OBD in a Global Environment

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Manufacturers Are Thinking Global

Ford has been a global company for more than a century, since establishing their first overseas assembly plant in Manchester, England in 1911.

Ford has a significant market presence in North America (US, Canada, Mexico), South America (Brazil, Argentina, Chile, Columbia, Ecuador, Venezuela) Europe (all EU countries), Asia Pacific (India, China, Korea, Japan, Hong Kong, Australia, New Zealand, Vietnam, Indonesia, Thailand, Philippines), Middle East and Israel.

So what does it mean to be a global company, especially in the area of powertrain?

Manufacturers Are Thinking Global

- Manufacturers are increasingly leveraging global engineering resources to increase product offerings.
- One way to accomplish this is to design vehicles locally, export them and adapt them to meet local OBD and emission regulatory requirements.
- Another way to accomplish this is to design vehicles globally to meet local OBD and emission regulatory requirements.
- Ford, historically, has designed vehicles locally and adapted them to other markets.
- For example, Ford has a NA Focus which is also sold in South America. Ford also has a EU Focus with is also sold in China and Australia. The NA, EU and SA Focus vehicles do not share any powertrains!

Some “Global” Products

US Focus 2.0L

EU Focus
1.4 – 2.5L

SA Focus 1.6L

China Focus 1.8L

Australia Focus 2.5L

Some “Global” Vehicle Powertrains

09	C170	FNA Ford	Focus (NA)	2.0L Duratec	2.0L-I4-Duratec I4-D4-G-PZEV	A4F27(FN)	North America
09	C170	FNA Ford	Focus (NA)	2.0L Duratec	2.0L-I4-Duratec I4-D4-G-PZEV	M5F34(MTX75)	North America
09	C170	FNA Ford	Focus (FSAO)	1.6L Rocam	1.6L-I4-Rocam-S2-FFV-E100	M5F17(B5)	South America
09	C170	FNA Ford	Focus (FSAO)	1.6L Rocam	1.6L-I4-Rocam-S2-G	M5F17(B5)	South America
09	C307	FOE Ford	Focus (Eu/ROW)	1.4L Sigma	1.4L-I4-Sigma-D4-G-80PS	M5F17(B5)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	1.6L Sigma	1.6L-I4-Sigma-D4-G-100PS	A4F27-VDK(FN)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	1.6L Sigma	1.6L-I4-Sigma-D4-G-100PS	M5F17(B5)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	1.6L Sigma TIVCT	1.6L-I4-Sigma-D4-G-TIVCT-115PS	M5F17(B5)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	1.6L DV6A Diesel	1.6L-I4-PSA DV-D4-D-TCI-90PS	M5F34(MTX75)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	1.6L DV6T Diesel	1.6L-I4-PSA DV-D4-D-TCI-100PS	M5F34(MTX75)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	1.6L DV6T Diesel	1.6L-I4-PSA DV-D4-D-TCI-110PS	M5F34(MTX75)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	1.6L DV6 Diesel	1.6L-I4-PSA DV-D4-D-TCI-ECO-110PS	M5F34(MTX75)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	1.8L Duratec	1.8L-I4-Duratec I4-D4-FFV-125PS	M5F17(B5)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	1.8L Duratec	1.8L-I4-Duratec I4-D4-G-125PS	A4F27-VDK(FN)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	1.8L Duratec	1.8L-I4-Duratec I4-D4-G-125PS	M5F17(B5)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	1.8L Duratec	1.8L-I4-Duratec I4-D4-G-125PS	M5F20-B5A(B5)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	1.8L LYNX Diesel	1.8L-I4-DSD-S2-D-TCI-LYX-CR-115PS	M5F34(MTX75)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	2.0L Duratec	2.0L-I4-Duratec I4-D4-CNG-126PS	M5F34(MTX75)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	2.0L Duratec	2.0L-I4-Duratec I4-D4-G-145PS	A4F27-VDK(FN)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	2.0L Duratec	2.0L-I4-Duratec I4-D4-G-145PS	M5F20-B5A(B5)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	2.0L Duratec	2.0L-I4-Duratec I4-D4-G-145PS	M5F34(MTX75)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	2.0L Duratec	2.0L-I4-Duratec I4-D4-LPG-141PS	M5F34(MTX75)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	2.0L DW10B Diesel	2.0L-I4-PSA DW-D4-D-TCI-110PS	A6F45-WC(MPS6)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	2.0L DW10B Diesel	2.0L-I4-PSA DW-D4-D-TCI-136PS	M6F45(MMT6)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	2.0L DW10B Diesel	2.0L-I4-PSA DW-D4-D-TCI-136PS	A6F45-WC(MPS6)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	2.0L DW10B Diesel	2.0L-I4-PSA DW-D4-D-TCI-136PS	M6F45(MMT6)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	2.4L I5 Volvo TC	2.4L-I5-Volvo I4/I5 Gas-D4-G-TC-280PS	M6F40(M66)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	2.5L I5 Volvo TC	2.5L-I5-Volvo I4/I5 Gas-D4-G-LTC-220PS	M6F40(M66)	Europe
09	C307	FOE Ford	Focus (Eu/ROW)	1.8L Duratec	1.8L-I4-Duratec I4-D4-G-125PS	A4F27-VDK(FN)	Asia Pacific
09	C307	FOE Ford	Focus (Eu/ROW)	1.8L Duratec	1.8L-I4-Duratec I4-D4-G-125PS	M5F17(B5)	Asia Pacific
09	C307	FOE Ford	Focus (Eu/ROW)	2.0L Duratec	2.0L-I4-Duratec I4-D4-G-145PS	A4F27-VDK(FN)	Asia Pacific
09	C307	FOE Ford	Focus (Eu/ROW)	2.0L Duratec	2.0L-I4-Duratec I4-D4-G-145PS	M5F34(MTX75)	Asia Pacific
09	C307	FOE Ford	Focus (Eu/ROW)	2.0L DW10B Diesel	2.0L-I4-PSA DW-D4-D-TCI-136PS	A6F45-WC(MPS6)	Asia Pacific
09	C307	FOE Ford	Focus (Eu/ROW)	2.0L DW10B Diesel	2.0L-I4-PSA DW-D4-D-TCI-136PS	M6F45(MMT6)	Asia Pacific
09	C307	FOE Ford	Focus (Eu/ROW)	2.5L I5 Volvo TC	2.5L-I5-Volvo I4/I5 Gas-D4-G-LTC-220PS	M6F40(M66)	Asia Pacific

