A Review on The Development of Wiper System for Automotive Car Windscreen Cleaning Application

Abstract **- The current review focuses on the development of the car wipers and washer's design from the year 1939 till the year 2021. Based on the review, it is observed that the wipers and washers placed on an automotive vehicle went through major revolutionary designs to optimize cleaning of windscreen. A review on the importance of a proper functional wiper and washer system was also done to understand the safety factor of having such system for road passengers' vehicles. Based on this review, it was found that road accidents are more likely to occur in foul weather especially in rainy and windy conditions as the wiper and washer systems may not be effectively working optimally.**[1] **This paper also proposes future research path ways to further enhance the car wiper and washer's design as a whole through comprehensive research, trial and error.**

Keywords—Wiper; Washer; Automotive; Road Passengers Vehicles.

I. INTRODUCTION

Driving in foul weather can be absolutely dangerous especially when water molecules and debris end up accumulating on the windscreen during a heavy downpour or in windy conditions. Bad weather such as rain and windy conditions still remains to be the leading cause to road accidents according to studies.[1] These water droplets and debris causes temporary blindness that reduces the vision of the driver when driving in such bad conditions. This case of temporary blindness causes the driver to slow down, concentrating on taking an immediate action of turning on the wiper switch or else it can very well end up causing a huge accident where multiple human's lives are at stake. With that said, an automotive car is always equipped with a wiper system consisting of a pair of wiper blades and a pair of washer nozzles that is a safety feature as they wipe off remaining water molecules left on the windscreen and wash off remaining debris stuck on to the windscreen to increase visibility of drivers. However, an effectively operating wiper blade can generally be affected in large downpours which usually ends up deteriorating the rubber blade much quickly.[2]

All accidents that occur in Malaysia are primarily recorded by the Royal Malaysia Police (RMP) where it is the official source of Malaysia's road accident database. Table I and Fig. 1 illustrates the distribution of cases based on weather classification in Malaysia, with the largest number of road accidents occurring in fine weather followed by rain, foggy and windy conditions.[1]

Table I. Number of road accidents according to weather classification [1]

Weather	Total	Percentage, %
Fine	88,875	90.82
Windy	306	0.31
Foggy	1,705	1.74
Rain	6,970	7.12
Total	97,856	100.00

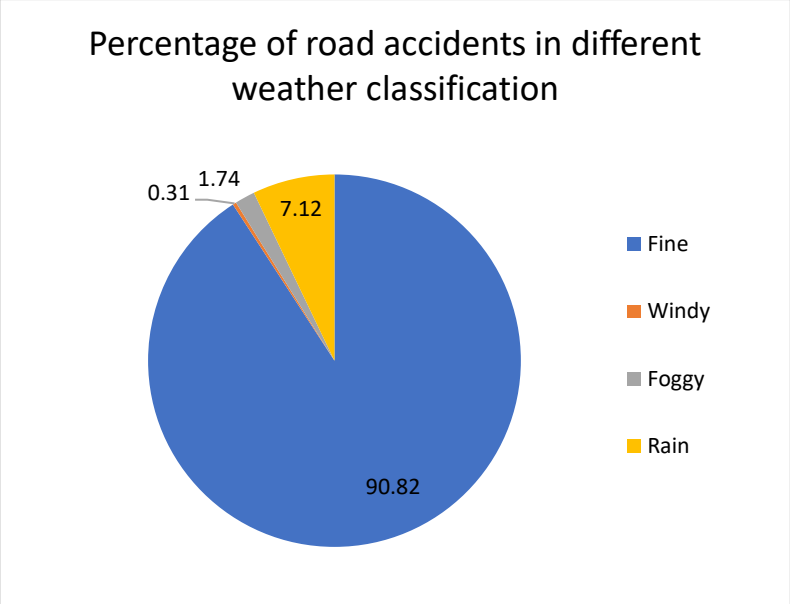

Fig. 1. Percentage of road accidents in different weather classification [1]

The largest highway available in Malaysia is formally known as the PLUS Expressways Berhad that connects from north to south of the west coast of Peninsular Malaysia. The PLUS highway has been operating since the year 1934 having a high volume of traffic each year, whereby between the years 2003 to 2007, PLUS highway has recorded over 300 million automotive vehicles. Apart from the Royal Malaysia Police, PLUS independently manages its own accident cases as well as data collection. Table II and Fig. 2 illustrates the data collected according to the weather classifications at PLUS (2003-2007), with the largest number of road accidents occurring in fine weather followed by rain, foggy or hazy and strong windy conditions.[3]

Table II. Number of road accidents according to the weather classifications at PLUS [3]

Weather Classification	Number of Cases	Percentage, %
Fine	26,919	72.92
Rain	9,809	26.57
Fog/Haze	102	0.28
Strong wind/crosswind	87	0.23
Total	36,917	100.00

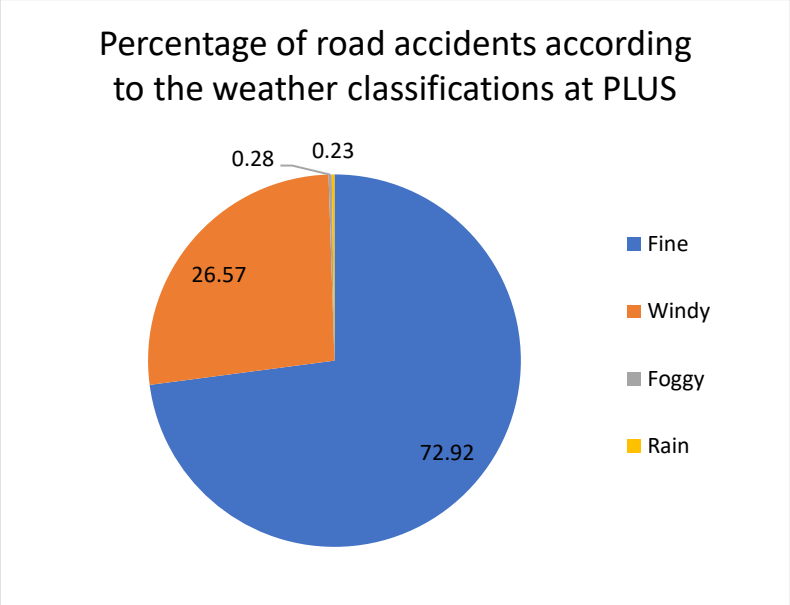

Fig. 2. Percentage of road accidents according to the weather classifications at PLUS [3]

Mary Anderson had introduced the functions of wipers in the year 1903 where she had come to realise that visibility of drivers was compromised especially in raining conditions as the windscreen always had remaining water molecules that would not dry off immediately. Following the invention of wipers, the windscreen washer nozzle linked to a washer liquid reservoir tank was discovered by Richland Auto Parts Company of Mansfield, Ohio back in 1931 after the first motorised power windscreen wiper was introduced to lubricate wiper blades for efficient cleaning purposes. It was not until 1937 where Héctor Suppici Sedes, a mechanic and race car driver developed a functional windscreen washer by creating holes along a pipe for the use of dispensing washer liquid to clean debris such as dirt and insects off the windscreen.[4]

Details of wiper and washer system together with the history of this mechanism will be presented through this paper. A review of car wiper and washer models are screened through starting from the year 1939 up till the year 2021. Along with the review of these models, future possible research on car wiper and washer systems will be introduced while keeping in mind of certain advantages and disadvantages on this research works. Hence, it is hoped that with the drawbacks and complexity addressed in this paper, a window of opportunity will certainly open up new pathways for future research and discovery on the car wiper and washer systems.

II. Development Of Car Wipers And Washer's Design

The invention of the windscreen wiper was only introduced in 1903, where Mary Anderson had noticed the lack of visibility of the windscreens when it was either raining or snowing. Throughout the implementation of the windscreen wiper invention, it has helped remove a substantial amount of rain, snow and debris off the windscreen. However, there was a lack in the area of clearness when mud or insects which tend to get stuck onto the windscreen in dry weather.

The idea of windscreen washer had not been discovered until 1931 which was after the first motorized power windscreen wiper was developed in 1917. This evolution of the wiper system was discovered by Richland Auto Parts Company of Mansfield, Ohio to provide lubrication to the wipers for efficient cleaning purposes where a reservoir of liquid had to be installed. Moving on, in the year 1937, a Uruguayan race car driver and mechanic by the name of Héctor Suppici Sedes, had developed a windscreen washer by drilling a pipe across the windscreen forcing the water to flush out, cleaning the surface of the screen when there was mud, or any insect stuck on it.[4]

When 1939 came by, an established automobile company called Chevrolet, had introduced an accessory to be used on their 1939 Chevrolet Master 85, whereby a windscreen washer could be installed onto the vehicle as seen in Fig. 3. Water for the windscreen washer is supplied from the tank mounted under the hood which is forced by vacuum to the windscreen in a single stream manner. Operation of the windscreen washer is by depressing the button on the dash to allow liquid to be sprayed onto the windscreen and followed by turning on the windscreen wiper controller.[5] The windscreen wiper is controlled through a lever placed in the vehicle itself where it is located close to the lower end of the centre dividing strip of the windscreen.[6] When the lever is moved to the right, it starts the motion of the obsolete design windscreen wiper which is commonly found on multiple vintage vehicles having the split screen design. The 1939 Chevrolet Master 85 comes equipped with a wrist type stainless steel windscreen wiper arm and rubber blade where it can often be seen on a lot of the vintage vehicles.[5]

The implementation of an accessory such as the washer nozzle is an essential component to have as it helps lubricate the wiper blades to effectively clean the surface of the windscreen. This allows the wiper blades to function a lot longer efficiently to remove any debris off the windscreen. However, even with the lubrication provided by the washer liquid to the wiper blade, it does tend to deteriorate over the course of a period which will result in leaving dirt or water streaks along the area of the windscreen which ultimately distracts the driver. Adding to that, the wiper mechanism of an obsolete design prevents wipers from wiping off debris and liquid from the middle sector of the screen which also disturbs the vision of the driver. Another factor that distracts drivers is by having the washer nozzle distributing liquid in a single stream towards the centre of the windscreen that prevents the corners to be cleaned leaving the entire middle area fill with filth.

