The North American industrial laser automotive BIW market with past and present applications

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Laser 1960 - “a solution looking for a problem”

**CO2**
- Spectra Physics
- United Technologies Industrial Lasers (UTIL)
- Photon Sources
- Coherent Inc.
  
**70’s – 80’s**

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**YAG**
- General Electric
- Coherent General
- J R Laser/Lumonics
- Martek
- Hobart

**80’s – 90’s**

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**Other Laser Sources**
- Lawrence Livermore Labs
- Haas/Trumpf

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Laser Architecture Trends

CO$_2$-Laser

YAG-Laser

Efficient Disc

Fiber

Direct Diode

63 Laser in 2003
Where Lasers Are Used

- TECHNICAL PROGRAMS ON LASER PROCESSES, APPLICATIONS, & ENGINEERING
  - Ablation
  - Acoustic Impact Hardening
  - Brazing
  - Assembly
  - Cladding
  - Cutting
  - Diagnostics
  - Drilling
  - Heat Treatment
  - Hybrid Processes
  - Inspection
  - Machining
  - Marking
  - Material Deposition
  - Micromachining
  - Microprocessing
  - Micro Fabrication
  - Nano Fabrication
  - Scribing
  - Soldering
  - Surface Texturing
  - Welding

- TECHNICAL PROGRAMS ON INDUSTRY PLATFORMS
  - Aerospace
  - Automotive
  - Bio-medical
  - Communications
  - Constructions
  - Defense
  - Dental
  - Electronics
  - Energy/Fuel Cell/Solar Cell
  - Entertainment
  - Fabrication
  - General Manufacturing
  - Job Shops
  - Machine Tools
  - Medical Devices
  - Metals
  - Micro-electronics
  - Off-Road
  - Oil/Gas/Power Generation
  - Plastics
  - Food/Drink Packaging/Consumer Goods
  - Semiconductors
### Automotive Cutting Applications:

- **1972** – General Motor, Delco Remy (Anderson, IN) uses four Coherent General 300 W CO\(_2\) lasers to cut ignition coils.

- **1975** – First published photo (Schweissen und Schneiden – Germany) of a 400 W CO\(_2\) laser cut three dimensional auto body part.

- **1979** – Nissan installs a three-axis laser cutter, with a 500 W CO\(_2\) laser from Messer Greisheim, for body panel trimming die replacement in their Production Trial Division.

- **1979** – Ford Motor Co. (Indianapolis, IN) cuts power steering pump wiper vanes using four 1.0 kW CO\(_2\) lasers from Photon Sources.

- **1980** – Toyota and Honda use a Fuji 3-axis system, with a Coherent General CO\(_2\) laser, for trim die replacement.

- **1980** – BMW (Munich, Germany) uses a two-axis gantry system from Messer Griesheim, with a 500 W CO\(_2\) laser to cut prototype parts.


- **1982** – VW (Wolfsburg, Germany) installs a three-dimensional laser cutter to prototype auto body components.

### Automotive Welding Applications:

- **1973** – Ford purchases an underbody welding system built by Gilman with Hamilton Standard (UT) 3 kW CO\(_2\) laser. First attempt to weld sheet metal with poor fit up.

- **1975** – Hot staking 1018 steel bearing race retainer ring to a 52100 case at a process rate of 1900 per hour. CO\(_2\) replaces YAG first dial feed table application at Ford.

- **1975** – At Rochester Products (Buffalo, NY) laser spot-welds 52100 nozzle tip to D4 steel tube. Four recessed spot welds, 0.0002 in., do four welds in 3 seconds. Nd: glass lasers from Laser Inc.

- **1976** – General Motors (Dayton, OH) uses three Photon Sources 1.2 kW CO\(_2\) lasers to weld steel quad valves assemblies for emission control.

- **1976** – Fiat (Torino, Italy) develops process to weld synchronous gears, replacing a brazing operation. Process leads to improvement in noise level for this manual transmission gear. Laser contribution narrow heat affected zone, interference fit, no extra machining required. Led to first installation of a transverse flow 2.5 kW CO\(_2\) laser.

