STOUT

2020 Automotive Defect & Recall Report

A Compass of Insight for Navigating Uncertainty

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INTRODUCTION

Stout's 2020 Automotive Defect & Recall Report marks the 6th iteration of the automotive industry's most comprehensive analysis of component defect trends. The information in this report is curated from a wide array of national and international sources; it explores component defect and recall-related activity in the automotive industry with a specific focus on component defect risks and trends, trends in recall completion percentage activity, efforts to improve methods of consumer outreach, and forward-looking indicators of recall risk. This report serves as an update from prior years' reports that includes recall activity from 2019 as well as additional insights and trends not included in past iterations.

02

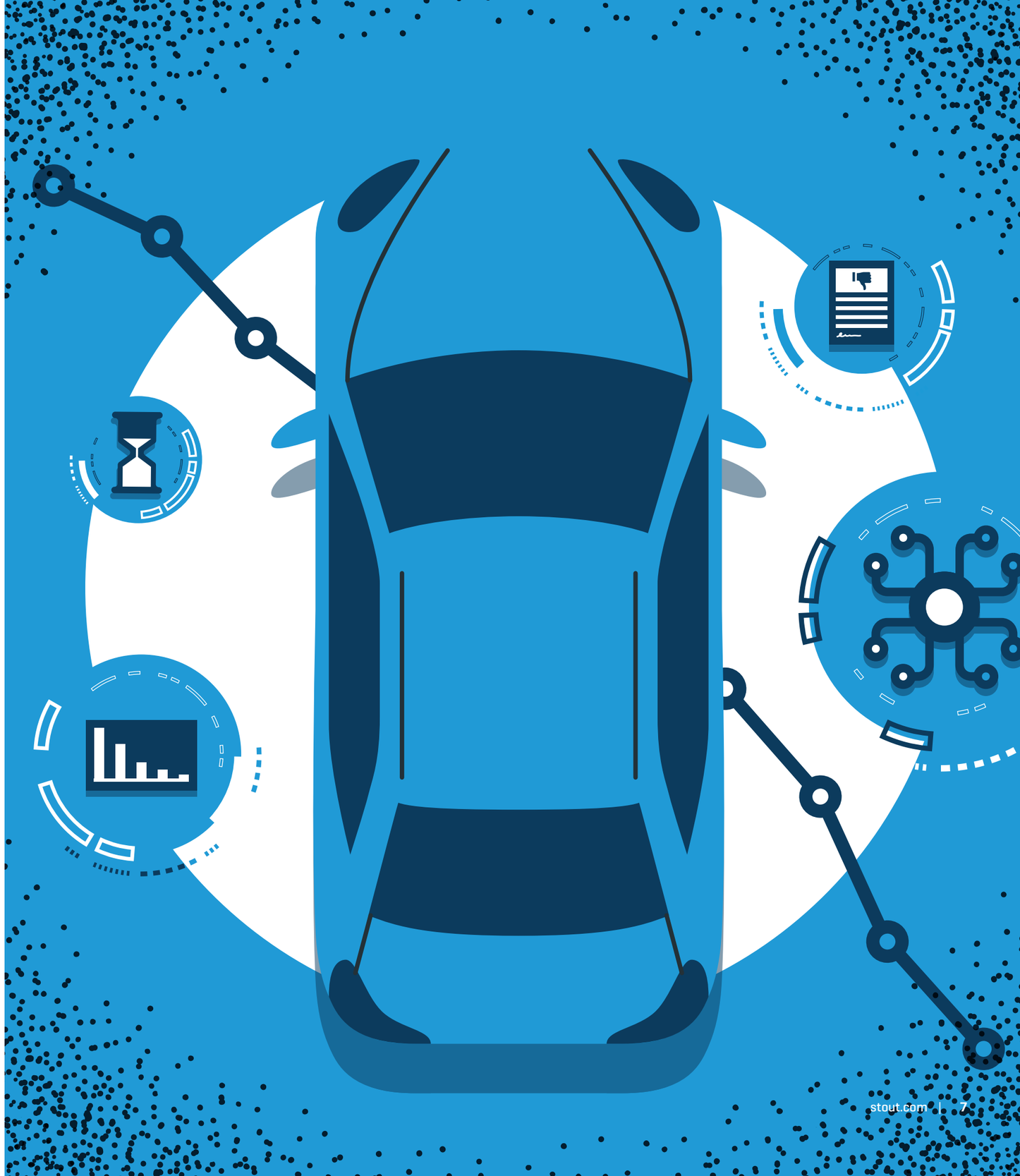
KEY CONSIDERATIONS IN ANALYSIS OF AUTOMOTIVE RECALL

Stout's analysis of automotive recalls focuses on the size and frequency of recalls, measured by both unique recall campaigns and number of units affected.

In addition to quantitative assessments, Stout also performs a detailed qualitative analysis by reading each defect description and other relevant documents. This allows for the identification of more subtle trends related to industry influences such as electrification, digitalization and light weighting of vehicles as well as whether the defect was likely the result of a design, manufacturing or assembly related issue.

When analyzing completion percentages, vehicle age is one of the most important factors influencing whether a vehicle owner completes the recall repair. As vehicles age, the current owner is less likely to have a servicing relationship with a franchised dealer. In addition, the quality of vehicle owner contact information erodes for vehicle owners that do not maintain their current mailing address with the DMV. This is often the case for more transient and lower income populations that may experience less housing stability. Additionally, vehicle values depreciate while they experience changes in ownership commensurate with that decline. Older vehicles are more likely to be owned by persons with less housing stability and less income, resulting in lower levels of data quality for older vehicles. Taken in combination, the lack of a servicing relationship with franchised dealer and lower data quality make conducting recalls of older vehicles particularly challenging.

Other influential factors on recall completion include the size of recall, the defect's impact on vehicle operability, risk / urgency, vehicle types, outreach methods and remedy part availability. Stout also analyzes whether a component supplier is identified in § 573 notifications. We find that supplier identification varies significantly by the type of defective component as well as whether the defect is manufacturing or design related.



2019 was a year of declining new vehicle sales, an aging fleet and increased recall activity.

2019 saw a continued reduction in new light vehicle sales from the 2016 peak with total new sales falling below 17 million for the first time since 2014. The decline in new vehicle sales corresponds with the oldest average age of the U.S. light vehicle fleet, 11.8 years in 2019.[1] Total highway miles driven in 2018, the most recent year that the Bureau of Transportation Statistics has published, increased to 3,240,327 representing a nearly 9% increase over 2017.[2]

Continuing the trend observed in the last two years though, 2019 saw an increase in light vehicle recalls. In addition to more recall campaigns in 2019, the number of larger recalls in terms of the number of vehicles affected also increased in 2019. As the U.S. fleet continues to age and U.S. vehicles drive more miles, it is increasingly critical that OEMs and suppliers alike understand trends in component defects, benchmark their risk of defect against industry counterparts, develop proactive strategies to prevent component failures, minimize the financial impact of automotive recalls and effectively maximize recall completion percentages.

LIGHT VEHICLES IN 2019

11.8 YEARS
OLDEST AVERAGE AGE

INCREASED
RECALL ACTIVITY

MORE
LARGE RECALLS

02 RECENT TRENDS IN AUTOMOTIVE RECALLS

The number of light vehicles recalled in the U.S. increased in 2019 to 28 million from approximately 22 million in 2017 and 2018, excluding the Takata recalls.[3] Individual light vehicle recall campaigns increased to a record 317 unique campaigns, also excluding the Takata recalls.

LARGEST AND SMALLEST RECALL CAMPAIGNS OF 2019:

VEHICLES RECALLED BY GM

SINGLE VEHICLE RECALL BY MERCEDES-BENZ

SINGLE VEHICLE RECALL BY PORSCHE

The largest recall of 2019 was by GM and affected 3,456,719 vehicles including 2015-2017 Cadillac Escalade, 2014-2018 Chevrolet Silverado, GMC Sierra, 2015-2018 Chevrolet Suburban, Tahoe, and GMC Yukon vehicles. This recall is the result of a decrease in vacuum created by the brake vacuum pump over time. These vehicles are equipped with a hydraulic brake assist as a backup which allowed for a software remedy to recalibrate the hydraulic assist at low speeds. GM notified owners of this recall on October 8th, 2019; as of July 17, 2020 which represents the 3rd quarterly report, this recall had achieved a 66% remedy completion.

The smallest recalls of 2019 included two single vehicle recalls by Mercedes-Benz and Porsche.

SEVEN NON-TAKATA CAMPAIGNS IN 2019 AFFECTED MORE THAN 1 MILLION VEHICLES (37% OF THE NON-TAKATA RECALL CAMPAIGN POPULATION):

GM BRAKES

The amount of vacuum created by the vacuum pump may decrease over time (3.5 million vehicles).

SUBARU BRAKE LIGHTS

Brake light switch malfunctioning due to exposure to certain contaminants (1.3 million vehicles).

FORD AUTOMATIC TRANSMISSION

The transmission may unexpectedly downshift into first gear, regardless of vehicle speed (1.3 million vehicles).

NISSAN BACKUP CAMERA

The back-up camera and display settings can be adjusted such that the rear-view image is no longer visible and the system will retain that setting the next time the vehicle is placed in reverse (1.2 million vehicles).

FORD SUSPENSION

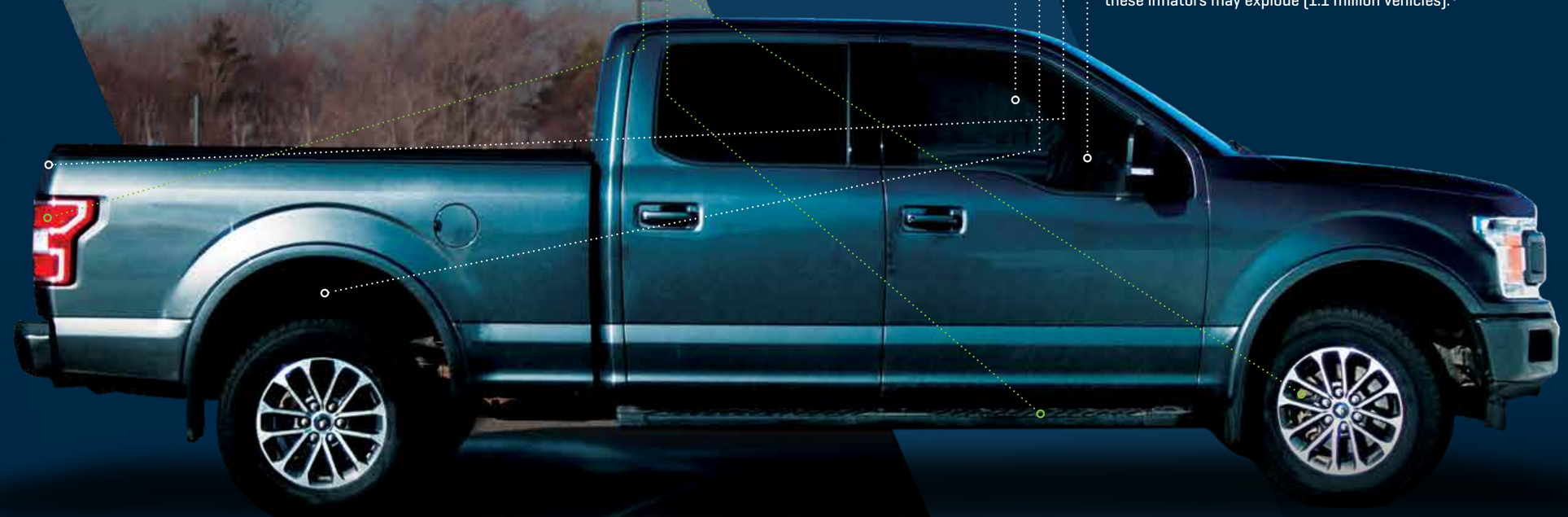
The rear suspension toe links may fracture due to stress on the rear suspension (1.2 million vehicles).

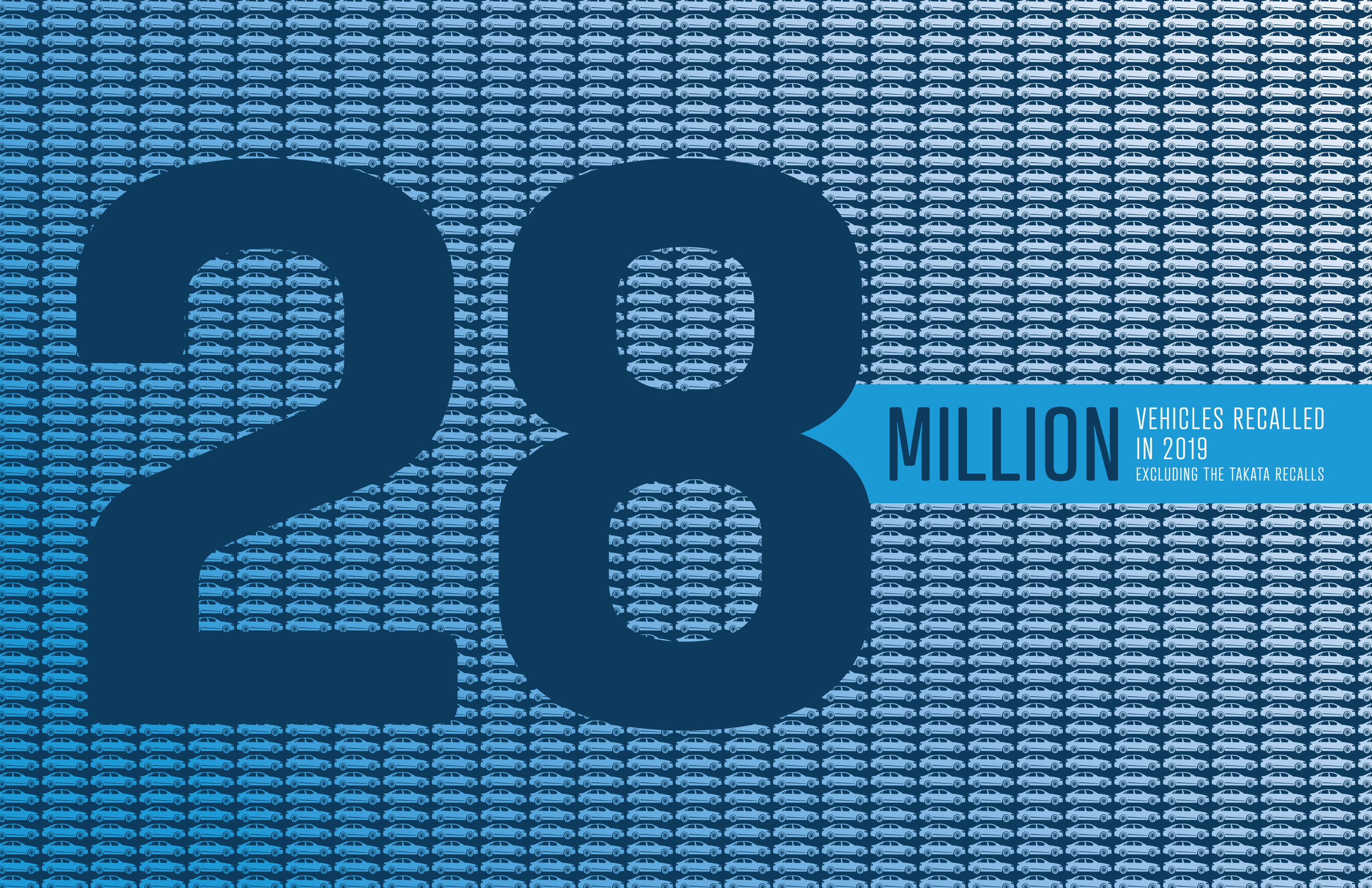
FCA TAILGATE LATCH

The tailgate actuator limiter tab may fracture and cause the tailgate to unlatch and open while driving (1.1 million vehicles).

HONDA AIRBAGS

Due to a manufacturing error, in the event of a crash necessitating deployment of the driver frontal air bag, these inflators may explode (1.1 million vehicles).[4]



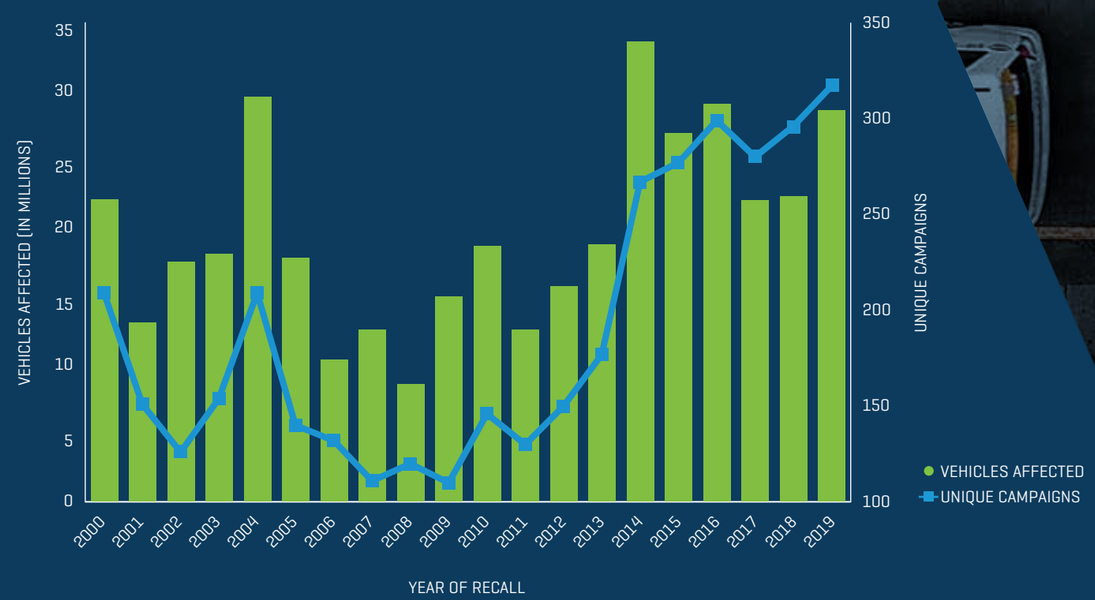

MILLION
VEHICLES RECALLED
IN 2019
EXCLUDING THE TAKATA RECALLS

TRENDS IN RECALL CAMPAIGNS

The number of unique recall campaigns, exclusive of the GM Ignition Switch and Takata recalls, has increased over the last five years from less than 150 per year in the mid-2000's to over 300 for the first time in 2019.

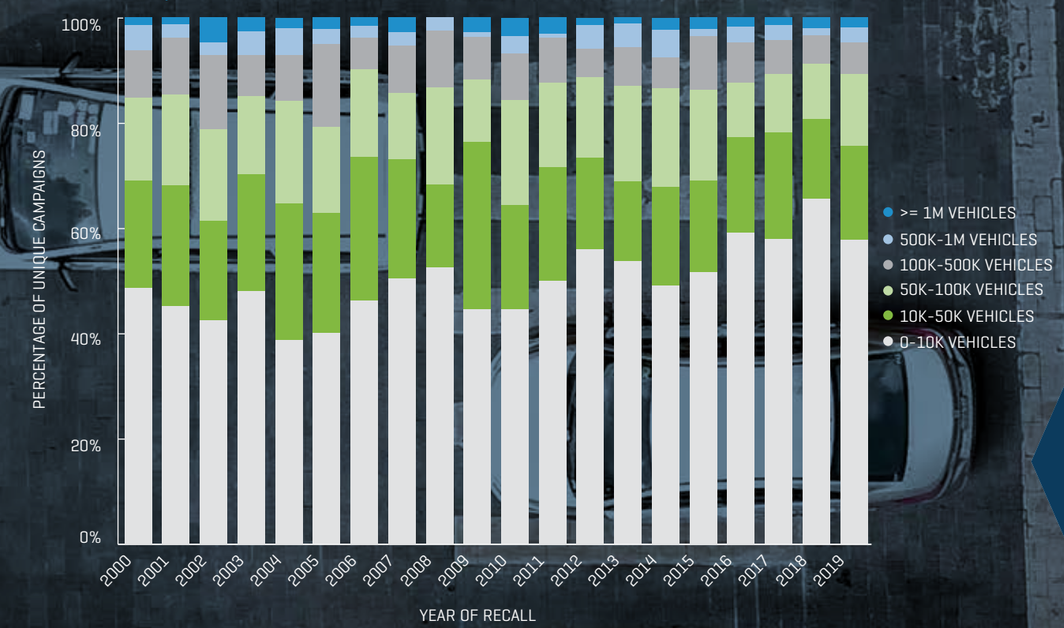
The number of vehicles affected by these recalls have increased from 12-15 million per year to more than 28 million in 2019 (Figure 1).