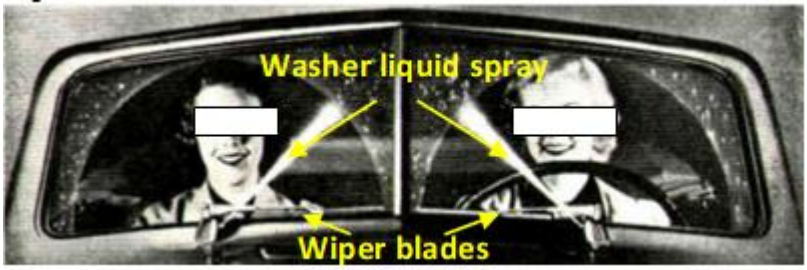

Fig. 3. 1939 Chevrolet Master 85 windscreen washer [6]

A. 1965 Jaguar E-Type

A luxury vehicle brand namely Jaguar had manufactured the Jaguar E-Type in the year 1965 which was ultimately a British race car known for its aerodynamic feature and beauty. This Jaguar E-Type had an unusual attachment of three wiper blades, as shown in Fig. 4, instead of the conventional two wiper blades. Due to the windscreen dimensions which were exceptionally short and wide, the three-blade attachment was needed to cover a certain percentage of the screen.[7] Having said that, the wiper blades that were used needed to be shorter in dimension as well to maximize the coverage of the windscreen. With that in mind, these wiper blades had a smaller area to sweep off water and dirt off the screen.

This wiper mechanism uses the tandem-pattern three-lever system that overlaps one another when the wiper is in use. Apart from that, there is however only two washer nozzle attachments available on this vehicle as can be seen in Fig. 4. These washer nozzles are placed right on the vehicle's engine hood in between the gaps of the wiper arm. When washer is in use, washer liquid is gushed out from the nozzle onto the windscreen in a single stream fountain-like manner only to cover approximately one fourth bottom part of the screen. The wiper and washer are both operated through a switch available next to the steering wheel of the vehicle.

The idea of the three-wiper blade was brilliant in the sense that the windscreen can be cleared quickly with the shorter wiper blade having smaller radius which meant smaller area to clean. The operation of the washer was not the most convenient as it only sprayed one fourth of the screen, leaving the rest of the windscreen dry which eventually leads to not properly cleaning off dirt or dust on the top part of the screen. In the long run, users had to constantly change up their three wiper blades as they often deteriorated quickly due to the usage of rubber material which then led to having water or dirt streaks on the windscreen when the wiper was in use.

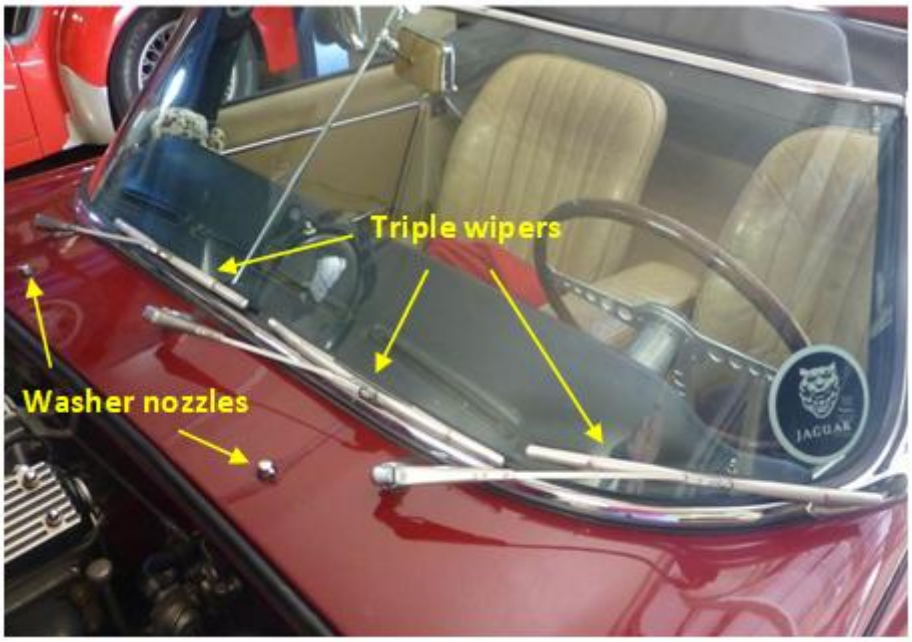

Fig. 4. Triple wiper blades of 1965 Jaguar E-Type [7]

B. 1971 Alpine A310 V6

A French owned vehicle manufacturing company, Alpine launched the first generation of the Alpine A310 back in 1971. The vehicle was designed to have an utterly different wiper mechanism, shown in Fig. 5, compared to the standard wiper system. The two wiper blades on the Alpine A310 appear to be mounted at the centre of the windscreen that pivots the rubber wiper blade towards the middle as it travels through the screen while sweeping away liquid or dirt. The wipers are at rest when they are both on opposite ends and are facing outwards at the bottom of the windscreen.

These wiper blades do not move in parallel synchronization like most conventional wiper mechanisms. However, they seem to be working on an opposed system whereby they sweep facing towards one another. Considering the functions of opposed wiper system, it does have a decent windscreen coverage with just a slight area where water and dirt would accumulate over time.[8] Aside from the wipers, a pair of washer nozzles with each two small jets is placed opposite to one another at the

bottom end of the windscreen as can be visualised also in Fig. 5. The washer liquid gushes out from the jets in a “V” shaped streamline fountain-like manner as shown in Fig. 6, distributing only to the bottom half of the windscreen. Both the wipers and washers are operated using a stalk switch like most common vehicles however, to choose the required speed of the wipers can only be done by twisting the stalk and pulling the stalk forward will dispense washer liquid.

The design of these wipers does get the job done when it comes to cleaning the major areas of the windscreen with the opposed system. Despite that, it does leave a long streak of swept water and dirt along the middle part of the windscreen when the wipers are used. This can however distract the driver when driving especially in foul weather conditions. Also having a rubber blade would mean replacing it from time to time as it wears out rapidly which would increase the cost of the user. With that in mind, the liquid distributed by the washer nozzles only covers the bottom half of the windscreen which then would leave the top half of the windscreen to remain dirty and that defeats the purpose of having a washer nozzle fixed on to the vehicle.

Fig. 5. Opposed wiper system of Alpine A310[8]

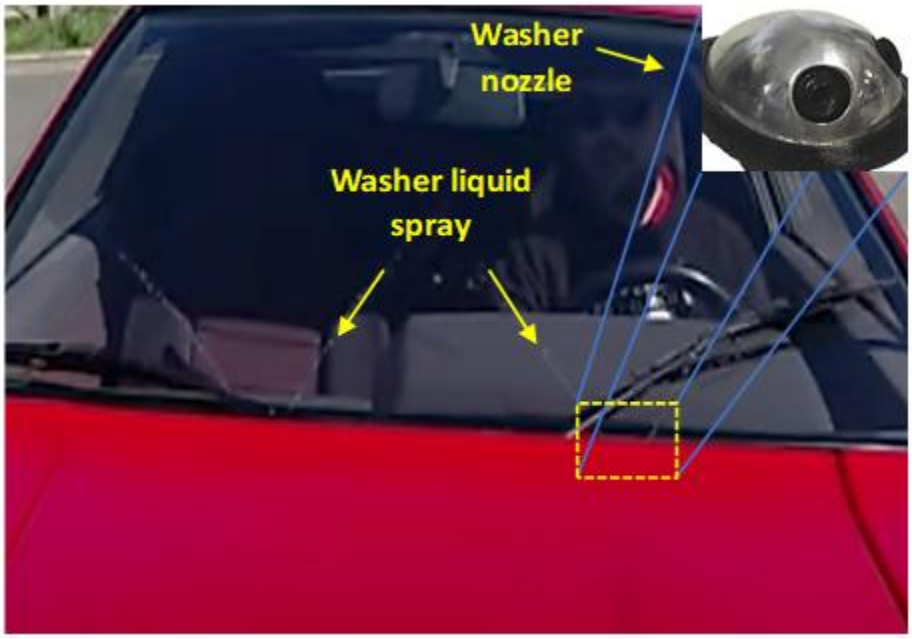

Fig. 6. Washer nozzle and liquid of Alpine A310 [8]

C. 1982 Porsche 911

The two-door high performance Porsche Nine Eleven was introduced in 1964 by a German automobile manufacturer, Porsche AG.[9] The Porsche 911 comes with a pair of wiper arms, shown in Fig. 7, that works predominantly like other vehicles in the market with a tandem-pattern double-lever system. Although, it does have some interesting features that should not be overlooked, such as the spacing between the two average sized wipers which are fairly close to one another compared to other cars. This wiper mechanism of the narrow blade spacing is often seen on older vintage cars.

The arrangement seen on this vehicle allows the behaviour of the wiper to overlap quite a lot which enables the wipers to sweep off a huge amount of area on the windscreen. When in resting position, the left wiper blade rests on top of the right wiper blade horizontally. On the other hand, a pair of washer nozzles, seen in Fig. 7, are placed directly off the engine hood of the vehicle allowing washer liquid to be distributed onto the windscreen. The motion of washer liquid from each nozzle is by dispensing it in a "V" shaped streamline, which can be seen in Fig. 8, covering approximately up to half of the windscreen. Both the wipers and washer function through a switch in the form of a stalk placed behind the steering wheel for better accessibility of the driver.

With that all in mind, the functionality of the wiper blades having to sweep a major area of the windscreen is absolutely important for the safety of drivers to concentrate on the road especially during heavy rain. The extreme overlapping prevents a dead spot of triangle from forming at the top middle sector of the screen. Despite the overlapping, there are still the corners of the windscreen whereby the wiper is not able to reach and sweep off water and dirt. That crucial area could be a huge distraction for the drivers.

