



TABLE OF CONTENTS

05 / Introduction

15 / This Report

18 / 2018: Year in Review

31 / Recall Completion Percentage

46 / Supplier Identification:
Part 573 letter review

54 / Electronic Component Defects

72 / Tires

84 / Additional Sources of Defect Data

92 / International Recall Information

94 / Conclusion

96 / About Stout

98 / About the Authors

99 / Sources



341

Number of light vehicle¹ safety recall campaigns in 2018.

The most ever recorded in the U.S.

INTRODUCTION

Stout's 2019 Automotive Defect & Recall Report serves as 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.

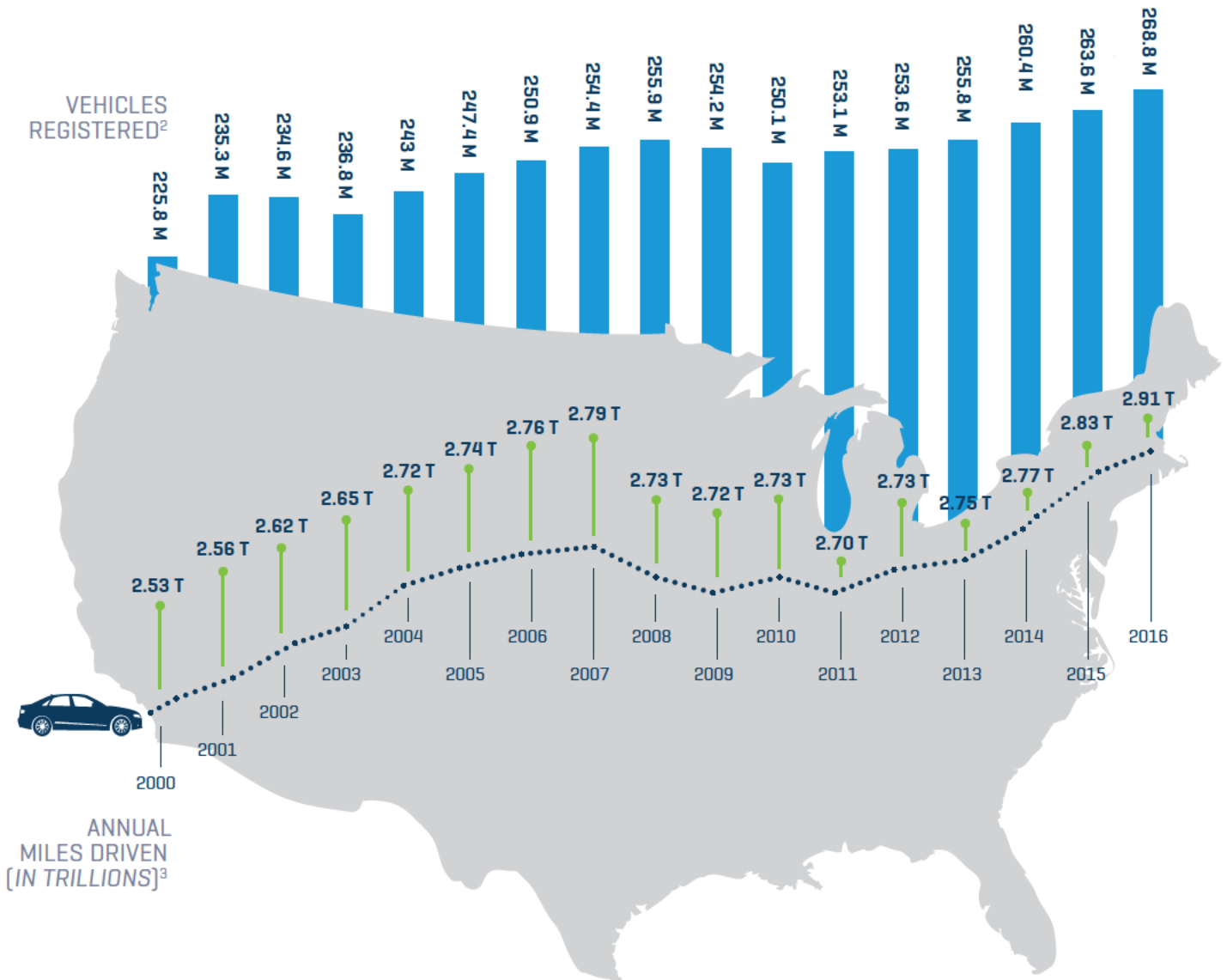
A Time of Uncertainty

Currently, there are more registered light vehicles on the road driving more miles than ever before in the United States (Figure 1).

This fleet poses two divergent challenges to OEMs and suppliers:

- » Defects related to unanticipated wear and tear on older vehicles.
- » Defects related to the integration of new and advanced technology.

