DOWNLOAD PDF AUTOMOTIVE BRAKING SYSTEMS

Chapter 1 : PPT â€“ Automotive Braking Systems PowerPoint presentation | free to view - id: Mzk5Z

Modern cars have brakes on all four wheels, operated by a hydraulic blog.quintoapp.com brakes may be disc type or drum type. The front brakes play a greater part in stopping the car than the rear ones, because braking throws the car weight forward on to the front wheels.

Parking Brake Frictional brakes are most common and can be divided broadly into " shoe " or " pad " brakes, using an explicit wear surface, and hydrodynamic brakes, such as parachutes, which use friction in a working fluid and do not explicitly wear. Common configurations include shoes that contract to rub on the outside of a rotating drum, such as a band brake ; a rotating drum with shoes that expand to rub the inside of a drum, commonly called a " drum brake ", although other drum configurations are possible; and pads that pinch a rotating disc, commonly called a " disc brake ". Other brake configurations are used, but less often. For example, PCC trolley brakes include a flat shoe which is clamped to the rail with an electromagnet; the Murphy brake pinches a rotating drum, and the Ausco Lambert disc brake uses a hollow disc two parallel discs with a structural bridge with shoes that sit between the disc surfaces and expand laterally. A drum brake is a vehicle brake in which the friction is caused by a set of brake shoes that press against the inner surface of a rotating drum. The drum is connected to the rotating roadwheel hub. Drum brakes generally can be found on older car and truck models. However, because of their low production cost, drum brake setups are also installed on the rear of some low-cost newer vehicles. Compared to modern disc brakes, drum brakes wear out faster due to their tendency to overheat. The disc brake is a device for slowing or stopping the rotation of a road wheel. A brake disc or rotor in U. English , usually made of cast iron or ceramic , is connected to the wheel or the axle. To stop the wheel, friction material in the form of brake pads mounted in a device called a brake caliper is forced mechanically , hydraulically , pneumatically or electromagnetically against both sides of the disc. Friction causes the disc and attached wheel to slow or stop. Pumping[edit] Pumping brakes are often used where a pump is already part of the machinery. For example, an internal-combustion piston motor can have the fuel supply stopped, and then internal pumping losses of the engine create some braking. Some engines use a valve override called a Jake brake to greatly increase pumping losses. Pumping brakes can dump energy as heat, or can be regenerative brakes that recharge a pressure reservoir called a hydraulic accumulator. Electromagnetic[edit] Electromagnetic brakes are likewise often used where an electric motor is already part of the machinery. Some vehicles, such as some transit buses, do not already have an electric motor but use a secondary "retarder" brake that is effectively a generator with an internal short-circuit. Related types of such a brake are eddy current brakes , and electro-mechanical brakes which actually are magnetically driven friction brakes, but nowadays are often just called "electromagnetic brakes" as well. Electromagnetic brakes slow an object through electromagnetic induction , which creates resistance and in turn either heat or electricity. Friction brakes apply pressure on two separate objects to slow the vehicle in a controlled manner. Characteristics[edit] Brakes are often described according to several characteristics including: Peak force â€” The peak force is the maximum decelerating effect that can be obtained. The peak force is often greater than the traction limit of the tires, in which case the brake can cause a wheel skid. Continuous power dissipation â€” Brakes typically get hot in use, and fail when the temperature gets too high. The greatest amount of power energy per unit time that can be dissipated through the brake without failure is the continuous power dissipation. Continuous power dissipation often depends on e. Fade â€” As a brake heats, it may become less effective, called brake fade. Some designs are inherently prone to fade, while other designs are relatively immune. Further, use considerations, such as cooling, often have a big effect on fade. Smoothness â€” A brake that is grabby, pulses, has chatter, or otherwise exerts varying brake force may lead to skids. For example, railroad wheels have little traction, and friction brakes without an anti-skid mechanism often lead to skids, which increases maintenance costs and leads to a "thump thump" feeling for riders inside. Power â€” Brakes are often described as "powerful" when a small human application force leads to a braking force that is higher than typical for other brakes in the same class. This notion of "powerful" does not relate to continuous power dissipation, and may be confusing in that a brake may be "powerful" and brake strongly with a gentle brake

application, yet have lower worse peak force than a less "powerful" brake. Pedal feel â€” Brake pedal feel encompasses subjective perception of brake power output as a function of pedal travel. Pedal travel is influenced by the fluid displacement of the brake and other factors. Drag â€” Brakes have varied amount of drag in the off-brake condition depending on design of the system to accommodate total system compliance and deformation that exists under braking with ability to retract friction material from the rubbing surface in the off-brake condition. Durability â€” Friction brakes have wear surfaces that must be renewed periodically. Wear surfaces include the brake shoes or pads, and also the brake disc or drum. There may be tradeoffs, for example a wear surface that generates high peak force may also wear quickly. Weight â€” Brakes are often "added weight" in that they serve no other function. Further, brakes are often mounted on wheels, and unsprung weight can significantly hurt traction in some circumstances. Noise â€” Brakes usually create some minor noise when applied, but often create squeal or grinding noises that are quite loud. Foundation components[edit] Foundation components are the brake-assembly components at the wheels of a vehicle, named for forming the basis of the rest of the brake system. These mechanical parts contained around the wheels are controlled by the air brake system. This force is greatly reduced when the engine is running at fully open throttle, as the difference between ambient air pressure and manifold absolute air pressure is reduced, and therefore available vacuum is diminished. However, brakes are rarely applied at full throttle; the driver takes the right foot off the gas pedal and moves it to the brake pedal - unless left-foot braking is used. Because of low vacuum at high RPM, reports of unintended acceleration are often accompanied by complaints of failed or weakened brakes, as the high-revving engine, having an open throttle, is unable to provide enough vacuum to power the brake booster. This problem is exacerbated in vehicles equipped with automatic transmissions as the vehicle will automatically downshift upon application of the brakes, thereby increasing the torque delivered to the driven-wheels in contact with the road surface.