Fig. 7. Wiper blades and washer nozzle of Porsche 9 [9]

Fig. 8. Narrow blade spacing of Porsche 911 [9]

D. 1984 Mercedes-Benz W124

In 1984, Mercedes Benz had developed a new vehicle series which goes by the name of Mercedes-Benz W124. This Mercedes-Benz series had a unique attachment of a mono-wiper fixed onto the vehicle, shown in Fig. 9, which is nothing like the idea of a conventional wiper system. The engineers at Mercedes-Benz were convinced that having two wiper blades attached to a vehicle was not enough to cover the whole area of the windscreen. They have instead developed a technology that uses only one rubber blade having an eccentric mechanism at the base which extends the wiper blade to the corners of the windscreen known to be as the eccentric clean sweep system.[10]

With that said, operation of the single arm wiper that uses the technology like a cam device, extends and moves the arm away from the pivot twice to the corners which can cover a substantial amount of area of up to 86% of the windscreen. This cam like device retracts in between the extension process to prevent wiper blade from extending too much.[11] Other than the functions of the wiper blade, the double washer nozzles of the W123 is placed on the engine hood of the vehicle enabling it to spray washer liquid directly onto the windscreen when necessary. The washer nozzles each have two tiny jets that spray washer liquid in two single streams with high pressure which can be seen in Fig. 10.

Ideally, this was one of the most innovatively designed wiper blades in the market at the time with having the aerodynamic advantages of a single blade and coverage of up to 86% of the windscreen, however, there are many potential drawbacks to having a single arm wiper system. The single arm wiper system would not be able to clean the windscreen as fast as a conventional two wiper system especially during heavy rain. Apart from that, the replacement of the rubber blade would occur very frequently as it deteriorates after multiple usage leaving the screen to be not cleaned properly. The function of each nozzle having to spray two single streams of washer liquid would not have optimally clean the entire windscreen as the positioning of the spraying is only towards the centre on the screen.

Fig. 9. Mono wiper blade of Mercedes-Benz W124 [10]

Fig. 10. Washer nozzle function of Mercedes-Benz W124 [11]

E. 1987 Peugeot 405

A substantially large family car, Peugeot 405 was launched in July 1987 by the French automaker Peugeot where it succeeded the Peugeot 305 and won the European Car of the Year award.[12] This success of a car came together with a unique wiper and washer system where the washer liquid flowed out directly from the connection of wiper blade itself as shown in Fig. 11. The operation of the wiper mechanism that had conventional rubber blades attached to it was rather simple and similar compared to the other family cars available at that time. The two wiper arms attached to the bottom of the windscreen functions in a tandem-pattern double-lever system with overlapping sector wipe patterns had the proper windscreen coverage when wiping took place.

The technology of the washer dispensing liquid out from the wiper blade was possible with the attachment of two rubber tubes from the washer reservoir tank. These tubes are then flowed and fixed onto both the wiper arms separately with a nozzle having two small jets ending at the connection where the wiper blade would be attached. The dispense motion of the washer liquid from these nozzles are perpendicular to the wiper arm whereby when the wiper starts moving up, the washer liquid is streamed out in a “V” like shape from each nozzle covering the windscreen. The system is operated through a stalk available next to the steering wheel having similar functions like other vehicles where the speed of wiper is adjusted by moving the stalk upwards or downwards and by pulling the stalk towards the user works the washer liquid.

The working principle of the wiper and washer mechanism introduced a new technology into the automotive industry. The washer liquid dispensed from the blade itself prevented a lot of spraying across the windscreen avoiding temporary blindness helping the drivers to concentrate on the road better. Although the stream of washer liquid comes out in the shape of a "V" from the nozzle, most of the liquid would end up spilling away from the windscreen onto the ground. With most of the washer liquid always ending up on the ground, users had to dispense more liquid onto the screen for cleaning purposes and this indirectly means that the users had to constantly refill the reservoir tank from time to time. Not only that, but the rubber blade would also need constant replacement due to the degrading effect of the blade when used over the course of a long period.

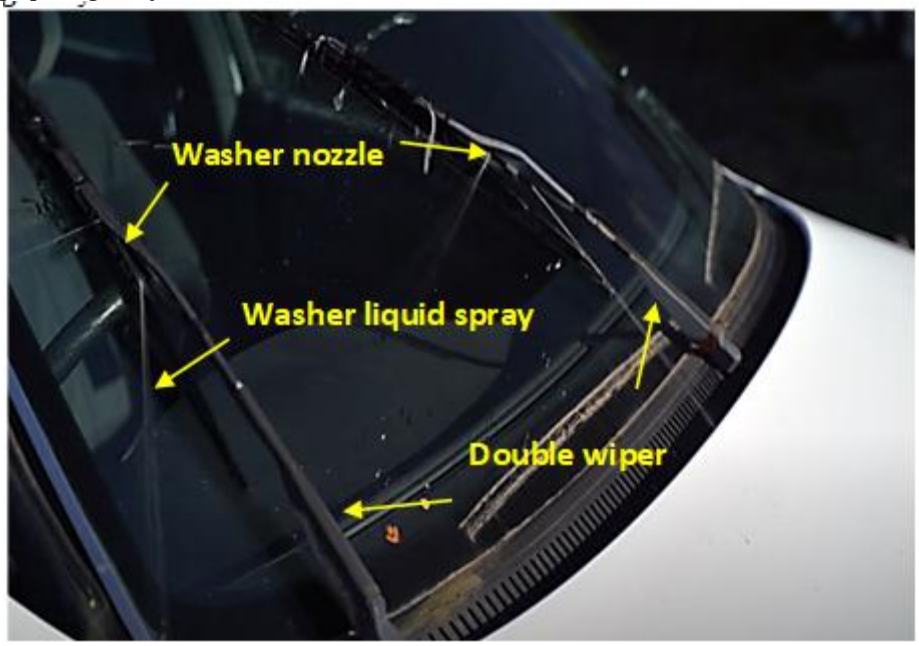

Fig. 11. Wiper blade and washer nozzle of Peugeot 405 [12]

F. 1999 Renault Twingo

In the 1990s, a French automaker, Renault manufactured their iconic four-seater Renault Twingo replacing the Renault 4.[13] The four-seater vehicle came equipped with a single U-shaped wiper arm with standard rubber blades as shown in Fig. 12. The wiper arm is attached slightly off centre of the windscreen while the single washer nozzle was right at the middle of the windscreen. The use of single washer nozzle was not implemented until 1998 whereby prior to that year, Renault had been using double washer nozzle. The wiper blade used was exceptionally longer than the standard ones as the dimension of the windscreen was rather large for a small car.

The wiper arm functions on the single pantograph system for the wiper mechanism whereby the wiper blade starts the motion from its resting position horizontally, moving across the screen up to a vertical position and ending the motion by returning to the horizontal position. Having such a long wiper blade definitely covers a larger area on the windscreen which is beneficial during foul weather conditions. The washer nozzle which is fixed on to the engine hood of the vehicle has two tiny jets to dispense washer liquid in a "V" shaped stream when needed. The operation of the wiper mechanism is simply using a standard stalk function which is placed next to the steering wheel to determine the wiper speed and to dispense washer liquid.

The use of a single wiper is definitely a unique trend and positively it does cover a huge area of the windscreen giving the driver to confidently drive without having vision obstructions. Although using a single washer nozzle would save washer liquid in the long run, this liquid would not be enough to cover the entire windscreen where heavy cleaning is needed. Streaks of liquid and dirt would be visible as the rubber blade tends to degrade a lot over a certain period leaving no other choice but to only replace it with a new set. The single wiper technology can have its own downfalls especially during heavy downpour when ideally the standard two wiper blades instead would be the best choice to remove rainwater off the windscreen immediately.

Fig. 12. Single wiper and washer of Renault Twingo [13]

G. 2000 Audi A2

A German manufacturer, Audi, produced a compact MPV-styled five-seater supermini car with a hatchback body design constructed from aluminium.[14] The vehicle comes with the attachment of a steel single arm wiper along with two wiper nozzles seen in Fig. 13. This single wiper arm is fixed slightly off centre of the windscreen having to be fitted with a longer than usual rubber wiper blade. While the two separate nozzles with two tiny jets are fixed below the engine hood separated by a large enough gap having a hidden effect when looked from the front of the vehicle. The wiper mechanism functions using the principle of a single pantograph system.

The long wiper blade needs to be fixed onto this vehicle for maximum coverage due to the large dimensions of the windscreen. Having said that, the wiper starts its motion from the resting position horizontally, moving upwards and changing the orientation of the blade to vertical position and ending the cycle back into its original horizontal position. The washer nozzle on the other hand has two separate jets that gushes out washer liquid with high pressure in a "V" shaped stream spraying the entire middle sector of the screen. The switch to adjust the speed of the wiper blades is however just a normal stalk that sits at the back of the steering wheel that is also a switch for the washer liquid when the driver pulls the stalk towards themselves.

Using a long wiper blade is the best attachment as it does cover approximately the entire screen especially on the driver side of the screen. Washer nozzle placed separated from one another allows the liquid to travel to the corners of the screen where it usually tends to be overlooked to get maximum cleaning effect. Having such wiper and washer mechanisms has its own weakness such as the rubber blade that often deteriorates fast and tends to leave disturbing water and dirt streak all over the screen. Adding to that, a single arm wiper mechanism would definitely not work as efficiently as if there were two wiper blades functioning parallel to one another. The washer nozzle that sprays washer liquid onto the windscreen will only cause temporary blindness to the driver that could potentially cause an accident.

