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The global chassis sector report

An analysis of the braking, steering & suspension markets

2006 edition

by Alex Graham

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GLOBAL AUTOMOTIVE RESEARCH ANALYSIS & FORECASTING

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Contents

List of tables:

List of figures

Chapter 1

Introduction

The chassis of a car serves as the interface between the car body, occupants and the road

The purpose of this report is to examine developments and trends in product groupings associated with the automotive chassis sector. In particular, this report will define and examine the key components, systems and modules that make up the chassis of a modern car, with specific regard to market usage, technological trends and forecast developments. This will include mainstream, mass-market technology, as well as innovative and advanced technology where appropriate in each product area.

In addition, the report will review market shares of the leading supplier competitors in each major product area, and the approach of each supplier to the market, including its role within the emergence of innovative technologies. Likewise, there will be an analysis of the technology and sourcing trends apparent among the major global carmakers.

For the purposes of this report, the major product groups in the chassis are the braking and steering systems, as well as the suspension componentry by which the body is married to the chassis, and the spring and damping systems[1] that control pitch and roll when the vehicle is in motion.

Broader definitions can also include the drivetrain, fuel supply and exhaust gas systems in the chassis.

Modules & systems: a definition

Chassis systems have evolved to offer greater stability, comfort and driver assistance

In this report, a module is considered an assembly of components, which are physically co-located on a car, such as a brake corner module, or an axle module. These modules may contain several components from different systems.

A system is made up of a group of components that are functionally related, but may be found in different parts of the vehicle. A brake system is one example.

The passenger vehicle chassis

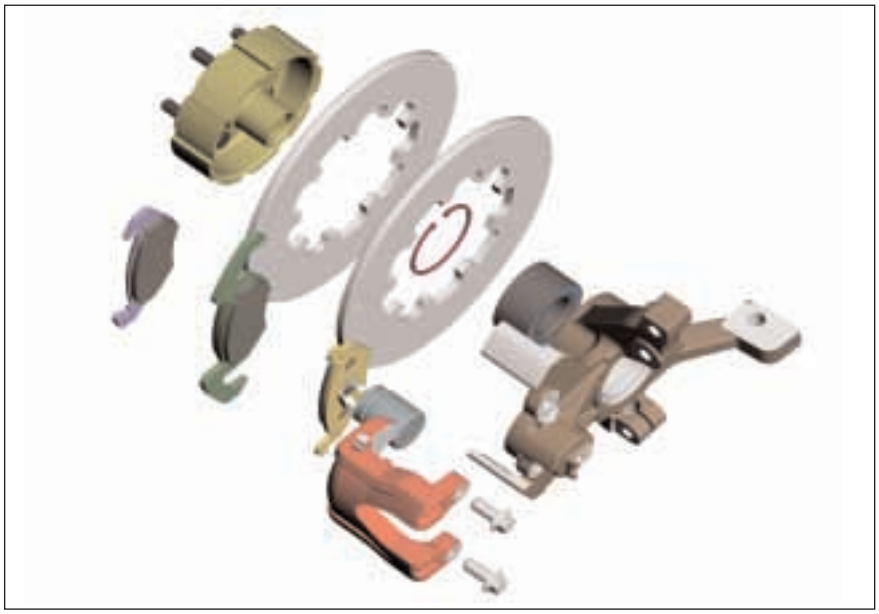
The chassis of a modern car, like the chassis of an historic car, primarily serves as the interface between the car body, occupants and the road. The components and systems in a chassis perform the functions of steering, stabilising and decelerating the vehicle, and are all geared to providing the optimum road contact at each wheel/tyre corner of the vehicle.

Over time, chassis systems have evolved to offer greater stability, comfort and driver assistance, all of which improves road safety. Both antilock braking and electronic stability control can brake a vehicle and maintain its lateral stability far more effectively than the vast majority of drivers can do manually. Power assisted steering has greatly reduced driver effort in steering input, and the first active steering systems went to market in 2003.

[1] Reference to dampers or damping systems in this report means shock absorbers.

"The traditional solution to coping with increasing vehicle weight and performance is to up-rate conventional braking systems, including larger discs (often forcing larger wheels) and advanced materials, but this is a costly solution that has a negative impact in many other areas of vehicle engineering," says Chris Baylis, director of engineering at Delphi's Leamington, UK, innovation centre, which led the development of MTB.