Chapter 2 : Automotive Braking System Market Size, Share And Forecast To

An automotive braking system is a group of mechanical, electronic and hydraulically activated components which use friction / heat to stop a moving vehicle. How does a braking system work?

The industry is driven by the increasing demand of eco-friendly and fuel-efficient vehicles. The rising environmental concerns have forced the automakers to adopt certain technologies that can curb the increasing exhaust gas emissions and fuel consumption by vehicles. The regenerative braking systems RBS , when deployed as a component in the vehicle, helps in achieving better fuel economy and also reduces these emissions. On the basis of storage type, the automotive regenerative braking systems market is segmented into battery, flywheel, ultracapacitors, and hydraulics. However, ultracapacitors have better charge-discharge capabilities than batteries, and are able to burst high amount of power even at degrees Celsius. Owing to such differentiating features, ultracapacitors are expected to be the fastest growing energy storage type used in RBS, during the forecast period. Based on vehicle type, the automotive regenerative braking systems market is categorised into passenger cars and commercial vehicles. Passenger car is expected to be the dominating category in terms of value, during the forecast period. The major reason attributed to this is the growing market of electric and hybrid passenger cars, and extensive usage of RBS systems in these vehicles. The market in the region is expected to grow at a robust pace owing to the surge in the demand of fuel-efficient hybrid vehicles, and rising need of long-range battery electric vehicles. The legislative bodies in countries such as China, Japan, South Korea, Singapore, and India are actively working to curb the increasing Greenhouse Gas GHG emission and have issued several regulations for the same. The stringent government regulations and increasing demand of RBS for electric vehicles is expected to bolster the growth of the market in the region. Automotive Regenerative Braking Systems Market Dynamics Drivers Stringent government regulations associated with GHG emission by vehicles is one of the major drivers for the automotive regenerative braking systems market. GHG emission by vehicles is increasing continuously, following which, several environmental agencies, along with the transportation departments of several regions, have imposed regulations to control the increasing carbon level. The regulation aims at limiting the carbon dioxide emission to 95 grams per kilometer for all the passenger cars, until The regulation also aims at limiting the carbon dioxide emission to grams per kilometer until , for all commercial vehicles. A similar trend can be witnessed with other nations; for instance, in the U. As RBS has the capability to control exhaust emission rate by vehicles to a great extent, the automakers are adopting this advanced braking technology in their vehicles to comply with the stringent regulations. The growing inclination of automakers towards RBS is expected to give an impetus to the automotive regenerative braking systems market during the forecast period. Restraints High manufacturing cost is one of the major restraints for the growth of the automotive regenerative braking systems market. A regenerative braking system consists of energy harnessing components that recover energy from the braking parts, and energy storage reservoirs flywheel, batteries, and ultracapacitors. Due to high functionality and critical nature of these components, the manufacturing cost of these components is greater than that of conventional braking parts, which increases the overall manufacturing cost of RBS when compared with conventional braking systems. The high cost of RBS may decrease the target customer pool and may hinder the growth of the automotive regenerative braking systems market in the coming years. However, the commencement of mass production, high adoption rate, and technological advancements in RBS are anticipated to result in reduced manufacturing cost in the future. Opportunity The high growth of ultracapacitor based RBS segment offers a lucrative opportunity for the automotive regenerative braking systems market growth. The ultracapacitor based RBS segment is expected to grow at the fastest pace when compared with the other RBS types, during the forecast period. The major reason behind this is the better performance capability of ultracapacitor-based RBS. Additionally, they can discharge and recharge quickly, efficiently work during peak power demands, and deliver substantial amount of power quickly. Owing to such differentiating features, the adoption rate of ultracapacitor-based regenerative braking systems in the automotive industry is expected to increase. Innovative products and services, pricing strategies, market

initiatives, and developing and extending the product lines are some of the initiatives undertaken by the market players to maintain competition in the industry. Continental AG, Adgero S. S, Skeleton technologies, and Denso Corporation are some of the prominent players in the automotive regenerative braking systems market in the years and The other key players in the industry include Aisin Seiki Co. It is recommended for a single user. It is recommended for up to five users. It is recommended for organizations where multiple people would like to access the report from multiple locations.

Chapter 3 : Automotive Brake Systems Market Size | Industry Report,

A brake is a mechanical device that inhibits motion by absorbing energy from a moving system. It is used for slowing or stopping a moving vehicle, wheel, axle, or to prevent its motion, most often accomplished by means of friction.