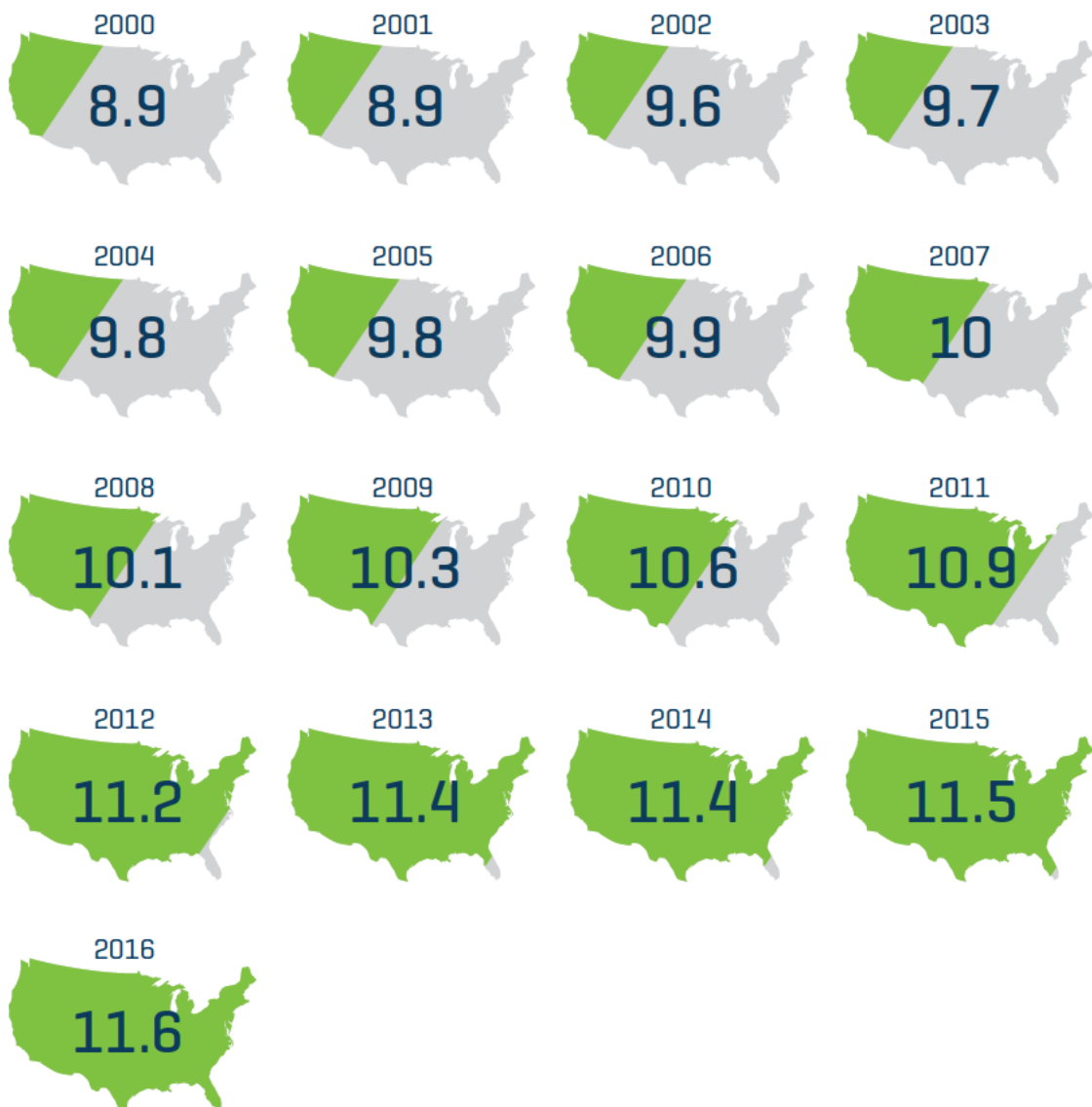
FIGURE 1 / ANNUAL VEHICLE REGISTRATIONS & AVERAGE MILES DRIVEN IN THE UNITED STATES




As *Figure 2* illustrates, the average age of these light vehicles is the oldest on record.

The maturation of the light vehicle fleet represents a unique and significant challenge for OEMs and suppliers as unforeseen defects emerge in older vehicles that span multiple model years.

FIGURE 2 / AVERAGE AGE OF LIGHT VEHICLES IN OPERATION IN THE UNITED STATES (IN YEARS)⁴





In contrast to the aging fleet, new light vehicles recently introduced into production are equipped with technologies and components that are more complex than ever before. They feature new materials that are designed to reduce production costs and enhance overall vehicle performance in areas like fuel economy, comfort, and safety. It is a significant challenge to predict how these advanced systems and materials will integrate with other components, as well as how they will perform when exposed to real-world environmental factors like moisture and thermal cycling. This type of forecasting is particularly challenging for new suppliers who have not traditionally been involved in the automotive industry, yet are being asked to play a prominent role in the design and engineering of these new vehicles.