Figure 1: Delphi's Maximum Torque Brake (MTB)



Source: Delphi

The twin-disc structure allows much better heat dissipation

As the available torque is much higher at each corner, it also permits a smaller brake booster – up to one kilogram lighter in a large SUV for example – and the twin-disc structure allows much better heat dissipation. Delphi claims that in a high performance SUV, its new brake disc concept could offer the following benefits:

- 7kg lighter overall;
- Reduce operating temperature by 100°C;
- Shorter stopping distances in the event of a booster failure; and
- Reduced noise, vibration and harshness (NVH) over time.

Delphi first displayed a hydraulic MTB concept in August 2003. As of October 2005, MTB had not entered production, but sources at Delphi say that they have entered series development with potential OEM customers in Europe. It is not thought that Delphi's entry into Chapter 11 bankruptcy protection from October 8th 2005, will have a significant negative impact.

Brake control systems

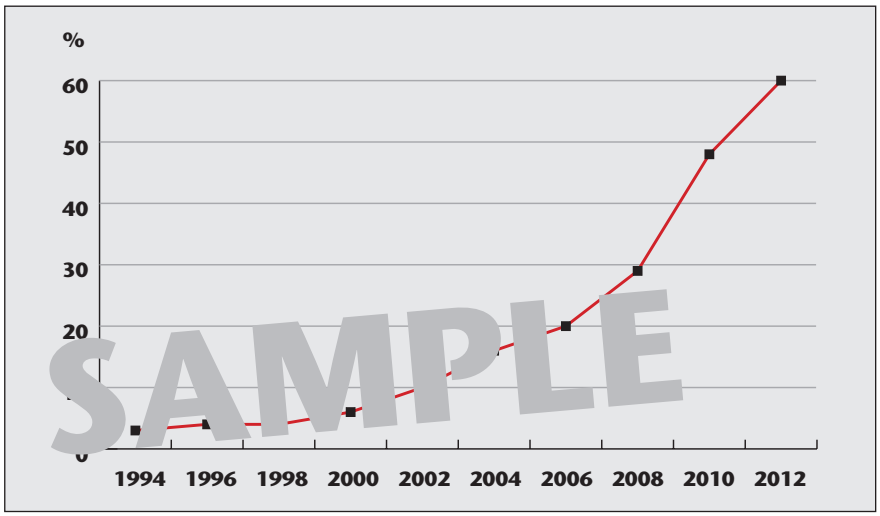
Antilock brake systems (ABS)

The mechanical systems were bulky and unreliable

The first concepts for an antilock braking system began to appear in the 1930s, and through the 1950s and 1960s various mechanical systems appeared on some race cars and low-volume niche cars.

But the mechanical systems were bulky and unreliable, and the first modern hydraulic ABS system was brought to market by Bosch in the Mercedes-Benz S-Class and BMW 7 Series in 1978.

Figure 6: ESC/ABS fitment rate (%), North America, 2000 – 2009

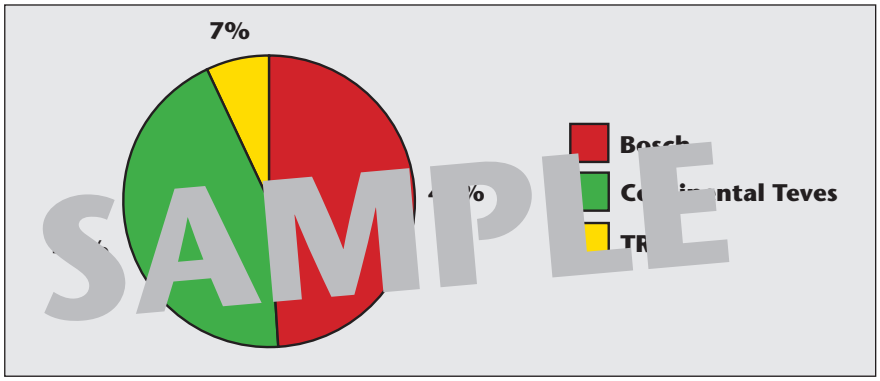


	%
1994	3
1996	4
1998	4
2000	
2002	
2004	
2006	20
2008	29
2010	48
2012	60

Source: ABOUT Automotive/Autelligence

But with competition from every established system supplier – especially in light of the news in late 2004 that Teves had secured a major part of the Ford contract in North America – margins will be tight.