Request Advisory Development of the smart braking systems in automotive brake system market resulted in decreasing number of accidents. Advancement of automotive brake system includes safety systems, which enables speed control as well as prevents vehicle from skidding. This in turn minimizes the risk of potential accidents, thereby driving the growth of automotive brake system market. Rapid increase in the production and sales of vehicles coupled with stringent regulations regarding stopping distances is anticipated to magnanimously contribute further towards growth of automotive brake system market. Growing demand for installation of passive and active safety in vehicles is expected to trend in automotive brake system market. Growing concern over road traffic crashes and increasing number of deaths have influenced the key players in automotive brake system market to integrate robust safety features in developing vehicles. Stringent safety regulations by regulatory bodies and governments will continue to drive the growth of automotive brake system market. Latest technologies in automotive brake system market are creating challenges for automakers owing to their inability to incorporate the high-cost technologies in low-priced vehicles. This in turn is expected to adversely affect the revenue growth of automotive brake system market in the forthcoming years. The developing industry of automotive has largely emphasised on the development of the vehicles that are fast and safe. Brakes have become an important and crucial part of any vehicle so as to ensure the safety which becomes very essential when the demand of speed is increasing steadily. Being commonly used in different automobiles an automotive brake system comprises a brake device having different components such as brake pads, brake shoes, brake drum, rotor, piston, calliper, master cylinder, and brake booster which are used for decelerating a vehicle. Automotive Brake System Market: Also the increasing governmental mandates for improving the vehicle safety has strongly contributed to the demand of the global automotive brake system market. The major restraint in the global automotive brake system market implies to be the higher cost of the newer technology of Electronic Brake Systems EBS when compared to the commonly used Hydraulic Brakes. Segmentation On the basis of product type, the global automotive brake system market is segmented as Disc Brakes and Drum Brakes. Region-wise Outlook The global automotive brake system market is expected to register a favourable growth for the forecast period, ? Asia-Pacific is projected to endure its control on the global automotive brake system market. The key countries in the mentioned region are projected to be India, South Korea, and China as an outcome of the increasing demand for commercial vehicles and passenger cars. Japan also contributes to the global automotive brake system market remarkably. China is expected to be the largest opportunity in terms of revenue of the industry. Europe is expected to be the second largest market in global automotive brake system market followed by North America. The research report presents a comprehensive assessment of the market and contains thoughtful insights, facts, historical data, and statistically supported and industry-validated market data. It also contains projections using a suitable set of assumptions and methodologies. The research report provides analysis and information according to categories such as market segments, geographies, types, technology and applications. The report covers exhaustive analysis on:

Chapter 4 : How the braking system works | How a Car Works

Brakes translate a push of a pedal to slowing down your car - but how? Learn how brakes work, about the physics of braking and see a simple brake system.

Disk Brake Drum Brake As of , disk brake is the largest segment, in terms of revenue, of the overall automotive braking systems market worldwide. Owing to quick response and reduced vehicles stopping distance, disc brake system is prominently applied in most of the automobiles. Disc brakes are compatible with two wheelers, passenger cars and light commercial vehicles. Rise in demand for on-road automotive vehicles worldwide and increased safety in braking system, automotive disc brake system market is expected to maintain its dominance in the future. The overall demand for automotive braking system is estimated to remain average in the drum brake segment. Efficiency of drum brakes is limited as compared to disc brakes. Factors including excessive heat generation, elongated stopping distance and fractional delayed response compared to disc brakes have made drum brake system to fall back, in terms of application. With limited application such as emergency brakes and parking brakes, overall demand for drum brake is estimated to remain stagnant in the coming years. Consequently, the overall drum brake segment growth is expected to remain low in the overall automotive braking system market. The global automotive braking system market is segmented, based on vehicle class, into following categories Passenger Cars Heavy Commercial Vehicles HCV Two-wheelers Automotive braking system is applied to different segments of automobile, depending on their design, working condition and efficiency. On the basis of vehicle class passenger cars segment dominated the overall automotive braking system market, in With significant rise in the sales of passenger cars, the demand for efficient braking system for these cars has also escalated, over the period of time. Two-wheelers braking system segment succeeds passenger car segment. With the adoption of new technologies in braking systems, two wheelers are also getting advantages of advanced features for safety. Moreover, rapid industrialization and increased trading activities and industrial logistics have significantly boosted the consumption of light and heavy commercial vehicles. Consequently, automotive braking market for these segments too is expected to grow at a consistent rate in the coming years. The global automotive braking system market is segmented, based on its working technique, into following categories: Hydraulic Braking System Pneumatic Braking System Hydraulic and pneumatic braking systems have completely taken over the conventional mechanical braking system across all the vehicle class. Hydraulic braking system is by far the most widely adopted braking system in automobile industry. Hydraulic braking system offer several merits such as quick response, compact construction and efficient braking. Vehicle stopping distance of hydraulic braking system is significantly less compared to other braking methods. Subsequently, hydraulic braking system is suitable for almost all of the vehicle classes including passenger cars, light commercial vehicles and two wheelers. With the consistent growth expected across the automotive industry, hydraulic brake system is projected to retain its dominant position in the market throughout the forecast period. Pneumatic braking system segment follow hydraulic braking segment, in terms of revenue, as of Pneumatic braking systems are heavy in construction and can transfer braking force over longer distance than hydraulic braking system. Owing to these attributes, pneumatic braking system is particularly used in heavy commercial vehicles. In addition, the overall running cost of pneumatic braking system is also limited as it uses air as its working medium. Consistent rising demand for commercial vehicles worldwide would lead to steady demand for pneumatic braking system. The global automotive braking system market is segmented, based on the technology, into following categories: One of the most predominantly used electronic features in automotive braking system is antilock braking system ABS. Antilock braking system aids in preventing vehicle skidding on sudden application of brakes, thereby reducing the risk of any severe accidents. ABS has been made mandatory in various in countries including the U. This has led to strong across the ABS segment, over the period of time. Electronic stability control system ESC is expected to emerge as the fastest growing segment in the overall automotive system market. ESC offers various improved features than ABS including better traction control and prevention of mishaps due to over-steering. Further, regenerative braking is another

