

Innovate2011

The Rational Software Conference

11th and 12th of October

Let's **build** a smarter planet.



More Great Cars Faster....

....in a Sustainable World

Mark Stanton, *Group Chief Engineer*
Vehicle Engineering & Attributes, Jaguar Land Rover



JLR: Key Facts



Largest UK automotive employer
approaching 19,000 UK employees, 45,000 in supply chain, supporting 130,000 jobs in total

Only car company researching, designing and manufacturing in the UK

Largest UK automotive investor in R&D
approaching £1.5bn per year in Product Creation
4500 Engineers in core Product Development,
6000 Worldwide and growing

Ambition Business Growth Plan
40 new product actions in the next 5 years

Sell products in 174 countries
In 2010/2011, China up 70%, North America up 21%, Russia up 32%



2011 Line Up



XK



XJ



XF



Range Rover



RR Sport



Evoque



Discovery 4



Freelander 2



Defender

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 **Software. Everywhere.**



Our PD Sites: Whitley



A former site for Whitley and Lancaster Bomber production

55 acres & 76,000m² of office space

3000 employees

**Home to Powertrain Engineering,
Electrical Engineering and the
Jaguar Design Studio**



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Our PD Sites: Gaydon

Converted from V-Bomber base in 1977

World-class R&D centre of the Automotive Industry

60 Km of Test Tracks



4500 people and rising

VR suite, climatic wind tunnels, rig test and engine test beds, electro-magnetic chamber

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The Challenges



More Great Cars...

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in a Sustainable World

40 product actions in the next 5 years

Reduced development lifecycles

Corporate social responsibility

> Emerging Markets

Increased Complexity

Robustness

Rise of the BRIC markets

Interconnected technologies

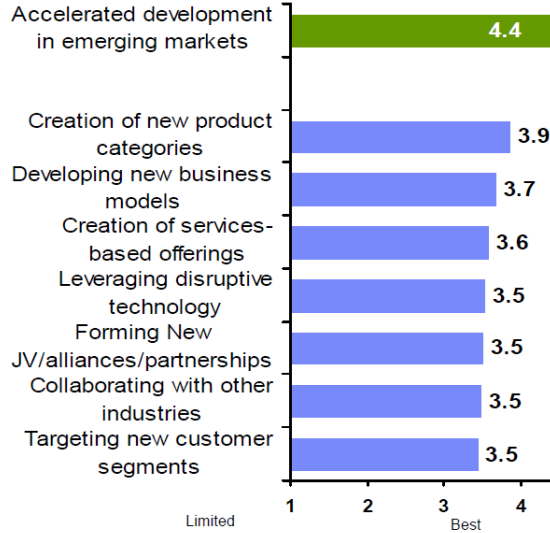
Highest-ever quality expectations



Emerging Markets: Why are they important?

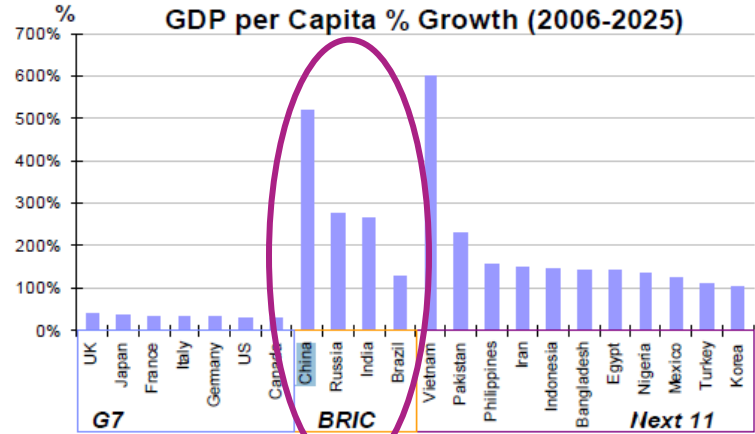


Rate the Best Opportunities for Growth by 2020



The growth in emerging markets is recognized as it outpaces the developed markets

Growth in emerging markets creates both opportunity and responsibility for auto companies