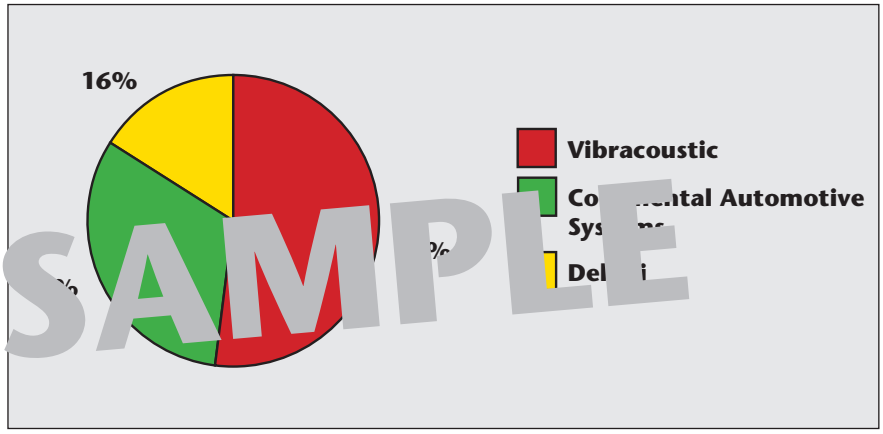
Figure 7: ESC/ABS market share, Western Europe, 2004



Company	Share
Bosch	%
Continental Teves	%
TRW	

Source: ABOUT Automotive/Autelligence

Figure 10: Air suspension systems market share, Global, 2004



Company	Volume	Share
Vibracoustic	296 800	%
Continental Auto ive Sys s	1 00	%
Delphi	3 00	1

Source: ABOUT Automotive/Autelligence

It is simpler for an OEM to equip every vehicle on the line with air suspension

Because of the expense of the system, applications are mainly limited to a small number of luxury SUVs and sedans including the Ranger Rover, Lincoln Navigator and Rolls-Royce Phantom. Interestingly, on many of the vehicles concerned, air suspension is offered as standard fit. This suggests that the technology is very effective and highly appreciated by the consumer, and possibly that due to its complexity and cost, it is simpler for an OEM to equip every vehicle on the line with air suspension, instead of trying to manage another build permutation.

Table 1: Selected models featuring air spring suspension as standard

Brand	Model	Supplier
Audi	A6 Allroad	Continental Automotive Systems
	A8	Continental Automotive Systems
Bentley	Continental GT	Continental Automotive Systems
DaimlerChrysler	Maybach	Continental Automotive Systems
Volkswagen	Phaeton	Continental Automotive Systems
Land Rover	Range Rover (front)	Continental Automotive Systems
	Discovery 3/LR3*	Delphi
	Range Rover Sport	Delphi
	Range Rover (rear)	Vibracoustic
Mercedes-Benz	S-Class	Vibracoustic
Rolls-Royce	Phantom	Vibracoustic

*officially, air suspension is standard on some variants of the Discovery 3. In practice, over 95% of vehicles are fitted with air spring, making it effectively standard.

Source: ABOUT Automotive/Autelligence

Chapter 5

Steering

The introduction of steer-by-wire in any mainstream application is still a far-off goal

As with braking technology, the rate of change of technology in steering systems has been comparatively gentle. The first hydraulically assisted power steering systems were fitted to North American passenger cars in 1951, but even until the mid-1990s, it was not uncommon for compact and economy cars in the European market to be sold without power assistance.

Then in the late 1990s, Japanese carmakers and their suppliers, including Koyo and NSK, began to introduce power steering that uses electrical energy to assist the driver, rather than hydraulic power.

Steering systems that actively assist in the event of an emergency are now available on a small range of high-end cars, but the introduction of steer-by-wire in any mainstream application is still a far-off goal.

Electric power assisted steering (EPS)

EPS is lighter, smaller and simpler than hydraulic systems

The growth in installation rates of electric power steering in European and Japanese markets was rapid from 1997, as the technology offers several benefits over hydraulic systems where lower medium and smaller cars are concerned.

In Europe, small cars (city, compact, lower-medium) make up around 65% of the total new car market by volume, or in the region of 9.5 million cars per year. Japan's domestic market is dominated to an even greater proportion by smaller cars. Since 1998 - 1999, at least 85% of cars in these segments have been fitted with EPS. By 2010, every car in these segments will have electrically assisted steering systems.

EPS uses an electric motor attached to the steering gear, which draws power from the battery in place of a reservoir, pump and belts drawing power directly from the engine.

EPS only draws power when assistance is needed, so can reduce the parasitic fuel drain of the steering system by around 75% compared to hydraulic power. That results in a real-world fuel saving of around 0.2l/100km in a typical European small car.

There are three main types of EPS

And the elimination of bulky hydraulic hardware means EPS is lighter, smaller and simpler than hydraulic systems. Suppliers also generally deliver pre-tested and pre-assembled steering sets, saving time and cost on the final assembly line.

There are three main types of EPS, all relating to the location of the electric motor – column, pinion, or rack mounted. Pinion and rack mounted systems are more powerful, but rack mounted EPS is very compact and is commonly fitted to city and compact cars.

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