FIGURE 1 / UNIQUE CAMPAIGNS AND VEHICLES AFFECTED BY YEAR



The increase in the number of vehicles affected in 2019 can be attributed to more recall campaigns and more large recall campaigns. Recalls of greater than 100,000 vehicles increased from 41 in 2018 to 59 in 2019. Recalls of greater than 1 million vehicles increased from six to seven, recalls between 500,000 to 1 million vehicles increased from four to nine, and recalls between 100,00 to 500,000 increased from 31 to 43 (Figure 2).

FIGURE 2 / PERCENTAGE OF CAMPAIGNS BY SIZE OF RECALL



When looking at recall size characteristics, different trends in the number of unique model / model year combinations included in the recall are observed. Recalls affecting over 500,000 vehicles on average include eight models over eight model years while the smallest recalls affect two vehicle models over two model years on average. Large recalls affect many different vehicles over many different years and small recalls have fewer models affected over shorter production periods. Large recalls are more likely to be design related defects where the part was manufactured to specifications, but there was some flaw in the design that didn't accurately incorporate the effects of environmental factors (e.g. moisture intrusion), integration with other components or other factors of vehicle operability and safety. Indeed, 53% of recalls involving more than 100,000 vehicles were likely to be design related from 2010 – 2019. The smaller recalls are more likely to encompass manufacturing or assembly defects on a specific line for a specific time period and part traceability allows for the specific vehicles that used these parts to be identified, representing 67% of recalls involving 10,000 or fewer vehicles from 2010 - 2019.

The mid-size recalls with between 10,000 and 500,000 vehicles affected impact, on average, three models over three model years. In this category there is a mix of manufacturing, assembly and design related defects, but likely instances where gaps in traceability exist and more unique vehicle models over more production years are recalled in an abundance of caution.

OEMs and suppliers with recalls in this size category might be well served to re-examine traceability programs to identify if larger recalls could have been avoided with tighter controls.

FIGURE 3 / HIGHEST NUMBER OF RECALLS PER DISTINCT MODEL & MODEL YEAR BY RECALL YEAR

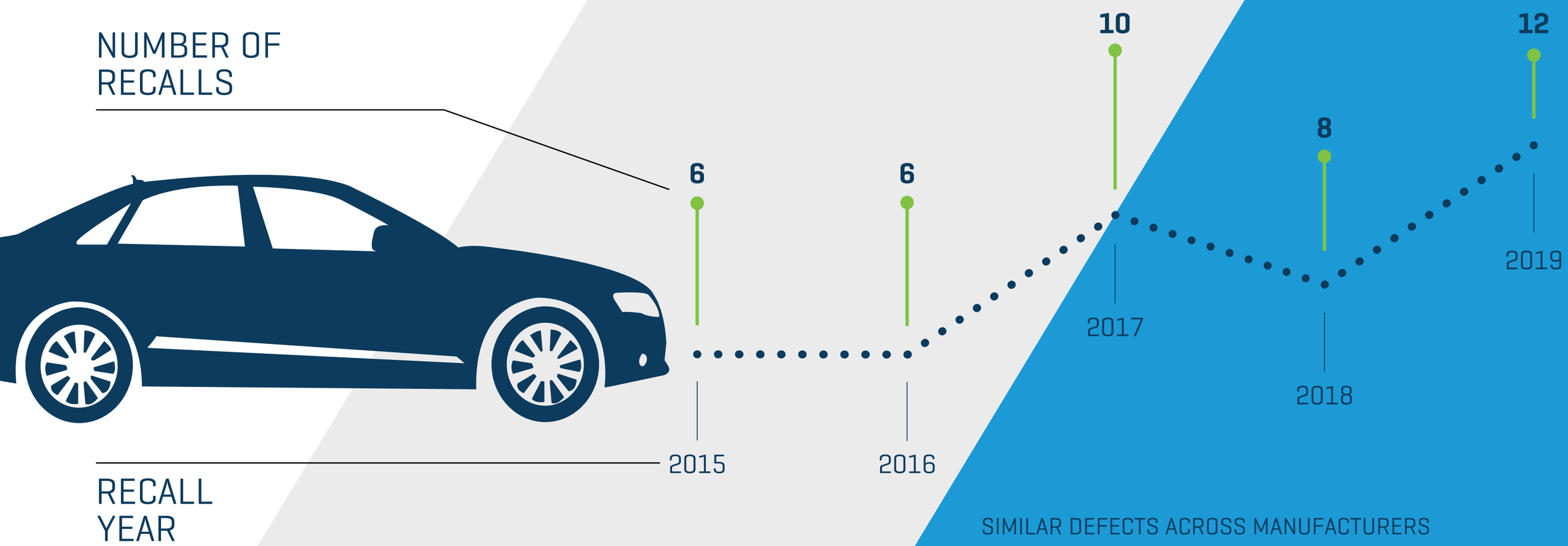


Figure 3 shows the highest number of recalls per distinct model and model year combination. For example, in 2019, one model and model year combination was involved in 12 recalls initiated in 2019.

While the trend in the last five years is an increase in the number of times a specific model and model year combination has been recalled, 60%-70% of model and model year combinations are recalled only once per year. In each year all model and model year combinations under recall had two or less recalls per year at least 90% of the time. In the last five years, 93% of vehicles involved in a recall have been recalled five times or less.[5]

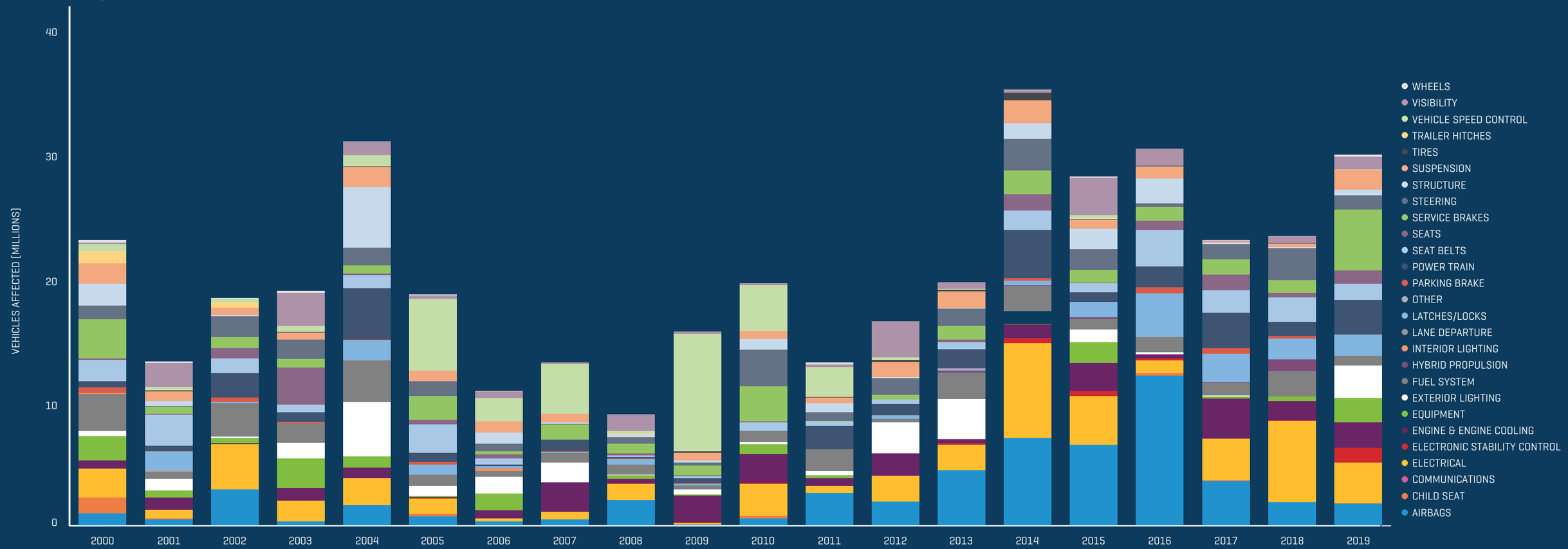
SIMILAR DEFECTS ACROSS MANUFACTURERS

In 2019 Stout identified two instances where two separate manufacturers initiated recalls for what appears to be the same defect. In the first, two manufacturers initiated a recall filing regarding faulty seat belt tensioners and named the same manufacturer in § 573 notifications. The other instance involved recalls from degrading transmission shifter cable bushings where two OEMs named the same supplier for the same component in separate filings. As consolidation increases across vehicle platforms, this poses an increased risk for both suppliers and OEMs as higher production volumes are concentrated with fewer suppliers.

There are also instances where two recalls have very similar defect descriptions, but different suppliers were identified. For example, in 2019 four vehicle manufacturers issued light vehicle recalls resulting from degrading shifter cable bushings. Two of these manufacturers named the same supplier in their recall filings but the other two manufacturers named different suppliers. This may indicate an issue in a common tier two or tier three supplier, or a flaw in a commonly used machine or process used by multiple suppliers.

COMPONENTS AFFECTED

FIGURE 4 / VEHICLES AFFECTED BY COMPONENT & YEAR—EXCLUDING GM IGNITION SWITCH AND TAKATA RECALLS AFFECTED



In 2019, the component groupings with the most vehicles affected included service brakes, exterior lighting and power train defects, based on the NHTSA component classification.

SERVICE BRAKES

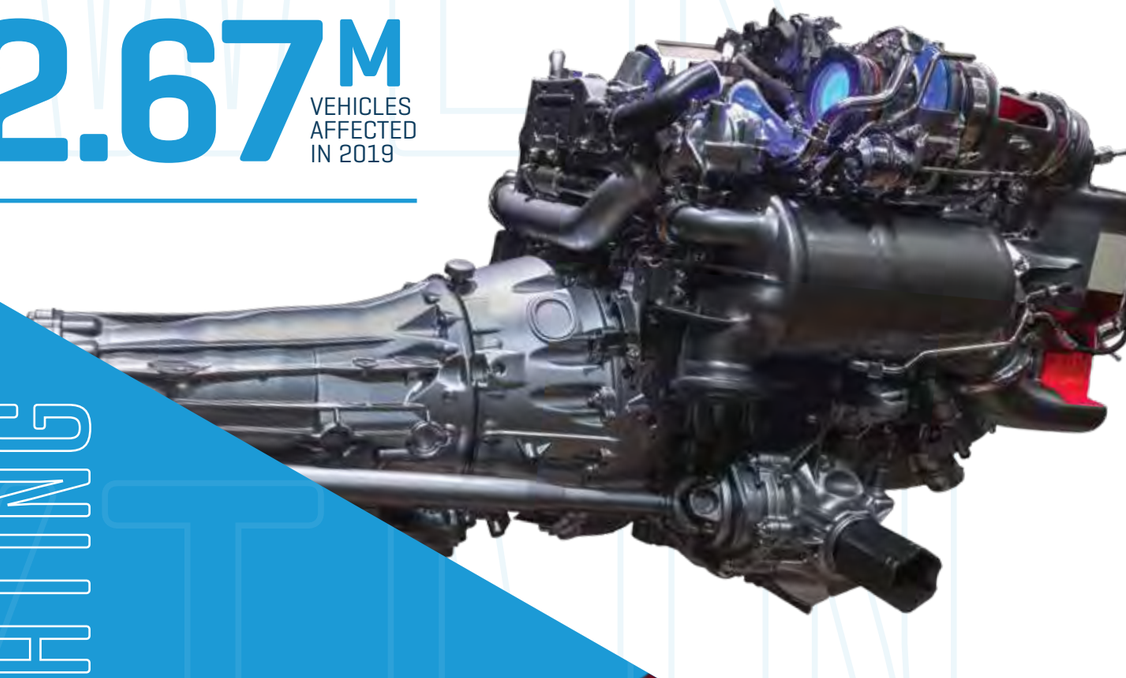
Service Brakes saw the biggest increase from under 2 million vehicles affected in most prior years since 2000 to 4.7 million in 2019, of which 3.5 million relate to a single campaign.

4.7M
VEHICLES AFFECTED IN 2019

POWERTRAIN

Vehicles affected by Power Train defects more than doubled going from 1.1 million vehicles affected in 2018 to 2.67 million in 2019, of which 1.2 million vehicles relate to a single campaign.

2.67M
VEHICLES AFFECTED IN 2019



EXTERIOR LIGHTING

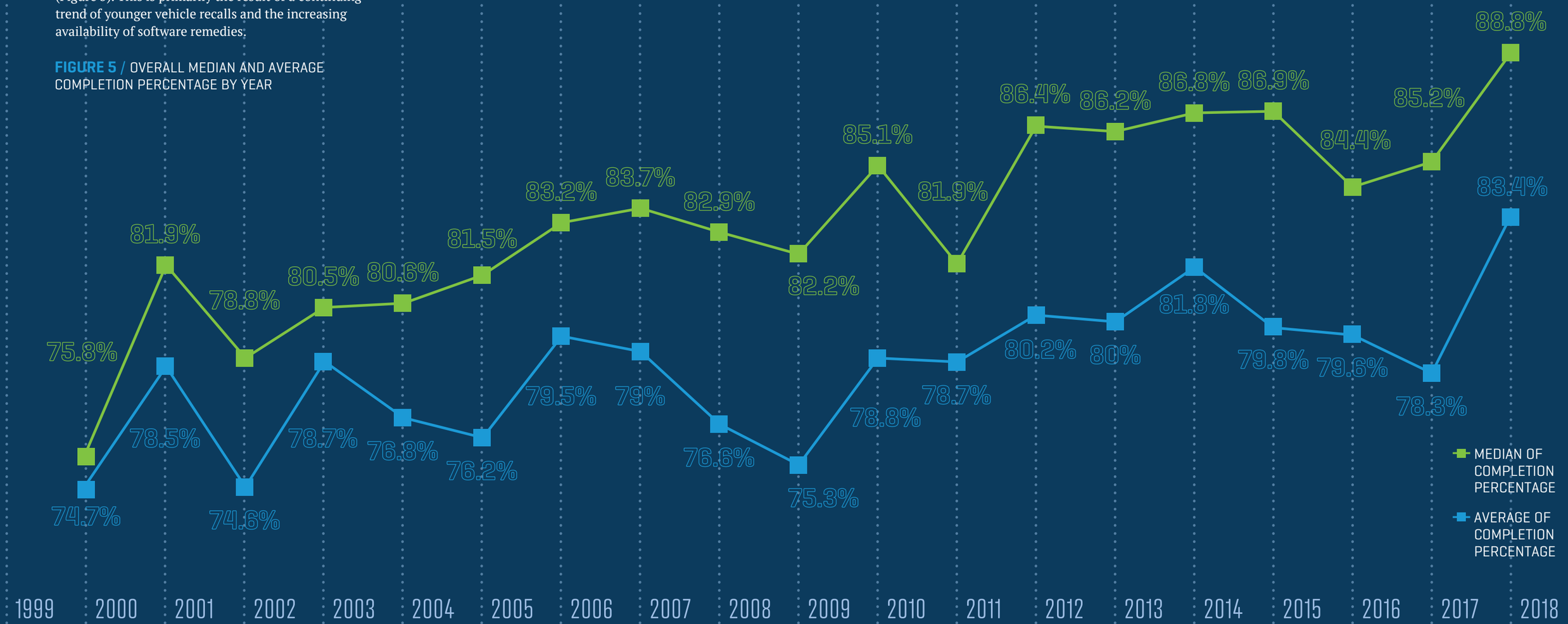
Exterior Lighting defects increased from minimal activity in the last few years to 2.5 million vehicles affected in 2019, of which 2.2 million were from three recall campaigns.

2.5M
VEHICLES AFFECTED IN 2019

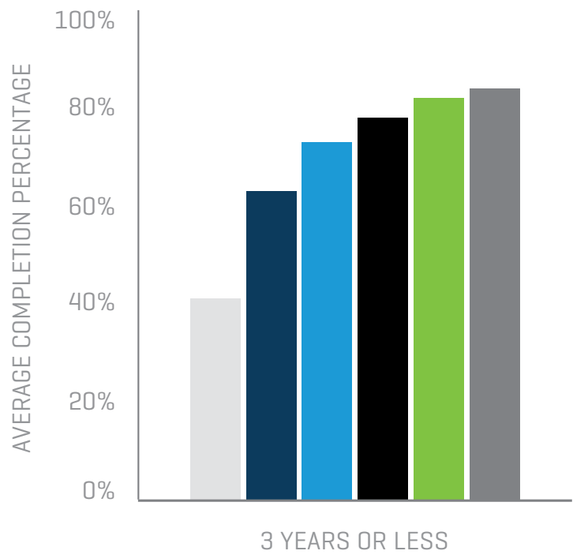
COMPLETION PERCENTAGES

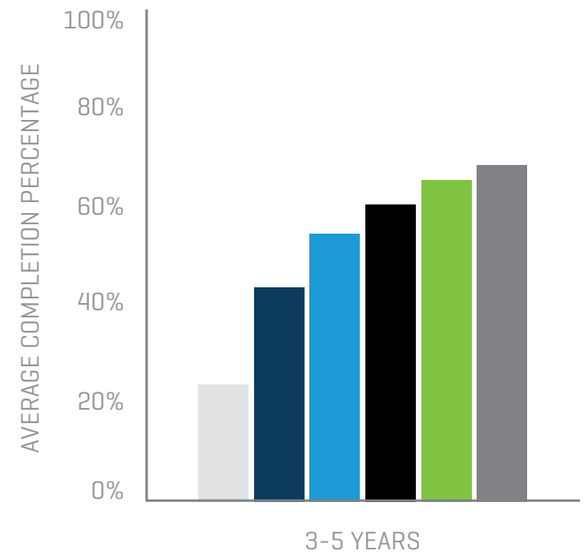
Completion percentages, measured after six quarters from recall remedy launch, have generally been increasing over the last two decades with 2018 average completion percentages peaking at 83.4%[6] (Figure 5). This is primarily the result of a continuing trend of younger vehicle recalls and the increasing availability of software remedies.

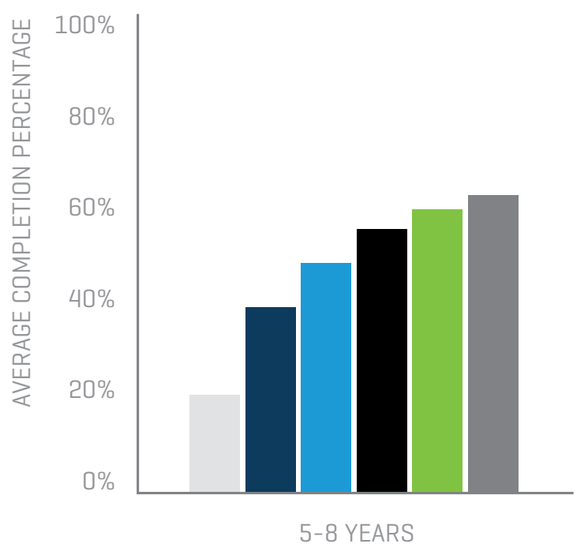
FIGURE 5 / OVERALL MEDIAN AND AVERAGE COMPLETION PERCENTAGE BY YEAR

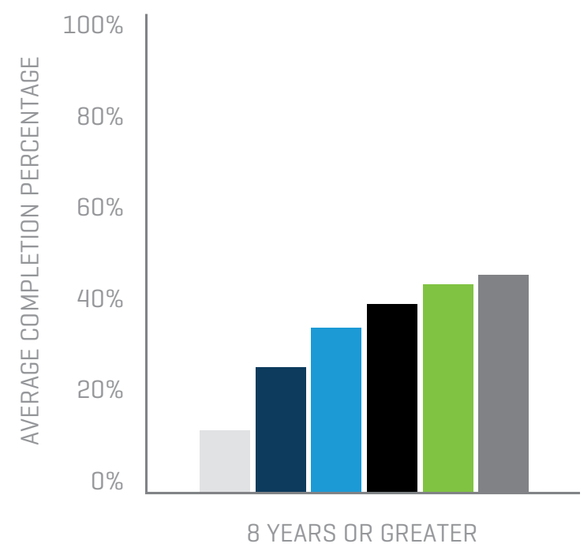


Historically, most completion percentage gains occur in the first three quarters from launch.