What Is Global?

Ford has significant regional engineering presence in North America (NA), Europe (EU), South America (SA) and Asia Pacific (AP) (specifically, in Australia)

Vehicles are mostly designed in North America, Europe and Australia.

Powertrain controls, however, are often designed and calibrated in each region.

Each region understands the local emission, fuel, OBD and certification requirements, however, when these vehicles are “exported” to another region, there is a steep learning curve to understand these same requirements for the target markets.

More “Global” Models

EU CUV (Kuga)

EU Fusion

NA SUV (Escape)

NA/SA Fusion

EU Mondeo ~ NA Fusion

Global Issues

For example, if Ford wants to sell a NA Fusion in Brazil, there are different OBD regs (OBD-Br2), emission regs (Brazil LEV) and market fuels (E22, E100).

If Ford wants to sell a EU Fiesta in the US, again, there are different OBD regs (OBD II) and emission regs (LEV-II) and cert fuels.

The different regulations and certification test procedures makes this “export” task very difficult and regional engineering resources often lack the knowledge to complete this task.

Global Issues

On the other hand, if vehicles and powertrains are designed globally (centrally), the responsible activity must understand all the emission, OBD, testing and fuel requirements around the world.

The vehicle and powertrain is generally designed to meet the most stringent requirements unless it is cost-prohibitive or regional requirements conflict.

This can result in a vehicle that is over-engineered for some regions, carries extra cost or extra complexity.

Each member of the engineering team must manage a set of world-wide requirements and make the cost/complexity trade-offs required to optimize the design.

Global Issues – Emission Warranty

- Emission warranty comes into play for some vehicle architecture decisions.
- Emission warranty in the US can range from 2yr/24,000 miles for Federal emission performance warranty to 15yr/150,000 miles for California emission performance warranty for anything that lights the MIL.
- California defect reporting rules can force a recall.
- Europe and most other countries have no emission warranty or recall jeopardy, only the manufacturer warranty.
- Because of this, most modules in US OBD-II vehicles avoid sharing data with the ECM/PCM so as not to become an emission-related component or module.

Global Issues – Emission Warranty

- Without this restriction, modules can freely share emission-related data on the network for data like VIN, vehicle speed, engine-off time, fuel level, tire/axle ratio and ambient air temperature.
- If sold in the US, these systems have to be re-architected to either add network and module diagnostics or develop backup strategies that maintain vehicle and OBD functionality in the event of a component or network fault.
- Diagnostics have to be done in an OBD ECU, otherwise body or chassis modules could become “diagnostic critical” modules.

Global Issues – Vehicle Design

There are other regulatory considerations are when designing global vehicles. Some are:

PCV system, OBD connector location, fuel cap, fuel tank and evaporative system hardware, catalyst system design, cold start system for E100, instrument cluster indicator lights (e.g. “Check Fuel Cap”).