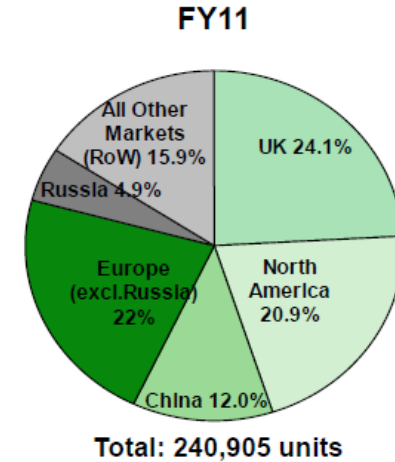
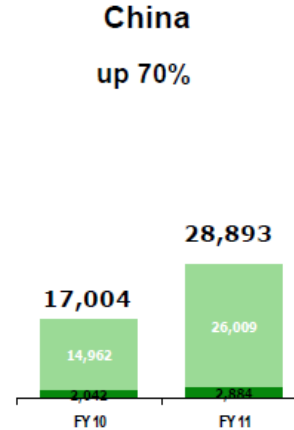
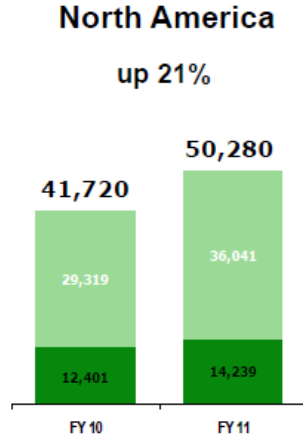
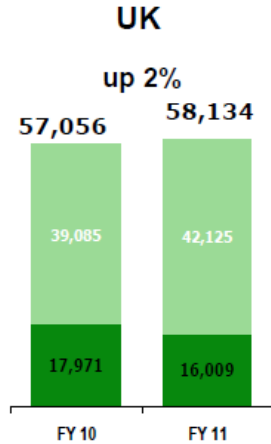


From IBM Auto 2020
Global Interviews across
Automotive Industry

Emerging Markets: Our Sales



Land Rover Jaguar



http://www.jaguarlandrover.com/pdf/Investor_Presentation_FY2011.pdf

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Emerging Markets: Understanding the Needs