In addition to the influx of new suppliers and changing use and maintenance habits of vehicle owners, the cumulative challenges presented by both the older and newer light vehicle populations result in an ever-changing landscape where defect risk-assessments can quickly become outdated as new information becomes available. When new defects emerge across the industry, insights can be gained regarding the failure of similar components, or materials, that can be used to revise assumptions in prior analyses to better quantify exposure to similar defects and prepare for remedies. For example, in addition to reserving the correct amounts to fund defect remedies, a high exposure to certain defects might influence the preservation and maintenance of certain tooling that will be needed to produce remedy parts that is otherwise not needed for the production of new parts.

Different Risks. Different Responses.

Both older and newer vehicle populations present their own unique set of challenges, with different risk characteristics of each group to consider. These different characteristics require differences in approach and response to a recall.



OLDER
VEHICLES

With the older vehicle population, one that has already accumulated several years of service time, manufacturers should prepare for the potential financial, legal, and managerial ramifications of a component defect and/or recall initiative should that action become necessary as these vehicles continue to age.

VS.

NEWER
VEHICLES



With newer vehicles that are not yet or are still in production, manufacturers can mitigate their present and future risk — and associated costs — by investigating potential areas of defect early, and modifying or remedying vehicles in production.

RISK MITIGATION CHALLENGES



Unique to Older Vehicles

Recalls of older vehicles pose unique challenges in the identification of root cause, development of remedy parts, and effective outreach to vehicle owners. Older vehicles have often endured prolonged exposure to demanding environmental conditions such as moisture intrusion, thermal cycling, corrosion, dirt and grime, and other wear and tear. These conditions can cause failures that can be difficult to simulate through product testing or anticipate after years of service life. For that reason, even components manufactured to an original specification can pose an unexpectedly unreasonable risk to safety as vehicles age.



Recalls of older vehicles often relate to components installed over multiple vehicle models and model years and can include many years of production, resulting in large vehicle populations in need of a remedy. In addition to the resource burden of producing a sufficient supply of remedy parts for a large recall of older vehicles, obtaining remedy parts can be challenging if the tooling used to originally manufacture these parts is no longer in service.

Additionally, identifying the correct vehicle owner and contact information of that owner increases in difficulty as vehicles age due to owner turnover, relocation, and other factors. Subsequent owners of vehicles that did not purchase the vehicle at a franchised dealer may also be skeptical or fearful of franchised dealers. Additional barriers such as lower levels of English language comprehension, education, and income are often correlated with owners of older vehicles, adding to the cost and complication of older vehicle recalls.

With the average age of the light vehicle fleet reaching an all-time high, understanding the nature and type of component defects in older vehicles allows for a better assessment of exposure to potential failures in the future that are not yet observable. Identifying these potential areas of exposure will allow OEMs and suppliers to prepare for potential defects for components supplied for vehicles manufactured many years ago by establishing appropriate financial reserves, preserving tooling, and anticipating areas where complex remedy part engineering may be needed to effectively reduce the impact on safety, earnings, and reputation.

Unique to Newer Vehicles



As new technologies and components are introduced in light vehicles, the impact of defects to these components is unknown due to limited historical defect data. Many of these new technologies are complex and are relied on by other functions of the vehicle like engine and/or powertrain control modules. Thus, failure in one small component can impact the overall performance and safety of the vehicle. In developing risk assessment and quality control strategies, it is important to understand how and when these components are failing as well as the remedies required to correct the defect.

The potential long-term functionality of components and the potential for changing risk profiles is also a challenge to consider for newer vehicles. The integration of back-up cameras into vehicles provides a recent example case. When originally introduced, back-up cameras were optional equipment and considered an owner convenience. As of May 2018, back-up cameras became required equipment in all vehicles sold in the U.S., reflecting a transition to safety-critical components under regulation of NHTSA. As the functionality of back-up cameras has developed, they have also been integrated with other vehicle systems such as infotainment assemblies, highlighting the integration of multiple vehicle systems with safety features.

Manufacturers should be forward-thinking about the potential for their components to be classified in the future as safety-critical, and the ramifications of that consideration.

While new technologies make integration more unpredictable for manufacturers and suppliers, they also provide them with new avenues in which to communicate with vehicle owners, and to deliver less expensive and disruptive defect remedies. These new modes of vehicle-owner outreach and remedy are discussed later in this report.

Other factors such as component and vehicle type, as well as the nature of the defect, are also relevant for formulating risk management strategies. An understanding of these factors provides relevant intelligence on assessing the risk that defects will have on the objectives of an OEM or supplier.

Data-Driven Insight

Stout's 2019 Automotive Defect & Recall Report was developed to provide members of the automotive industry with clarity as they navigate the risks and uncertainties associated with component defects and safety recalls. The different analyses and insights presented in this report are designed to give industry participants a more complete and in-depth understanding of the current trends and activity in the automotive industry so they can develop their processes more strategically, communicate with vehicle owners more effectively, and ultimately mitigate liability and risk exposure.