Assuming US regulations are the most stringent can also lead to trouble. For example, Euro V+ Particulate Matter (PM) standards may drive gasoline DI vehicles to add a particulate trap and associated OBD monitors.

Global Issues – OBD Complexity

- Managing even one aspect of a truly global vehicle and powertrain program, like OBD, is a complex task.
- Many countries have enacted OBD requirements: Australia, Argentina, Brazil, Beijing & Shanghai, China, European Union, Hong Kong, India, Japan, Mexico, Middle East, New Zealand, Russian Federation, South Korea, Taiwan, Turkey, United States, and the list keeps growing.
- It is difficult to track each country's OBD requirements, especially if they have subtle differences or if they are in the process of writing new regulations.
- Fuel standards don't always match emission and OBD requirements.

Global Issues – Emission Complexity

- Although many countries adopt existing OBD regulations, like OBD-II or EOBD, some countries want to develop their own OBD regulations.
- For example, Brazil, India, Japan and South Korea have developed their own OBD regulations.
- Countries that adopt EU emission standards use EOBD, however, standards from Stage III to Stage V mean that the OBD requirements are different based on the emission standard being used. The standards phase in in different time periods as well.
- For example, a “world sedan” for a given model year may have to meet, PZEV and Tier2 Bin4 in the US, Stage V in Europe, LEV2 Bin8 in Brazil, Stage III in the Mideast, Stage IV in Russia, Turkey, New Zealand and China, Stage IV w/IOBD-I in India.

Global Issues – Calibration Complexity

- Vehicles which are engineered to meet US emission and OBD-II standards are the easiest to export to other markets because they were designed to meet the most stringent requirements.
- However, selling a vehicle equipped with a PZEV catalyst in Brazil, Europe or in the Mideast will greatly penalize the vehicle from a cost standpoint so emission control systems tend to be optimized for each emission standard.
- In a global environment, a global powertrain calibration group may have to do 8 or 10 different emission calibrations rather than 2 or 3 regional calibrations.
- At a minimum, there is a different OBD calibration required for each emission calibration although there are reasons to want to optimize the OBD calibration as well.

Global Issues – Warranty Impact

- Why do different OBD calibrations?
- Doing so minimizes warranty and customer dissatisfaction.
- The highest OBD-II warranty claims in the U.S. are for the evap monitor, misfire monitor and fuel monitor.
- OBD outside the US tends to be less stringent in these areas, as are many competitor vehicles that are designed to meet local requirements.
- For example, EOBD is less stringent for evap monitoring (no leak check requirement) and misfire monitoring (no redline requirement, no 2 revs after start requirement).
- Local fuel quality issues can increase fuel monitor warranty so less stringent thresholds can help. (ethanol, sulfur, MMT, RVP, etc.).

Global Issues – Economies of Scale

On the other hand, if you get all the requirements right, you can get large economies of scale out of global powertrain and vehicle programs.

A global engine, if designed properly, can be sold all over the word at high volumes with the same controls software and different calibrations. Global powertrain software minimizes software development cost, engine mapping cost, and the calibration learning curve.

A global vehicle platform can achieve very large economies of scale. (e.g. 800K to 2 M units/year globally)

Global Issues – What to do???

There are pros and cons for the “global” versus “local” strategies.

“Global” is complex, requires many tradeoffs and requires the designers to know about all regulations worldwide.

“Local” requires fewer tradeoffs and designers have a wealth of local knowledge, but re-doing work regionally is not resource-efficient.

So how best to deal with the complexity of a centralized design activity while taking advantage of the local/regional expertise needed to keep up with local regulations and requirements?

Global Design Recommendations

As usual, the best practice is probably somewhere in between.

1) Design hardware, controls and software centrally for a global market. It may be hard to do at first, but as time goes on, requirements and “lessons learned” will be captured in the requirements, software, and calibration procedures.
2) Retain a local engineering presence to keep up with local regulations, perform some calibration and certification work and provide problem feedback.
3) “Export” low volume products where it is easier to have a regional group specialize in that task.

Conclusions

- The effort to re-engineer and certify vehicles to meet local emission and OBD requirements is significant but can make sense in small volume applications.
- Global design is difficult to implement in the short run. It is difficult to understand regulatory and customer requirements worldwide but it can have substantial long term benefits.
- Global powertrain controls and OBD can yield substantial efficiencies in terms of engine mapping, calibration efficiency, software quality and lessons learned.

Conclusions

- It is imperative to keep pace with all the local emission, fuel, and OBD requirements. This is a time consuming activity that is greatly aided by having engineers or regulatory personnel in the areas that are active in emission and OBD rule-making.
- The logistics of having meetings in different time zones is difficult but can be managed through careful meeting planning, the internet, e-rooms, webex, etc.

The End

Thanks for your attention!

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