Differences in anthropology of diverse cultures

Owner-Driver vs. Chauffeur ratio in different markets

Fuel quality and availability

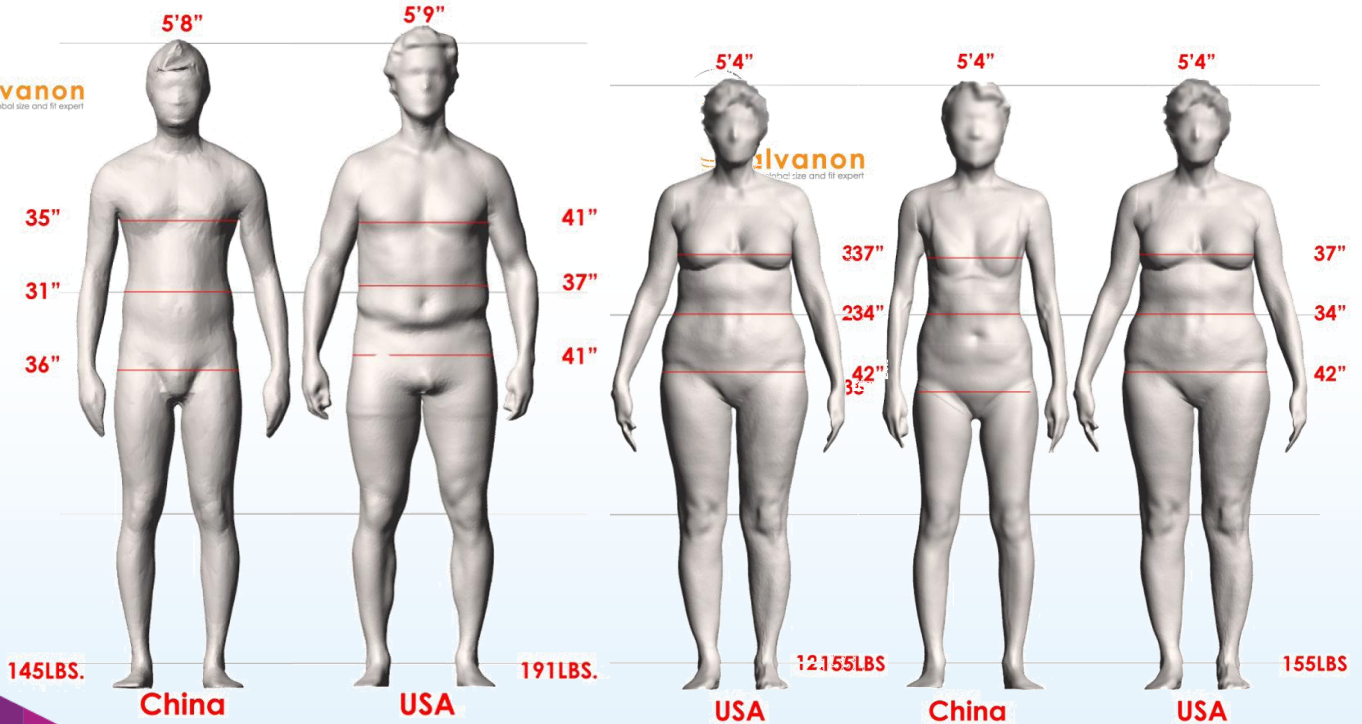
Electric charging points in the future

Terrain, road surfaces and altitude

Government legislation and environmental tax



Emerging Markets: Understanding the People



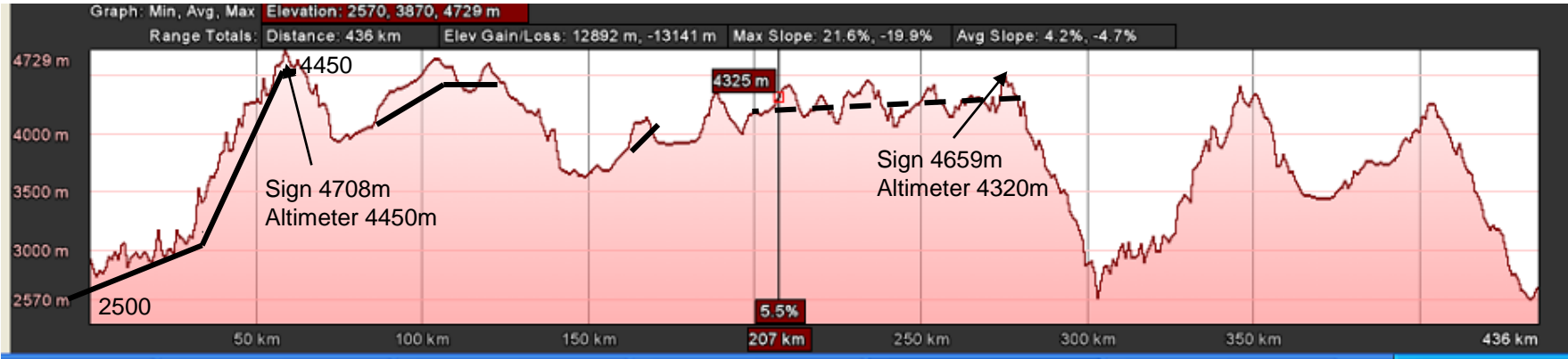
Emerging Markets: Understanding the Environment



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Emerging Markets: Typical Test Route