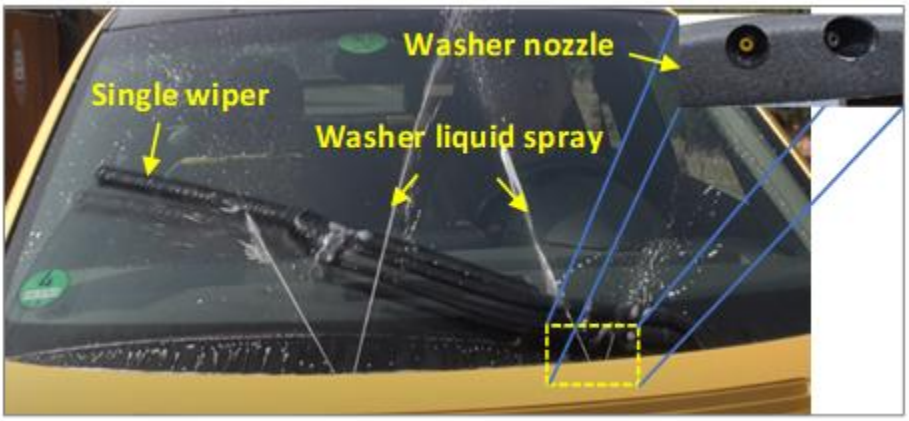

Fig. 13. Single wiper and washer nozzles of Audi A2 [14]

H. 2004 SEAT Altea

A multi-purpose-vehicle (MPV) SEAT Altea was brought to life in 2004 by a Spanish car manufacturer SEAT. The SEAT Altea had also come together with a pair of unusual windscreen wipers, shown in Fig. 14, that was primarily designed to improve road user's safety. The uniquely designed wipers that comes with a rubber attachment blade uses the principle of sequential sweep with a little twist adaptation to it. The wiper mechanism also comes with a pair of washer nozzles to spray washer liquid on to the surface of the windscreen for cleaning purposes in dry weather conditions.

The main talk about this distinctive wiper mechanism is that when the blades are not in use, they are parked vertically and hidden away within the 'A pillars' which are basically placed of the extreme corners of the windscreen.[15] When the wiper blades are in use, the left wiper blade moves downwards into a horizontal position first followed by the right side and when the blades move back upwards into their vertical position, the right wiper blade moves first followed by the left wiper blade. The washer position on the other hand is placed directly below the windscreen hidden by the engine hood that sprays washer liquid in a fan like manner covering the majority of the screen which can be seen in Fig. 15. Operation of the wiper and washer is through a stalk that is positioned right at the back of the steering wheel for easy accessibility to adjust speed of wiper blades when needed.

Hiding the wiper blades away from the screen is an incredibly genius idea as it does presents the car to be very sophisticated. Apart from that, the movement of the wiper blades does cover a whole lot of the screen leaving the screen to be clean of water streaks and dirt. However, with the washer nozzle that sprays washer liquid in a fan like manner does make it a concern as it creates a moment for the driver where temporary blindness is present. The wear and tear of the rubber blade over time definitely causes the screen to leave some water or dirt marks which on the contrary distracts the driver's view when driving especially in foul weather conditions.

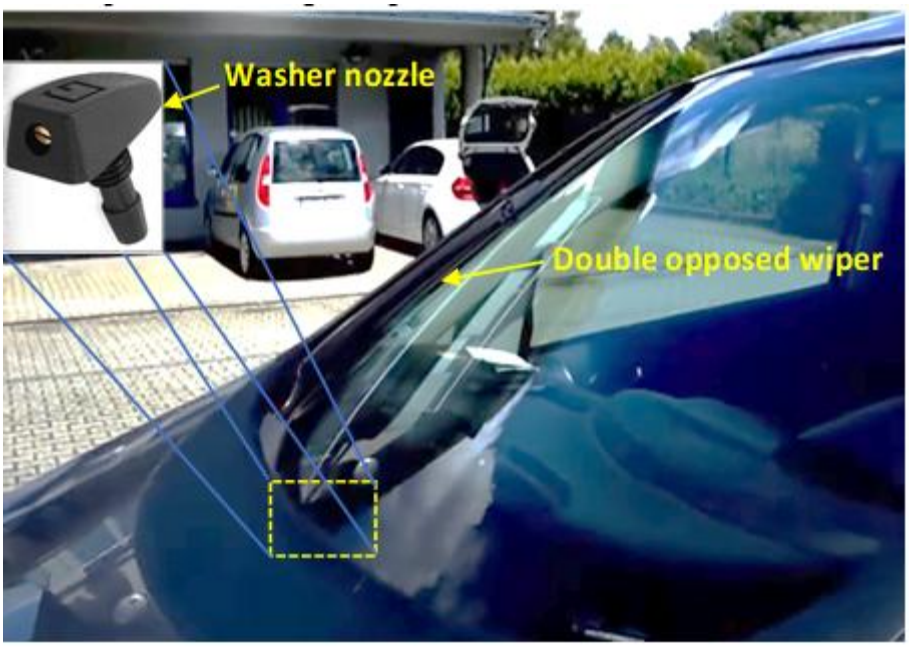

Fig. 14. Horizontally parked wipers of SEAT Althea [15]

Fig. 15. Spray of washer liquid on SEAT Altea [15]

I. 2005 Honda Civic

A Japanese automobile manufacturer launched the eighth generation of a sedan model Honda Civic in 2005 with four doors. The sedan comes featured with a new unique double wiper arm design that Honda has never presented in the previous generations. The wipers are newly designed for the main purpose of attaching them to the eighth generation Honda Civic for extreme visibility in heavy rain.[16] These equal sized thin rubber wiper blades are each mounted on the extreme corners of the windscreen shown in Fig. 16. This uniquely designed wiper mechanism claims to be the superior cleaning pattern as most of the windscreen area is covered by the long wipers. Given that the wipers are thin in dimension, it extremely reduces wind noise when travelling at higher speeds due to its aerodynamic profile.

The mechanism of the wipers works on the opposed-pattern double-lever system that overlaps the middle sector of the windscreen giving it a sequential sweep. The resting position of the wipers is when the right wiper blade rests above the left wiper blade and the movement of the wiper starts with the right wiper moving upwards first followed by the left wiper blade. The washer nozzle is however placed directly below the windscreen allowing the washer liquid to be sprayed evenly in a fan like distribution across the windscreen seen in Fig. 17. The switch to operate both the wipers and washers is by using a standard stalk behind the

steering wheel whereby speeds of the wiper blades motion can be adjusted.

In regard to the newly designed wiper mechanism, it definitely does get the job of wiping water and dirt away from a major part of the screen leaving just a small triangle at the top middle sector where it is often not used by the driver anyway. As for the washer, the nozzle does get a huge coverage of the screen which would result in a cleaner windscreen. Despite the huge coverage, when spraying does take place, the driver immediately experiences temporary blindness as it does take a couple of seconds for the wipers to wipe the liquid off the screen.

Fig. 16. Opposed pattern wiper blade of Honda Civic [16]

Fig. 17. Spray of washer liquid on Honda Civic [16]

J. 2020 Proton X70

A Malaysian automotive company launched the Proton X70 CKD series in 2020 with their new and improved vehicle from the first launch of the CBU series in 2018. Although the vehicle has undergone several improvements in the CKD series, some features are still maintained the same as the CBU series. The advanced wiper mechanism system remains one of the major safety factors to still be installed onto the CKD series only for the executive and premium models.[17] Proton X70 is equipped with a pair of washer nozzles, seen in Fig. 18, a pair of wiper arms that works on the tandem-pattern double-lever system and an auto rain sensing device which is placed behind the rear-view mirror in the interior part of the vehicle that assesses rain intensity for the motion of these wipers shown in Fig. 19.

The rubber wipers blades on the Proton X70, shown in Fig. 20, are rather familiar to most users as it is comparatively similar to most vehicles on the market. The wiper arm is attached below the windscreen line as the washers are placed directly under the engine hood hidden away, out of sight giving the vehicle a more polished look. When the wiper blades are at rest, they are parked horizontally facing towards the outer left side. Adding to that, the washer nozzles dispense washer liquid in a fan like manner projecting towards the bottom area of the windscreen allowing a lot of the liquid spray to travel towards the upper part of the screen. This wiper system does function with a stalk placed behind the steering wheel that has manual and automatic functions. Manual functions only operates when the user pulls the stalk downward which will produce a wiping motion according to the adjusted intermittent speed as for the automatic function, when the rain sensor senses rain droplets, the wipers are turned on to wipe off the liquid from the screen according to the intensity of the rain for absolute visibility while driving.

Similar to the Proton X70, there are other vehicles in the market that have the same operation of their wiper and washer mechanism fixed onto the vehicle. Having said that, vehicles such as the 2021 Ford Ranger, shown in Fig. 21, 2021 Mitsubishi Outlander, seen in Fig. 22, 2021 Nissan Navara Pro 4x, which can be observed in Fig. 23, and 2021 Toyota Corolla Cross, shown in Fig. 24, are fixed with rain sensing device and a pair of rubber wipers blades that work on the tandem-pattern double-lever system. When the wiper blades are not in use, the pair is parked horizontally facing towards the other left side similar to the Proton X70. The wiper blades function in the same way as the Proton X70 whereby when the wipers are switched to the automatic function, the wiper blades move according to the intensity of rain which is sensed by the rain sensing device placed in the vehicle. The washer nozzles of these models that dispenses washer liquid in a fan like manner projecting towards the windscreen are primarily placed similar to the Proton X70 which is beneath the engine hood giving it a sophisticated look of the vehicles.

Advancement of today's vehicle that presents an auto rain sensing device shows how far the automotive industry has progressed in the safety department providing ultimate comfort for drivers and passengers. Despite that, there are factors that need to be taken into consideration such as the spraying of washer liquid that causes temporary blindness to drivers when the need of wiping dirt off the screen arises. The projection of the washer liquid to the screen creates an area full of washer liquid droplets that only distracts the drivers as the wipers only start functioning after a few seconds. Adding to that, the blades made of rubber is definitely a downside as it tends to degrade ever so quickly especially when wipers are constantly in use. If these wipers do not get replaced immediately, streaks of dirt and water will be left of the windscreen leaving it to be unclear for the driver.

