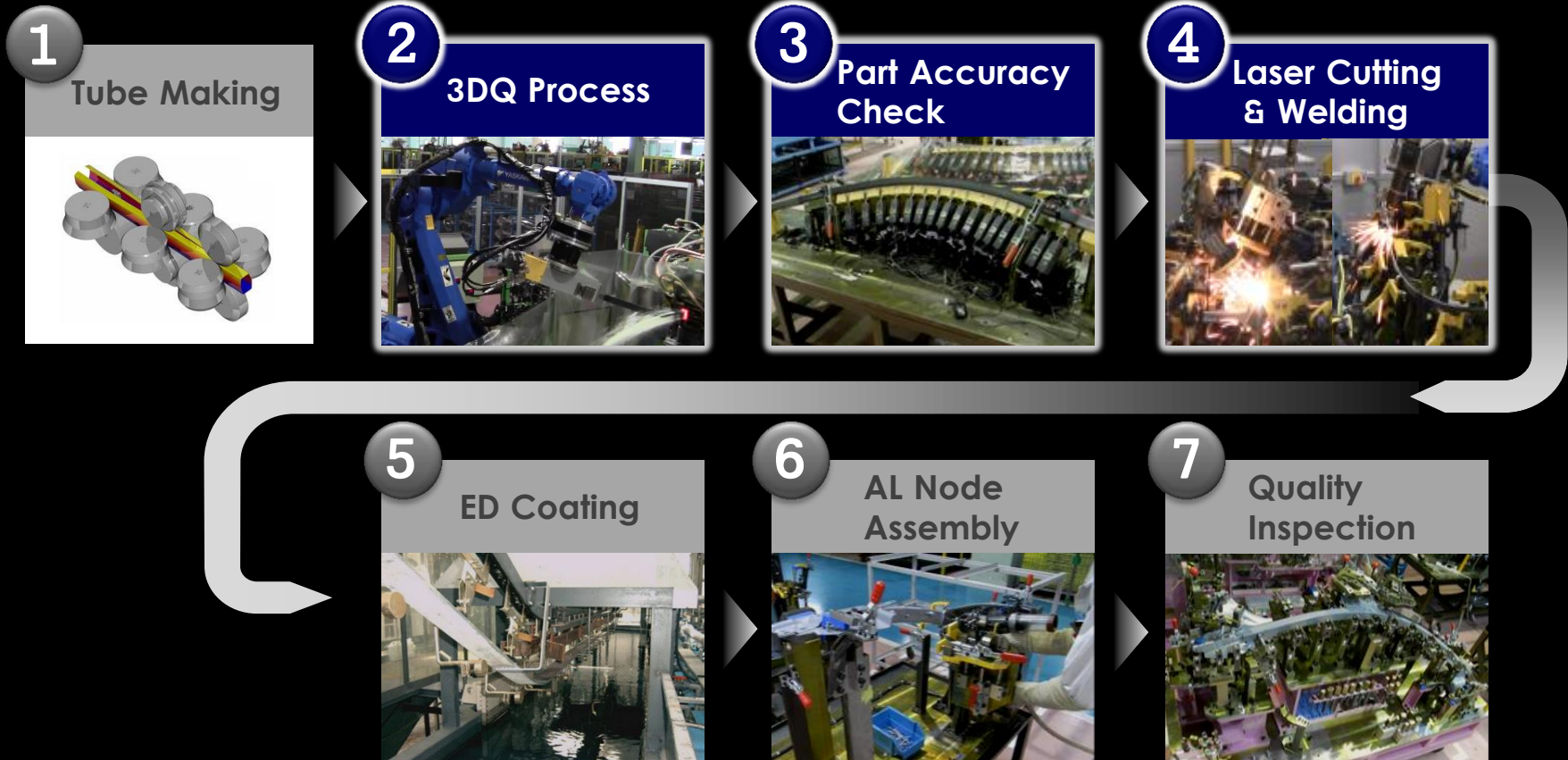


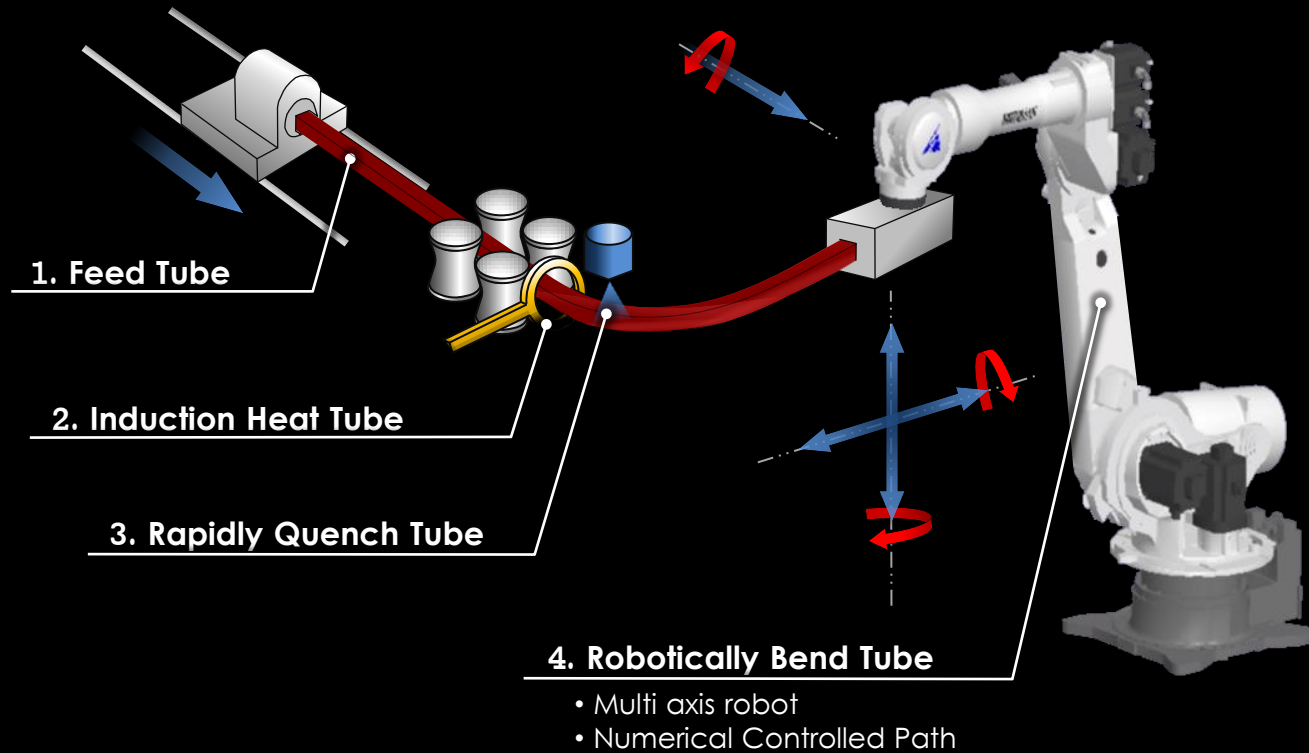
- Crashworthiness
- No-Sacrifice Supercar DQR

**Precision Craftsmanship**



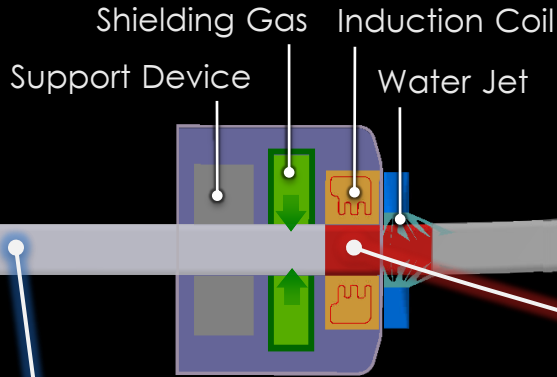
- High Accuracy
- High Efficiency





## High Formability & Low Residual Stress

- No Wrinkling
- No Spring Back
- No Section Collapse
- No Delayed Fracture



### High Strength Tube

Processing Details:

- Tensile Strength  $\approx$ 600 MPa
- Yield Strength  $\approx$ 400 MPa

### Quenched Product

Processing Details:

