We are a mobility technology company and one of the world’s largest suppliers to the automotive industry.
It starts with a vision....
We define and create the future of mobility
Magna International

Employees: +166,000 globally

Manufacturing Facilities: 346 globally

Market Position: #1 in NA, #3 globally

Sales: $40.8 Billion USD in 2018
Collective Expertise: Competitive Advantage

- Complete Vehicles
- Body Exteriors & Structures
- Power & Vision
- Seating Systems
Collective Expertise: Competitive Advantage

Complete Vehicles

☑️
3.3 Million Automobiles manufactured in Graz, Austria

- Voiturette (1906)
- Alpenwagen (1919)
- Puch 500 / 650 / 700c / 126 (1957 – 1975)
- Pinzgauer (1971 – 2000)
- Mercedes-Benz G-Class since 1979
- Audi V8L (1990 – 1994)
- Chrysler Voyager (2002 – 2007)
- Saab 9³ Cabrio (2003 – 2009)
- BMW X3 (2003 – 2010)
- Chrysler 300 C (2005 – 2010)
- Peugeot RCZ (2010 – 2015)
- MINI Countryman (2010 – 2016)
- MINI Paceman (2012 – 2016)
- BMW 5 Series since 2017
- Jaguar E-PACE from Q4 2017
- Jaguar I-PACE from 2018

In Production

- Mercedes-Benz
- BMW
- Audi
- Jeep
- Chrysler
- Saab
- Jaguar
- MINI
Collective Expertise: Competitive Advantage

Power & Vision
Automotive Industry Trends

**Future Mobility Solutions**
- Autonomous and semi-autonomous operation
- Sensors and Communication (V2V, V2I)
- Cyber Security

**Evolving Business Models**
- Ride Sharing
- Car Sharing
- Ride Hailing

**Electrification**
- Fully Electric, Plugin Hybrid & Mild Hybrid
- Battery Efficiency and Fast Charging

**Environmental & Safety Legislation**
- Powertrain & Engine Efficiency
- Lightweighting
- Recycling
- Alternative Fuels (hydrogen & biofuels)
Magna Innovation Pillars

Smarter.
Comfort, Convenience and Connectivity
Designing and delivering an inspired, best-in-class cabin experience

Cleaner.
Efficiency and Sustainability
Optimizing the use of energy to meet the needs of our customers and our planet

Safer.
Active and Passive Safety
Engineering protection and peace-of-mind for all who share the road

Lighter.
Lightweight Material and Science
Driving performance and quality through innovative mass reduction

Affordable.
Development and Manufacturing Efficiency
Align and optimize processes for the development and manufacture of products
Magna Corporate R&D

Relative Design Optimization Projects

- Multi Material Vehicle (MMLV), with Ford
- Liteflex, Integrated Door Systems, with FCA
Design Optimization – a synthesis of product design, lightweight materials and manufacturing processes

**MMLV - Advanced Vehicle**
- 23.5% (364kg) full vehicle mass reduction
- 16% (43g/km) reduction CO₂eq
- Equivalent styling, safety & functionality
- Affordable lightweighting, cost not published

**LiteFlex, Integrated Door System**
- 40% (52.5kg) mass reduction, 4 door vehicle
- 2% (6g/km) reduction in CO₂eq
- Equivalent styling, safety & functionality
- Affordable lightweighting, $2.81 per lb. saved
Multi-Material Lightweight Vehicle

Lightweight Material and Science

LIGHTER
CLEANER
AFFORDABLE

Efficiency and Sustainability
Development and Manufacturing Efficiency
<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Mass Reduction</th>
<th>Demonstrated Benefit</th>
</tr>
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<tbody>
<tr>
<td>MMLV Mach I</td>
<td></td>
<td><strong>24% Mass Reduction (343kg)</strong></td>
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<tr>
<td>MMLV Al-intensive vehicle</td>
<td>1,195kg</td>
<td>- 23.5% full vehicle mass reduction</td>
</tr>
<tr>
<td>2014 Fusion Steel-intensive</td>
<td>1,538kg</td>
<td>- Mass reduction enabled use of 1 liter, 3 cyl. FOX engine used in B-segment Ford Fiesta</td>
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<td>- Functionally equivalent</td>
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<td>- Prototype Vehicles, high volume processes</td>
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<td>- Test Validation</td>
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<td>- NVH</td>
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<td>- Durability</td>
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<td>- Crash Safety</td>
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<td></td>
<td>- 16% reduction in GHG (43g CO₂ eq/ km)</td>
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<tr>
<td>MMLV Mach II</td>
<td></td>
<td><strong>42% Mass Reduction (569kg)</strong></td>
</tr>
<tr>
<td>MMLV Mg-intensive vehicle</td>
<td>969kg</td>
<td>- 41.6% full vehicle mass reduction</td>
</tr>
<tr>
<td>2014 Fusion Steel-intensive</td>
<td>1,538kg</td>
<td>- Mass reduction enabled use of 1 liter, 3 cyl. FOX engine used in B-segment Ford Fiesta</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Functionally equivalent</td>
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<tr>
<td></td>
<td></td>
<td>- CAE Validation of NVH, durability &amp; crash safety</td>
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<tr>
<td></td>
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<td>- 29% reduction in GHG (78 CO₂ eq/ km)</td>
</tr>
</tbody>
</table>