- **1978** – AC Sparkplug (Wichita Falls, TX) uses 3 RWC systems with Spectra Physics CO\(_2\) lasers to weld, in a 3 sec cycle, oxygen sensors for catalytic converter system. And five systems to weld electric terminal to louvered s/s shields. Both use vibratory bowl feeders.
CO$_2$ Laser Welding

Ford Torino 1972-73 underbody welding (P-226)

UTIL 3kW laser on a 2-axis Gilman System

Courtesy of Belforte Associates Archives
Ford Aerostar 1986 roof-rack option holes (M-177),

Ferranti 450 W CO$_2$ laser on a Robomatix dual head system

Courtesy of Belforte Associates Archives
**CO$_2$ Laser Welding**

Chevrolet Beretta 1985 roof welding (P-136)

Spectra-Physics 3 kW lasers (2) on a Robogate motion system

Courtesy of Belforte Associates Archives
CO$_2$ Laser Welding

Chevrolet Caprice 1988 Radiator Support Assembly

Spectra-Physics 5kW with L-100 robot
57 welds in 48 sec.
Solid State YAG Cutting

GM 325/350 SUV-1991 Underbody

Powertrain, seat and accessory hole options are laser cut to order eliminating trim dies.
Flexible work cells to reduced 69 product variations.

In Production for 13 years till 2004.
Solid State YAG Cutting

Ford F150 Pickup Truck - Floor Pans - 1996

Powertrain option hole customization prior to paint
4 On-line Systems
Productivity - 65 Jobs/hour
Solid State YAG Welding

Buick LeSabre Wheelhouse Assembly - 1994

2 Systems - 1 robot with a 3kW CW Martek laser each
68 Jobs/hour each cell
Solid State YAG Welding

Ford LS 2000 Aluminum Hood -1998

2 Grille holes cut on hood with no distortion and max air flow

2kw CW – YAG
Productivity 37 jobs/hour
Solid State YAG Cutting

Ford Thunderbird – M205 All exterior body panels - 2000

3 Systems
2 Robots with 2kW lasers each

Cost effective solution to trim dies. Ideal for Low Volume (Under 30,000 Vehicles/year) where high variability and agility is essential
Solid State YAG Welding

Freightliner Argosy Aluminum Underbody Assembly - 1998

Robot with 4kW Trumpf laser with pressure roller and wire feed
Replacing 92 Conventional Rivets in 2.3 Minutes
NA Federal regulations on automotive design

**Corporate Average Fuel Economy (CAFE)**
By 2021 Average fleet fuel rating – 40.3 to 41 mpg (17.4 km/l)
By 2025 Average fleet fuel rating – 48.7 to 49.7 mpg with 163 g of CO\(_2\) /mile (101g/km)

**National Highway Traffic Safety Administration (NHTSA)**
The strength of the roof is determined by the strength-to-weight (SWR) ratio before the roof is crushed 5 in. (127mm)
Current SWR – 2.5X
By 2016 – 4X

http://www.iihs.org/iihs/ratings/ratings-info/roof-strength-test
**Functional Requirements**
- gap-free clamping in the joining zone
- constant focus position

**System Requirements**
- pressure wheel, pressure finger
- pressure wheel and backup wheel
- lateral correction stylus
- seam tracking sensor
- force balancing system
- force application system
- hot/cold wire feeder
- hybrid welding technology

Laser welding applications, joints & process heads
Designing the product for laser processing

- Create or join to hollow sections

Two Piece Assembly Class “A”
Bodyside to Structural Hydroform
P415 Laser Welding

Process and Laser head positions

A-A

C-C

B-B

D-D
Trends in laser processing

Automotive:
Remote laser welding of steel & aluminum
Body sides, closures - doors, hoods, deck lids
With vision
Annealing HSS for fastener application

Aerospace:
Ablation – Cleaning & coatings Removal

General Industries:
Additive Manufacturing - Cladding, Resurfacing