promising technology being adopted in nascent times. With ability to generate electricity through braking force, regenerative braking is applied in electric and hybrid vehicles. With the rising in trend of electric and hybrid vehicles, overall regenerative braking system market is expected to grow at a continuous rate during the forecast period. The global automotive braking system market has been segmented, on the basis of geographical regions, as per following regions and countries:

Chapter 5 : Global Automotive Autonomous Emergency Braking Systems Market Research Report

Each car manufacturer has its own automatic braking system technology, but they all rely on some type of sensor input. Some of these systems use lasers, others use radar, and some even use video data.

On the basis of brake type, the market is segmented as disc brake and drum brake. Disc brake is expected to account for the largest market share during the forecast period due to the rise in safety regulations by the government. In North America and Europe, the emphasis on increasing the stopping distance, has led to the growth of the disc brake market. Currently, there is an increase in the production of passenger cars, which will drive the growth of the disc brake market. On the basis of brake system, traction control system TCS is expected to account for the largest market during the forecast period due to the growing technology in braking system. Government have set various regulations to make use of this type of braking system for the safety of people. Based on vehicle type, passenger car is expected to account for the largest market during the forecast period due to increase in production of passenger cars. Market Segmentation Asia-Pacific region is expected to account for the largest market share during the forecast period due to growth in demand for commercial and passenger cars in countries such as India, China, and South Korea. China is expected to have the largest contribution in automotive brake system market due to increased opportunity for the brake system companies. Europe is expected to be the second largest market in automotive braking system market. Increase in demand for the production of passenger cars and increase in government regulations for the safety of the vehicle are the factors responsible for driving the automotive braking system market. The rise in vehicle safety will drive the demand of braking system in passenger cars, which will lead to the growth of this market. Japan , Valeo France. Brake is a mechanism that prevents motion of the vehicle by absorbing energy when the vehicle is in moving condition. Thus, braking system is also used to stop the vehicle or slowing down of vehicle. They provide safety to the vehicle when the vehicle is in motion. The global automotive braking system market is expected to account for market size of The report for Global Automotive Braking System Market of Market Research Future comprises of extensive primary research along with the detailed analysis of qualitative as well as quantitative aspects by various industry experts, key opinion leaders to gain the deeper insight of the market and industry performance. The report gives the clear picture of current market scenario which includes historical and projected market size in terms of value, technological advancement, macro economical and governing factors in the market. The report provides details information and strategies of the top key players in the industry. The report also gives a broad study of the different market segments and regions.

Chapter 6 : Automotive Brake System Market: Global Industry Analysis, Size and Forecast, to

Automotive braking system is expected to grow at USD billion by end of year , Global Automotive braking system Market categorizes the Global Market by Brake Type, Brake System, Vehicle Type and Region | Automotive braking system Industry | MRFR.

The introduction of smart braking systems has led to a decrease in the number of accidents and loss of lives. These can be integrated with other safety systems that enable speed control and prevent skidding of vehicles to minimize risks of a potential accident. The increasing production of vehicles and sales, coupled with regulations over stopping distances, have contributed magnanimously to the growth and development of the industry. There is an increase in demand for the installation of active as well as passive safety in automobiles. The growing concerns over deaths due to road traffic crashes has prompted an increase in stringency of safety regulations. However, high costs of the latest technologies prove to be challenging for automakers, as they are unable to incorporate the technologies into low-priced vehicles. Another crucial problem faced by manufacturers is counterfeit of parts, which can hamper the vehicle performance and safety. Widespread awareness of the adverse effects of using counterfeit parts and reduction in prices of genuine auto parts are crucial in curbing counterfeiting. The market can be classified into two types namely disc and drum. Disc brakes use a slim rotor and caliper to halt wheel movement; whereas, drum brakes have an enclosed design and use circular components brake shoes to generate the necessary friction for reducing speed. The enclosed design of drum retains heat while operating. This leads to a dip in performance. Disc based systems are superior to drum based systems regarding braking power but, the use of drum is quite popular among automakers as they are cost-effective. The disc brakes segment is expected to grow at the fastest rate over the forecast period. There has been an increase in the usage of disc brakes in the recent years, primarily, due to their ability to function in adverse weather conditions without overheating or fading. Additionally, the ability to integrate with other advanced systems is expected to drive their demand. Vehicle Type Insights The market is broadly segmented into passenger cars and commercial vehicles. The brake systems are integral parts of a vehicle. Hence, an increase in vehicle production and sales would have a direct impact on the market. According to OICA, in , the sales of passenger cars increased by approximately 4. Similarly, the commercial vehicles segment showed a steady upsurge as the sales reached 24 million units in from 23 million units in Technological advancements and introduction of electro-mechanical brakes, which incorporated the precision of digital microcontrollers and sensors, have enabled automakers to deliver utmost safety for passengers. However, this has increased the cost of braking systems and subsequently, the overall vehicle cost. Passenger cars owners extravagantly spend on enhanced braking systems and thus, the segment is expected to grow at the highest CAGR of 5. The ABS segment held the largest market share in The active efforts of various automotive associations toward mandatory implementation of ABS in prominent regions have led to the growth of the ABS technology. Likewise, the rising adoption of ESC technology, owing to its perceived benefits in gaining vehicle control during an emergency situation, is expected to drive the growth of the automotive brake systems market over the forecast period. The TCS technology ensures traction in adverse road conditions, thereby, providing additional safety. Moreover, the technology can be implemented using the same infrastructure used for ABS. It enables the widespread adoption of TCS. Thus, the incorporation of advanced braking systems would enable automakers to achieve higher NCAP rating for a vehicle. The manufacturers in the region offer high-cost reduction, owing to the availability of low-cost labor and raw materials. Increasing popularity of active braking systems, coupled with a boost in sales of luxury and premium vehicles, is presumed to drive the market. This can be attributed to the increasing demand for improved performance in adverse weather conditions. Additionally, the mandatory implementation of the ESC technology, since , in all light vehicles is driving the regional market. Competitive Insights The market is dominated by prominent manufacturers such as Autoliv, Inc. The companies are primarily focused toward developing eco-friendly, reliable, and robust braking systems. Furthermore, they are actively engaged in extending their geographical presence to high-growing markets and strengthening their production