Fig. 18. Washer liquid dispensing from Proton X70

Fig. 19. Wipers and auto rain sensor

Fig. 20. Rubber blade of Proton X70

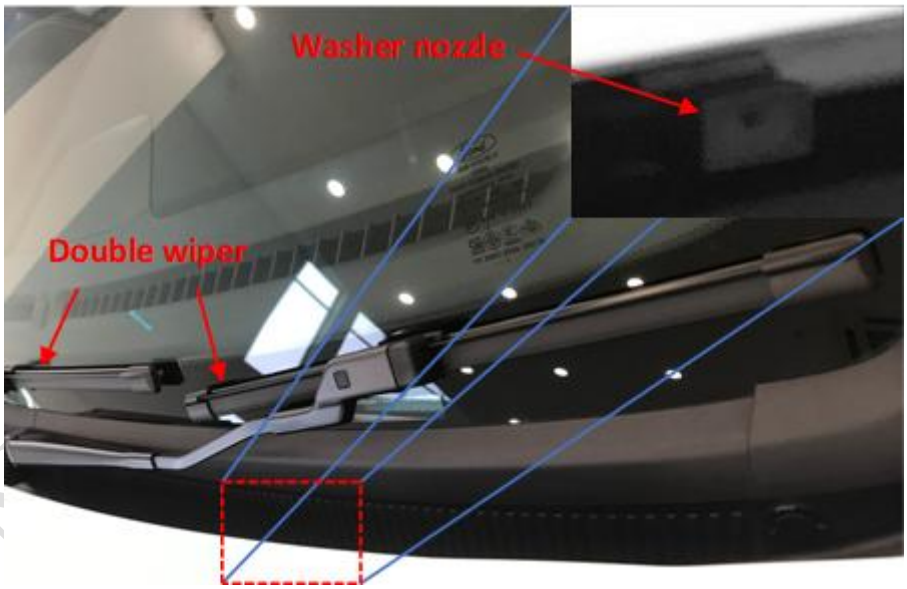

Fig. 21. Wiper and washer nozzle of 2021 Ford Ranger

Fig. 22. Wiper and washer of 2021 Mitsubishi Outlander

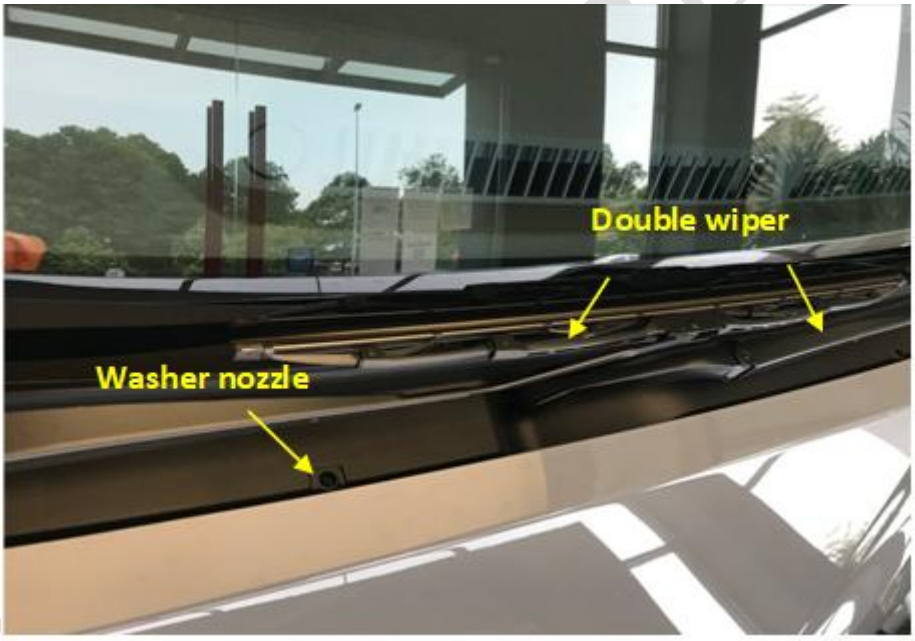

Fig. 23. Wiper and washer of 2021 Nissan Navara Pro 4x

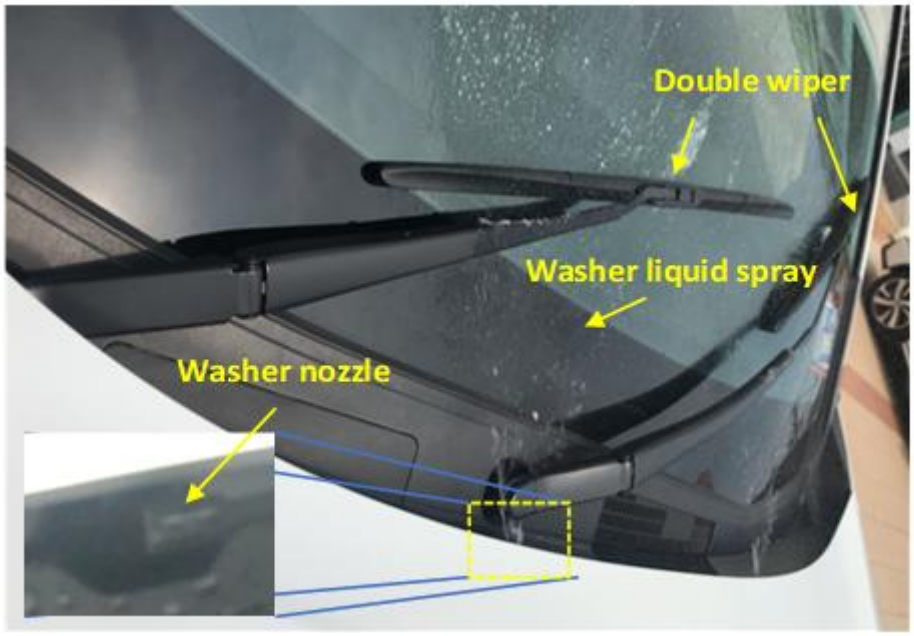

Fig. 24. Wiper and washer of 2021 Toyota Corolla Cross

K. 2021 Mercedes-Benz E200

Mercedes-Benz had launched the new W213 E-class facelift on the E200 Avantgarde in early 2021.[18] The vehicle comes equipped with a pair of Mercedes-Benz's manufactured wiper blades, as shown in Fig. 25, under the umbrella of a German multinational engineering and technology company, Bosch. The wiper blades are generically similar to most vehicles in the market that function on the tandem-pattern double-lever system with a rubber blade that uses a clip function to attach onto the wiper arm of the vehicle. Not only that, the E200 comes with a fixture of three washer nozzles evenly spread out, seen in Fig. 26, due to the wide panoramic windscreen installed onto the vehicle together with an auto raining sensor device which is placed behind the rear-view mirror shown in Fig. 27.

The wiper blades are placed directly at the bottom of the windscreen and are parked horizontally facing to the left when at rest. Movement of the wiper blades starts from the left, up to the right corner, sweeping a larger area off the screen especially on the driver side. On the other hand, the three identical washer nozzles that spray washer liquid in an overlapping fan like manner are placed directly under the engine hood hidden away in plain sight giving an elegant look of the vehicle. Instalment of three washers below the engine hood is possible with the length of the windscreen coming up to an approximation of 1.6 meters which is fairly wider compared to what is seen on other vehicles. The operation of wiper blades can be manually done by twisting the stalk upwards or downwards and operation of washer can be done by pulling the stalk which is placed right at the back of the steering wheel. However, a button placed on the side of the stalk in the E200 enables drivers to have an option to just have the wiper blade operate in one cycle or operate both the washer and wiper blades at the same time. Apart from that, the E200 is fitted with a rain sensor that senses the intensity of rain whereby only when the user sets the wiper stalk to automatic mode, the wipers move according to the intensity of rain no matter how fast or slow the vehicle is moving to gain maximum visibility.

Having three washer nozzles definitely helps cover and clean a larger area of the screen which is essential when the screen is filled with filth. Setting the wiper stalk to automatic mode enables the sensors to assess the rain intensity to provide the correct motion for wipers to function especially during heavy downpour which is definitely a major safety factor which the vehicle possesses. Aside from that, the spraying of washer nozzles in an overlapping fan like manner however does obstruct the driver when the washer is needed to be used. The washer nozzle continues to operate by spraying more liquid even when the wiper blades are sweeping the liquid off the screen. It creates an uncomfortable moment of temporary blindness for the driver that is certainly not safe for road users. Moreover, the rubber blades over the course of sometime causes streaks of water and dirt to accumulate along the screen due to its high rate of wear and tear, and has to be replaced eventually which can be a little troublesome for the user.

Fig. 25. Rubber wiper blades of Mercedes E200

Fig. 26. Spraying of washer liquid

Fig. 27. Auto rain sensor

L. Magic Vision Control

The 2012 Mercedes-Benz SL was the first vehicle model to introduce an adaptive windscreen cleaning system using the tandem system design which goes by the name of Magic Vision Control developed by Mercedes-Benz, shown in Fig. 28. The Magic Vision Control is essentially a window cleaning system, whereby it incorporates the function of washing and wiping without having any splashes that would cause temporary blindness that impairs the driver's view while driving.[19] This wiper system is assembled by integrating the wiper with water ducts that has fine laser cut holes along the entire length of the wiper equipped together with a rubber blade. Washer liquid that gushes out precisely along the length of the wiper will then be wiped off immediately by the rubber blade.[20]

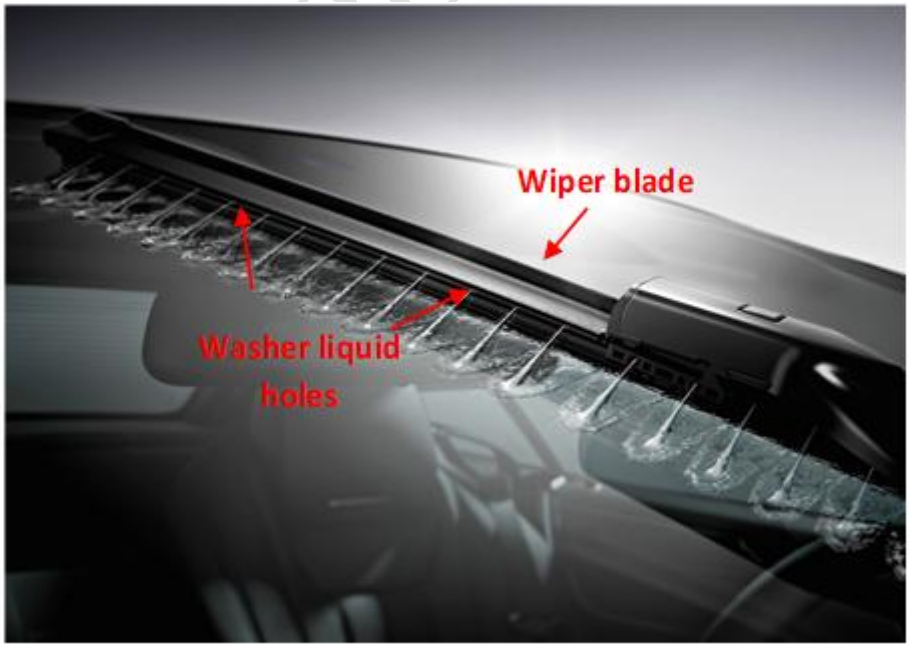

Fig. 28. Assembly of Magic Vision Control [19]