Areas of exploration in this year's report include the following:

1 / 2 / 3

An industry overview
and review of developments
specific to 2018

Identifying emerging
local and global safety
recall/defect trends

Examining
industry-leading responses
to safety recalls

4 / 5 / 6

Studying the emergence
of electronic defects and
related remedies

Identifying continuing
opportunities for accelerated
recall remedy

Developing unique
strategies to understand
and mitigate risk

The potential for risk exists nearly everywhere you look on an automobile. Data-driven insight is the best way for OEMs, suppliers, and other industry insiders to stay ahead of the curve and protect their business and financial interests.



MORE THAN **1 OUT**
OF 5 CARS IN THE
U.S. HAD AN OPEN
RECALL IN 2018⁵



A stylized graphic of a highway interchange with cars. The background is dark blue with a pattern of small white dots. The highway is represented by a light blue band with a dark blue center line. Numerous small car icons in white and light blue are scattered across the highway, some on the main road and some on a curved ramp. The overall aesthetic is modern and data-driven.

THIS REPORT

Stout's fifth annual Automotive Defect & Recall Report continues the original research Stout began when it produced its first report in 2015. To compile this report, Stout curates and analyzes data from a wide variety of both domestic and global sources including NHTSA, the DOT, Early Warning Reporting, multiple international recall-related databases, 573 Letters, Motor Vehicle Defect Petitions, financial reports, vehicle production data, Technical Service Bulletins, Petitions for Inconsequential Non-compliance, NHTSA investigations, and other sources.

This report leverages Stout's qualitative and quantitative approaches to understanding automotive industry defect trends and risks. Based on Stout's extensive experience serving automotive industry clients — from OEMs and suppliers to insurance and risk-management professionals, lawyers, and other advisors to the automotive industry — the data and insights found in this report are meant to help inform and shape future component defect risk-management and response strategies for all participants in the industry.

New This Year

Each year, Stout's Automotive Defect & Recall Report evolves to provide a more well-rounded view of component defect and safety recall activity. This year's report offers data and analysis covering several new topics, including the following:

TIRES

Quantitative and qualitative analysis of the incidence of tire related defects and opportunities for improving recall remedy participation from vehicle owners



ELECTRONIC COMPONENTS

- » Defect emergence and tail risk analysis
- » Remedy analysis



VEHICLE POPULATIONS

Analysis of trends observed related to the size and age of recalled vehicle populations and examination of targeted strategies to identify vehicle populations that are historically less responsive to recalls



OWNER OUTREACH

Exploration of enhanced vehicle-owner outreach strategies and discussion of specific techniques and best practices to improve owner response to recall notification



ADDITIONAL SOURCES

A comprehensive analysis of updated non-recall sources including new Early Warning Reports, Motor Vehicle Defect Petitions, Technical Service Bulletins, Petitions for Inconsequential Noncompliance, and NHTSA Defect Investigations



2018

YEAR IN REVIEW

Perhaps the most significant trend of 2018 was the increase in software-based electronic defects.

Last year, nearly

8 MILLION VEHICLES IN THE U.S.

were affected by software-based defects, a higher total than the previous five years combined, and three times more than any previous year.

Stout observed a definitive shift within its own electronic components category between software recalls (increasing in frequency) and non-software-related recalls (decreasing).

This movement reflects the increasing technological complexity being integrated into today's vehicles. With the emergence of advanced driver assistance systems, connected vehicles, vehicle-to-vehicle, and vehicle-to-infrastructure communication, this will be an important area for manufacturers and suppliers to focus on in future periods.

It should be noted that Stout distills their proprietary analysis of electronic components into four distinct categories. A more detailed exploration of all four categories, as well as analysis of the inverse relationship between software and non-software-related recalls is described in the Electronic Components section of this report.

Electronic defects accounted for the highest percentage of vehicles recalled in 2018:

ESM
VEHICLES

= 26% OF ALL VEHICLES RECALLED*

**Excludes Takata recalls*



FIGURE 3 / UNIQUE CAMPAIGNS BY COMPONENT & YEAR

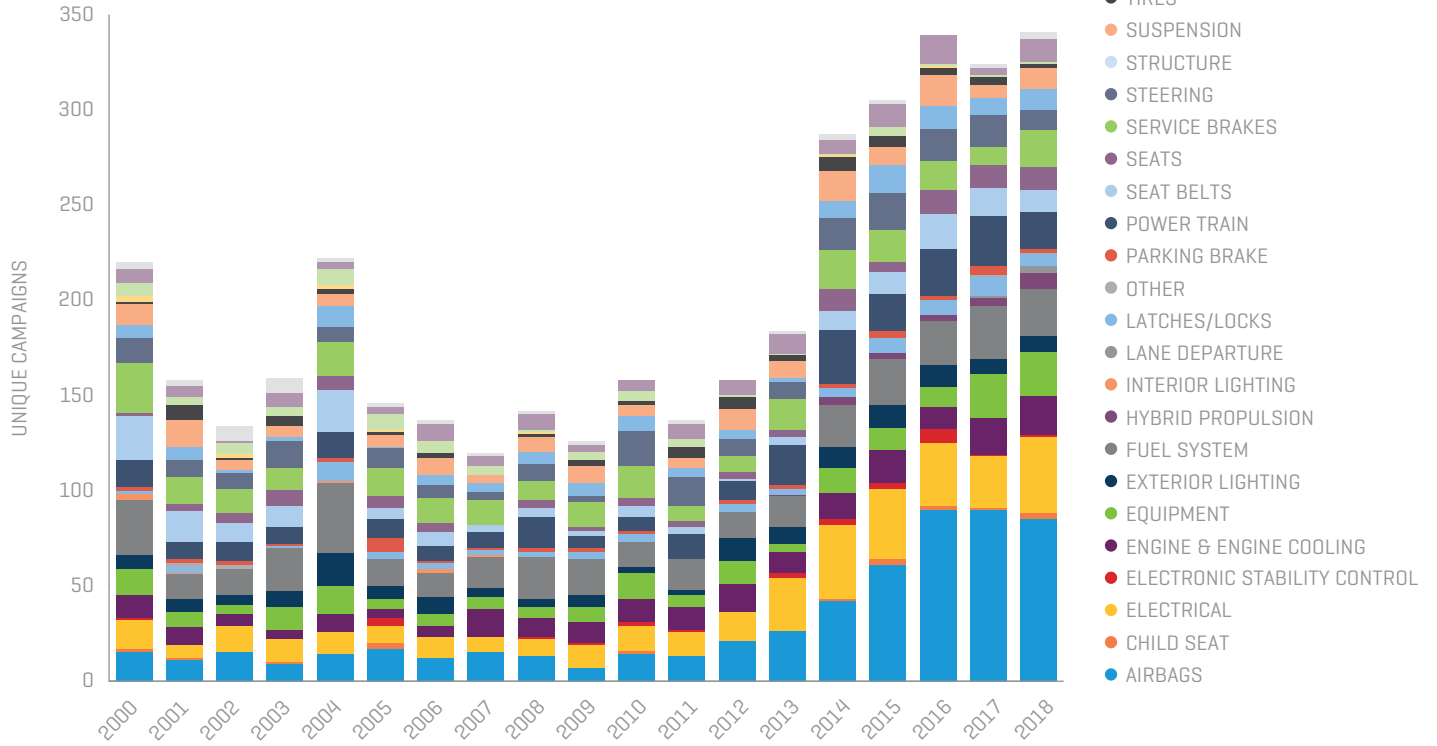
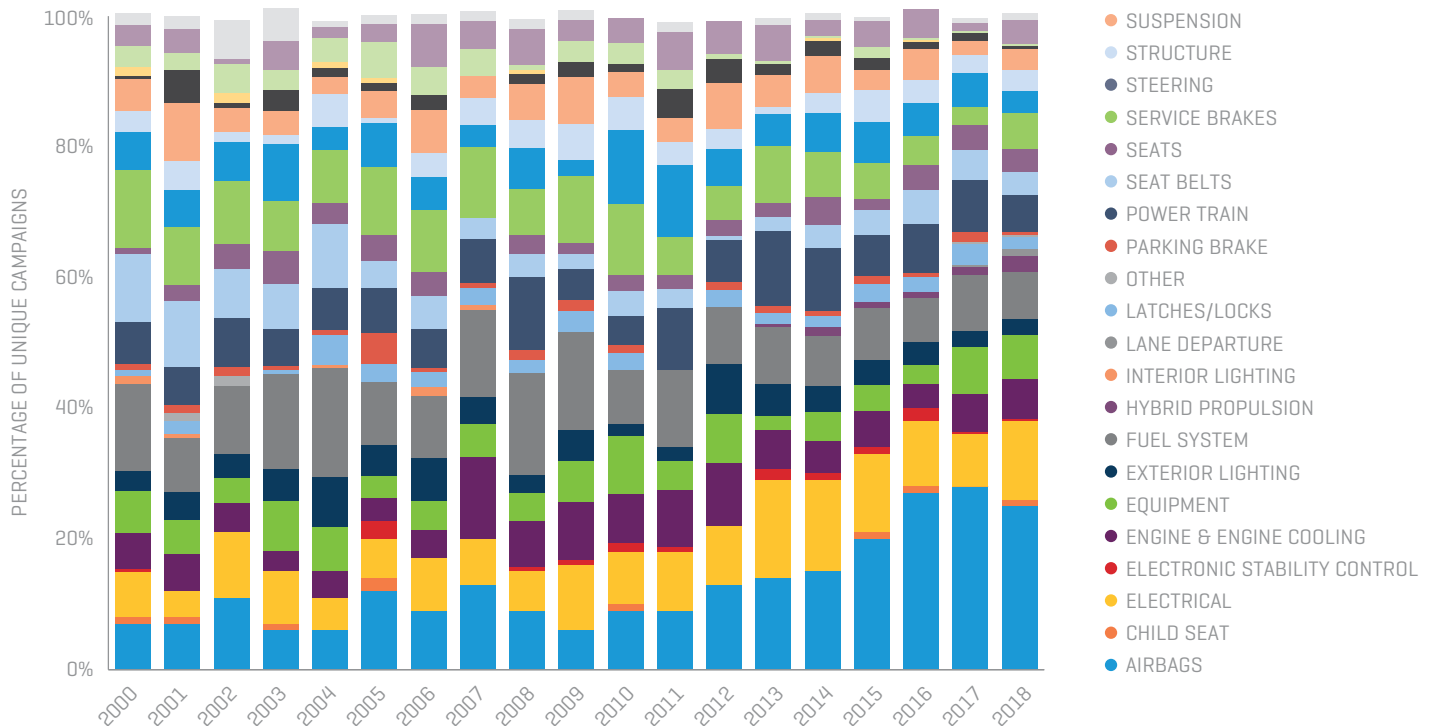