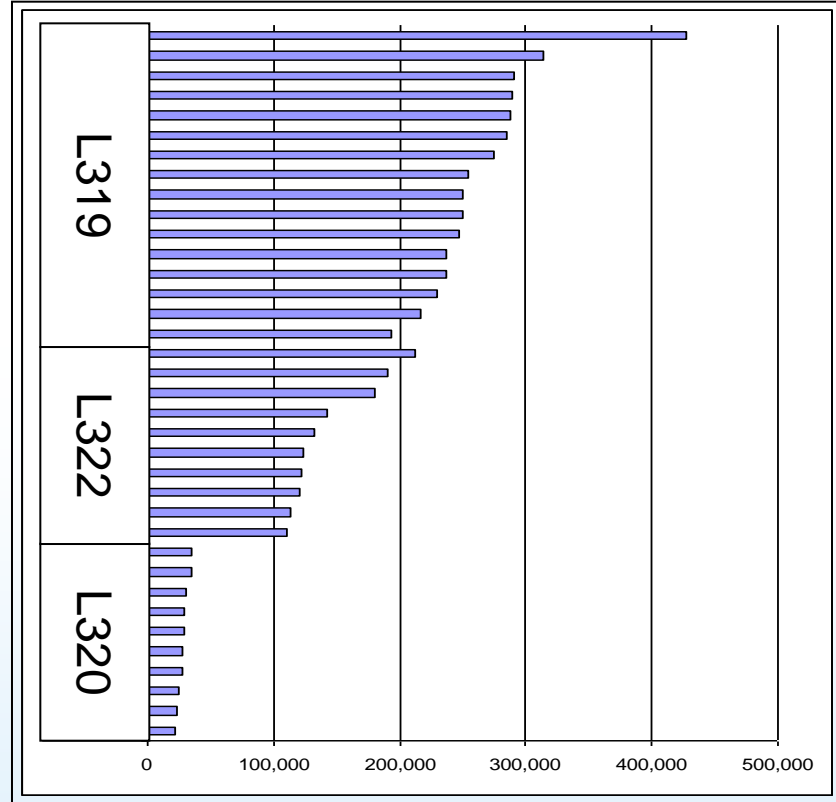


<p>Single track, tarmac worn out sections. 60kph</p>	<p>Rough road. Warn out 40-60kph.</p>	<p>Single track, tarmac worn out sections. Average 60kph</p>		<p>Rough road. Warn out road, in large areas especially hairpins no tarmac, large potholes, ruts, stones, road extremely poor. Average 40-60 kph</p>	<p>Good quality tarmac Downhill hairpins 100kph uphill and flat 60 kph downhill</p>
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A fleet of LR products in NW China



**Kurle Oil company, Kurle City,
Xinjiang Uyghur Region**



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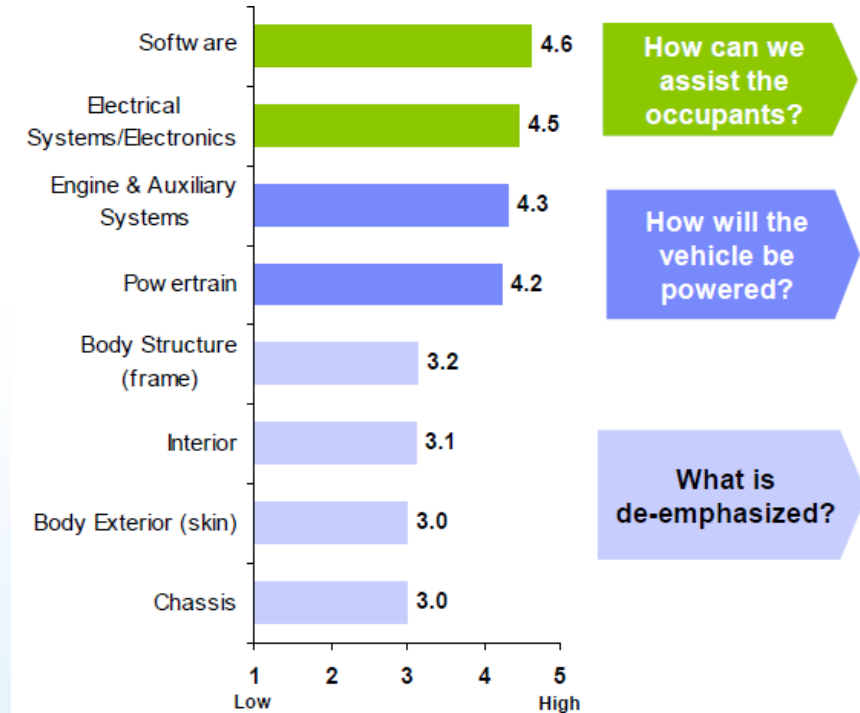
Rise of the BRIC markets

Interconnected technologies

Highest-ever quality expectations



Innovation is everywhere but software and electrical systems receive focus



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Aero vs Auto Software Comparison



F22 Raptor



1.7 million SLOC

The avionics system in the F-22 Raptor, Air Force frontline jet fighter

Boeing Dreamliner



6.5 million SLOC

The avionics and onboard support systems in Boeing's new 787 Dreamliner

Modern Car



100 million SLOC

The control and comfort systems in a modern luxury car – which can contain up to 100 individual modules