Magic Vision Control is intelligent enough to work for cabriolet driving, for summer and for winter conditions. When in cabriolet mode where the roof of the vehicle is opened, the amount of water is reduced by the electronic control system to prevent washer liquid from entering the interior of the vehicle. While

in winter conditions, the wiper has an additional fully heating system where blockages caused by freezing slush and snow can be melted and wiped away from the windscreen. The reservoir of the washer liquid is heated through the residual heat of the coolant where heating of the hose system is done electrically. The wiper blade that has two spring rails, are fitted with heater foil that produces an output of 35 watts per blade to heat the wiper lip to prevent ice from freezing onto the wiper blade. [21]

This technique of the innovative wiper blade does not only eliminate the brief blocked vision caused by the spraying of washer liquid, but it also saves the amount of washer liquid used compared to conventional systems for up to 50 percent which leads to using a smaller washer liquid reservoir tank. However, the downside of continuously using this particular wiper is that over time the rubber blade will wear out which then ultimately leads to having streaks of water along the whole windscreen. Streaks that are left on the windscreen shows that the technology of this whole wiper system primarily defeats and does not solve the main purpose which is to eliminate the temporarily blocked vision of the driver.

M. Bosch Jet Wiper

An established automotive manufacturer, Volvo, had made Bosch Jet Wiper, seen in Fig. 29, to be a standard feature in their 2015 Volvo XC90 as the wiper is far more superior in cleaning performance compared to the conventional windscreen wipers.[22] The intelligence of Bosch Jet Wiper comes equipped with a spray nozzle attached to the outsides of the wiper arm which distributes washer liquid evenly when the windscreen wiper is in use together with rubber blade placed on the insides which is responsible to sweep a large area of liquid off the windscreen. As the washer liquid is distributed evenly across the windscreen, the wiper blade simultaneously cleans the windscreen along the entire length of the blade leaving not a single drop of liquid. The attachment of the spray nozzle to the Bosch Jet Wiper differentiates completely from the conventional windscreen wipers as it eliminates the impaired vision of the driver caused by the mist spray of washer liquid from the engine hood which most vehicles have.[23]

The washer liquid is supplied to the Jet Wiper through a pump that is essentially connected to the reservoir tank of the vehicle. Spraying of washer liquid is only done when the wiper blade is moving upwards using the tandem system design for the best cleaning effect as the liquid is immediately picked up by the rubber blades that provide optimum cleaning system. In the case of conventional wiper systems, they are designed for a certain speed only. Having said that, the airflow diverts the spray when the windscreen wiper speed increases, which results in less liquid in the area where cleaning is needed. Whereby in the case of the Bosch Jet Wiper, air flow has no effect on the distribution of washer liquid as the nozzle spray is directly attached onto the wiper arm and close to the rubber blade.[24] A test for the best wiper blades was carried out by Allgemeiner Deutscher Automobil-Club (ADAC), a German automobile club in 2015, where Bosch wiper blades came in first and second out of the eight wiper blades that were tested. Having the Bosch Aerotwin as part of the Bosch Jet wiper, provides optimum wiping performance at every point due to its custom made Evodium spring strip that places the wiper perfectly on the windscreen. The wiper system can also be operated during the winter weather as the system is fully heated upon request, whereby the tube system and nozzle heating is activated depending on the external temperature.[25]

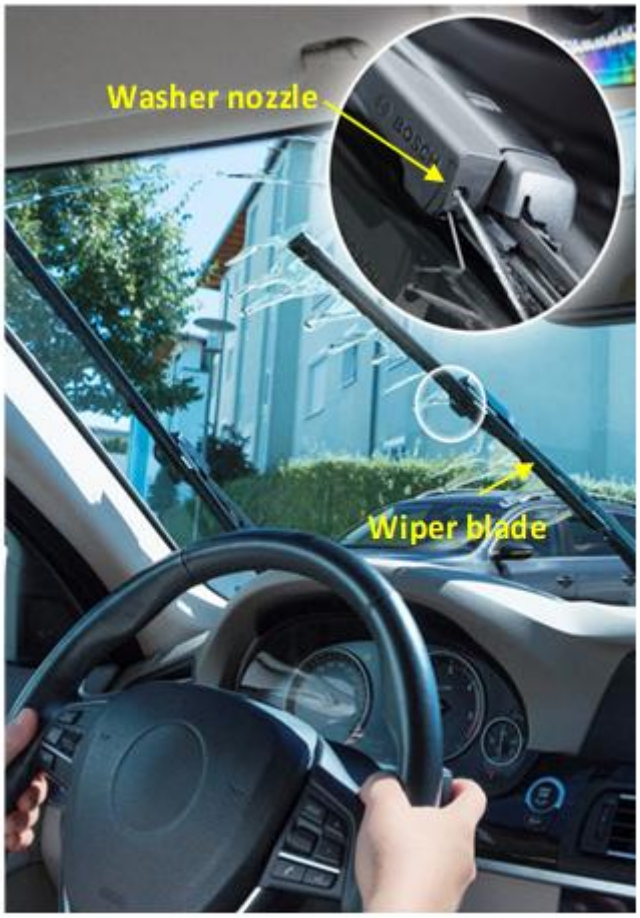

Fig. 29. Bosch Jet Wiper [23]

With the instalment of the Bosch Jet Wiper system, safe driving can be assured as drivers will not experience temporary blocked visions when using the washer and wiper system. Adding to that, washer liquid of this wiper used is reduced by more than half of what a conventional wiper system is used to, which then leads to having a smaller washer liquid reservoir tank. The implementation of this particular windscreen wiper onto a vehicle tremendously reduces the wind noise due to the aerodynamic feature which does not allow the wiper to lift even at greater speeds. However, having the rubber material of the blade which will eventually deteriorate overtime will cause streaks of liquid to appear on the windscreen. In spite of having those streaks of liquid, it defeats the purpose of the whole technology of eliminating temporary blindness.

N. Valeo AquaBlade

A French automotive supplier had a major breakthrough in the innovation of wiper blade technology named Valeo AquaBlade shown in Fig. 30. This utterly brilliant wiper blade had won the 2012 Automotive Premier Automotive Suppliers' Contribution to Excellence (PACE) award and was first premiered on the 2012 Mercedes-Benz SL.[26] With the introduction of these wiper blades attached to the vehicle, it enabled the washer reservoir tank to reduce in size which was 1.7L which directly translates to reducing the total weight of the vehicle itself. This unique invention is made up of a conventional rubber blade fixed in the middle together with a channel with tiny holes along the length of the wiper blade to distribute washer liquid when needed.

The holes found along the length of the blade are responsible to dispense washer liquid directly onto the windscreen instead of having the washer nozzles which are mounted onto the hood of the engine spray out vertically onto the screen. When the washer dispenses liquid through the holes of the blade, the rubber blades are then used to instantly wipe the washer liquid off the windscreen uniformly leaving the screen extremely clean of water streaks. Washer liquid used is comparatively much lesser when using this innovative wiper blade system than usual wiper blades hence why the reduced size in the reservoir tank of the vehicles.[27] A study on the usage of the blade was carried out by an independent organization Fraunhofer IOSB in Karlsruhe whereby the results shows that drivers with the Valeo AquaBlade

attached on their vehicles react 315 milliseconds instantly compared to drivers with conventional wiper blades attached on their vehicles. This fast time of reaction directly influences the braking distance of the vehicles which was seen to reduce by four meters in urban driving conditions with the driving speed of 50 km/h. Over the course of some years, Valeo has managed to broaden their horizons by extending the AquaBlade range to the other Mercedes-Benz series vehicles as well as to several other vehicle models available in the market including Ford.