capabilities. The company has also received a job development incentive grant of USD 1. The added production capacity would be utilized for manufacturing the MK C1 braking systems.

Chapter 7 : Automotive Braking Systems

New from just-auto this quarter, this report has been extracted from motor industry information and intelligence platform QUBE and provides a comprehensive overview of the global automotive original equipment (OE) foundation and electronic braking sector and assesses major suppliers, top markets, technology trends and market size forecasts.

A drum brake has a hollow drum that turns with the wheel. Its open back is covered by a stationary backplate on which there are two curved shoes carrying friction linings. With the brakes on, the shoes are forced against the drums by their piston. Each brake shoe has a pivot at one end and a piston at the other. A leading shoe has the piston at the leading edge relative to the direction in which the drum turns. The rotation of the drum tends to pull the leading shoe firmly against it when it makes contact, improving the braking effect. Some drums have twin leading shoes, each with its own hydraulic cylinder; others have one leading and one trailing shoe - with the pivot at the front. This design allows the two shoes to be forced apart from each other by a single cylinder with a piston in each end. It is simpler but less powerful than the two-leading-shoe system, and is usually restricted to rear brakes. In either type, return springs pull the shoes back a short way when the brakes are released. Shoe travel is kept as short as possible by an adjuster. Older systems have manual adjusters that need to be turned from time to time as the friction linings wear. Later brakes have automatic adjustment by means of a ratchet. Drum brakes may fade if they are applied repeatedly within a short time - they heat up and lose their efficiency until they cool down again. Discs, with their more open construction, are much less prone to fading. The handbrake Lever The handbrake mechanism The handbrake acts on the shoes by means of a mechanical system, separate from the hydraulic cylinder, consisting of a lever and arm in the brake drum; they are operated by a cable from the handbrake lever inside the car. Apart from the hydraulic braking system, all cars have a mechanical handbrake acting on two wheels - usually the rear ones. The handbrake gives limited braking if the hydraulic system fails completely, but its main purpose is as a parking brake. The handbrake lever pulls a cable or pair of cables linked to the brakes by a set of smaller levers, pulleys and guides whose details vary greatly from car to car. A ratchet on the handbrake lever keeps the brake on once it is applied. A push button disengages the ratchet and frees the lever. On drum brakes, the handbrake system presses the brake linings against the drums. Disc brakes sometimes have a comparable handbrake arrangement, but because it is difficult to place the linkage on a compact caliper, there may be a completely separate set of handbrake pads for each disc. Stop wasting time on YouTube and get serious! The Ultimate 20 hour car mechanics video course Learn everything about modern cars from our new video series. Clearly and easily explained. All modeled in 3D.

Chapter 8 : How Brakes Work | HowStuffWorks

Animated video showing the working of braking system in a car.