Q1
Q2
Q3
Q4
Q5
Q6

FIGURE 6 / SUMMARY OF AVERAGE COMPLETION PERCENTAGE BY QUARTER AND VEHICLE AGE

FIGURE 7 / VEHICLES THREE YEARS & YOUNGER-THIRD & SIXTH QUARTER MEDIAN COMPLETION PERCENTAGE

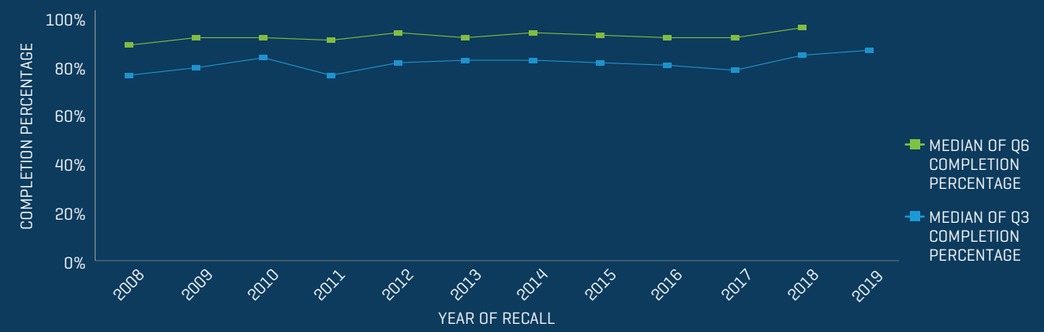


FIGURE 8 / VEHICLES THREE TO FIVE YEARS-THIRD & SIXTH QUARTER MEDIAN COMPLETION

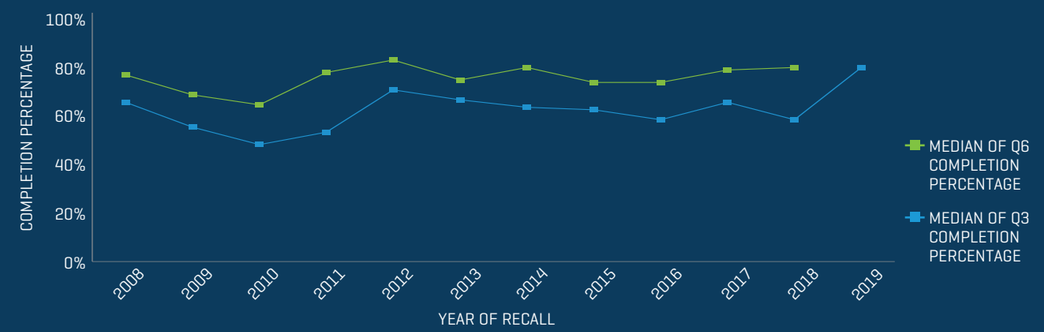


FIGURE 9 / VEHICLES FIVE TO EIGHT YEARS-THIRD & SIXTH QUARTER MEDIAN COMPLETION PERCENTAGE

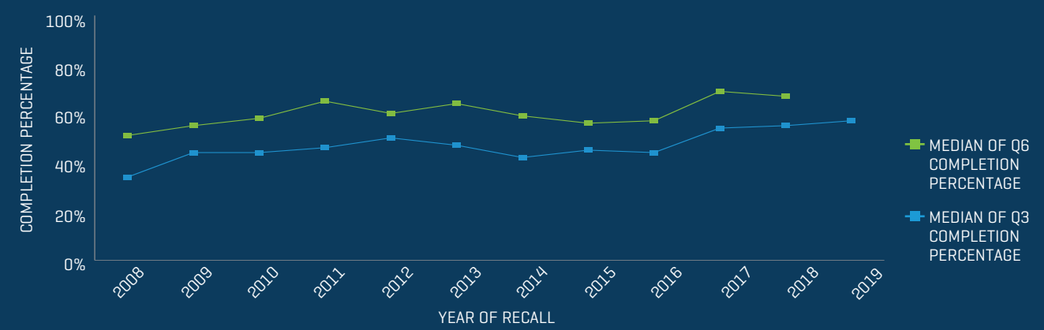
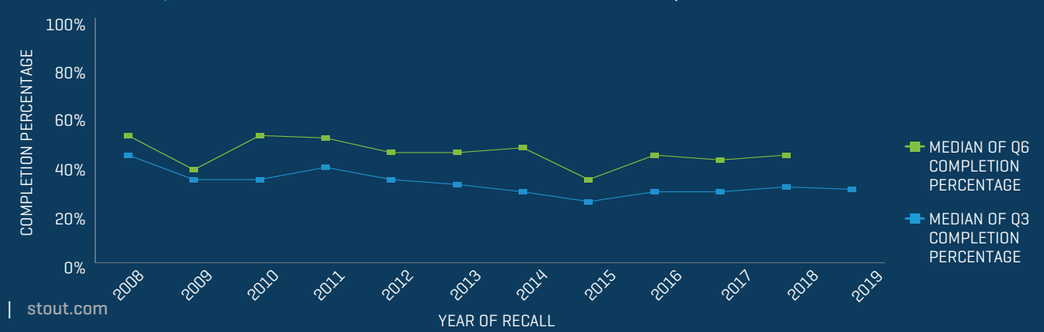


FIGURE 10 / VEHICLES EIGHT YEARS & OLDER - THIRD & SIXTH QUARTER MEDIAN COMPLETION PERCENTAGE



Completion Percentage Predictions After Three Quarters

The median spread in completion percentages is consistently between 10 and 15 percentage points across all age groups for all periods between the third and the sixth quarter from recall remedy launch. With most recall completions occurring within the first three quarters from remedy launch and the remaining repairs between the fourth and sixth quarters from remedy launch consistently increasing between 10 and 15 percentage points, analyzing the first three quarters of recall allows for the identification of trend analysis for recall campaigns that do not yet have six quarters of completion data available. Analyzing the first three quarters from remedy launch allows for the analysis of recall campaigns initiated in 2019. The early analysis of 2019 recall filings suggest that a continued upward trajectory in completion percentage will continue. The continued increase in completion percentages can be attributed to more software related defects and recalls of younger vehicles which typically report higher completion percentages.

Vehicle age is one of the most highly correlated variables to recall completion percentage. For each increase in age category, there is a consistent and material decline in completion percentage. As vehicles get further removed from a selling dealer, they are more likely to change ownership, with the new owners increasingly less likely to have a relationship with a franchised vehicle dealership. As the affected vehicle population ages, and as completion percentage increases, there is an increasing proportion of unrepaired vehicles for which the available registration information is incorrect. Accordingly, throughout the course of a recall, more and more advanced strategies are necessary in order to identify the correct vehicle owner and to motivate them to complete the repair. In the last five years, completion percentages for vehicles under eight years old has increased, but the gap is widening in completion percentages of vehicles that are eight years old or older and younger vehicles.

FIGURE 11 / QUARTER SIX MEDIAN COMPLETION PERCENTAGE BY VEHICLE AGE GROUP

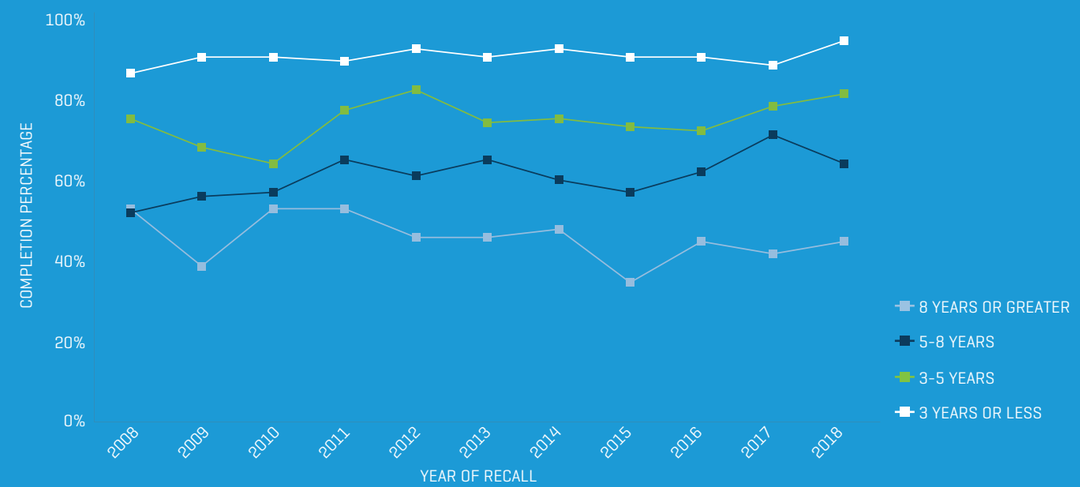


FIGURE 12

QUARTER SIX OPERABILITY MEDIAN COMPLETION PERCENTAGE BY VEHICLE AGE GROUP

The nature of the defect and its impact to vehicle operability has an influence on completion percentages. Operability looks to influence completion percentages in different ways for different vehicle age groups (Figure 12).

Newer vehicles are more routinely going back to dealers for regular service, warranty and maintenance and thus have higher completion percentages as a result and demonstrate little variability. Completion percentages for vehicles in the three to five year age group are the most positively correlated with defects that can result in limited operability as compared to other operability characteristics, while vehicles between five and eight years old exhibit the highest completion percentages related to defects that render vehicles non-operable. A similar trend can be observed for vehicles eight years old or older but not as pronounced as the five to eight year old category, likely due to the aforementioned challenges in recalls of older vehicles.

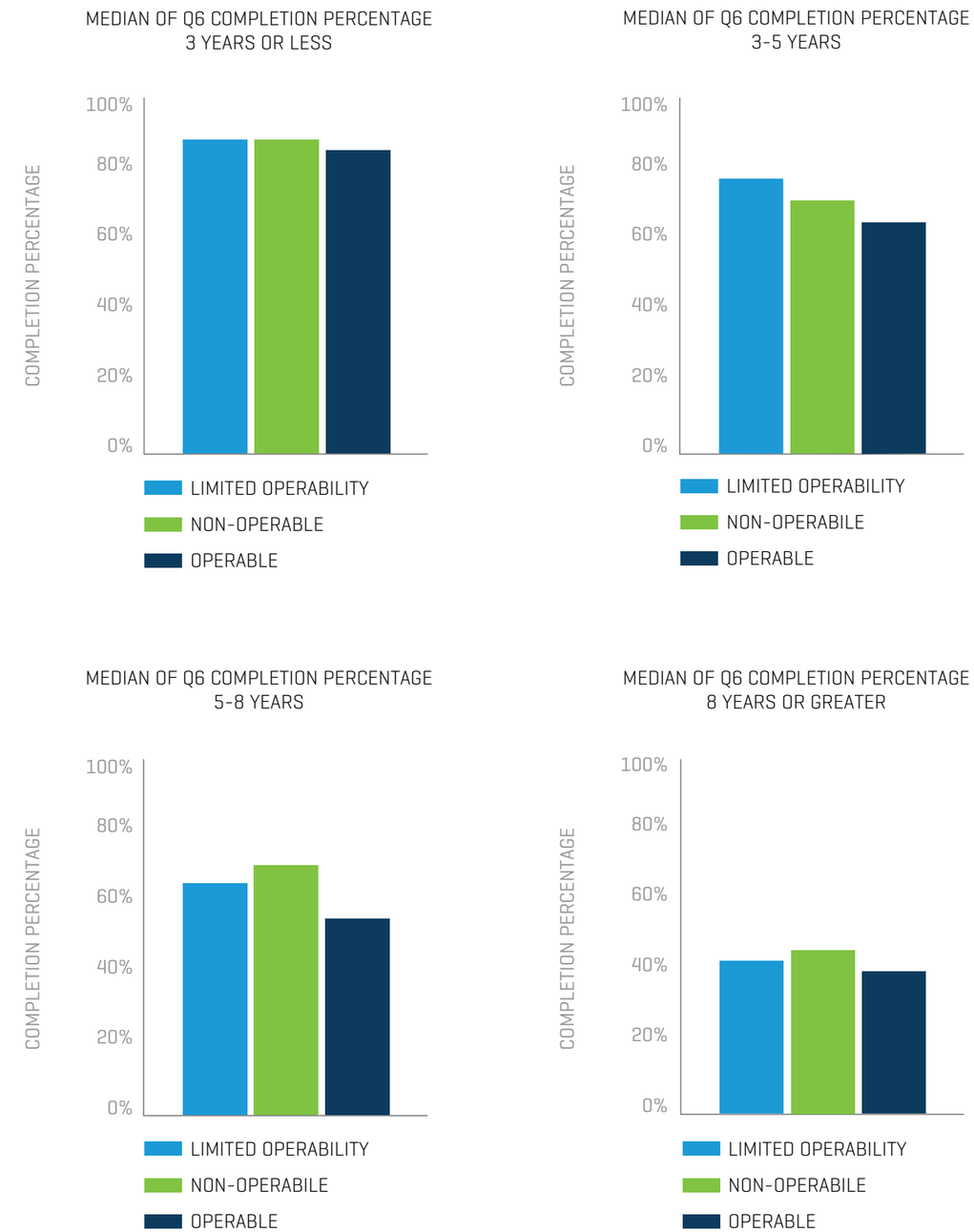


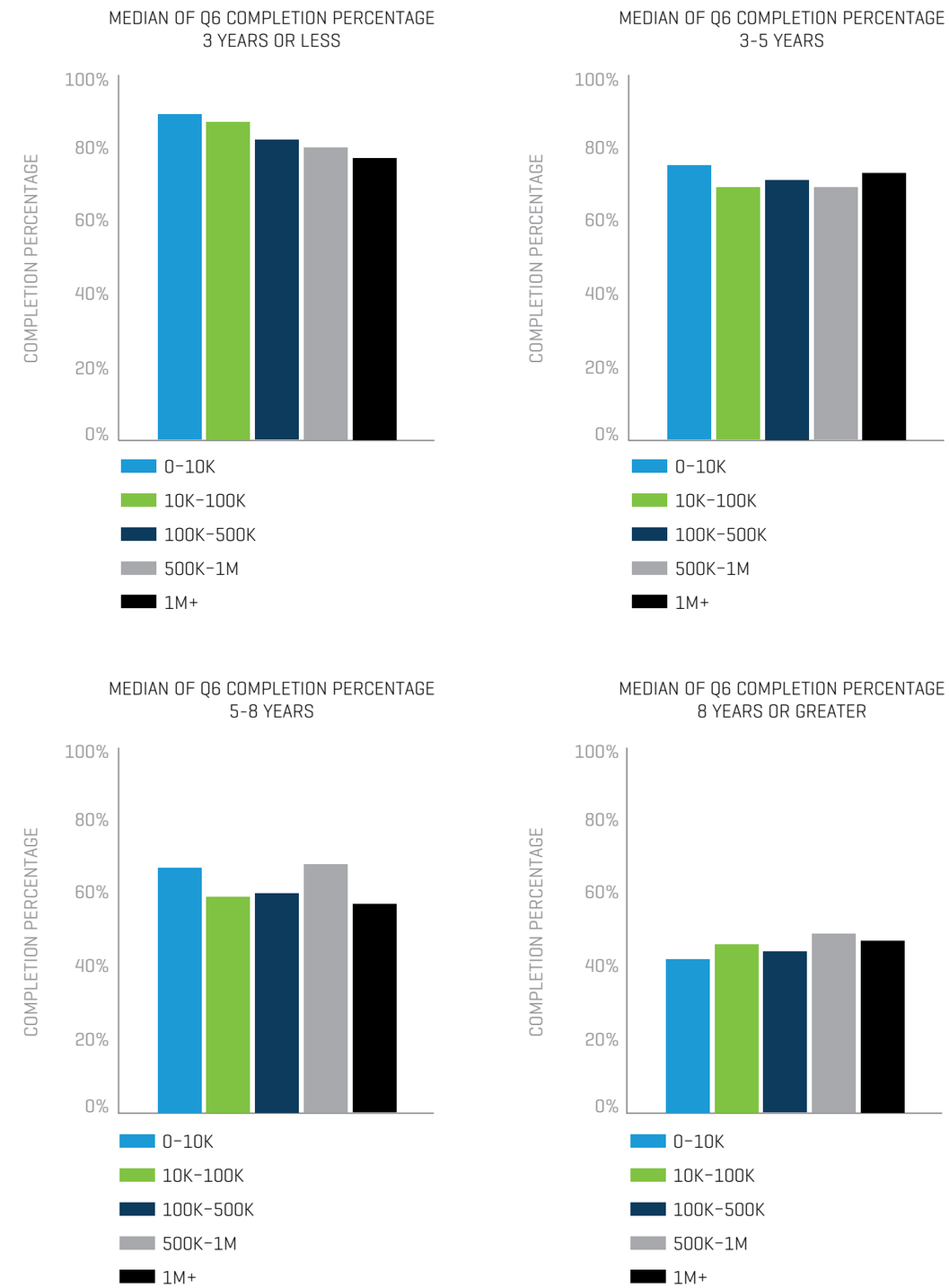
FIGURE 13

QUARTER SIX RECALL SIZE MEDIAN COMPLETION PERCENTAGE BY VEHICLE AGE GROUPS

The number of vehicles affected in a recall negatively correlates with completion percentages for younger vehicles (Figure 13).

In these recalls, the decrease in completion percentages as the number of vehicles increase is likely attributed to dealer capacity and the fact that most recall completions occur in the first three quarters. Because younger vehicle recalls have the highest completion percentages, large recalls can put a strain on dealer capacity.

Trends in the other age categories are not as readily apparent. This is partially the result of how recall data is collected and made available; separate completion percentages are not available for each model, model year of vehicle. Stout's analysis of vehicle age classifies vehicles by the oldest vehicle in each recall. As recalls increase in size, it is common for the recall to include more vehicles across multiple model years. Recalls of older vehicles, that also contain new vehicles will report higher completion percentages because of the benefit on completion percentage of the new vehicles which result in larger campaigns showing higher completion percentages.

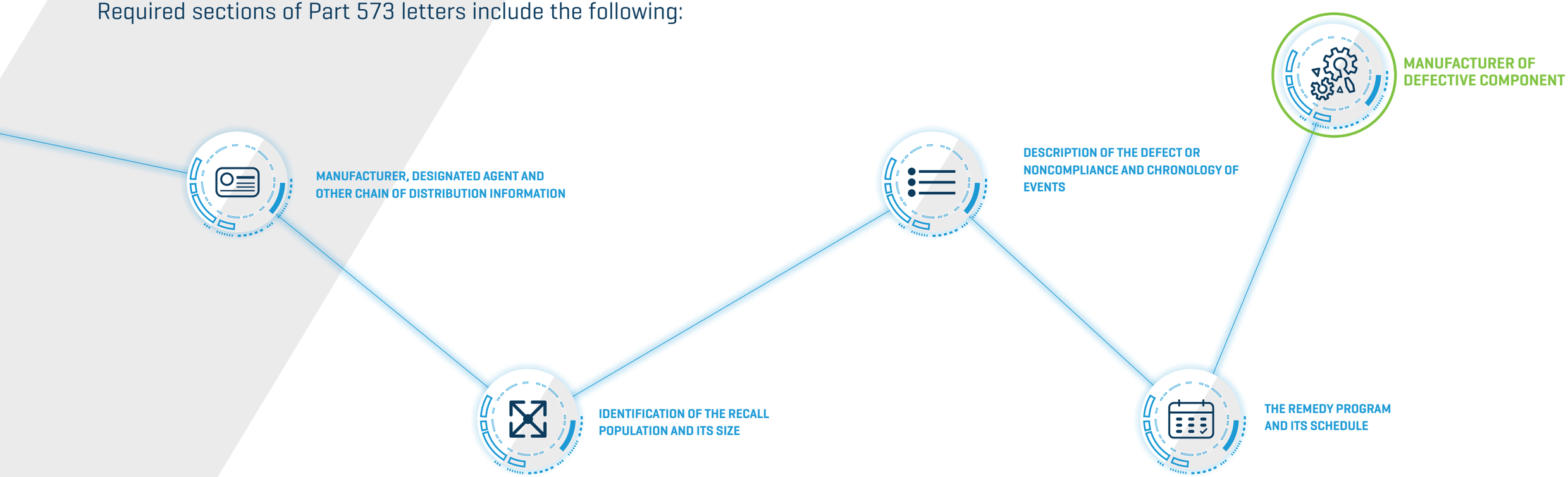


SUPPLIER IDENTIFICATION

For each recall initiated, OEMs are required to submit a § 573 notification that serves as a report to the U.S. Department of Transportation, National Highway Traffic Safety Administration that a defect related to motor vehicle safety or noncompliance with Federal Motor Vehicle Safety Standards exists.

Identification of a supplier by an OEM in a Part 573 letter indicates that the supplier had a role in the fabrication of a defective or non-complying motor vehicle component. The identification does not necessarily mean that the supplier in question is entirely, or even partially, at fault for the defect, only that the supplier was involved in the manufacture of the component. This involvement indicates the potential for involvement in a future cost recovery action.