Boeing 777



4 million SLOC

Operation of the avionics and onboard support systems is split across 79 different systems

F-35 Joint Strike



5.7 million SLOC

Operation of the onboard systems on an F-35 Joint Strike Fighter

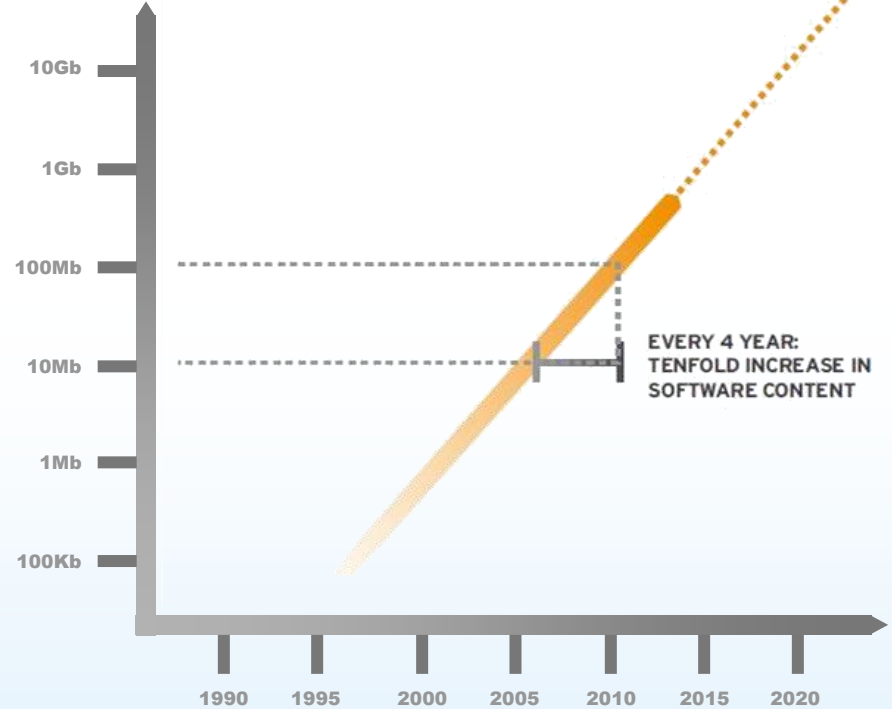


IN 2008 THE BUSINESS RESEARCH FIRM FROST & SULLIVAN ESTIMATED THAT CARS WILL REQUIRE **200 MILLION TO 300 MILLION** LINES OF SOFTWARE CODE IN THE NEAR FUTURE

Increase in Automotive Software



- It is widely acknowledged that 80% to 90% of vehicle innovations are based on software systems
- Current trends indicate that every four years there is a tenfold increase in the volume of software in high-end vehicles
- 50% to 70% of the development costs for an ECU are related to software



System Level Example



Auto High Beam Assist (AHBA) - Introduced in 2010:

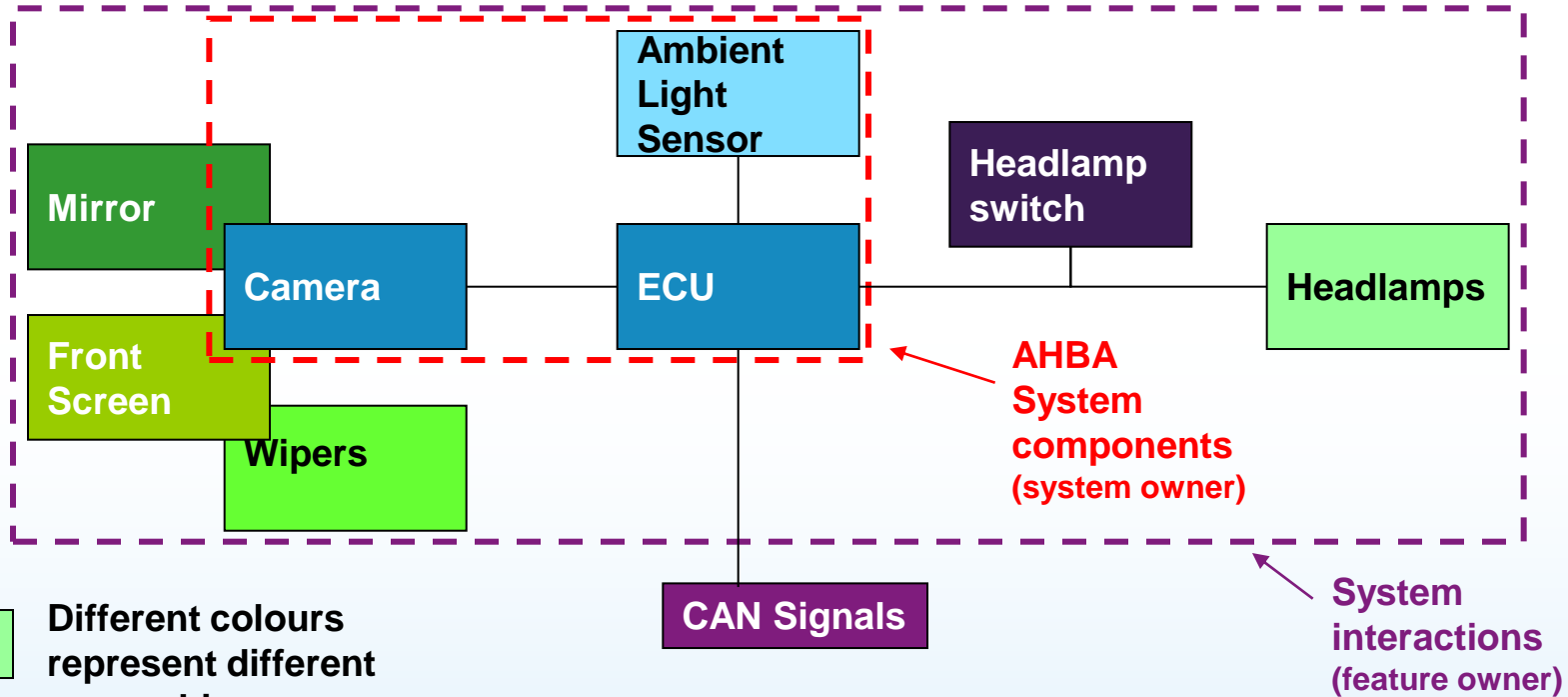
- Automatically turns on high beam when no other vehicle present
- Automates high and low beam switching
- Communicates to headlamps and changes pattern