FIGURE 4 / PERCENTAGE OF UNIQUE CAMPAIGNS BY COMPONENT & YEAR



Stability Observed

Despite the increased level of uncertainty throughout the automotive industry, there were several key areas in which the activities and trends that Stout documented in 2017 continued in 2018.

OEMs and suppliers continued their efforts to identify component defects early and initiate recalls quickly. This resulted in a higher number of campaigns involving fewer vehicles. *Figure 5* highlights the significant impact these efforts had over a relatively short period. A record number of U.S. recalls in 2018 affected significantly fewer vehicles than a similar number of unique campaigns in 2016.

In both 2017 and 2018, the number of vehicles affected by safety recalls stabilized between 25 and 30 million annually, as compared to 2014 through 2016 when the number of vehicles affected was between 48 and 49 million.

NUMBER OF UNIQUE LIGHT VEHICLE CAMPAIGNS

339

2016

341

2018

NUMBER OF VEHICLES AFFECTED

49M

2016

28M

2018

All campaigns and vehicles affected include Takata recalls

OEMs and suppliers continued their efforts to identify component defects early and initiate recalls quickly. This resulted in a higher number of campaigns involving fewer vehicles.

FIGURE 5 / UNIQUE CAMPAIGNS AND VEHICLES AFFECTED BY YEAR



Large Recalls Less Frequent but More Significant

Since 2014, recalls involving more than 100,000 vehicles have represented less than 20% of all unique campaigns. As *Figure 6* indicates, 65% of the recalls in 2018 involved fewer than 10,000 vehicles, and many involved significantly less. This is likely a reflection of the effort that OEMs and suppliers are putting forth to investigate and respond to potential defects quickly in order to minimize the number of vehicles affected in any given recall campaign (See *Figure 7*).

However, recalls involving more than 100,000 vehicles consistently account for more than 85% of all vehicles recalled in any particular year. As *Figure 8* shows, 2018 was consistent with past trends. Nearly 90% of all vehicles recalled during the year were a part of campaigns involving 100,000 vehicles or more.

As *Figure 9* shows, the six recall campaigns that occurred in 2018 involving more than 1,000,000 vehicles — excluding the Takata recalls — accounted for over 50% of all the vehicles recalled for the entire year. There were 335 other unique campaigns that accounted for the rest.

While large-scale recalls are becoming less frequent, the financial and managerial strain when they do occur can be costly. Having risk-management strategies in place and proactively addressing component defects can help minimize these risks and related exposure.