Not surprisingly, braking is an exciting area for development within the automotive industry with a number of technologies competing to improve safety and overall efficiency. Professor, Institute for Powertrains and Automotive Technology, Vienna University of Technology, Austria, in order to learn more about the latest developments in the industry and to gain insight into which ones have potential. Professor Stockmar is a true automotive engineer who has had the good fortune of being able to combine his job with his passion. I am one of the very rare real automotive engineers. I actually studied automotive engineering whereas most of my colleagues are mechanical engineers. I know what both sides are expecting from the other. I hope that I can transfer some of my personal knowledge to my clients. As a young engineer I have designed and built my own racing car, an open two seater sports car that has been successfully raced in Europe by top drivers. You really are living the dream and are passionate about the industry. I think so, yes. My job is and was my passion. What do you think are the main challenges that the OEMs and their suppliers face with regard to brake systems? Number one is certainly reliability and safety. In the future we have to have an inside look into zero drag. Common brakes are not offering zero drag as they always have a little drag left. I think the next step will be real individual braking not only for the current ESP systems which we already know. Torque vectoring will also be the future, especially when looking into electric vehicles. I believe, for that, we need extremely quick-activating parts. When companies like Bosch and Continental presented their new brake boosters, the reduction of activation time was a very important item. We need the systems that are able to work perfectly together. This will be the next challenge and we have to know that in the future the brakes will work without the conventional energy source, namely vacuum. Conti, Bosch and TRW are going in different directions right now, but we will come to that later onâ€¦ The major supplier companies all have electric braking systems available but what is delaying them from implementing them on production vehicles? From my point of view there are at least two general reasons for the delay. This is one of the reasons why Continental put the wedge brake on hold when they bought Siemens VDO because they were not convinced that, at the end of the day, it would be percent reliable. Number two is the development cost. The necessary investments are tremendous for the production lines of a new brake system - at least several hundred million euros - and this is a reason why for example, Bosch, Continental, and TRW have now presented their brake boosters in order to present a bridge technology. I think the brake boosters are indeed bridge technologies. Eventually they will present their electro-mechanical brake systems. Today we see only three different systems when we look at the electro-mechanical brakes. Self-amplification will certainly be a unique selling proposition for the electric brake and I do not know any design of a ball screw brake that is offering the same proposal. The wedge brake has not been continued since Conti bought Siemens and to my knowledge all the different designs of the ball screw brake need a big motor or gear ratio and they are, interestingly, always a part of the 42 or volt discussion because of the big electric motor they need. That leaves the cam disc which, for me personally, seems to have some good advantages and, most importantly, it is a proven electro-mechanical system. That means the design is ready. Can we take that as you picking a winner? Also, for other applications, I think the cam-disc brake could be a winner. However, the company who developed that, and have since gotten patents for it, is a very small company situated here in Vienna. It might well be that the company is too small to guarantee a breakthrough in electro-mechanical braking. Right, but as an engineer I am in favour of the cam-disc brake. What could be helpful in that case would be that a big OEM, Volkswagen or Toyota or you name them, sees the advantages of the cam-disc system, and says we want that system. Then the others have to follow. Sure, they might be able to buy up a small company with promising technology and then fund it. To continue looking specifically into braking, what developments have been most influential over the past five years and what developments do you see having a major impact looking ahead five years? There we have two different arguments. During the last decade, perhaps even more than the last decade, I saw two completely different development lines. On the one hand there was, and still is, a growing demand for more braking

power, because of the competition you can call it a race for more engine output. Five hundred horsepower today for a sports car is already the average. That was one development line. The other direction that we all can see is caused by the demand for light brake design and low-cost solutions. That was a look back in the rear view mirror and now looking ahead I see the major impact coming from the growing market penetration of electric vehicles and also hybrids. Developments are needed for these types of vehicles. New brake systems and the electrification of all auxiliary drives in the vehicle will make the conventional brake systems obsolete. Conti and Bosch and TRW and others may see it differently but am convinced at the end of the day this will be right. We are normally talking about passenger cars but we should not forget that there are interesting applications also in commercial vehicles when they go into hybrids, for example, busses for inner city traffic, collection trucks and so on. This is my view into the near future. Perhaps powering some alternative functions in the car? Some vehicles certainly will feature that system in the near future due to the very stringent fuel consumption regulations in the EU and also in other countries around the world. I see that coming, but once again it can only be a bridge technology before we go into hybrid and the electric vehicle markets. It will only be a dream technology in the near future, or the far future, when electric energy comes from regenerative sources. This will be a long way and will be an extremely costly way so people will be surprised, if not shocked, by the future price of electric energy. What technological role has motor sport played in road going cars? The performance of discs, with ceramics or carbon fibre matrixes, the brake pad materials, the brake fluids and brake calipers have all been significantly improved by the special development for motor sport vehicles. Without motor sport, all the developments that have come would have come later. Some of these improvements found their way in the course of the technology transfer into the standard brake systems for road vehicle cars, particularly for sports cars. However, we must bear in mind that the normal passenger vehicles are asking for more brake comfort, especially noise, vibrations and lifetime for the brake pads, for the discs and so on, than normal racing cars. So not all the development could be transferred into a normal road going car, but a good portion of braking power has been transferred from the motor sport into road-legal cars. During the economic downturn, a lot of factory and other teams have either gone under or have closed shop on some of their motor sport. This is also sad for development. On the other hand, brake systems are a very good example of how motor sport can influence modern technology for road going cars so that the knowledge is being disseminated from motor sport into other areas. And most importantly, the engineering teams have a completely new approach to development. If a company is rotating the engineering part of the development group from engineering for road going cars into motor sport and vice versa, I think that under these conditions, you will have the best output. People always being able to think out of the box and come back and re-apply. Given the conservative nature of the industry, innovation is often of the evolutionary type, I think we mentioned this earlier, are there any potential revolutionary or disruptive innovations that you see on the horizon? I could answer that question with a simple "No" but it would be too short. Let me go deeper into that topic. We discussed the future market of hybrid and electric vehicles, and I think this is a very important point. In the long run they will solely feature electric mechanical brakes. In combination with electric drives, the load on brake systems will be reduced because the electric generator will take over a bigger portion of the brake load, as we already discussed, recuperating a good part of the kinetic energy of the vehicle. That means, in combination with the electric motors which then are working as generators, the normal brake load will go down, so brakes can change. They will be lighter and perhaps be cheaper. However, in-wheel brake, electric hub motor and suspension combination, the deeper integration of the standalone brake system will be the next evolutionary step though it will certainly not be a revolution. And we know what Conti, Michelin and Edison, have presented in recent years. They are all pointing in the same direction. There will be a combination of brake, motor, suspension systems in the wheel, in the rims. Then vehicles will show a modular design concept and perhaps in the future it will be even easier to build up more vehicle types based on the same technology. Savings is exactly the point. I have to mention that because cost reduction is one of the most important tasks for every engineer in the past and, of course, will be in the future, perhaps even more so. For that reason I can only see evolution going on without a disruptive revolution right now. Maybe from a slightly different perspective, would you see any revolutions for the end user? I always think of anti-lock brakes as being a bit