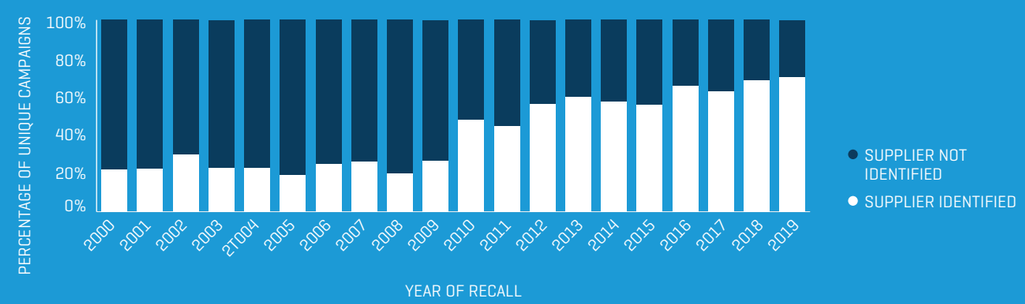
Required sections of Part 573 letters include the following:



In 2019, 117 unique suppliers were identified in § 573 Notifications.

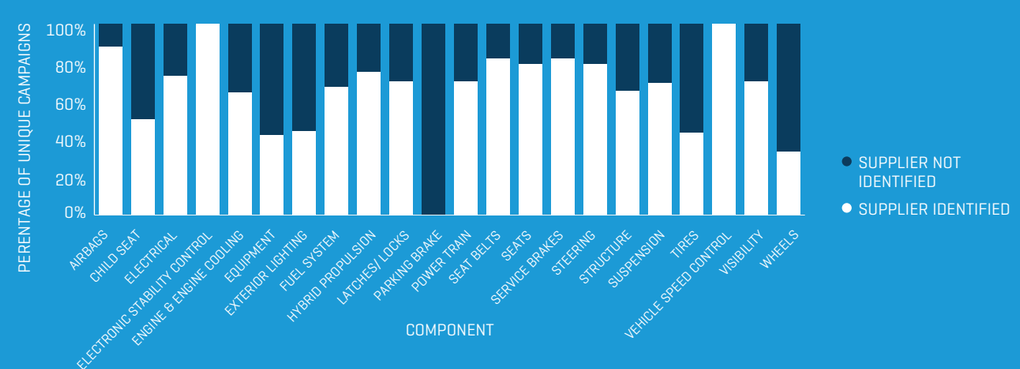
74 (64%) were identified in only one recall and 97 (83%) were identified in one or two recalls. Only 14 suppliers were identified in three or more recalls, excluding Takata and OEM self-identification. Four suppliers were involved in recalls that had more than one million vehicles affected. Two suppliers were named in single recalls of one million or more vehicles while the other two suppliers were named in 10 and 18 campaigns, respectively.

FIGURE 14 / PERCENTAGE OF CAMPAIGNS BY SUPPLIER IDENTIFICATION & YEAR



Airbags, electronic stability control, and vehicle speed control represent components where a supplier is most likely to be identified (Figure 15).

FIGURE 15 / PERCENTAGE OF CAMPAIGNS BY SUPPLIER IDENTIFICATION & COMPONENT IN 2019



Supplier identification for recalls likely involving design related defects show slightly different trends than recalls that are likely the result of manufacturing related defects.

The proportion of recalls likely the result of design related defects have steadily risen since 2009 where 40% of suppliers were identified in § 573 Notifications which increased to 75% by 2019 (Figure 16A).

In recalls that were likely the result of a manufacturing related defect, suppliers were identified in over 80% of § 573 Notifications in recalls in 2008. In most years from 2009-2017, this dropped to under 80% before returning to 90% in 2018 and 84% in 2019 (Figure 16B).

FIGURE 16A / PERCENTAGE OF UNIQUE CAMPAIGNS BY SUPPLIER IDENTIFICATION AND YEAR (LIKELY DESIGN RELATED)

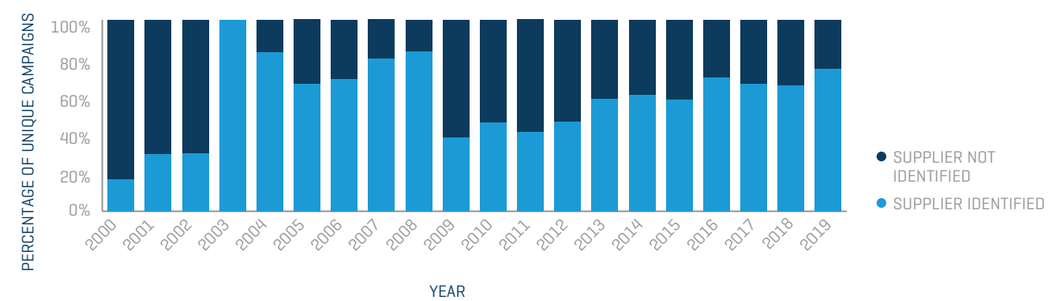
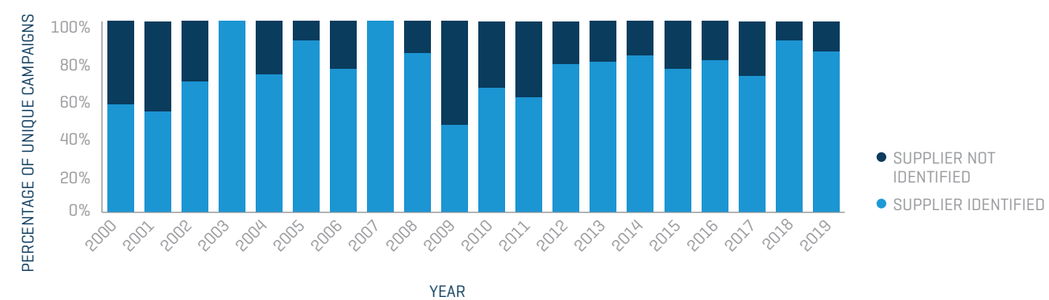


FIGURE 16B / PERCENTAGE OF UNIQUE CAMPAIGNS BY SUPPLIER IDENTIFICATION AND YEAR (LIKELY MANUFACTURING RELATED)



INTERNATIONAL RECALLS

As the globalization and standardization of component production increases around the world, so too does the risk of multi-national recalls. Analysis of international recall data and global trends can provide valuable insight for industry participants into what might be ahead for the U.S., as well as how other jurisdictions respond to component defects.

Stout identified, compiled and translated data from many of the world's largest vehicle markets to conduct custom analysis that highlights pertinent trends and activity. Each year, Stout continues to add new global defect data to provide a more comprehensive understanding of global automotive component defect trends.

In its analysis, Stout observed that the majority of international component defect and recall activity in 2019 mirrored the activity in the U.S. Specifically, Stout's analysis indicated a continued trend of elevated recall activity in each jurisdiction studied, with much of that increase attributable to recalls involving airbags and electronic components. These similarities are likely attributable to the continuing global standardization of component supply and production. However, Stout identified some unique observations, including the following:

As Figure 17 shows, the number of light vehicle recalls in Canada continued to increase in 2019, reaching a record number of campaigns as was the case in the U.S. Canada continued to experience elevated levels of airbag recalls, but also realized increases in recalls related to visual systems and lights and instruments. These component categories have experienced rapid development with the deployment of advanced technologies in recent years. The emergence of these recalls in Canada reflect recent activity observed in the U.S. related to back-up cameras and advanced lighting systems discussed later in this report.

In 2019, the U.K. also experienced an increase in the number of recalls, continuing a five-year trend. This increase reflects more campaigns involving defects related to suspension and electrical system components (see Figure 18). Stout observed that many of the recalls in the U.K. involving these component categories required software remedies, reflecting the trend of increasing software remedy solutions that was observed in the U.S. during 2019.

FIGURE 17 / COUNT OF CANADIAN RECALL CAMPAIGNS BY COMPONENT & YEAR

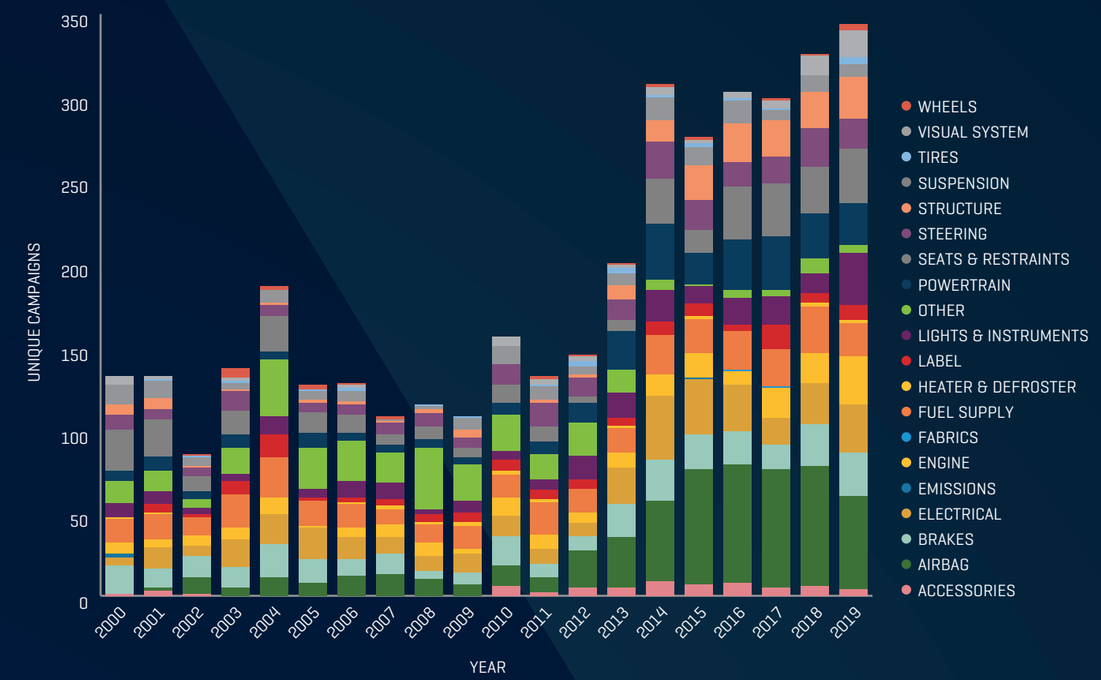
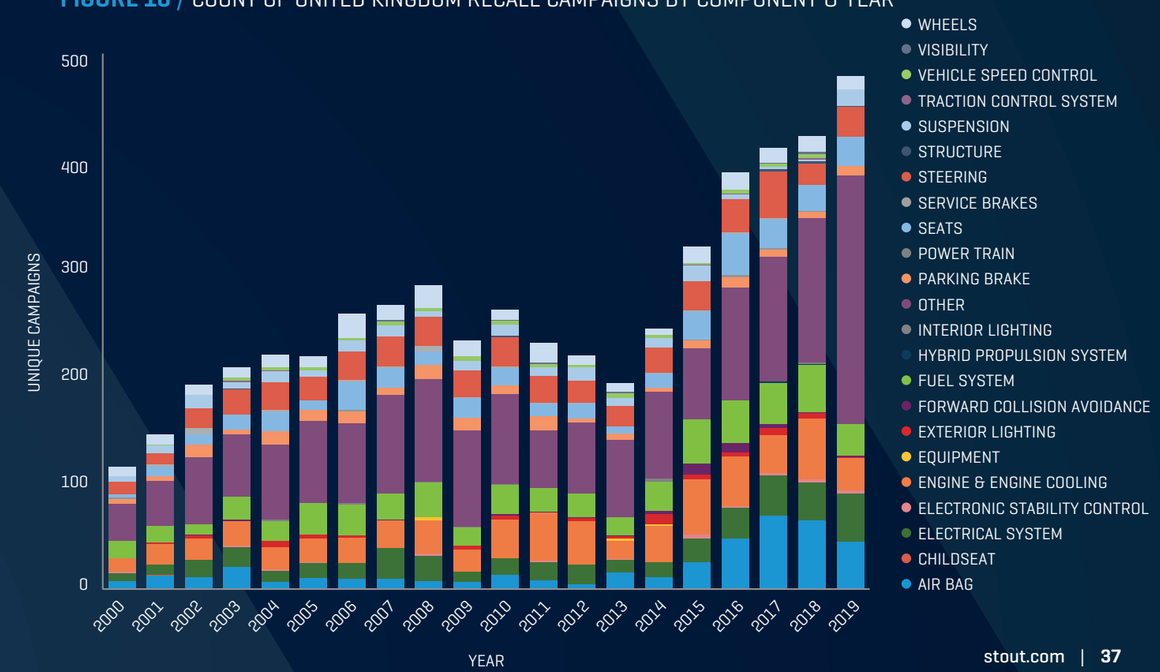
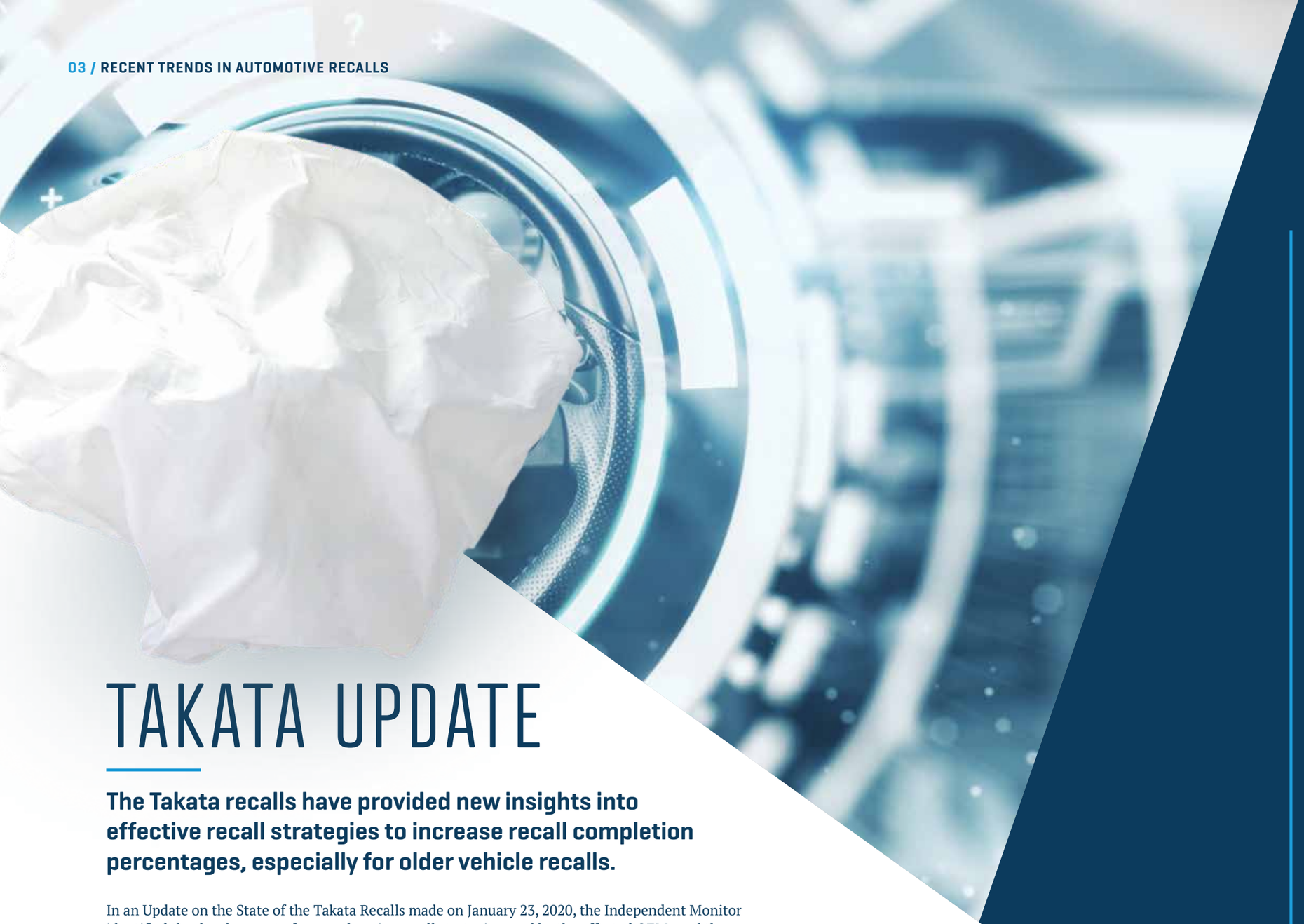


FIGURE 18 / COUNT OF UNITED KINGDOM RECALL CAMPAIGNS BY COMPONENT & YEAR





TAKATA UPDATE

The Takata recalls have provided new insights into effective recall strategies to increase recall completion percentages, especially for older vehicle recalls.

In an Update on the State of the Takata Recalls made on January 23, 2020, the Independent Monitor identified the development of comprehensive recall strategies used by the affected OEMs and the Engagement of Third Parties.

The Monitor identified data quality and data analytics as critical ingredients in identifying the correct vehicle owner and the location of unrepaired vehicles. This report provided examples of data source categories for vehicle identification and outreach, tools to locate in-transit vehicles, examples of preliminary indicators of vehicles potentially not being in transit and supplemental data, research and analysis for vehicle transit status.

Owner accommodations to overcome inconvenience in completing recall repairs were cited as critical to encourage many of the remaining unrepaired vehicle owners to replace their Takata airbags.

The affected vehicle manufacturers have launched a wide array of accommodations to encourage repairs which have included extended dealer hours, free loaner vehicles and mobile repair. Mobile repair was specifically identified as a preferred accommodation by vehicle owners through both OEM and Monitor research as well as through analysis of certain repair activity.

Escalating outreach communications, both in type and in frequency, has proven successful to engage previously unresponsive affected vehicle owners. This has included the use of dedicated case handlers, use of certified mail to send outreach, outreach from trusted third parties (the insurance industry, state DMVs, state and local agencies, independent repair facilities, vehicle auctions and independent automotive dealers), cash incentives and door-to-door canvassing.

Personal interaction with vehicle owners through phone outreach and door-to-door canvassing was found to be effective in conveying the urgency of the Takata recalls to vehicle owners that are aware of the recall but do not understand the risk of the defect.

Franchised dealer engagement continues to be an essential component to ensure that vehicle owners have a simple and convenient repair experience. However, much variation is seen in completion metrics across franchised dealers within OEM networks.

Ultimately, the Monitor concluded that no single strategy will be effective in reaching 100% accountability for the Takata recalls. Rather, a combination of all successful strategies is needed but to date has not been done by any of the affected OEMs at scale.

TECHNICAL SERVICE BULLETINS

TSBs increased for the third consecutive year in 2019 led by defects in electrical systems, structure and visibility.

NHTSA maintains a database of Technical Service Bulletins (TSBs), which contain service procedures issued by OEMs to service technicians for the diagnosis and repair of known defects. Defects identified by TSBs are often those that do not rise to the level of a safety recall. They could be as benign as a car radio powering off unexpectedly. However, defects identified in TSBs could be associated with recalls as well.

TSBs increased for the third consecutive year, as shown in Figure 19, following the pattern observed for U.S. recalls. As Figure 20 indicates, there were disproportionate increases in TSBs involving electrical systems, structure, and visibility components in 2019. It is notable that TSBs involving airbag components consistently represent less than 3% of all TSBs, while they are regularly involved in a much larger proportion of recalls. This is due in part to the likelihood that many non-safety critical components are involved in service actions other than recalls, while airbags continue to remain a critical safety feature of vehicles.