The revolutionary wiper blades have many added benefits and values having increased safety as one of the major advantages. Visual disturbance when operating the washer is no longer a problem as there is no spraying of washer liquid occurring hence increasing the safety of drivers. The less usage of liquid definitely helps with reducing the overall weight of system by almost 2 kg and directly impacts in the reduction of CO_2 emissions by 0.2kg. Despite the increase of visibility with a reduced braking distance, the major flaw of the AquaBlade is the attachment of rubber blade material that tends to wear quickly over time which will only leave more water and dirt streaks on the screen especially during raining conditions and when the washer is in use. This flaw however will only increase the cost of the user in the long run by needing to replace the blades frequently which causes a huge annoyance to the driver and therefore does not entirely eliminate the main issue.[28]

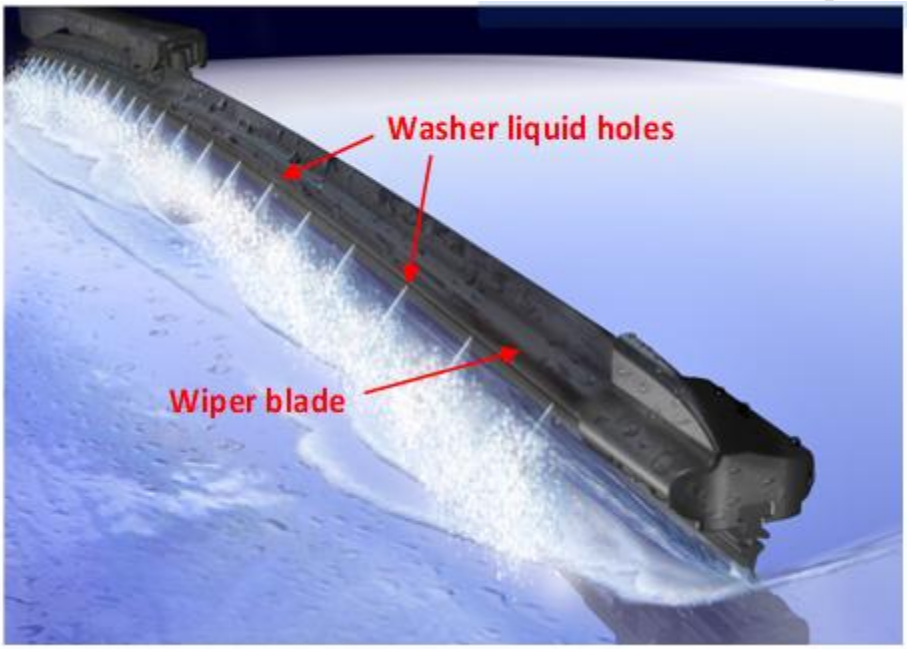

Fig. 30. Valeo AquaBlade [26]

III. Summary Of Car Wipers And Washer's Design Development

According to the in-depth review done on several models, a summary can be obtained to narrow down on the specifics of these models. These car wipers and washers design can be further grouped into seven divisions based on the system used which consists of obsolete design, tandem-pattern lever system, opposed system, eccentric system, single pantograph system, sequential sweep system and wiper attachment with built in washer nozzles. Some of the parameters which are presented in Table III includes the design of wiper used, year of model release, name of model, type of wiper and washer design, type of wiper and washer application and lastly the advantages and disadvantages of wiper and washer design.

Table III. Summary of car wipers and washer's design

No	Design	Year	Model	Remarks	References
1	Obsolete design	1939	Chevrolet Master 85	***Design and application:*** Functions on double wipers with an accessory of double washer nozzles that dispenses washer liquid in a single stream manner. ***Advantages:*** Washer nozzle distributing washer liquid provides lubrication to the wiper blade to clean off windscreen	[5], [6]

				properly. ***Disadvantages:*** Rubber wiper blades deteriorates quickly. Obsolete design of the wiper system prevents wiping the middle sector of the windscreen leaving that area fill with filth. Washer nozzle distributes liquid only towards the centre avoids cleaning the corners of windscreen.	
2	Tandem-pattern lever system	1965	Jaguar E-Type	***Design and application:*** Triple wipers with a pair of washer nozzles that dispenses washer liquid in a single stream fountain-like manner. ***Advantages:*** Having shorter wiper blades with smaller radius meant smaller area to clean. ***Disadvantages:*** The dispensing action of the washer nozzles only up to one fourth of the screen, hence preventing top area of screen to be cleaned efficiently. Th use of rubber blades ever so often tends to deteriorate over time leaving streaks on the windscreen.	[7]
3	Tandem-pattern lever system	1982	Porsche 911	***Design and application:*** A pair of wipers with a pair of washer nozzles that dispenses washer liquid in a "V" shaped streamline. Wiper blades are fixed very narrowly to one another. ***Advantages:*** Narrow wiper blades that have extreme overlapping motions prevents a dead spot of triangle form forming on the top part of the windscreen. ***Disadvantages:*** Despite extreme overlapping of wipers, corners of the windscreen are not covered leaving the sides to be uncleaned. Apart from that, the rubber blade material does wear off quite easily with the heavy amount of usage.	[9]
4	Tandem-pattern lever system	1987	Peugeot 405	***Design and application:*** Double wipers with washer nozzles that are placed directly onto the wiper blade spraying washer liquid onto the windscreen in a "V" like manner. ***Advantages:*** Washer liquid that gets dispensed directly from the wiper arm prevents excessive spraying on the windscreen preventing temporary blindness. ***Disadvantages:*** Half of the washer liquid that gets dispensed in a wide "V" shape from the nozzle ends up spilling away from windscreen leaving users to constantly refill washer reservoir tank. Adding to that, rubber blades that degrades over time needs to be constantly changed.	[12]

Table III (cont'd). Summary of car wipers and washer's design

No	Design	Year	Model	Remarks	References
5	Tandem-pattern lever system	2020 - 2021	2020 Proton X70 2021 Ford Ranger 2021 Mitsubishi Outlander 2021 Nissan Navara Pro 4x 2021 Toyota Corolla Cross	***Design and application:*** Pair of wipers with double washer nozzles hidden under engine hood that dispenses washer liquid in a fan-like manner. Auto rain sensing device senses rain intensity to determine speed of wipers. ***Advantages:*** Auto rain sensing device enables wiper blades to function according to the intensity of rain. Washer nozzle is hidden away from plain sight. ***Disadvantages:*** Spraying of washer liquid causes temporary blindness to driver. Rubber wiper blades always needs to be replaced.	[17]
6	Tandem-pattern lever system	2021	Mercedes-Benz E200	***Design and application:*** Double wipers with triple washer nozzles that sprays washer liquid in an overlapping fan-like manner. ***Advantages:*** Triple washer nozzle helps to cover a huge area of the windscreen. Rain sensor device enables wipers to function according to intensity of rain.	[18]

				Disadvantages: Spraying of washer liquid obstruct driver's vision causing temporary blindness. Rubber blades that have high degrading effect needs to be changed from time to time.	
7	Opposed system	1971	Alpine A310 V6	***Design and application:*** Double wipers with a pair washer nozzle that dispenses washer liquid in a "V" shaped streamline fountain-like manner. Wiper blades do not move in parallel synchronization. ***Advantages:*** Having an opposed system does clean a huge area of the windscreen. ***Disadvantages:*** Long streak of swept water and dirt are left in the middle sector of the windscreen. Washer liquid only distributes to the bottom half leaving the top half to be uncleaned.	[8]
8	Opposed system	2005	Honda Civic, 8th generation	***Design and application:*** Double wiper parked horizontally with a pair of washer nozzles that sprays washer liquid in a fan-like manner. ***Advantages:*** Opposed-pattern double-lever system allows wiper blades to wipe off a huge area of the windscreen including corners. ***Disadvantages:*** Wipers however do not get to clean a small triangle section at the top part of the screen. Spraying of washer liquid onto the screen leaves a temporary blindness effect for the driver.	[16]
9	Eccentric system	1984	Mercedes-Benz W124	***Design and application:*** A mono-wiper blade fixed onto vehicle with a pair of washer nozzle placed on the engine hood that sprays washer liquid in two single streams with high pressure. ***Advantages:*** Single blade provides aerodynamic advantages which also covers a huge area up to 86% of the windscreen. ***Disadvantages:*** Does not sweep windscreen as fast as other conventional methods. Rubber blade that deteriorates fast needs to be constantly replaced. Washer nozzle dispenses washer liquid only towards the middle of the screen leaving the sides to be dry and uncleaned.	[10], [11]
10	Single pantograph system	1999	Renault Twingo	***Design and application:*** Single wiper with a single washer nozzle that dispenses washer liquid in a "V" shaped stream. ***Advantages:*** Single wiper wipes a huge area of the screen. Single washer nozzle saves washer liquid. ***Disadvantages:*** Washer liquid unable to cover a huge part of the windscreen. Single wiper blade sweeps windscreen much slower than the conventional method.	[13]

Table III (cont'd). Summary of car wipers and washer's design

No	Design	Year	Model	Remarks	References
11	Single pantograph system	2000	Audi A2	***Design and application:*** Single wiper mechanism with a pair of washer nozzles that sprays washer liquid with high pressure in a "V" shaped stream. ***Advantages:*** Long wiper blade enables to sweep a huge area of the screen. Washer nozzle dispenses liquid to the extreme corners of the screen ***Disadvantages:*** Wiper blades do not sweep as fast as double wiper blade. Washer liquid gets sprayed on the entire screen causing temporary blindness.	[14]
12	Sequential sweep system	2004	SEAT Altea	***Design and application:*** Double wiper blades that are hidden within the A pillar on the side of the windscreen when at rest with a pair of washer nozzles which sprays washer liquid in a fan like manner. ***Advantages:*** Hidden wiper blades prevent vision obstruction to the driver. Wipers cover a huge area of the windscreen.	[15]

				Disadvantages: Spraying of washer liquid causes temporary blindness. Wear and tear of rubber blade forces users to replace.	
13	Wiper attachment with built-in washer nozzles	2012	Magic Vision Control by Mercedes-Benz	***Design and application:*** This set of wipers was first introduced on the Mercedes-Benz SL. Along both sides of the wiper blade, multiple holes are present for washer liquid to be dispensed out. ***Advantages:*** Eliminated temporary blindness for drivers. Saving washer liquid up to 50 percent. ***Disadvantages:*** Rubber blade that wears off quickly that leaves streaks on windscreen needs to be replaced constantly.	[19]–[21]
14	Wiper attachment with built-in washer nozzles	2015	Bosch Jet Wiper by Bosch	***Design and application:*** This set of Bosch jet wipers first featured on Volvo XC90. The washer nozzle of this wiper is placed on the wiper blade which dispenses washer liquid in one stream at a high pressure. ***Advantages:*** Drivers will not experience temporary blocked vision with the washer liquid dispensing directly from the wiper blade. Reduces wind noise due to the aerodynamic feature which does not allow the wiper to lift at high speeds. ***Disadvantages:*** Rubber blades that have high degrading effect needs to be changed from time to time to prevent streaks from forming on the screen.	[22]–[25]
15	Wiper attachment with built-in washer nozzles	2012	Valeo Aquablade by Valeo	***Design and application:*** This set of wipers first premiered on Mercedes-Benz SL. Multiple holes are present along the whole length of the wiper blade to spray out washer liquid on the windscreen directly. ***Advantages:*** Visual disturbance is avoided with the washer liquid having to dispense directly out from the wiper blade. Less washer liquid used reduces the overall weight of the system. ***Disadvantages:*** Rubber blade material that tends to wear quickly over time leaving streaks on screen. Changing of wiper blade increases user's cost in the long run	[26]–[28]

Comparing from the advantages and disadvantages of the summary presented above, the car wipers and washer's design using wiper attachment with built-in washer nozzles has the most benefits in contrast to the other wiper and washer systems available. Particularly the 2012 Magic Vision Control by Mercedes-Benz has its own added benefits as it reduces the effect of temporary blindness for the driver when wiper and washer are in use. With this application of wiper and washer, road accidents are bound to reduce drastically.