revolutionary because it required the driver to re-think and re-learn how they brake in a panic situation. Could we see anything like that from the upcoming technologies? A brake system that brakes without the driver in an emergency situation for me is not a revolution - quite honestly - because you can already buy that today. Buy a new Mercedes S Class and you will have it as a standard feature. Of course, it will change brake behaviour. We know that only approximately 50 percent of drivers are able to brake the right way in an emergency situation so then this will be a great help. I would like to come back to an article that was written in the year by a so-called engineering expert. He wrote, "All the different developments and evolution in the automotive industry have been done. From now on we will only continue in the existing and known technology. Only a few people can say that.

Chapter 9 : Brake - Wikipedia

Automotive Braking Systems - technology, trends and forecasts to twin brake disc systems, hybrid systems, Updated profiles of the major automotive brake system suppliers including.

Early systems[edit] The concept for ABS predates the modern systems that were introduced in the s. In , for example, J. These systems used a flywheel and valve attached to a hydraulic line that feeds the brake cylinders. The flywheel is attached to a drum that runs at the same speed as the wheel. In normal braking, the drum and flywheel should spin at the same speed. However, when a wheel slows down, then the drum would do the same, leaving the flywheel spinning at a faster rate. This causes the valve to open, allowing a small amount of brake fluid to bypass the master cylinder into a local reservoir, lowering the pressure on the cylinder and releasing the brakes. The use of the drum and flywheel meant the valve only opened when the wheel was turning. An additional benefit was the elimination of burned or burst tires. Wessel, however, never developed a working product and neither did Robert Bosch who produced a similar patent eight years later. The first fully electronic anti lock system was developed in the late s for the Concorde aircraft. Modern systems[edit] Chrysler , together with the Bendix Corporation , introduced a computerized, three-channel, four-sensor all-wheel [9] ABS called "Sure Brake" for its Imperial. In , Ford added an antilock braking system called "Sure-track" to the rear wheels of Lincoln Continentals as an option; [11] it became standard in Electronically controlled anti-skid brakes on Toyota Crown [18] In , four wheel drive Triumph Estates were fitted with Mullard electronic systems as standard. Such cars were very rare however and very few survive today. WABCO began the development of anti-locking braking system on commercial vehicles to prevent locking on slippery roads, followed in by the electronic braking system EBS for heavy duty vehicles. Mercedes-Benz W became the first production car to use an electronic four-wheel multi-channel anti-lock braking system ABS from Bosch as an option from on. Honda introduced electronically controlled multi-channel ALB Anti Locking Brakes as an option for the second generation of Prelude, launched worldwide in The Norwegian general agent also included sun roof and other options to be standard equipment in Norway, adding more luxury to the Honda brand. However, the Norwegian tax system made the well-equipped car very expensive, and the sales suffered from high cost. From the ALB-system, as well as the other optional features from Honda, was no longer a standard feature in Norway. In the Ford Scorpio was introduced to European market with a Teves electronic system throughout the range as standard. For this the model was awarded the coveted European Car of the Year Award in , with very favourable praise from motoring journalists. After this success Ford began research into Anti-Lock systems for the rest of their range, which encouraged other manufacturers to follow suit. In , Lincoln became one of the first automobile companies to provide standard four-wheel anti-lock brakes AND dual air bags on all of their vehicles. The ECU constantly monitors the rotational speed of each wheel; if it detects the wheel rotating significantly slower than the speed of the vehicle, a condition indicative of impending wheel lock, it actuates the valves to reduce hydraulic pressure to the brake at the affected wheel, thus reducing the braking force on that wheel; the wheel then turns faster. Conversely, if the ECU detects a wheel turning significantly faster than the others, brake hydraulic pressure to the wheel is increased so the braking force is reapplied, slowing down the wheel. This process is repeated continuously and can be detected by the driver via brake pedal pulsation. Some anti-lock systems can apply or release braking pressure 15 times per second. The ECU is programmed to disregard differences in wheel rotative speed below a critical threshold, because when the car is turning, the two wheels towards the center of the curve turn slower than the outer two. For this same reason, a differential is used in virtually all roadgoing vehicles. If a fault develops in any part of the ABS, a warning light will usually be illuminated on the vehicle instrument panel, and the ABS will be disabled until the fault is rectified. Modern ABS applies individual brake pressure to all four wheels through a control system of hub-mounted sensors and a dedicated micro-controller. ABS is offered or comes standard on most road vehicles produced today and is the foundation for electronic stability control systems, which are rapidly increasing in popularity due to the vast reduction in price of vehicle electronics over the years. Here, a minimum of two additional