"A synthesis of design, lightweight materials and forming processes"
MMLV Mach I Vehicle

Body Structure, Exterior & Closures
2014 Steel-Intensive Fusion 594kg
MMLV Al-intensive 456kg

24% Mass Reduction 138kg

MMLV Mach I BIW

- Al Sheet, 37%
- Steel Sheet, 29%
- Al Extrusion, 14%
- Al Casting, 13%
- PH Steel, 7%
MMLV Mach II Vehicle

Body Structure Exterior & Closures
2014 Steel-Intensive Fusion   594kg
MMLV FRC & Mg-intensive     352kg

40% Mass Reduction    242kg
The cost of lightweighting increases exponentially beyond 20% of full vehicle weight.

Material cost limits application to luxury segment vehicles.

Cost impact of body shop modifications to manufacture a new BIW architecture and lost production favor programs which include NEW body shop construction, new OEM entrants or contract manufacturing.
Lessens Learned

• The GREET models developed by Argonne National Lab correlated perfectly with the fuel savings associated with the MMLV Mach I vehicle.

• Mass Induced Fuel Reduction - w/o Engine Downsizing
  0.168 liters/100kg per 100km

• Mass Induced Fuel Reduction - with Engine Downsizing
  0.4 liters/100kg per 100km

• Typical spacing between OEM engine to 100 kg in mass difference. Minimal benefit of incremental mass reduction up to the 100 kg threshold to enable a downsized engine.

• The 343kg mass reduction associated with the MMLV Mach I C/D segment vehicle enabled use of the 1 liter, 3 cylinder engine used in the B-segment Fiesta, with no reduction in performance due to equivalent weight between Mach I and Fiesta.
Magna Corporate R&D
LiteFlex, Integrated Door Systems
LiteFlex - Drivers-side Door

2016 FCA Steel-intensive (front) 38.0kg
LiteFlex Al-intensive (front) 22.8kg

Mass Reduction 15.2kg

Demonstrated Benefit
- 40% mass reduction drivers side door
- Manufactured form tooling
- Built 42 prototype doors
- Production-intent validation testing
  - durability
  - crash safety
  - NVH
  - corrosion

“A synthesis of design, lightweight materials and forming processes”

LiteFlex - 4 door vehicle

2016 FCA Steel-intensive 127.6kg
LiteFlex Al-intensive (front/rear) 78.1kg

Mass Reduction 49.5kg

Demonstrated Benefit
- 39% full vehicle (4 doors) mass reduction
- Functionally equivalent
- 2% reduction in GHG \(6 \text{ CO}_2 \text{ eq/ km}\)
- CAE validation of
  - durability
  - crash safety
  - NVH
LiteFlex Door
An aluminum-intensive drivers side door

Forming Technologies
• Cold stamping
• High pressure casting
• Extrusion
• Warm forming

Material Usage
• 16.6kg Al sheet, 5xxx inner panels
• 7.6kg Al sheet, 6xxx outer panels
• 4.2kg Al sheet, 7xxx door beam
• 3.3kg Al casting, A-pillar support
• 1.9kg Al extrusion, upper support
• 0.2kg Al fasteners

33.8kg Al per vehicle

49.5 kg mass reduction per vehicle
LiteFlex Door
An aluminum-intensive drivers side door

**Design & Development Process**
- Establish design space & objectives
- Obtain & set performance targets
- Identify desired features & function
- Cost budget constraints
- Seek part integration opportunities
- Material and Process Alternatives
- Understand load paths
- Compare architecture performance
- Infrastructure compatibility
- Service & repair
- Joining processes
- Corrosion

Sag & Set | Overcheck | Header Stiffness | Beltline Stiffness | FMVSS 214
LiteFlex Door
Summary of Results

Drivers-side Door
Mass Reduction: Minus 15.2 kg

Complete Vehicle (4 doors)
Mass Reduction: 51.2 kg per vehicle
Life Cycle Impact: 6g CO$_2$ per km

Equivalent or better performance, safety and styling
5-star crash, durability, NVH, corrosion, appearance, fit / finish, and other vehicle attributes
Commercialization Potential of Ultralight Door

The incremental cost of the Ultralight Door is $2.90 per pound saved, which is very competitive with competing technologies.

Bolt-on closure components can be changed mid-cycle, as a refresh and do not require body shop modifications.

CAFE and air quality legislation has a significant impact on the decision making process.