FIGURE 19 / COUNT OF TECHNICAL SERVICE BULLETINS BY YEAR

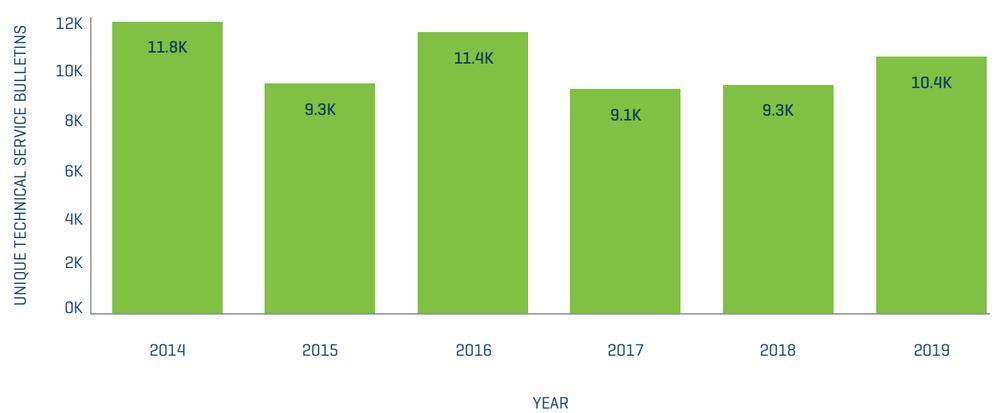
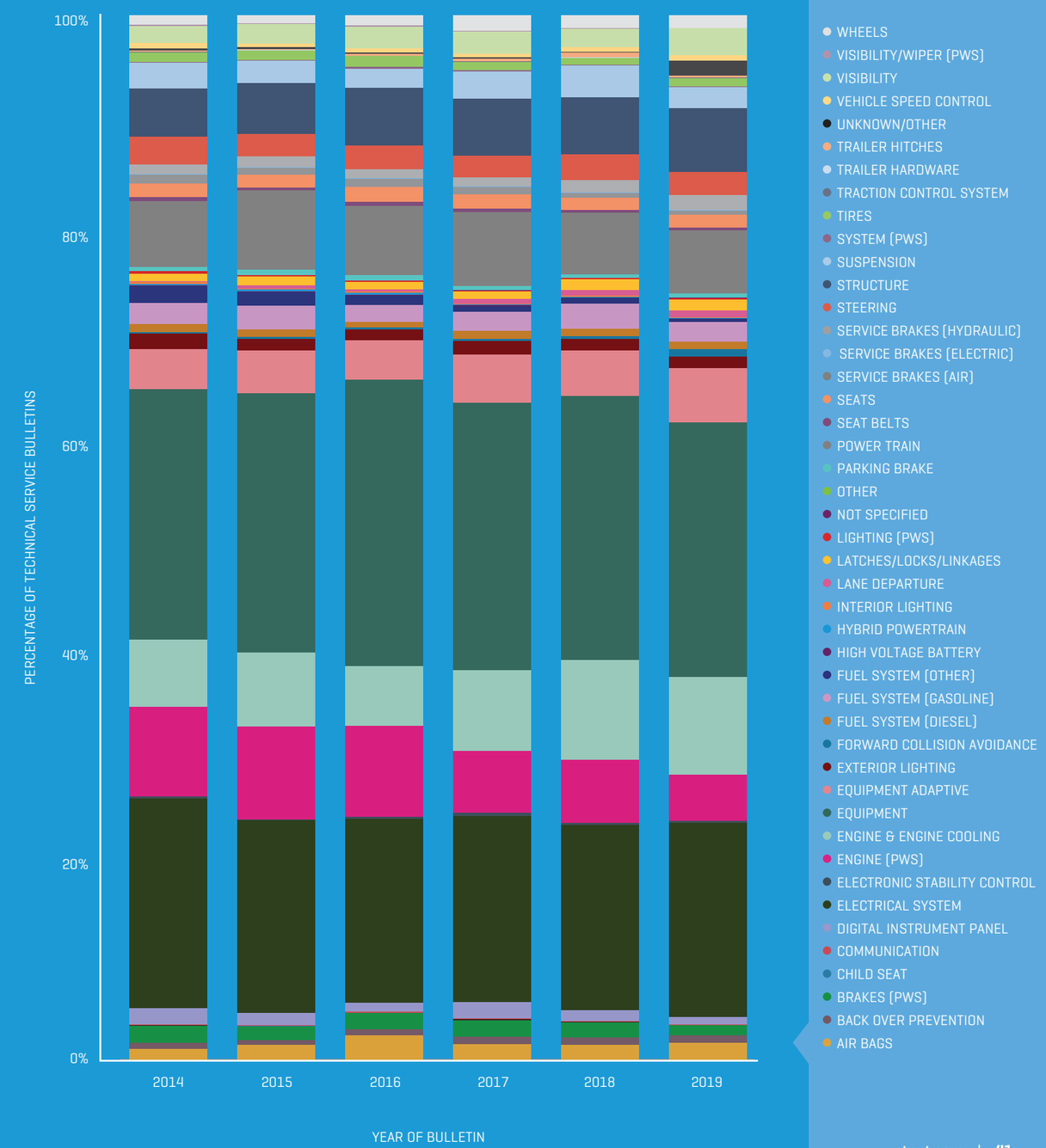


FIGURE 20 / PERCENTAGE OF TECHNICAL SERVICE BULLETINS



REGULATORY ACTIVITY

In the U.S., automobile recalls are initiated for vehicles not complying with Federal Motor Vehicle Safety Standards (FMVSS); the enforcement of such recalls being within NHTSA's purview. Announcements of changes in FMVSS as well as investigations, enforcement actions and the granting or denying of certain petitions provide insight into emerging areas of automobile recall in the U.S.

UPDATES TO FEDERAL MOTOR VEHICLE SAFETY STANDARDS

The current pace of technological innovation in the automobile industry is unprecedented. NHTSA is updating safety standards and seeking comments on others to keep pace with the introduction of new vehicle technologies and remove regulatory hurdles inhibiting the introduction of developing technologies.

In the Fall of 2019, the U.S. Department of Transportation explained, "NHTSA plans to issue regulatory actions that: (1) Allow for permanent updates to current FMVSS reflecting new technology; and (2) Allow for updates to NHTSA's regulations outlining the administrative processes for petitioning the Agency for exemptions, rulemakings and reconsiderations."

In November 2019, NHTSA requested comments on the development of test procedures aimed at objectively and practically assessing the performance of the following light vehicle systems: active parking assist; blind spot detection; blind spot intervention; intersection safety assist; opposing traffic safety assist; pedestrian automatic emergency braking; rear automatic braking; and traffic jam assistance.

INVESTIGATIONS

At the close of 2019, NHTSA's Office of Defects Investigation ("ODI") had 40 open defect investigations. Eighteen of these were Engineering Analyses and 22 Preliminary Evaluations. Engineering Analyses tended to be open for longer periods of time with 13 of the Engineering Analyses open for more than one year with the oldest having been open for 13 years. Eight preliminary evaluations were open for more than one year with the oldest having been open for a little over three years.

Airbags were the most investigated component group where four Engineering Analyses and four Preliminary Evaluations remained open at the close of 2019. Three of the four Preliminary Evaluations were related to occupant classifications system. Twelve Preliminary Evaluations and one Engineering Analysis were closed in 2019, 10 of which resulted in recalls.[7]

ENFORCEMENT ACTIONS

In 2019, NHTSA entered into three settlement actions (one with a manufacturer of light-duty vehicles, one manufacturer of heavy-duty vehicles and one with a dealership). Of significance was a $20 million dollar settlement with a light vehicle manufacturer. The fine was the result of failing to notify vehicle owners of recalls and submitting other recall filings within mandated timelines. Although the delinquent filings that resulted in the $20 million settlement were only five to six days late, there was a pattern of repeated missed filings that likely contributed to the amount of the fine.

MOTOR VEHICLE DEFECT PETITIONS

In 2019, NHTSA denied one Motor Vehicle Defect Petition. In its denial, NHTSA looked at its own engineering study conducted in 2011, the data related to FMVSS No. 226 Ejection Mitigation, complaints, EWRs and FARS and did not find any evidence to support the petition.

ZERO

NEW MVDPs FILED IN 2019

THESE SUBMISSIONS:

- Provide unique insight into issues identified by the public
- Highlight how NHTSA evaluates these potential safety concerns
- Identifies whether a defect affects vehicle safety

The petition claimed that the rollover side curtain airbag system, side window glass, rear seat belt and roof structure are defectively designed in the 2010 Chevrolet Tahoe. This can allow vehicle passengers located in the second and third row of the vehicle to be ejected in the event of a rollover crash. NHTSA cited its own review and report on ejection mitigation prepared in 2011 which found the subject vehicle's cushion has sufficient size or coverage and stays inflated for several seconds. NHTSA reviewed data related to the formulation of FMVSS No. 226 Ejection Mitigation where the subject vehicle performed better than some vehicles and worse than others. NHTSA also commented that no other complaint data was found related to the subject vehicle. EWR reports were examined related to the alleged defect and found three relevant reports but did not find any similarities to the petitioner's claim. FARS data regarding fatal occupant ejections of the subject vehicle did not stand out from other peer vehicles.

Instructive in NHTSA's denial of this petition are the various data sources – complaints, EWR, and FARS data – relied upon by the agency to arrive at its conclusion. The details of NHTSA's analysis described in this denial underscore the importance of these data sources when evaluating the risk of component defects.

PETITIONS FOR INCONSEQUENTIAL NONCOMPLIANCE

In 2019, 15 new Petitions for Inconsequential Noncompliance ("PIN") were reported on the Federal Register, seven were granted and one was denied by NHTSA. The most common defects related to labeling items with six PINs reported. Other components included:

- Tire Pressure Monitor [1]
- Seatbelt [1]
- Exterior Lighting [1]
- Tire [1]
- Speedometer [1]
- Turn Signal [1]
- Headlamp [1]
- Reflectors [1]
- Interior Materials [1]

The seven granted PINs were related to the following components:

LABELS [4]

Incorrect tire size/cold tire pressure, not permanently fixed, not legible.

SEAT BELT [2]

Seat belts sold without installation and usage/maintenance instructions.

STEERING [1]

Steering angle sensor defect.

The single denied PIN in 2019 was submitted in relation to a seat belt emergency locking retractor.

NHTSA found that the magnitude of non-compliance was not small as the seat belts locked at 90mm of webbing instead of 25mm which represents 3.6 times the standard at 0.7g of acceleration. NHTSA cited that 0.7g of acceleration was selected because that is the lower range exhibited from emergency braking prior to an accident. The locking mechanisms at issue in this recall also had a vehicle sensor in addition to a webbing sensor (i.e. detects changes in acceleration to the vehicle instead of webbing released from the seatbelt) that petitioners argued resulted in the noncompliance being inconsequential. The petitioners performed tests of crash scenarios but NHTSA noted that the petitioners only used dynamic tests and not static tests. NHTSA contended the static tests are relative to occupants being out of position which is also relevant to the FMVSS. The recent denial of this PIN reflects increased investigative focus on potential seat belt defects, particularly those involving retractors and pretensioners. Between 2016 and 2019, ODI initiated 11 investigations of seat belt components; of those, five involved pretensioners or retractors – three of which resulted in recalls. In the 10 years from 2006 – 2015, only six seat belt investigations were initiated and one of those involved a retractor.

The conclusions presented in this PIN denial reflect the agency's focus on safety and indicate that petitions related to defects related to key safety systems may not be viewed by NHTSA as inconsequential. NHTSA's denial of this PIN may provide key insights to automakers and component suppliers in the future braking systems and safety restraints developed to accommodate and enable advancements in crash avoidance technologies.

04 ELECTRONIC COMPONENT DEFECTS

Stout's analysis of integrated automotive electronic components examines how software and non-software-related failure modes contribute to the risks and costs of defects and recalls.

In order to generate its findings, Stout utilizes a variety of source materials for analysis, including NHTSA recall data, 573 letters, quarterly completion reports, and Technical Service Bulletins (TSBs). Stout then categorizes electronic components into four primary groups based on defect and remedy descriptions. These groups include the following:

» INTEGRATED ELECTRONIC COMPONENTS (IECs)

Encompasses the failure of electrical components due to physical defect, including defects related to water intrusion, wiring failure, etc. (these defects are not caused or fixed by software)

» SOFTWARE DEFECT

Includes the failure of components related to a defect in operating software

» SOFTWARE INTEGRATION

Failure that results from software interfacing with other components or systems in a vehicle

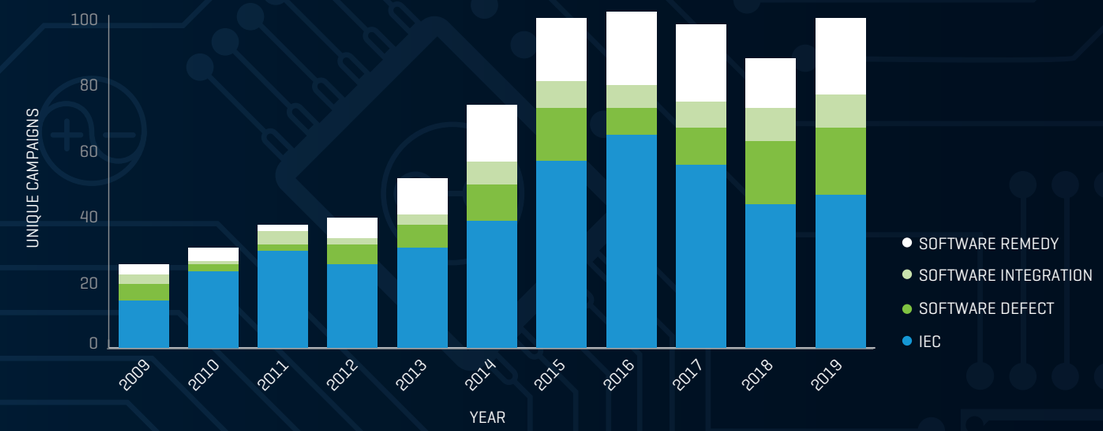
» SOFTWARE REMEDY

Failure is not clearly caused by a software defect, but a software flash or replacement is identified as the appropriate defect remedy

The overall number of recalls of electronic components and related failure modes set a record in 2019 after having steadily declined since the previous peak in 2016, as indicated in Figure 21A.

This growth was observed in most electronic component defect categories, but the greatest increase in the number of campaigns related to software remedies.

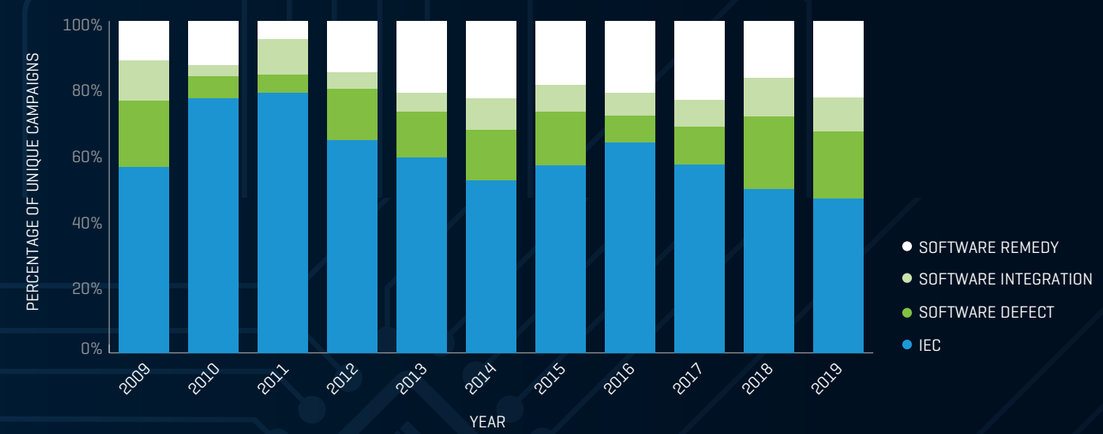
FIGURE 21A / RECALL CAMPAIGNS BY ELECTRONIC COMPONENTS & YEAR



The proportion of software-based defects, i.e., software defects, software integration, and software remedy, increased for the third consecutive year, while IEC related defects continued to decline, as shown in Figure 21B.

The increase in software-based defects, particularly the growth in the number of those involving software remedies highlights opportunities for OEMs and suppliers to employ modifications to vehicle systems such as software updates and calibration adjustments to remedy defects that would previously have required the repair or replacement of vehicle components. Indeed, two of the three largest non-Takata recalls in 2019 – GM's brake vacuum pump failure (3.5 million vehicles) and the unintended downshift on Ford trucks (1.3 million vehicles) – were the result of mechanical component failures that were repaired with software remedies. The increase in the number of software-based defects, particularly software remedies, is a trend that we expect will continue in years to come.

FIGURE 21B / PERCENTAGE OF RECALL CAMPAIGNS BY ELECTRONIC COMPONENTS & YEAR



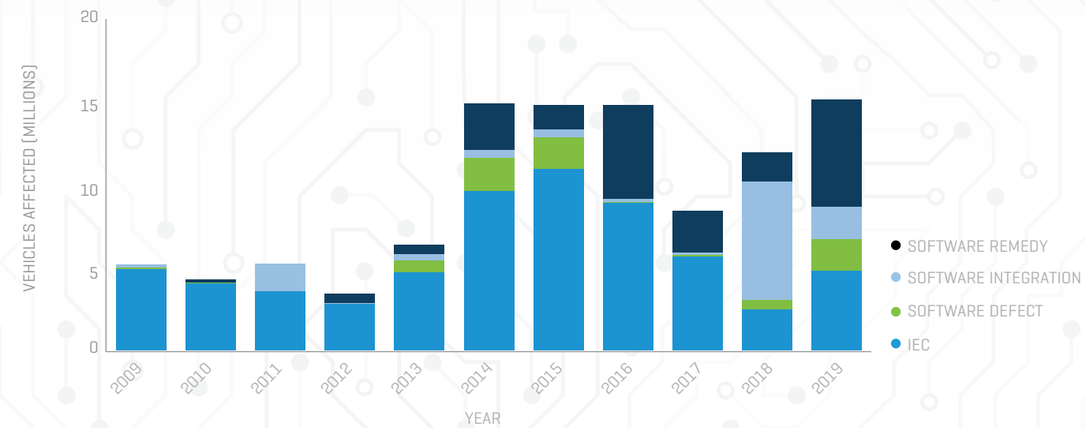
More than 15 million vehicles were recalled for electronic component defects in 2019, as shown in Figure 22A, a record-setting level.

For the second year in a row, the single largest recall of the year involved a software-based defect, and four of the five largest non-Takata related recalls involved electronic component defects. As observed with the number of recall campaigns, a significant proportion of the vehicles involved in electronic component defects – approximately 6.5 million – received software remedies, making 2019 the year with the greatest number of vehicles involved with these campaigns.

Figure 22B illustrates the disproportionate number of vehicles affected by software-related defects in 2019 versus those affected by non-software defects.

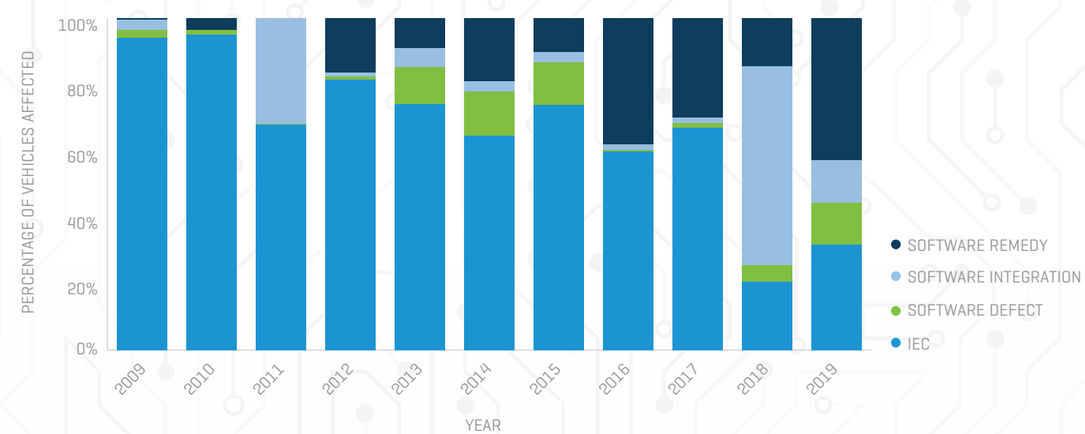
This inverse relationship is also likely to continue as software-based systems and components continue to play a more prominent role in the composition of today's light vehicle fleet, and as software remedies become more universally adopted (and can replace more traditional means of remedy delivery).

FIGURE 22A / VEHICLES AFFECTED BY ELECTRONIC COMPONENETS & YEAR



+15,000,000 VEHICLES RECALLED FOR ELECTRONIC COMPONENT DEFECTS IN 2019

FIGURE 22B / PERCENTAGE OF VEHICLES AFFECTED BY ELECTRONIC COMPONENETS & YEAR



SOFTWARE REMEDY TRENDS

Advances in technology provide additional methods to deliver remedies when electronic component defects occur. In addition to the analysis of defects involving electronic components, Stout has reviewed and analyzed the remedies available for these campaigns.

Most of the remedies for electronic component defects are performed by a technician in a traditional service setting at a dealership. However, there are software remedies (for software-related defects) that do not require vehicle owners to visit a dealership. These software remedies include:

USB FLASH DRIVE REMEDIES

Software updates are sent on removable media or made available to download from the OEM's website for owners to load through their vehicle's USB ports.

OVER-THE-AIR (OTA) REMEDIES

Software updates are pushed to vehicles over wireless networks.

Most software remedies that take advantage of alternative delivery methods involve updates to non-safety critical functions like navigation, infotainment, and a vehicle's sound system. For this reason, the delivery of these remedies is most commonly found in field service actions other than safety recalls.

In 2019, Stout did observe the second safety recall utilizing an OTA update as a remedy.

In December 2019, Mercedes-Benz notified owners that it would be providing an OTA update to the communications modules of certain 2013 – 2017 model year vehicles to ensure the determination of correct vehicle position and ensure the functionality of its emergency calling service. While delivered remotely, the update still required validation of the update by a service technician in order to complete the repair. This recall had achieved 66% completion by July 16, 2020, representing the second quarter of the remedy's delivery.