sensors are added to help the system work: The theory of operation is simple: The steering wheel sensor also helps in the operation of Cornering Brake Control CBC , since this will tell the ABS that wheels on the inside of the curve should brake more than wheels on the outside, and by how much. ABS equipment may also be used to implement a traction control system TCS on acceleration of the vehicle. If, when accelerating, the tire loses traction, the ABS controller can detect the situation and take suitable action so that traction is regained. More sophisticated versions of this can also control throttle levels and brakes simultaneously. The speed sensors of ABS are sometimes used in indirect tire pressure monitoring system TPMS , which can detect under-inflation of tire s by difference in rotational speed of wheels. There are four main components of ABS: ABS speed sensors Speed sensors A speed sensor is used to determine the acceleration or deceleration of the wheel. These sensors use a magnet and a Hall effect sensor , or a toothed wheel and an electromagnetic coil to generate a signal. The rotation of the wheel or differential induces a magnetic field around the sensor. The fluctuations of this magnetic field generate a voltage in the sensor. Since the voltage induced in the sensor is a result of the rotating wheel, this sensor can become inaccurate at slow speeds. The slower rotation of the wheel can cause inaccurate fluctuations in the magnetic field and thus cause inaccurate readings to the controller. Valves There is a valve in the brake line of each brake controlled by the ABS. On some systems, the valve has three positions: In position one, the valve is open; pressure from the master cylinder is passed right through to the brake. In position two, the valve blocks the line, isolating that brake from the master cylinder. This prevents the pressure from rising further should the driver push the brake pedal harder. In position three, the valve releases some of the pressure from the brake. Partially disassembled four-channel hydraulic control unit containing motor, pump and valves The majority of problems with the valve system occur due to clogged valves. When a valve is clogged it is unable to open, close, or change position. An inoperable valve will prevent the system from modulating the valves and controlling pressure supplied to the brakes. Electronic control module Pump The pump in the ABS is used to restore the pressure to the hydraulic brakes after the valves have released it. A signal from the controller will release the valve at the detection of wheel slip. After a valve releases the pressure supplied from the user, the pump is used to restore a desired amount of pressure to the braking system. Controller The controller is an ECU type unit in the car which receives information from each individual wheel speed sensor. If a wheel loses traction, the signal is sent to the controller. The controller will then limit the brake force EBD and activate the ABS modulator which actuates the braking valves on and off. Use[edit] There are many different variations and control algorithms for use in ABS. One of the simpler systems works as follows: It is looking for decelerations in the wheel that are out of the ordinary. Right before a wheel locks up, it will experience a rapid deceleration. If left unchecked, the wheel would stop much more quickly than any car could. It can do this very quickly, before the wheel can actually significantly change speed. The result is that the wheel slows down at the same rate as the car, with the brakes keeping the wheels very near the point at which they will start to lock up. This gives the system maximum braking power. This replaces the need to manually pump the brakes while driving on a slippery or a low traction surface, allowing to steer even in most emergency braking conditions. When the ABS is in operation the driver will feel a pulsing in the brake pedal; this comes from the rapid opening and closing of the valves. This pulsing also tells the driver that the ABS has been triggered. Brake types[edit] Anti-lock braking systems use different schemes depending on the type of brakes in use. They can be differentiated by the number of channels: With this setup, the controller monitors each wheel individually to make sure it is achieving maximum braking force. Older vehicles with four-wheel ABS usually use this type. The speed sensor for the rear wheels is located in the rear axle. This system provides individual control of the front wheels, so they can both achieve maximum braking force. The rear wheels, however, are monitored together; they both have to start to lock up before the ABS will activate on the rear. With this system, it is possible that one of the rear wheels will lock during a stop, reducing brake effectiveness. This system is easy to identify, as there are no individual speed sensors for the rear wheels. If the speed sensor detects lock up at any individual wheel, the control module pulses the valve for both wheels on that end of the car. It has one valve, which controls both rear wheels, and one speed sensor, located in the rear axle. This system operates the same as the rear end of a three-channel system. The rear wheels are monitored together and they both have to

start to lock up before the ABS kicks in. In this system it is also possible that one of the rear wheels will lock, reducing brake effectiveness. This system is also easy to identify, as there are no individual speed sensors for any of the wheels. On high-traction surfaces such as bitumen , or concrete , many though not all ABS-equipped cars are able to attain braking distances better i. In real world conditions, even an alert and experienced driver without ABS would find it difficult to match or improve on the performance of a typical driver with a modern ABS-equipped vehicle. The recommended technique for non-expert drivers in an ABS-equipped car, in a typical full-braking emergency, is to press the brake pedal as firmly as possible and, where appropriate, to steer around obstructions. In such situations, ABS will significantly reduce the chances of a skid and subsequent loss of control. In gravel, sand and deep snow, ABS tends to increase braking distances. On these surfaces, locked wheels dig in and stop the vehicle more quickly. ABS prevents this from occurring. Some ABS calibrations reduce this problem by slowing the cycling time, thus letting the wheels repeatedly briefly lock and unlock. Some vehicle manufacturers provide an "off-road" button to turn ABS function off. The primary benefit of ABS on such surfaces is to increase the ability of the driver to maintain control of the car rather than go into a skid, though loss of control remains more likely on soft surfaces such as gravel or on slippery surfaces such as snow or ice.