System Boundary Diagram



Auto
High
Beam
Assist



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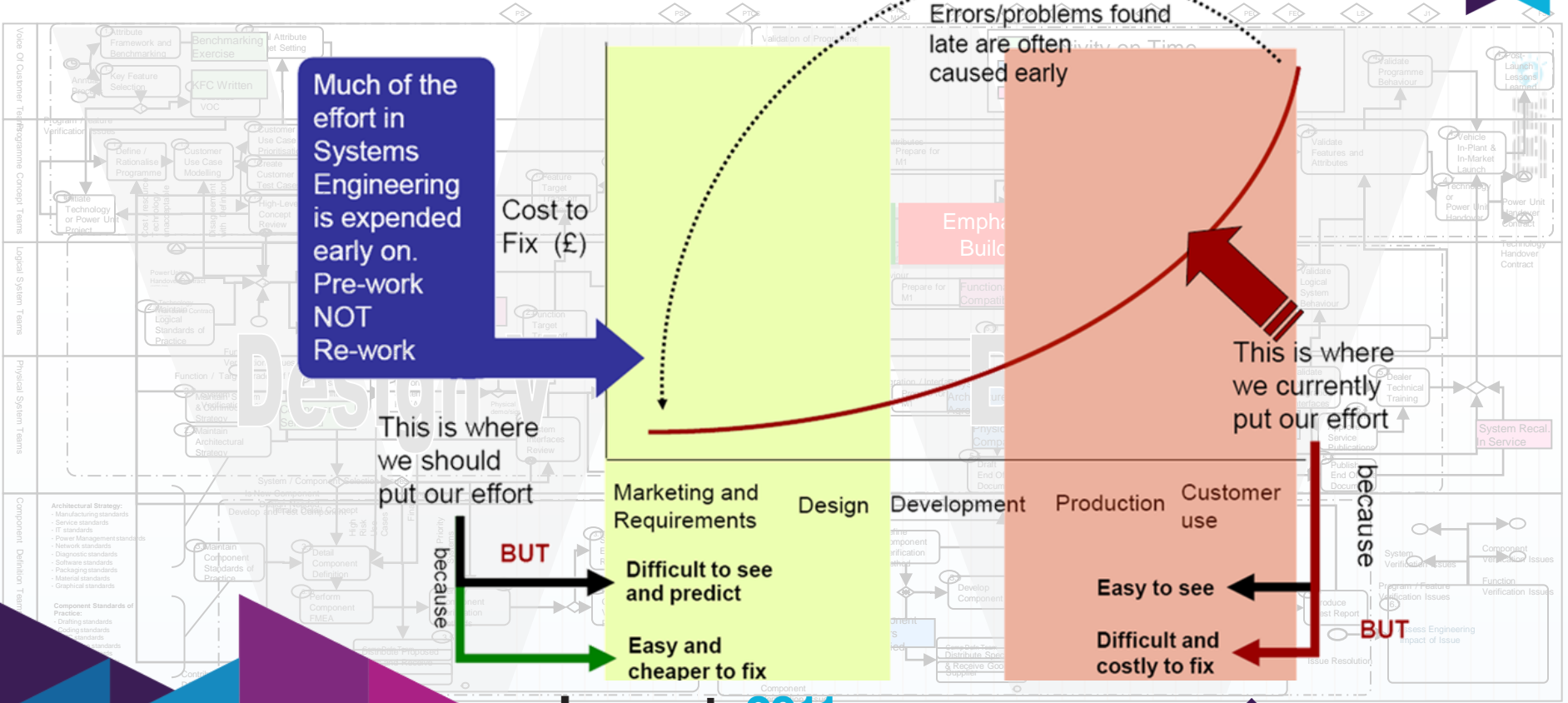
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Design & Build V&V



Much of the effort in Systems Engineering is expended early on. Pre-work NOT Re-work

Cost to Fix (£)