IV. Future Research

Wiper and washer designs are always improving as the years pass together with the advancement of technology. However, comparing from the initial designs of wipers and washers to the current designs, there is definitely room for enhancements and advancements by improving the overall design to avoid causing temporary blindness to the driver. Listed below are some of the recommended future researches that can be done for the improvements of these designs.

- Develop a wiper blade that would never need constant replacement from time to time for the ease of users by replacing the typical rubber material.
- Installation of debris sensor to activate washer nozzle automatically to spray off dirt and dust.
- Develop a wiper blade that entirely cleans the whole windscreen without leaving any corners empty.
- Instead of relying on the driver to activate the wiper stalk switch when needed, attach a liquid sensor device that automatically activates the windscreen wipers without any aid from the driver.
- Instead of using the typical and conventional rubber as the wiper blade material, eliminate the entire mechanism of windscreen wipers by applying nano technology to implement unique coatings on the windscreen itself.

Challenges to be improved

As it appears, the main challenge of a designed rubber wiper blade is that it ever so often wears out which causes light scratches and streaks to be formed on a virgin windscreen. This occurrence is known as wear of material over time. Wear and tear of wiper blade material arises according to type of rubber material such as natural rubber and synthetic rubber, type of windscreen surface and different environmental conditions such as extreme weather, airborne debris and moisture.[29] Often times wear marks of wipers on the windscreen cannot be

observed through the naked eye, however when there is a reflection of the sunlight, these wear marks present along the wiper sweep area can be noticeable as shown in Fig. 31.

Fig. 31 shows a comparison of a virgin windscreen versus a worn-out windscreen.

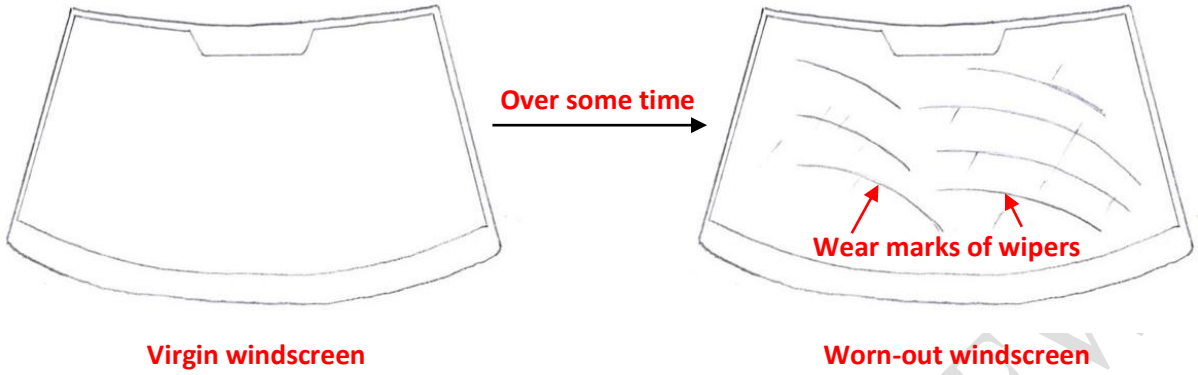

Fig. 31. Comparison of a virgin windscreen versus a worn-out windscreen

Starting off with type of rubber material, whereby the use of natural rubber and synthetic rubber presents different characteristics that contributes to the effects of wiper blade function. Natural rubber is obtained from a plant called *Hevea Brasiliense*, where it is a natural biosynthesis polymer. Despite having high tensile strength, it however possesses characteristics that has low resistance to atmospheric oxygen, greases and other hydrocarbon solvents. On the other hand, synthetic rubber is made by hand under controlled conditions from butadiene and styrene. Synthetic rubber has poor tensile strength and poor mechanical properties where it tears easily.[30] Both these rubber materials appear to exhibit properties that leads to affecting the performance of wiper blade. Moving on to next factor that affects the performance of wiper which is the type of windscreen surface. Windscreens are prone to chipping and cracking due to a possible accident. These situation affects the surface of the windscreen to appear rough and directly translates to the performance of the rubber wiper blade. The roughness from the chipping and cracking hence causes the rubber wiper blade to wear off easily which then leaves streaks of dirt and water along the entire windscreen.

As for the last factor, different environmental condition can be broken down into three parts which consists of extreme weather, airborne debris and moisture. Extreme weather such as freezing temperatures that makes the rubber blade brittle and hard, compromises the functions of the blade having to always replace the pair. However, in the heat, the molecular chains of the rubber material shorten and hence stretches once it is cooled. The UV light degradation often impacts and causes the rubber blades to perish and crack. Grease, dirt and dust are airborne contaminants that give a rise to the wear and tear of the rubber blades. Particles of these airborne contaminants damages the surface of the rubber wiper blades and compromises the operation of the blades. Lastly, moisture in the form of acid rain and salt water also causes the rubber wiper blades to degrade and wear off quickly as it changes the material properties of these blades having to constantly replace. Fig. 32 shows the different factors that affects the function of wiper blades.[29]

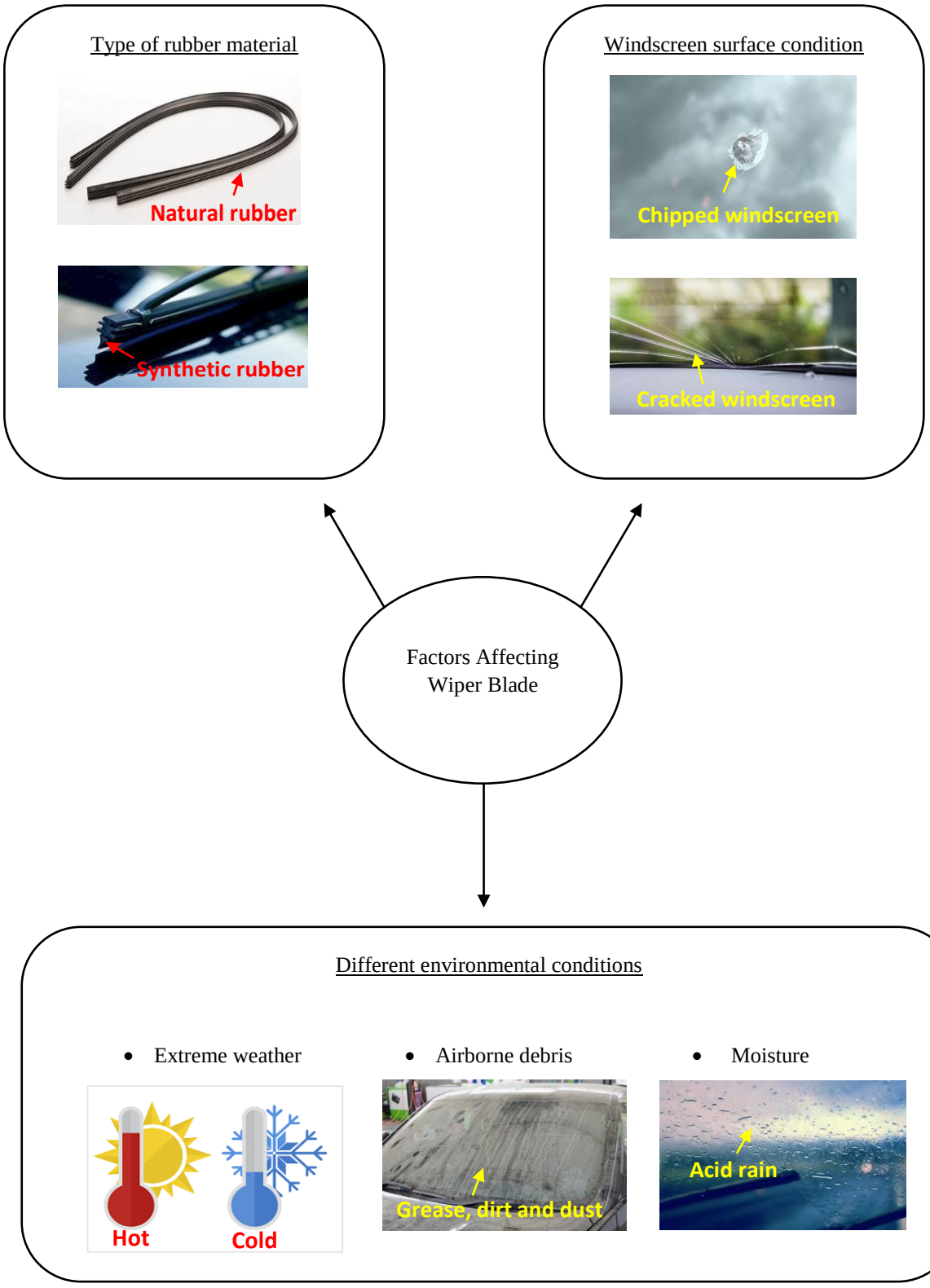

Fig. 32. Factors affecting wiper blade

V. SUMMARY

It is an established understanding that windscreen wipers and washers are definitely a staple in automotive vehicles. The importance of

having a clear windscreen especially during unpleasant weather conditions will allow drivers to concentrate on the road while driving to avoid any fatal accidents which is often caused by temporary blindness for drivers. The improvement in wiper and washer designs since the implementation of wipers and washers on vehicles in the late 1930s has surely impacted the automotive industry in a positive way. Looking from the timeline of the many wiper and washer designs discussed above, the industry is undoubtedly moving towards the right direction of progress. In every aspect of life, there are certainly more advancements along the way that can be introduced into the design of these wipers and washers that shall not be bound to any limitations

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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