NOTABLE ELECTRONIC COMPONENT DEFECT TRENDS

Predicting how new and evolving components and technologies will assimilate into a vehicle will be an ongoing challenge for OEMs and suppliers. With that in mind, Stout has compiled and analyzed data to provide insight into what may happen as more advanced driver-convenience and safety technologies are introduced in the years ahead.

Each year, Stout reviews the defect emergence trends related to increasingly important driver-convenience and safety technologies to understand their susceptibility to defects and identify their relationships to other critical vehicle technologies.

This year Stout has highlighted the recent defect trends related to three key component categories at the vanguard of these new vehicle technologies.

I DRIVER ASSISTANCE TECHNOLOGIES

II EXTERIOR LIGHTING

III ELECTRIFICATION

DRIVER ASSISTANCE TECHNOLOGIES

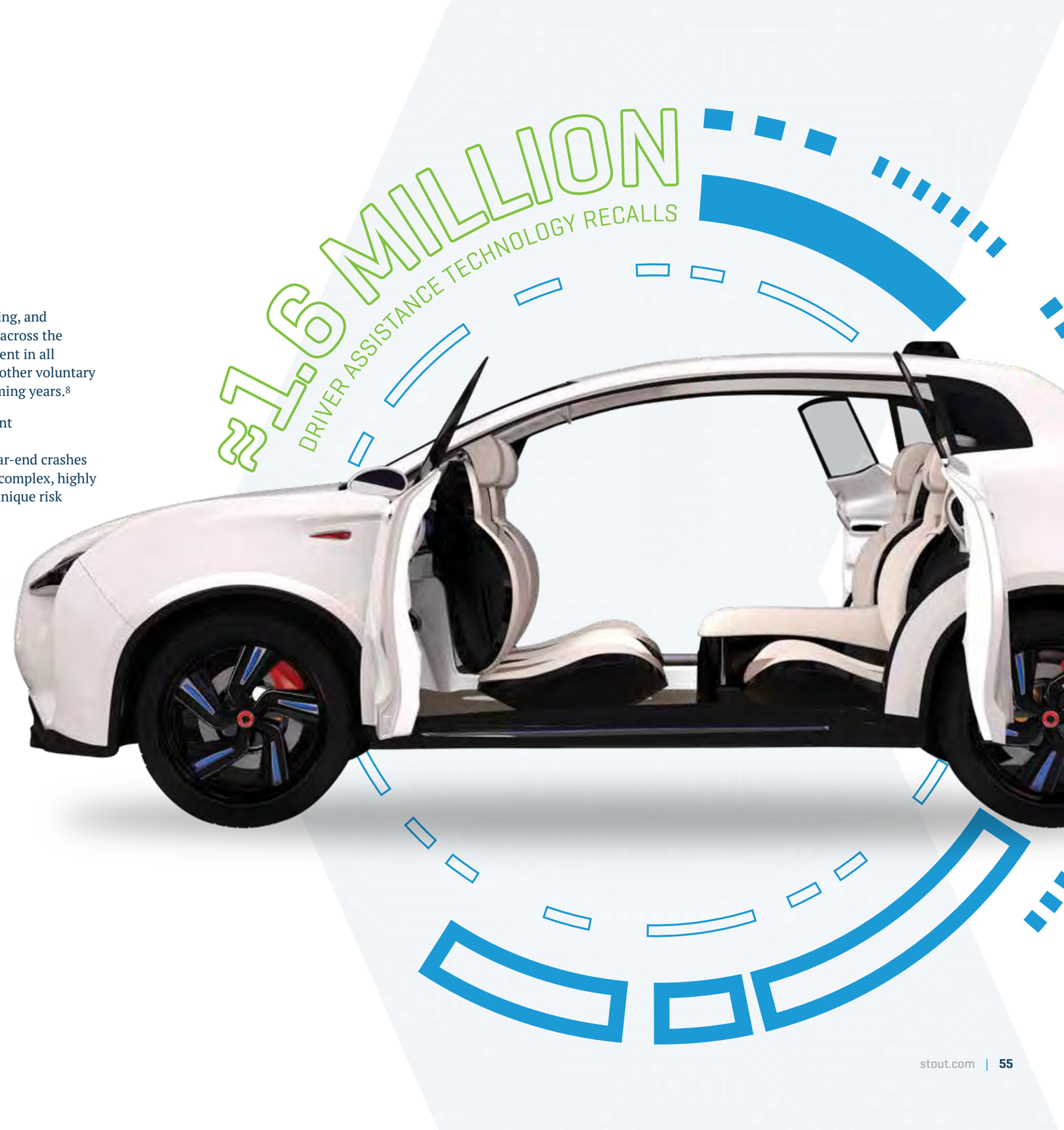
Many advanced driver assistance technologies, including collision avoidance, emergency braking, and various driver attentiveness alerts and warning systems, are now offered standard on vehicles across the industry. Back-up cameras, once a driver convenience feature, are now required safety equipment in all vehicles manufactured for sale in the United States after May 1, 2018. Automakers have made other voluntary commitments to make certain automated braking technologies standard equipment in the coming years.[8]

The continued implementation of driver assistance technologies in vehicles presents significant opportunities for the enhancement of vehicle safety. According to the Insurance Institute for Highway Safety, vehicles with forward collision warning and automatic braking reduced rear-end crashes by 50%, with forward collision warnings alone reducing such incidents by 27%.[9] However, the complex, highly integrated, and safety critical nature of driver assistance technology components indicates a unique risk profile that should be top of mind for component and vehicle manufacturers.

Before 2019, recall activity involving driver assistance technology components has been limited. As approximately 1.6 million vehicles were involved in recalls involving driver assistance technologies in 2019, a clearer picture of the defect patterns and risk of recall is now beginning to emerge:

» One recall of 1.2 million vehicles related to back-up display settings occurred in 2019, involving 2018 – 2019 model year vehicles. This was the first major recall of back-up cameras since these systems became required equipment on vehicles manufactured for sale in the United States after May 1, 2018. This condition was remedied with a software update.

There were three recalls of forward collision avoidance systems in 2019, including one recall of 50,000 vehicles, the largest recall of these components to date and one-third of all vehicles ever recalled for forward collision avoidance defects. It is also worth noting that all three of these recalls involved software-based defects rather than IEC failures.



II

EXTERIOR LIGHTING

NHTSA's exterior lighting component designation has traditionally identified defects related to vehicle headlights, taillights, signals, and reflectors, among other components. New vehicle exterior lighting systems incorporate dynamic LED and integrated circuit technologies and offer a range of enhancements over traditional lighting systems which improve visibility of the road for the driver and of the vehicle to others on the road. Like driver assistance technologies, these features represent significant enhancements to driver convenience as well as vehicle safety.

Vehicle lighting systems, including exterior lighting, must adhere to a host of requirements in FMVSS related to characteristics such as roadway illumination and visibility of the vehicle to others on the road. As such, the exterior lighting component category is one in which Stout often observes a regular level of recall, defect investigation, and service bulletin activity.

In addition to component defects related to traditional exterior lighting systems, Stout is now observing the emergence of electronic component defects related to new and advanced lighting systems, commensurate with their implementation in automakers' fleets. Indeed, in 2019 Stout observed the greatest number of exterior lighting recalls involving electronic components, including those involving the software operating these lighting systems. In the 2018 publication of this report, Stout highlighted the increased proportion of PIN denials related to exterior lighting, including PINs involving newer lighting systems. The emergence of exterior lighting recalls involving electronic components this year is a reminder that a careful review of early defect indicators such as PINs can provide insight into the development of subsequent issues involving elevated warranty or recall activity.

STOUT OBSERVED NINE EXTERIOR LIGHTING RECALLS IN 2019 INVOLVING MORE THAN 1.4 MILLION VEHICLES IN TOTAL. SIX OF THESE RECALLS INVOLVED SOFTWARE-BASED DEFECTS.

The largest exterior lighting recall in 2019 involving an electronic component defect affected 1.3 million Subaru model year 2008 – 2016 vehicles. The brake lamp switch in these vehicles failed as a result of exposure to oxidized silicon believed to originate from exposure to other consumer products in the field. The manufacturer continued to receive reports of field failures after implementing a replacement switch and conducted a voluntary recall in Japan. After concluding that substantially similar vehicles were sold in the United States, a recall was initiated in this market as well.

There are several key insights to be gleaned from the Subaru brake lamp switch recall:

- Failures of electronic components are often the result of the complex relationships between various vehicle systems, the habits of vehicle owners, and the environmental conditions in which vehicles operate. The interaction between these factors contributes to the uncertainty and the risk the failure of these components which may be difficult to imagine when they are being designed and tested.
- Previously identified defects can still result in massive recalls. Despite having identified the subject defect and implementing a remedy, Subaru continued to receive reports of failing brake lamp switches. Because the original design had continued to be used in nearly a decade's worth of production, the affected vehicle population grew even as the automaker worked to develop a remedy.
- Analysis of component defects is complex and can benefit from a broad understanding of potential defect data sources. Subaru initiated a recall of the affected vehicles in the United States after concluding they were substantially similar to those recalled in Japan. By analyzing recall data published by NHTSA and Japan's Road Transport Bureau, as well as the details of foreign campaigns reported to NHTSA by vehicle manufacturers – datasets all maintained and analyzed by Stout – it is possible to map the international footprint of defects resulting in massive recalls and understand the key factors that may contribute to risks in a variety of vehicle markets and regulatory jurisdictions.

III

ELECTRIFICATION

Electric and other alternative vehicle propulsion systems represent another field of rapid innovation and fundamental change to motor vehicle technology.

The development of these propulsion systems requires the integration of many new components, systems and materials not previously incorporated into traditional internal combustion engine vehicles. The adoption of these new technologies presents opportunities for new risks related to component integration, environmental exposure, and other design and manufacturing defects manifesting in motor vehicles.

Alternative propulsion vehicles represent a minority of vehicles on the road across the world, and as such, the defect emergence related to their unique components and systems is limited. For example, a review of NHTSA's 2019 recall data related to batteries indicated moderate activity, the majority of which pertains to traditional battery systems. Most of these defects appear to arise from issues associated with vehicle assembly.

9 BATTERY CAMPAIGNS IN 2019 / 1M VEHICLES AFFECTED

Stout identified two recalls in 2019 involving batteries related to hybrid or plug-in electric propulsion.

Both recalls were small, affecting approximately 2,000 vehicles together. Stout's review of the defect descriptions related to these recalls suggests that these sensitive components are susceptible to water intrusion as well as manufacturing-related defects that are commonly observed among many component categories. Expanding the review to other non-battery components found in alternative propulsion vehicles, Stout again found limited recall activity in 2019, identifying only two recalls involving just over 2,000 vehicles in total.

Recall activity related to battery and electrification components in 2019 was largely composed of those components found in traditional propulsion. Where defects related to electric propulsion were identified, the recalls were small and in most cases were the result of manufacturing related defects.

GIVEN THE SMALL SAMPLE, 2019'S RECALL EXPERIENCE CAN BY NO MEANS BE CONSIDERED DETERMINATIVE, HOWEVER IT MAY BE INSTRUCTIVE AS ELECTRIFICATION FITMENT AND VOLUMES INCREASE IN THE YEARS TO COME.

Stout continues to analyze the defect trends related to each these once nascent and now increasingly visible new vehicle technologies. Stout observed this year that although defects that rise to the level of recall remain infrequent for each of these component categories, development patterns which provide a framework for analyzing the incidence of these defects in the future are beginning to emerge. As new driver assistance, enhanced lighting and electrification systems are integrated into future vehicle platforms, competitive advantages will accrue to those automakers and their suppliers who prevent and adequately plan for defects related to these new technologies.

ELECTRONIC COMPONENT DEFECTS

CONCLUSIONS

01

The gap in recall activity between non-software and software-related defects was one of the significant trends of 2019. Recalls involving software-based defects, and the number of vehicles affected by these defects, reached record levels in 2019. As sophisticated electronic components and systems continue to be integrated into more vehicles, Stout expects the elevated level of software-based defects to continue.

02

The number of vehicles affected by recalls involving software remedies also reached record levels in 2019. Recalls in 2019 involving software remedies included two of the largest recalls of the year, as well as only the second safety recall remedied by an OTA update.

03

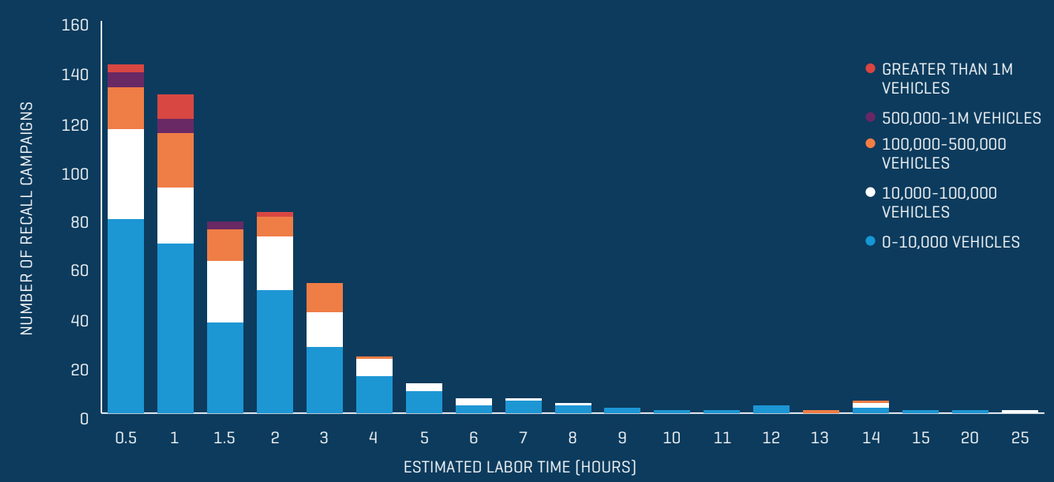
Stout observed new defect emergence trends for some of the newest vehicle technologies involving electronic components. This has been anticipated as these technologies continue to be implemented in more vehicles. Stout also expects to see more defects related to these technologies as their integration expands.

05 RECALL REMEDY TIMES

Recall remedy times have an average of 1.9 hours with high variability by component.

Stout identified dealer repair bulletins for 552 U.S. recall campaigns, excluding campaigns that could be remedied through a software update, between 2016 and 2019 where the remedy labor times could be identified. Many recall campaigns contained multiple labor codes where some campaigns contained labor codes that were combined with one or more labor codes creating an additive effect while other campaigns contained repair times that were mutually exclusive for different vehicles or inspection results. Stout coded each recall campaign to identify the maximum labor time allotted per campaign. For example, if one vehicle model had a one-hour labor time and another vehicle model had a 1.5 hour labor time, then 1.5 hours was used. If an inspection procedure was .2 hours and a repair procedure was one hour, depending on the result of the inspection, 1.2 hours was used in our analysis. Stout's analysis found that most recall campaigns involve a remedy time of under three hours but significant variability of allotted labor times across recall campaigns (Figure 23).

FIGURE 23 / RECALL LABOR TIMES BY AFFECTED VEHICLES



Stout found recall labor times to follow a probability distribution with the most frequent labor times close to the overall average of the dataset and larger deviations of the average infrequent in occurrence.

For all 552 recall campaigns analyzed, an average labor time of 1.9 labor hours was identified with a range from 0.1 hours to 25 hours of repair time (Figure 24). Longer repair times, those 10 hours and greater, are infrequent and relate to recalls where the defective component is deep inside the vehicle and significant vehicle de-assembly, and subsequent re-assembly, is needed to access the defective component. For example, a recall requiring more than 25 hours of repair time involved removing the engine cylinder and replacing the pistons and engine short block.

As components were analyzed individually, the range in labor times is generally narrower with higher concentrations of recalls being close to the average labor time. For example, recalls of airbag components had an average repair time of 1.6 hours with a total range of labor times between 0.3 and 5.2 hours (Figure 25).

FIGURE 24 / RECALL LABOR TIMES – PROBABILITY DISTRIBUTION

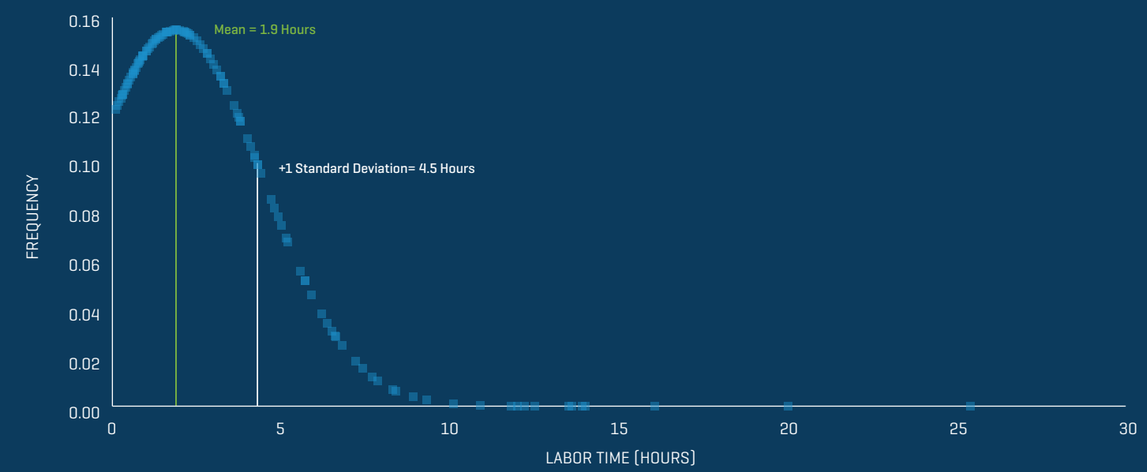
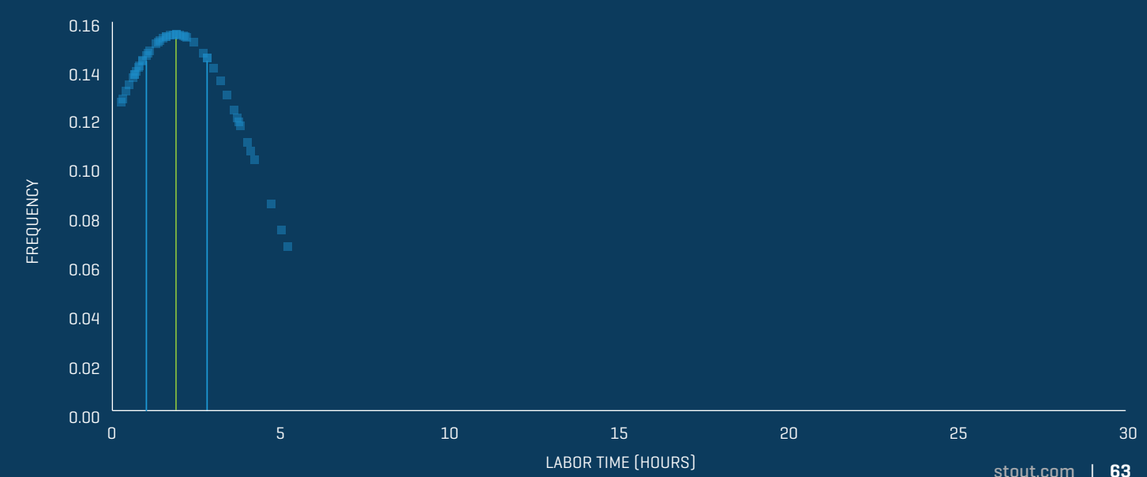


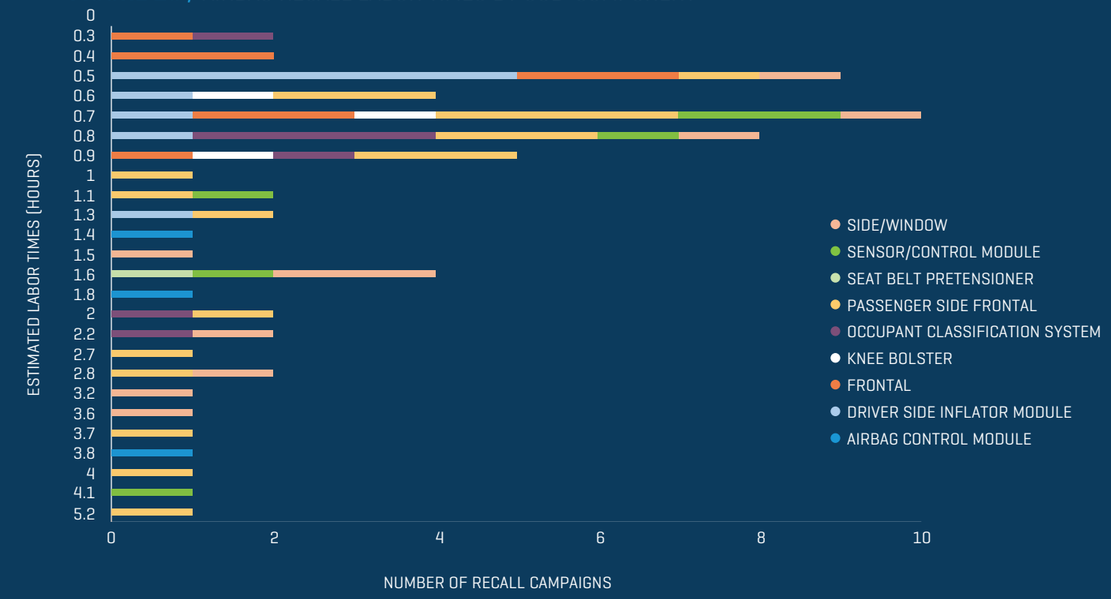
FIGURE 25 / AIRBAG RECALL REPAIR LABOR TIMES – PROBABILITY DISTRIBUTION



Sixty-three percent of airbag recalls were remedied in an hour or less. Longer repair times were found with high end exotic vehicles such as Ferrari, McLaren, Maserati and Rolls Royce. The longest repair time of 5.2 hours involved an instrument panel that was not manufactured to specifications that impaired the passenger airbag from deploying correctly. Other categories with repair times greater than one hour included control modules, occupant classification systems, front and side impact sensors, seat mounted airbags, side curtain airbags and knee mounted airbags (Figure 26). Passenger airbags showed a high degree of variability as some remedies required removal of the dashboard, increasing remedy times, while others did not.