Errors/problems found late are often caused early

Emphasize Build

This is where we should put our effort

This is where we currently put our effort

Marketing and Requirements
Design
Development
Production
Customer use

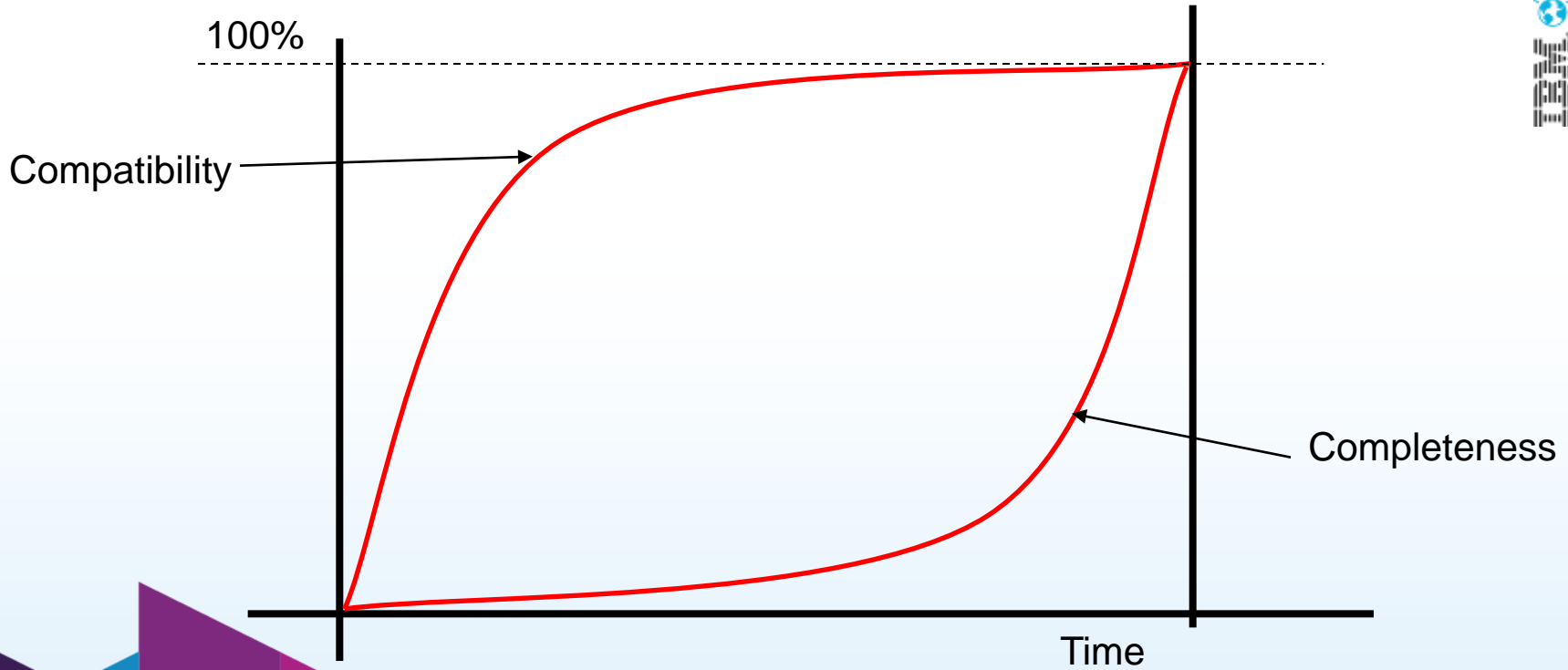
Easy to see
Difficult and costly to fix

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Compatibility vs Completeness



....consistent with a true system approach





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Summary: The Challenges



Globalization /
Emergent Market
Needs

Sustainability
Needs...



Global markets are
driving new
requirements

- **New emergent markets are driving change**
- **Niche and luxury markets require understanding of new customer and environmental needs**
- **Increase in regulatory requirements from new markets**
- **Opportunities from diversification across complex markets and new product variants**

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Summary: The Challenges



Globalization /
Emergent Market
Needs

Sustainability
Needs...



Global markets are
driving new
requirements

- Growth in highly sophisticated in-vehicle electric/electronic (E/E) systems
 - Product innovation driven from “intelligent systems”
 - Growing customer demands and expectations
 - Time-to-market and integration challenges
- Increased usage of electronics and embedded software
- It is already complex

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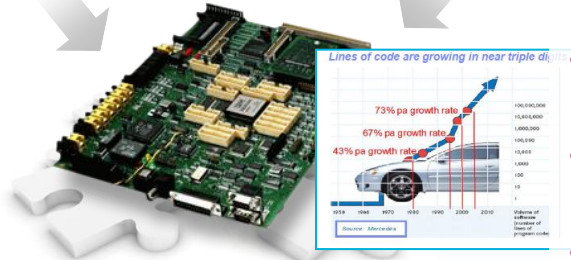
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Summary: The Challenges



“Intelligent”
vehicles

Interconnected
technologies



- **Large number of product variants**
- **Strong competitive pressures driving change**
- **Development standards e.g. ISO26262**
- **System Engineering led approach**
- **Any tool must be scalable from the 10,000 re-used requirements we have today to ???,000 requirements in future.**

Increased usage of electronics and embedded software

Partnership with industry



E.g. Investing in Rational DOORS for requirements management...



Our cars are highly **INSTRUMENTED**

- By 2010, 12% of new cars will ship with embedded telematics.



Our cars get more **INTERCONNECTED**

- Over 3 million car navigation devices were sold in China in 2008, more than double the amount in 2007.

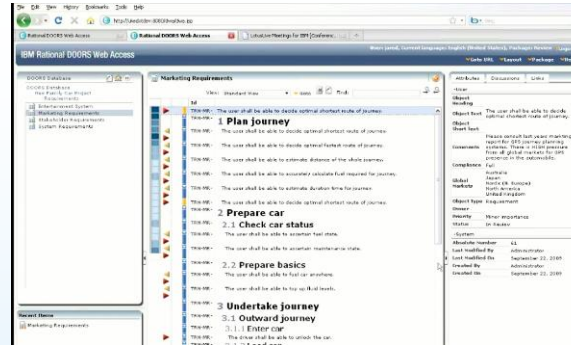


Our cars become **INTELLIGENT**

- The market for Advanced Driver Assistance Systems is estimated to reach 143 million Euros by 2015



Smarter Products



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