- Tensile Strength > 1500 MPa
- Yield Strength > 980 MPa



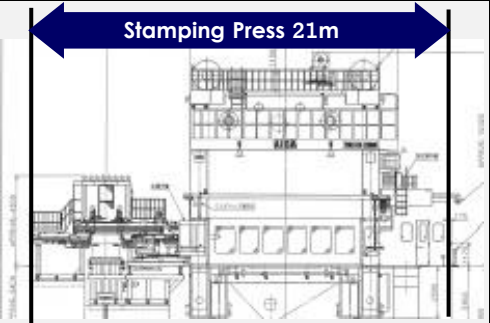














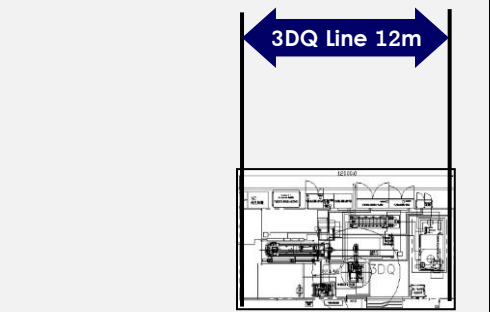
Ultra high strength due to Martensitic grain structure

### Heated Portion

Processing Details:

- Temperature >850°C
- Tensile Strength  $\approx$ 50 MPa
- Yield Strength  $\approx$ 40 MPa

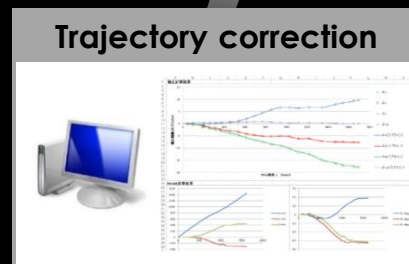
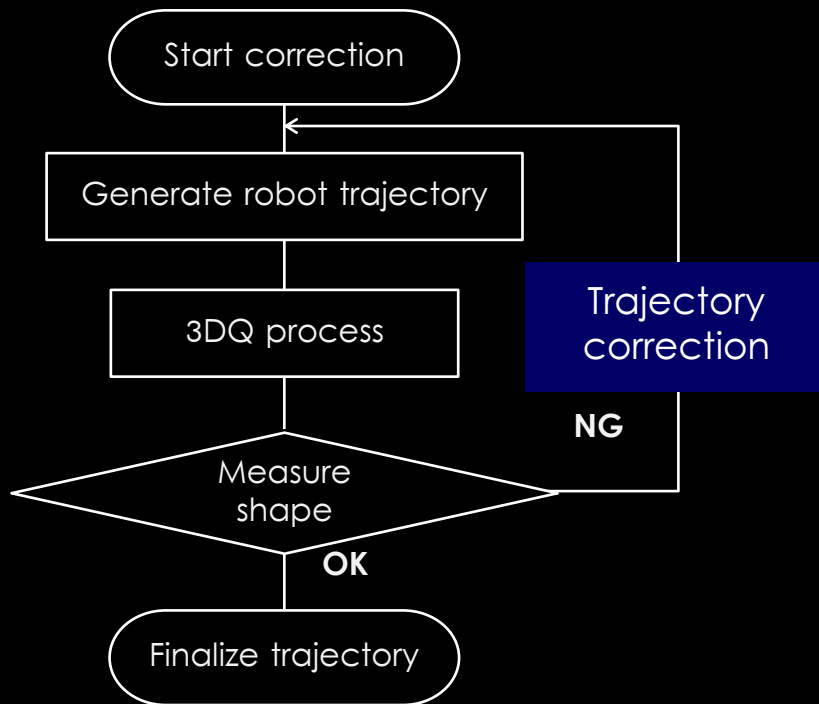
## 3DQ can produce parts without dies and with minimal space

Process	Production Line Size		Dies				
<p>2500ton Transfer Press</p> 			<table border="1"> <tr> <td></td> <td></td> </tr> <tr> <td></td> <td></td> </tr> </table> <p>At minimum, 4 processes are needed</p>				
							
							
<p>3DQ</p> 			<p>Dies are not used</p>				

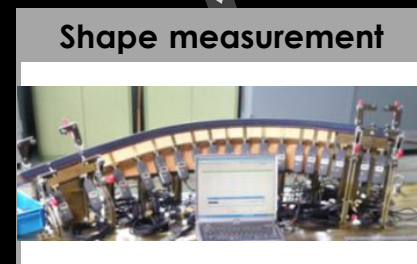


## Accuracy Correction Process

Process trajectory correction achieves  $\pm 0.3\text{mm}$  accuracy



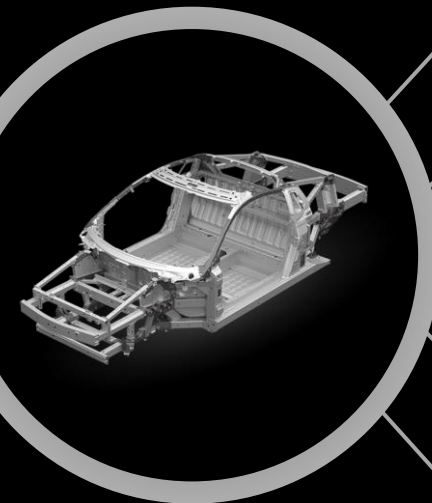
Compensation check and correction for shape variation after every part