The variation in labor times within airbag recalls is further correlated with vehicle types and airbag subtypes.

FIGURE 26 / AIRBAG RECALL LABOR TIMES BY SUB-COMPONENT



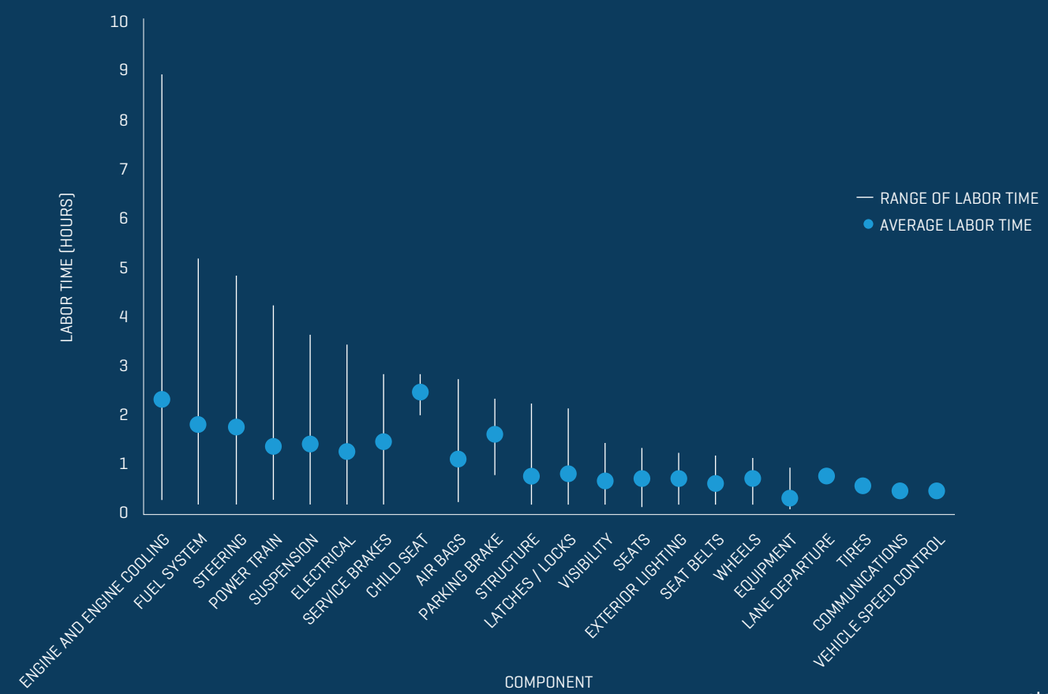
When statistical outliers were removed, identified as campaigns with labor times of +/- one standard deviation (z-score) from the average labor time for each component, Stout found a generally narrow window of repair times for each component. 85% of the 552 campaigns originally analyzed remained in the data set after removal of outliers. After removal of outliers, only a few components have a repair range of more than three hours (Figure 27).

Only Engine and Engine Cooling, Fuel System, Steering, Suspension, Electrical and Powertrain components had a maximum labor time of over three hours in this analysis. This is primarily due to the complexity and diversity of the repairs. However, even for these components the occurrence of a recall with labor times over three hours is rare as demonstrated by the average repair time remaining under three hours.

Even for very similar defects though, remedy times can show variation between OEMs. For example, two separate recalls were identified in 2019, by two separate OEMs involving transmission shifter cable bushings manufactured by the same supplier. One OEM's labor time was 0.3 hours but the other OEM's labor time was twice that at .6 hours. The differences between the two OEMs are likely the result of different assembly and design applications but also an opportunity for further review and benchmarking.

The time to complete a recall repair can have a significant impact on the overall cost of the recall. Understanding the frequency of recall occurrence within different component groupings and the probability and distribution of repair times within allows for better quantification of risk in manufacturing certain components. This identification also allows OEMs to consider future design and engineering opportunities for shorter repair times for components at higher risk of becoming defective under a warranty period. Benchmarking repair times among similar components also allows OEMs to compare their recall remedies among other like defects and identify potential opportunities to consider alternatives among remedy options.

FIGURE 27 / LABOR TIMES BY COMPONENT



06

EMISSIONS RECALLS

EMISSIONS DEFECTS

Much attention is given to recalls and other responses to defects involving safety issues, however significant regulatory action is taken in relation to defects that result in increased emissions that contribute to levels of certain regulated emissions.

In 2015, Volkswagen recalled nearly 550,000 diesel vehicles in the U.S. in connection with revelations about emissions defeat devices installed in 2.0L and 3.0L vehicles.[10] More recently, FCA has announced that it is recalling more than 860,000 vehicles as a result of in-use emissions investigations, requiring the replacement of catalytic converters in those vehicles.[11] This FCA recall is in addition to the automaker's 2017 recall of over 100,000 diesel vehicles equipped with their own emissions defeat software.[12]

Like vehicle safety regulations, many different countries and other jurisdictions, including individual states within the U.S., maintain their own unique regulations in addressing motor vehicle tailpipe emissions. This can lead to varying emissions requirements in the different markets in which OEM's sell their vehicles, even variation within single countries.

For the first time, Stout has analyzed U.S. Environmental Protection Agency (EPA) vehicle emissions recall data. Through Freedom of Information Act (FOIA) requests, Stout has gathered data related to emissions defect reports, recall reports, and recall completion maintained by the EPA related to light vehicles. In this section, Stout presents its first-ever findings and shares unique insights related to the nature of emissions related defects.

1960 1970 1980 1990 2000

EPA COMPLIANCE ACTIVITIES[13]

1963 CLEAN AIR ACT

1975 ENERGY POLICY AND CONSERVATION ACT

2005 ENERGY POLICY ACT

2007 ENERGY INDEPENDENCE AND SECURITY ACT

The EPA derives its authority to regulate vehicles, fuels, and engines from statutes enacted by Congress. Through these acts, the EPA is responsible for emissions compliance oversight from initial product design to performance in the field.

The EPA can require automakers to recall and repair affected vehicles if it determines a substantial number in a category or class do not meet emissions standards while in use. However, emissions defects in emissions-related components may not always result in a recall if those defects do not increase emissions.

The EPA's Office of Transportation Air Quality (OTAQ) considers defect and recall reporting to be critical components of compliance for the light-duty vehicle sector. These programs are considered critical to the enforcement of the EPA's air quality regulations for the light-duty because:

- Light-duty emissions standards are the most stringent.
- Light-duty vehicles have sophisticated and complex emissions control systems, increasing opportunities for defects to occur.
- Dealership infrastructure conveys information to consumers and repairs vehicles.
- Manufacturers are required to report emissions related defects to the EPA.

Stout's analysis has focused on the EPA's regulations pertaining specifically to light-duty vehicles.

DEFECT REPORTS

An emissions-related defect is a defect in design, materials or workmanship in a device, system or assembly as described in a vehicle's application for certification previously approved by the EPA. Vehicle manufacturers are required to notify the EPA of emissions-related defects in 25 or more vehicles in the same class and category. These notices can result in a recall but may not if the defect in an emissions related component does not result in an increase in emissions.[14]

The EPA has published a summary of defect reports by sector for the years 2014 – 2017, included in Figure 28. The light-duty vehicles category contains the most defect reports during this period, which reflects the importance of this compliance mechanism to this vehicle sector.

FIGURE 28 / EMISSIONS DEFECT REPORTS BY SECTOR

	2014	2015	2016	2017
LIGHT-DUTY VEHICLES	199	273	228	284
HIGHWAY MOTORCYCLES	0	3	4	5
HEAVY-DUTY HIGHWAY VEHICLES	22	29	27	31
NONROAD SPARK IGNITION ENGINES	9	2	4	4
RECREATIONAL VEHICLES	1	2	4	9

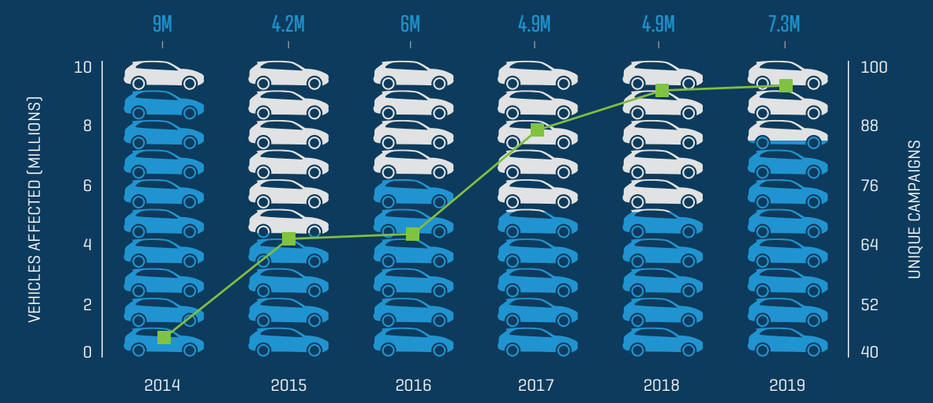
Because issues revealed in defect reports may not result in recalls if they do not result in an increase in emissions, they provide an interesting insight into emissions defects for OEMs and suppliers. Defect reports can provide an indication of nascent defects and those at the margins of emissions regulations. Understanding the risks indicated by defect reports not only provides an advanced notice of issues that may ultimately result in recalls, but can help to illuminate the boundary between minor defects and major recalls.

EMISSIONS RECALLS

Like safety recalls, emissions recalls may be initiated on a voluntary or a mandatory basis. For both, vehicle manufacturers are required to submit a recall plan for remedying defects, as well as quarterly progress reports (discussed further below). Vehicle manufacturers are also required to notify vehicle owners of the nonconformity and provide instructions for obtaining a remedy.[15]

As seen in Figure 29, the greatest number of recalls during the period studied by Stout was observed in 2014 when approximately nine million vehicles were recalled. The annual number of vehicles affected in the other years analyzed between 2015 – 2019 ranged between 4.2 million to 7.3 million vehicles. During this period, we observed the largest recall affecting 1.9 million vehicles, and the smallest affecting only three vehicles.

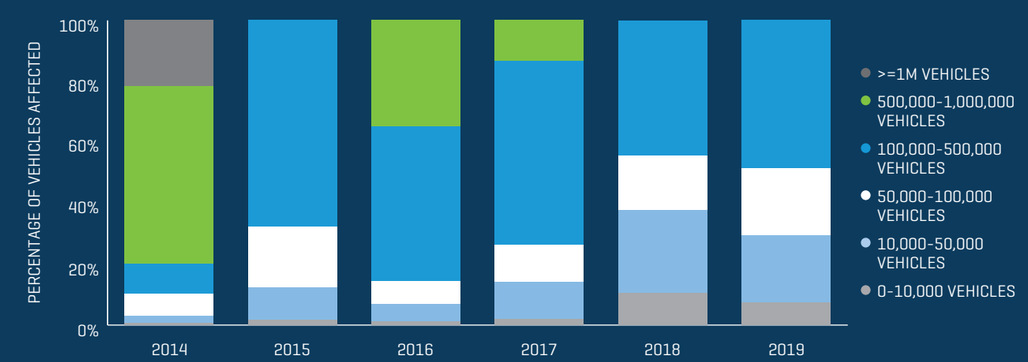
FIGURE 29 / UNIQUE EMISSIONS RECALL CAMPAIGNS & VEHICLES AFFECTED BY YEAR



Despite the stability in the number of vehicles affected by emissions recalls, particularly between 2015 – 2018, Figure 29 shows an increasing number of recall campaigns over this period, notably in the wake of the Volkswagen diesel Clean Air Act violations, indicating enhanced compliance oversight.

The relationship between the number of emissions campaigns and the vehicles affected suggests decreases in the size of emissions recall campaigns during this period. Indeed, Figure 30 indicates a decrease in the size of emissions recall campaigns, however this trend reverses slightly in 2019. Despite the reversal, approximately 50% of emissions recall campaigns affected fewer than 100,000 vehicles in 2019.

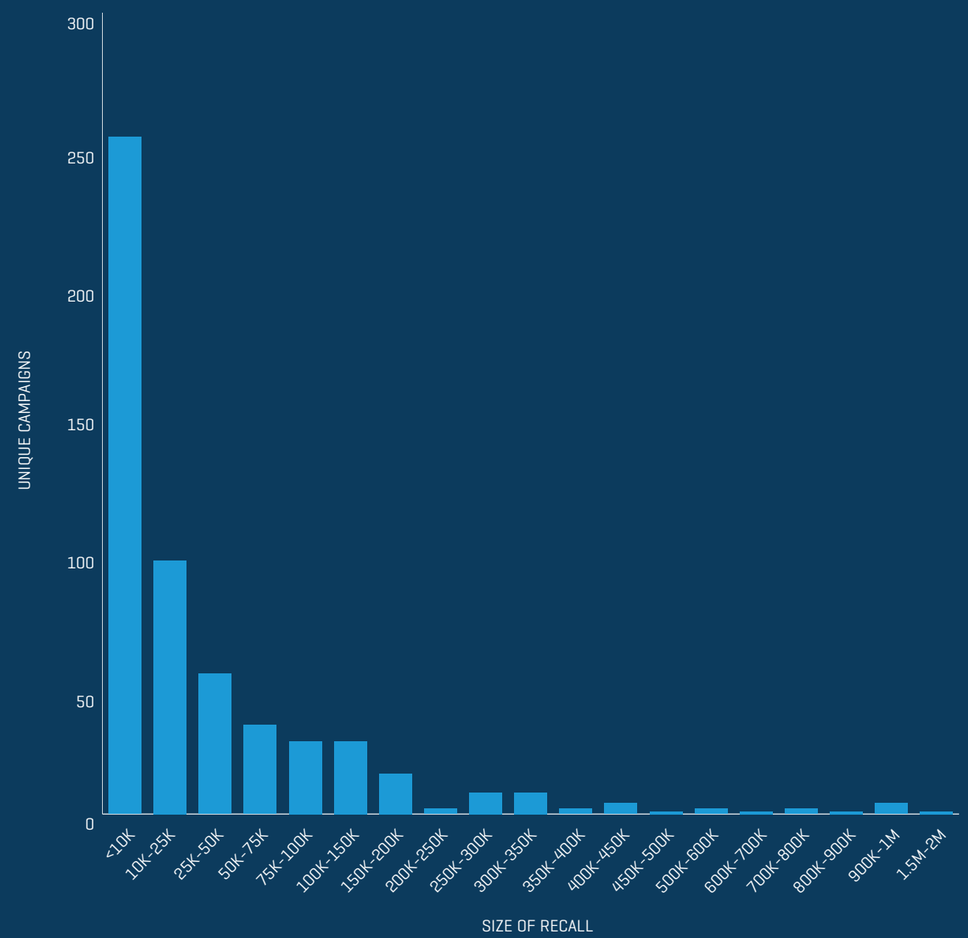
FIGURE 30 / PERCENTAGE OF VEHICLES AFFECTED BY YEAR & SIZE OF EMISSIONS RECALL



Over the entire period 2014 – 2019, as shown in Figure 31, most emissions recalls – greater than 80% – involve fewer than 10,000 vehicles, and very few vehicle campaigns involve more than 200,000 vehicles.

This pattern is similar to what has been observed in the distribution of safety recall sizes. In the case of emissions recalls, the EPA's data indicates specific tracing of individual test groups allowing manufacturers to focus recall populations. Stout has also observed that the majority of emissions recalls involve vehicles that are three-years-old or younger at the time of recall, which also limits total recall populations.

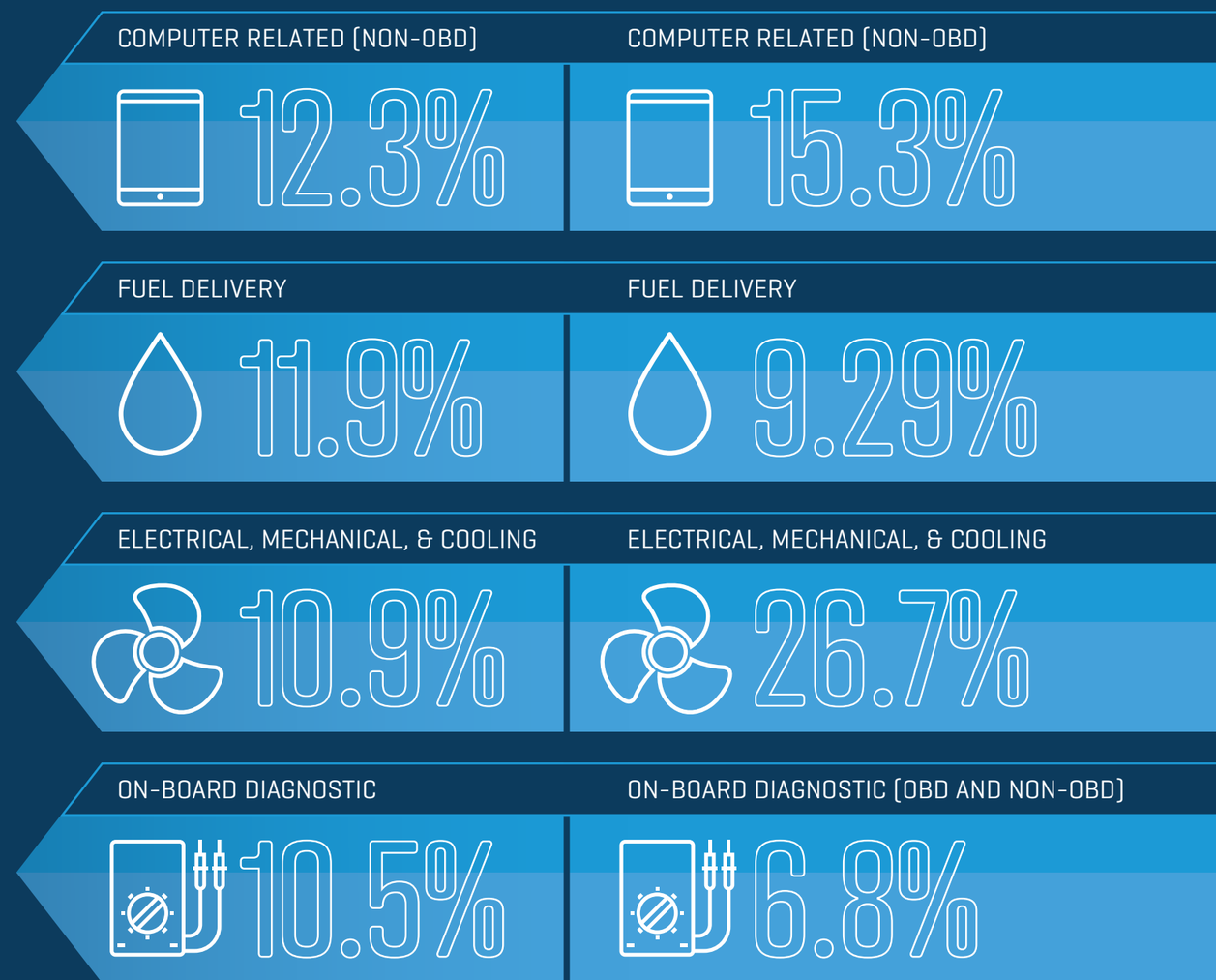
FIGURE 31 / UNIQUE CAMPAIGNS BY SIZE OF RECALL



Stout also analyzed the components identified by the EPA as involved in emissions recalls. As shown in Figure 32, electronic and computer-related defects represent more than 20% of all emissions recalls between 2014 and 2019 where component categories were reported by the EPA. Figure 33 indicates that a similar proportion of vehicles affected by emissions recalls involve electronic and computer-related defects. As observed in Stout's analysis of electronic component defects, many of the emissions recalls involving electronic and computer-related defects require remedies utilizing software updates and recalibrations.