72 digital measurement points

# Three-Dimensional Hot Bending and Direct Quench

# New Sports eXperience



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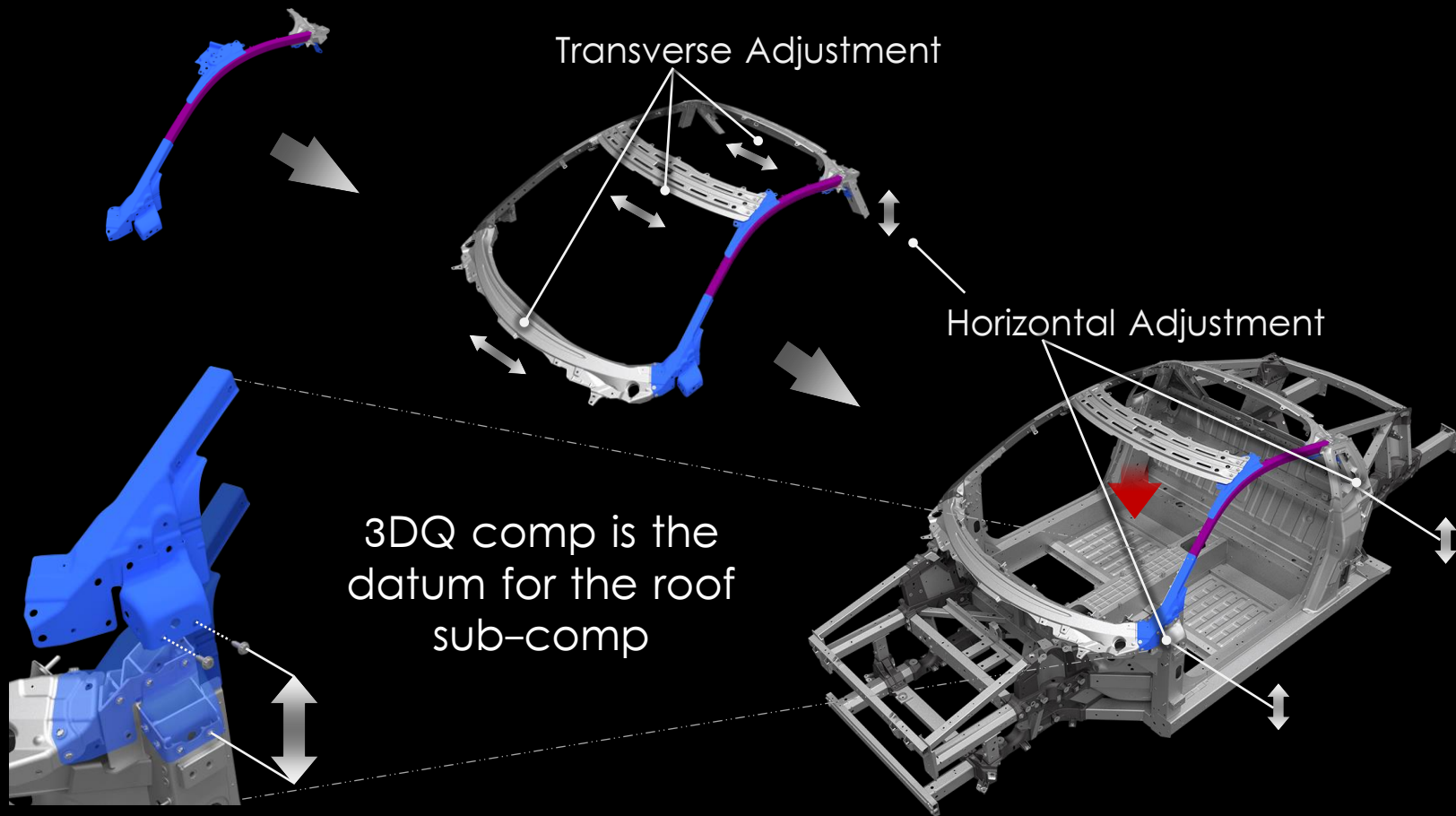