FIGURE 32 / COMPONENTS MOST FREQUENTLY INVOLVED IN RECALLS 2014–2019

FIGURE 33 / COMPONENTS WITH THE GREATEST NUMBER OF VEHICLES AFFECTED 2014–2019



EMISSIONS RECALL COMPLETION PERCENTAGES

Vehicle manufacturers are required to submit six consecutive quarters of recall remedy data to the EPA indicating the number of vehicles 1) involved in the action, 2) inspected and repaired, and 3) those not available for repair. This remedy data was provided to Stout along with the defect and recall reports requested in its FOIA request to the EPA. Stout has analyzed the EPA's remedy information to understand average and sixth quarter completion percentages and quarterly completion progress for emissions recalls. Stout has further refined its analysis by the ages of vehicles involved in emissions recalls to understand how this factor impacts emissions recall completion percentages. This information can help OEMs and suppliers plan for the impacts of emissions recalls as well as devise strategies for improving recall completion percentages.

As shown in Figure 34, the average completion percentage for emissions recalls has ranged from approximately 72% - 81% between 2014 and 2018; the overall average during this period is approximately 77%, which is slightly below the average for safety recalls during this period. It is worth noting the average age of vehicles involved in emissions recalls in 2017 was greater than in the other years presented, consistent with the reduction in the average completion percentage in that year.

Figure 34 also depicts the median completion percentage for emissions recalls from 2014 – 2018, which ranges from 82% - 85%. The trend in emissions recalls median completion percentages does steadily improve from 2015 through 2018.

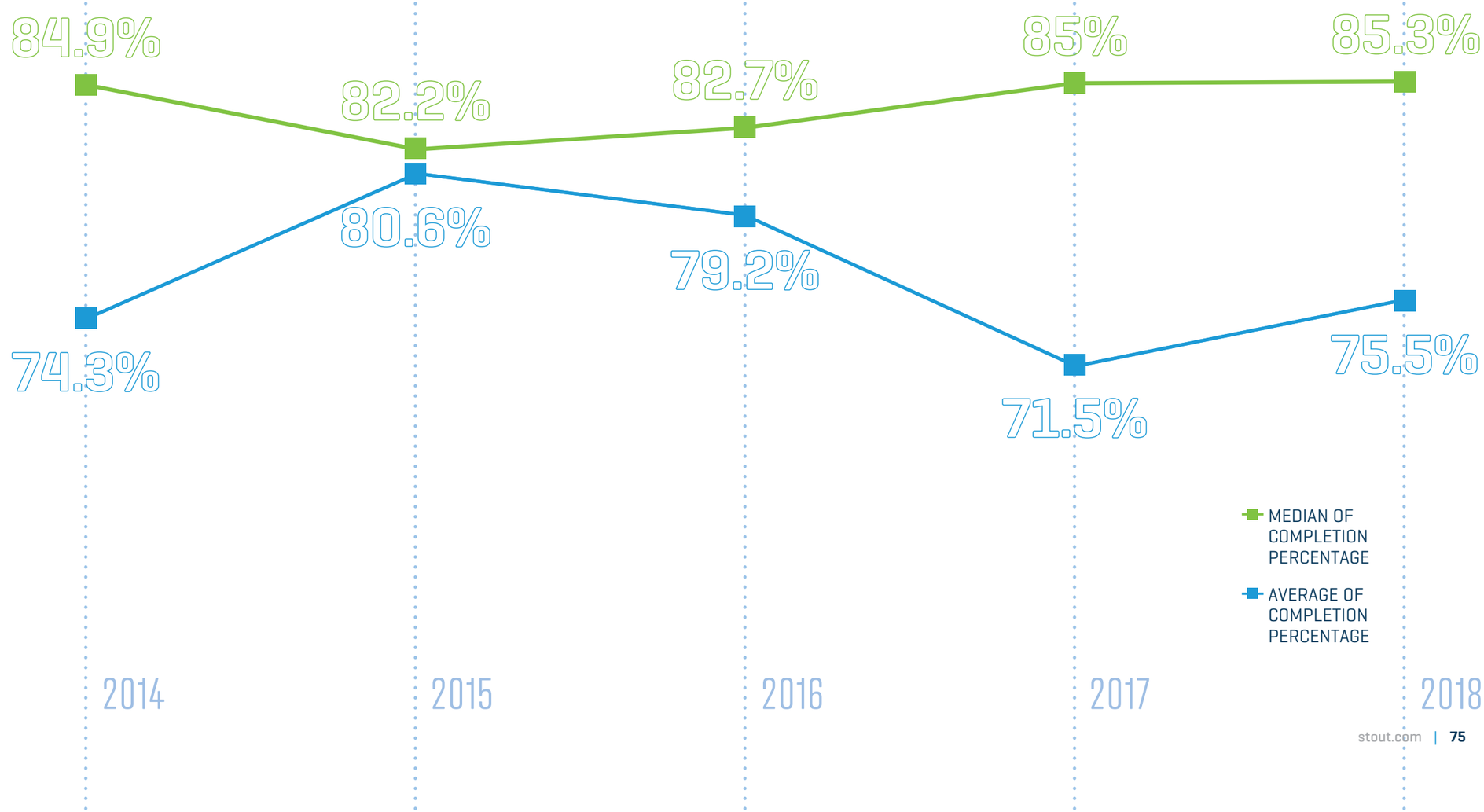


FIGURE 34 / COMPLETION PERCENTAGE BY YEAR

The relationship between emissions recall completion percentages and vehicle age is similar to what Stout has observed for safety recalls – specifically, completion percentages decline as vehicle age increases. As show in Figure 36, average completion percentages drop by nearly 30% for vehicles three to five years old at the time of recall as compared to vehicles three years old or less at the time of recall. The average recall completion declines slightly further as vehicle age reaches five to eight years old at the time of recall.

FIGURE 35 / AVERAGE COMPLETION PERCENTAGE BY QUARTER AND VEHICLE AGE (EMISSION RECALLS)

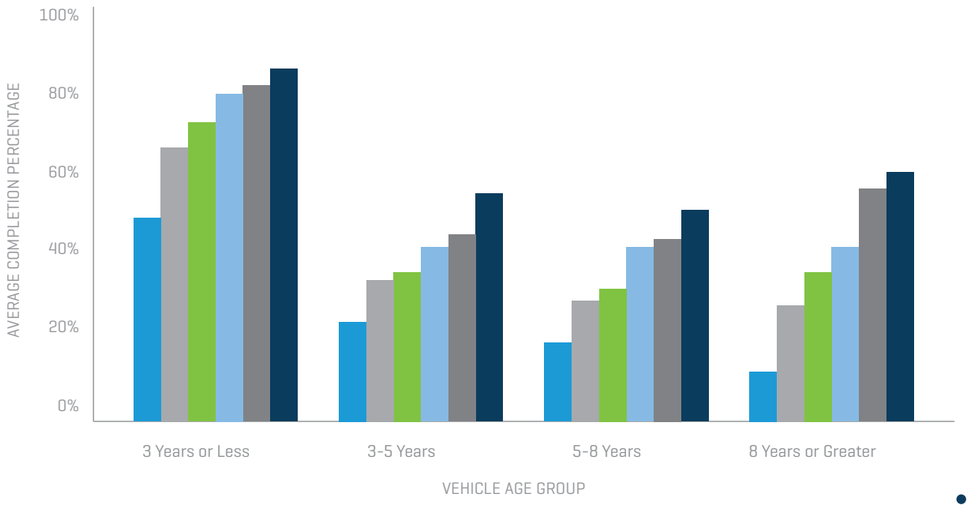
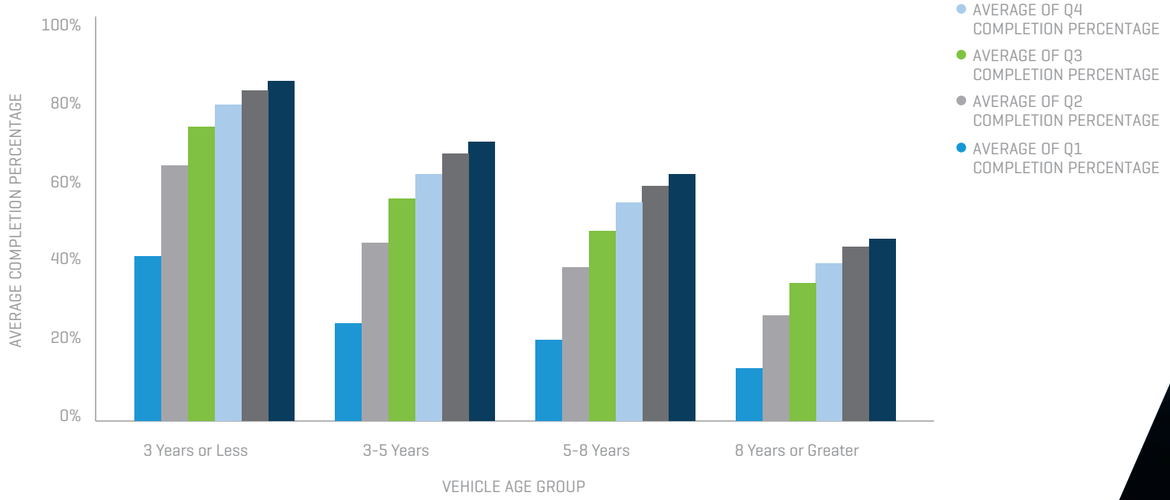


FIGURE 36 / AVERAGE COMPLETION PERCENTAGE BY QUARTER AND VEHICLE AGE (SAFETY RECALLS)



Despite the similarities, emissions recalls display characteristics that differ from the completion performance of safety recalls as shown in Figure 35. We observed greater completion performance in the first quarter of emissions recalls than corresponding safety recalls. Emissions recalls of vehicles that are eight years old or older at the time of recall also exhibit unique behavior: instead of decreasing further as vehicles age, the average completion percentage for these recalls increases to nearly 60% after six quarters, which is greater than all but the youngest vehicle age group. Indeed, the sixth quarter completion percentage for emissions recalls is approximately 12% greater than their safety recall counterparts.

Although emissions recalls and safety recalls exhibit more similarities than differences, it is important to consider that the differences between these recalls can impact recall completion performance. For example, the emissions testing requirements of many states may accelerate the completion of emissions recall repairs if such repairs remedy a condition required for vehicle owners to receive emissions certification. Additionally, these testing requirements create a point-of-contact for owners of older vehicles and may encourage them to repair faulty emissions conditions and have recall repairs performed. Any requirement that older vehicles to be tested to receive state emissions certification may also help overcome the challenges often encountered when trying to reach owners of older vehicles.

EMISSIONS RECALLS

CONCLUSIONS

Emissions related defects represent a category of exposure for automakers and suppliers to be considered along with their safety defect risk profile. Similar to safety recalls, most emissions recalls appear to impact targeted populations of newer vehicles. However, as Stout's research has indicated, emissions recalls of hundreds of thousands or more than one million vehicles do occur. Should large recalls require the replacement of costly components and extensive labor procedures, the impact to vehicle and component manufacturers could be significant. Consideration of emissions defect and recall data provides valuable insight into the nature of these potential defects, allowing OEMs and suppliers to better mitigate their risks associated with emissions defects, plan for the costs of potential defects, and improve the overall effectiveness of emissions related recall and customer service campaigns when they do arise.

07 AUTOMOTIVE RECALL IN 2020

To say that 2020 has been a year of uncertainty would be trite, yet as of this writing, we all wait to see what tomorrow's headlines may bring. The COVID-19 pandemic has impacted our lives in ways unthinkable only months ago and it is nearly certain that we will be forced to continue to adjust to new ways of life during and after the crisis. Such changes are likely to have persistent and unforeseen consequences influencing how owners use their vehicles and maintain relationships with dealers, and the manufacture of vehicles and automotive components. It may be months or even years before we can fully appreciate the scope of the pandemic's influence on automotive component defects and remedies.

Stout has factors to consider as we look forward:

DEFECT EMERGENCE

As vehicle owners use their vehicles less, some defects may take longer to manifest in the field and be identified by vehicle manufacturers. Required shutdowns at OEM and supplier facilities may also result in issues related to supply chain disruptions, improper equipment maintenance and staffing shortages, possibly causing variation in product quality that allows defects to occur.

RECALL REPAIR TRENDS

Repairs for existing recalls will likely be delayed as vehicle owners practice social distancing and observe shelter in place recommendations and orders. Over the short and intermediate term, this will have the effect of reducing recall completion percentages. Once the effects of the virus have waned, dealer capacity will likely be a factor in recall repairs as previously deferred maintenance by vehicle owners is completed. This will have a particularly challenging impact on recalls of older vehicles until such time as dealer capacity constraints are alleviated.

DEALER RELATIONSHIPS

Already we are seeing a response from the automotive industry to perform more services without the necessity of visiting the dealership – such as mobile repair (at the vehicle owner's home) and new vehicle delivery. These programs are likely to expand as OEMs and dealers consider ways to appreciate concerns or limitations for customers. When combined with routine maintenance that could be performed remotely, recall repairs will also present unique opportunities for revenue for the dealership.

The duration, resolutions, and consequences of the COVID-19 pandemic remain unknown, however it is likely that issues impacting vehicle safety and automotive component defects will arise. Stout will continue reviewing data to identify relevant trends including vehicle miles drive, defect emergence, and remedy completion percentages in order to understand how the COVID-19 crisis has and will continue to impact the automotive industry.

08 CONCLUSION

THE AUTOMOTIVE INDUSTRY IS IN THE MIDST OF DRAMATIC CHANGE

as vehicles are equipped with new technologies, using new materials and integrating new components intended to improve vehicle safety and performance, as well as enhance the overall experience for drivers and passengers. These innovations have introduced into modern vehicles a host of innovative software, electronic components, and advanced materials that may yet interact in unforeseen or unexpected ways with other components and systems in vehicles, driver behaviors, and the environment. The emergence of the COVID-19 pandemic in early 2020 has introduced an additional element of uncertainty that was unthinkable even months before.

While defect trends associated with advanced automotive technologies are still emerging, Stout has identified indications of how these components are beginning to contribute to recalls in vehicles, offering insight into what OEMs and suppliers may expect to encounter as such technologies become more prevalent. More U.S. vehicles in 2019 were affected by recalls involving software-based remedies. While software-based recall activity in 2019 was influenced by several large recalls, the increasing significance of software-based defects is a trend we have observed and expect to continue in years to come.

Any analysis of the risk of component defect must also recognize vehicle longevity and the aging of the current U.S. vehicle fleet. Vehicles are remaining on the road longer than ever, which provides opportunities for the emergence of latent defects in materials, design, and manufacturing, and exposure to environmental and operating conditions not previously experienced in past generations of vehicles. Failures in these populations of vehicles present unique challenges to OEMs and suppliers (as they tend to be larger), may include multiple vehicle models and model years and may involve a variety of other factors and failure modes. These factors can complicate the root cause investigation and repair of these vehicles, such as limitations to the ability to conduct effective owner outreach and challenges related to the availability of replacement components.

Given the risk of component defects and the challenges presented by complex new technologies and an aging vehicle fleet, it is important now more than ever that automotive OEMs and suppliers look to all available sources of component defect data (internal and external) to understand emerging defect trends and proactively develop systems and processes to mitigate those risks, and to identify opportunities to improve business intelligence regarding the risk of automotive component defects. Stout has painstakingly developed the industry's most comprehensive repository of automotive component defect data, incorporating our unique industry expertise to provide meaningful interpretations of that data. Through the ongoing study of automotive component defect data and analysis of defect patterns and emerging trends, Stout provides unique insights to the industry which can be utilized to develop informed, thoughtful, and effective strategies to mitigate risks of automotive component defects and manage potential exposure to their consequences — all while enabling more informed business decisions in a highly competitive market.

STOUT

WHAT WE DO

Stout professionals have provided consulting services and expert testimony for significant automotive industry warranty and recall programs and disputes.

On behalf of both OEMs and suppliers, Stout has analyzed:

- Warranty and recall data collection systems, warranty repair history, administrative processes and costs, recall risks and costs, component risk factors, recall completion rates, and other information
- Warranty and recall circumstances of many sizes and types – from the largest of recalls affecting millions of vehicles, to small recalls or extended warranty actions affecting several thousand vehicles – and everything in between

Our analyses are used to assist clients in understanding the risk and economic costs of warranty service repair, recall campaigns, and other actions for purposes of risk mitigation, improved business processes, customer and supplier negotiations, claim reassessment, or settlement and trial testimony.

We work closely with our clients to understand the risk and potential impacts associated with defects of automotive components, whether it is a customer service action, extended warranty offers, a voluntary recall or one required by NHTSA, or the other responses to warranty data, component defects, or customer complaints.

HOW WE DO IT

We take a collaborative approach leveraging our clients' knowledge, experience, and expertise – seeking to integrate cross-functional expertise from our clients with Stout's data and experience. To do this, we:

- Develop and use dozens data sets containing recall and other campaign defect data
- Use our expertise in understanding the wide variety of potential warranty and recall activities, and the costs associated with each
- Employ traditional and creative approaches in assessing risk from multiple perspectives, as appropriate
- Make use (wherever possible) of supplier and program-specific information to further refine and support our analysis
- Apply both quantitative and qualitative risk factors impacting warranty and recall risk, as warranty and recall risk is often nuanced and not easily represented by simple mathematical or actuarial calculations
- Identify likely warranty and recall scenarios and establish cost and risk parameters for each
- Work to develop risk mitigation strategies based on our work with the cross-functional teams of our clients (engineering, legal, insurance, risk management, sales, etc.)

ABOUT THE AUTHORS

NEIL STEINKAMP is a Managing Director at Stout. He is a leading expert in the field of automotive recall and defect analysis. His expertise includes strategic consulting regarding risk mitigation processes, intensive data analysis of structured and unstructured recall and defect data, analysis of recall costs and exposures, and assessments of factors impacting recall completion percentages. He has consulted with OEMs, suppliers, dealers, vendors, and their advisors.

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RAYMOND ROTH is a Director at Stout. He is a leading expert in the behavior of automotive recalls. His expertise includes strategic consulting using data driven techniques to identify barriers to recall completion and strategies to overcome those barriers as well as identification of component defect trends and benchmarks. He has consulted with OEMs, suppliers and dealers regarding strategic business initiatives.

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ENDNOTES

1 https://www.bts.gov/content/average-age-automobiles-and-trucks-operation-united-states

2 https://www.bts.gov/content/us-vehicle-mileshttps://www.bts.gov/content/us-vehicle-miles

3 For purposes of this report "Takata Recalls" are those recalls initiated and conducted in connection with the Coordinated Remedy Order issued by NHTSA.

4 This recall relates to PSDI-5D replacement driver-side airbag inflators installed as a remedy for defective Takata PSAN inflators. The failure of the PSDI-5D units was found to be the result of over pressurization of the inflators due to a manufacturing anomaly as described in the Part 573 Safety Recall Report for campaign 19V-182.

5 Not all recalls pertain to every production unit so any unique VIN might not have been recalled for every MMY recall.

6 Completion percentages after six quarters from recall remedy launch are not yet available for 2019 recall campaigns.

7 One closed investigation was opened in 2017, nine in 2018 and three in 2019.

8 https://www.nhtsa.gov/press-releases/nhtsa-announces-update-historic-aeb-commitment-20-automakers#:~:text=The%20installation%20of%20AEB%20is,warning%20by%20September%201%2C%202022.&text=During%20the%20reporting%20period%2C%2020,new%20passenger%20vehicles%20with%20AEB.

9 https://www.iihs.org/topics/advanced-driver-assistance#overview

10 https://www.consumerreports.org/cro/cars/guide-to-the-volkswagen-dieselgate-emissions-recall-

11 https://www.freep.com/story/money/cars/chrysler/2019/03/13/fca-recall-emissions/3149654002/

12 https://www.consumerreports.org/pickup-trucks/fca-diesel-owners-to-get-money-and-fix-in-emissions-settlement/#:~:text=Owners%20of%20the%20roughly%20104%2C000,get%20an%20engine%20software%20update.

13 EPA 2014 – 2017 Progress Report: Vehicle & Engine Compliance Activities

14 EPA 2014 – 2017 Progress Report: Vehicle & Engine Compliance Activities

15 EPA 2014 – 2017 Progress Report: Vehicle & Engine Compliance Activities