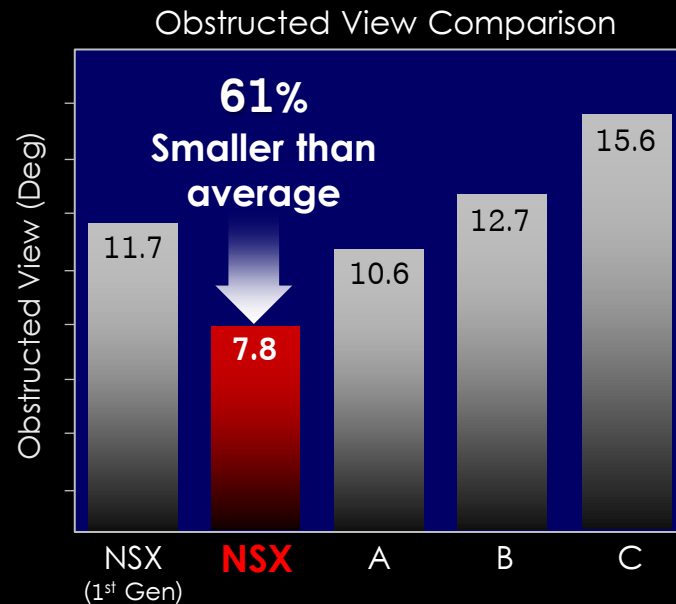
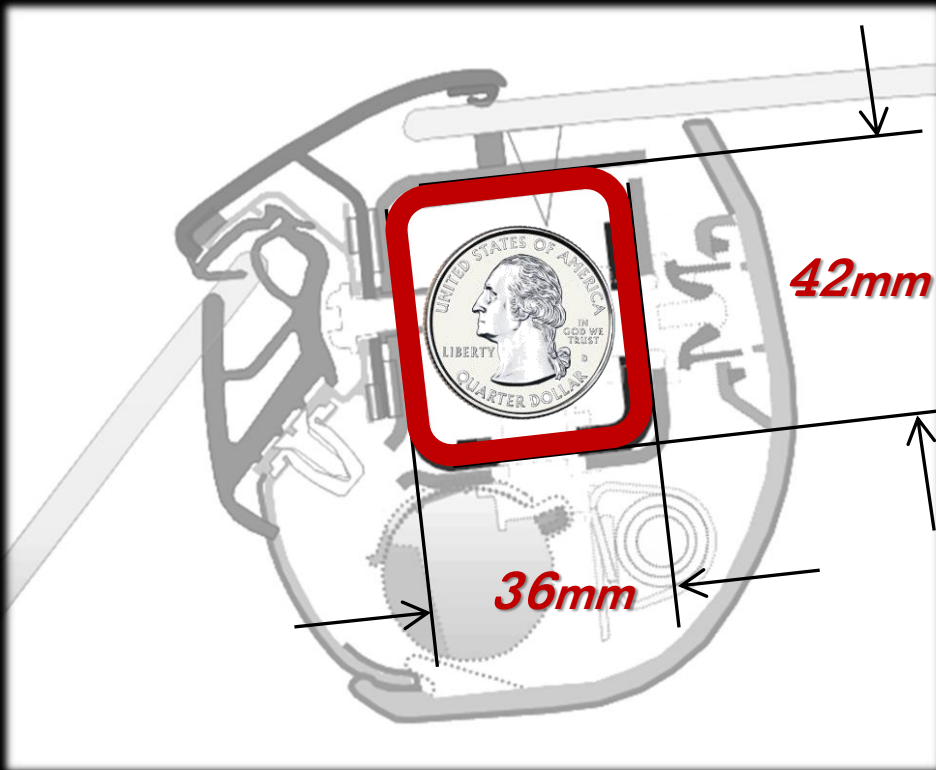
- Crashworthiness
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**Precision Craftsmanship**



- High Accuracy
- High Efficiency





## Utilization of the 3DQ Technology allowed us to achieve our goals

- ☑ **Minimize Pillar Size**  
Provided best in class obstructed view
- ☑ **Maximize Interior Space**  
Enabled low roof and interior packaging requirements
- ☑ **Minimize Weight**  
Best balance of performance and weight for NSX
- ☑ **Achieve Occupant Safety**  
Projected best in class safety performance

**Ultra High Strength, Rigid Uniform Cross Section, the best option...  
3-Dimensional Hot Bending and Direct Quench Technology.**



# For More Information

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