FIGURE 6 / PERCENTAGE OF UNIQUE CAMPAIGNS BY SIZE OF RECALL

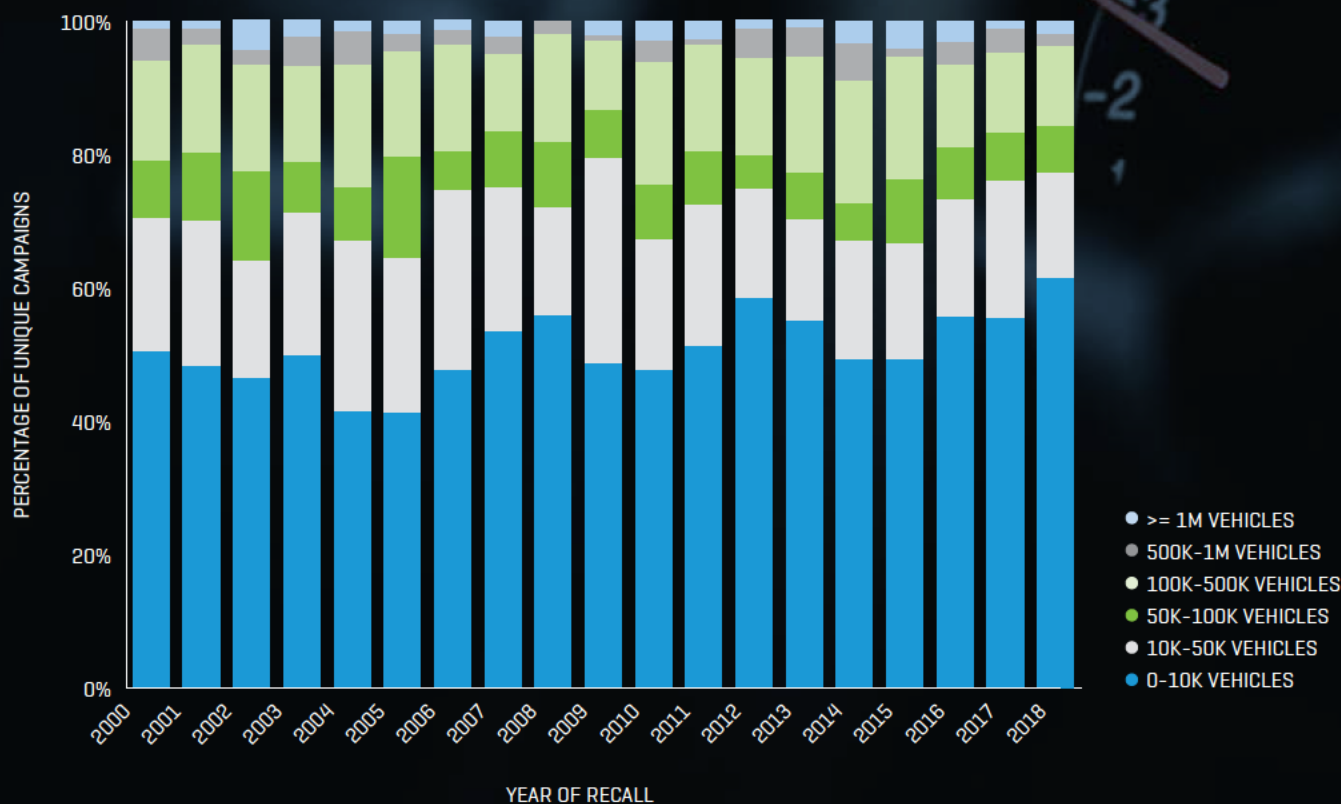


FIGURE 7 / 2018 INDUSTRY-WIDE RECALL SEVERITY (DISTRIBUTION OF UNIQUE RECALLS BY SIZE)*

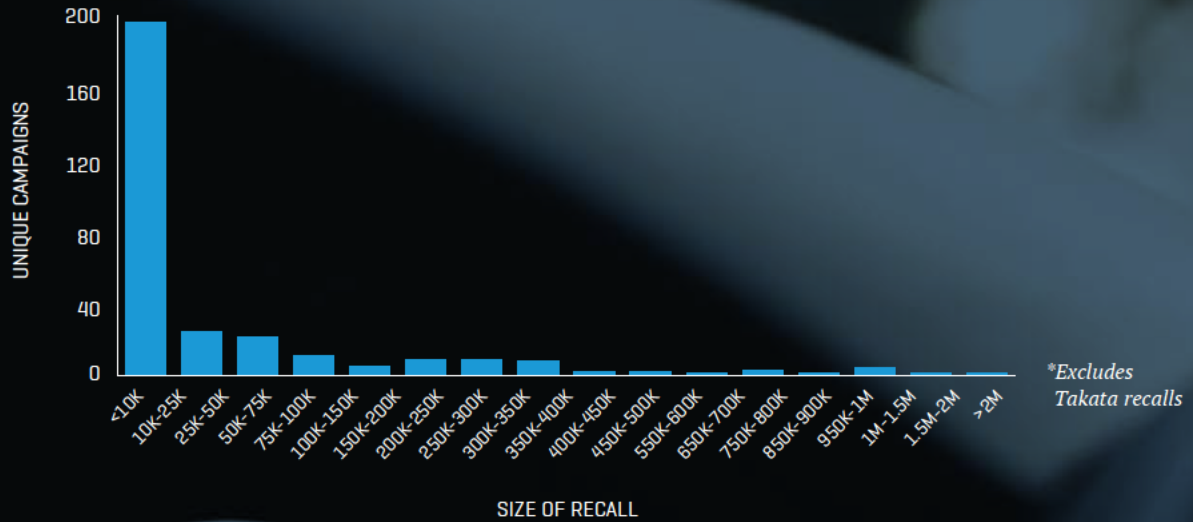


FIGURE 8 / PERCENTAGE OF VEHICLES AFFECTED BY SIZE OF RECALL

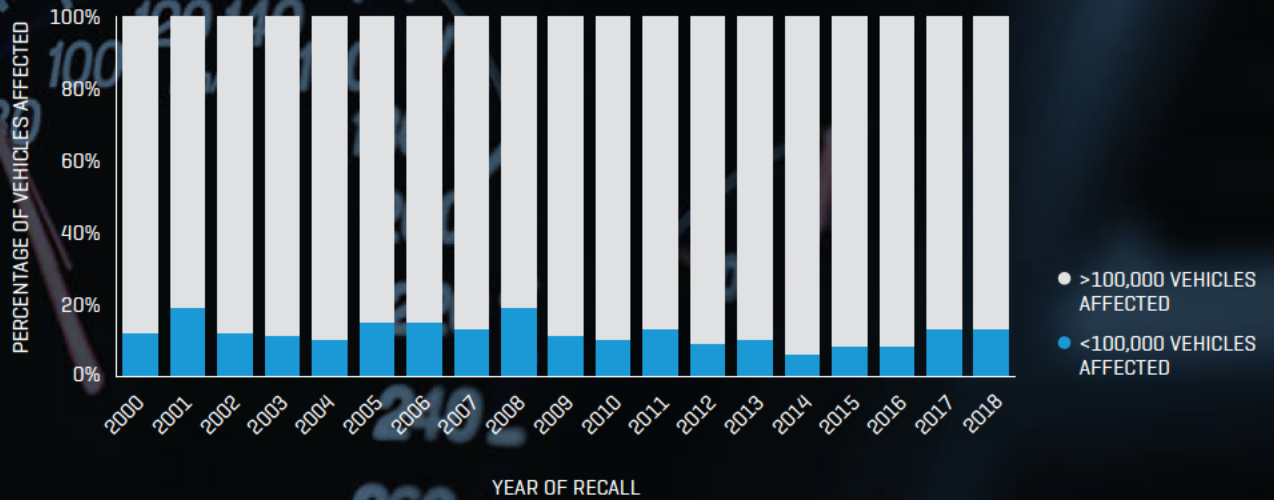
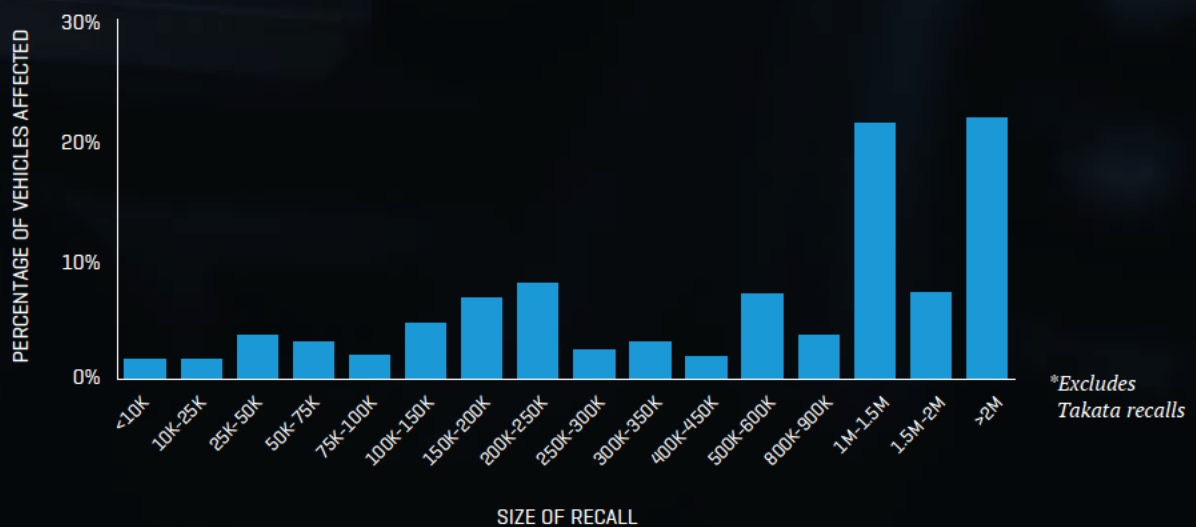


FIGURE 9 / 2018 INDUSTRY-WIDE RECALL SEVERITY (PERCENTAGE DISTRIBUTION OF VEHICLES AFFECTED BY SIZE)*



RECALL CAMPAIGNS IMPACTING MORE THAN 1M VEHICLES IN 2018

FCA VEHICLE SPEED CONTROL
4.8 MILLION VEHICLES

FORD SEAT BELTS
1.6 MILLION VEHICLES

FORD FUEL SYSTEM
1.3 MILLION VEHICLES

FORD STEERING WHEEL
1.3 MILLION VEHICLES

FCA LATCHES
1.1 MILLION VEHICLES

GM STEERING
1 MILLION VEHICLES



LARGEST AND SMALLEST RECALL CAMPAIGNS OF 2018



VEHICLES RECALLED BY FCA
18V322



VEHICLES RECALLED BY
BUGATTI [18V420]
& MERCEDES-BENZ
[18V724 & 18V872]



Excluding the Takata recalls, there were approximately

**24
MILLION**
vehicles recalled
in 2018

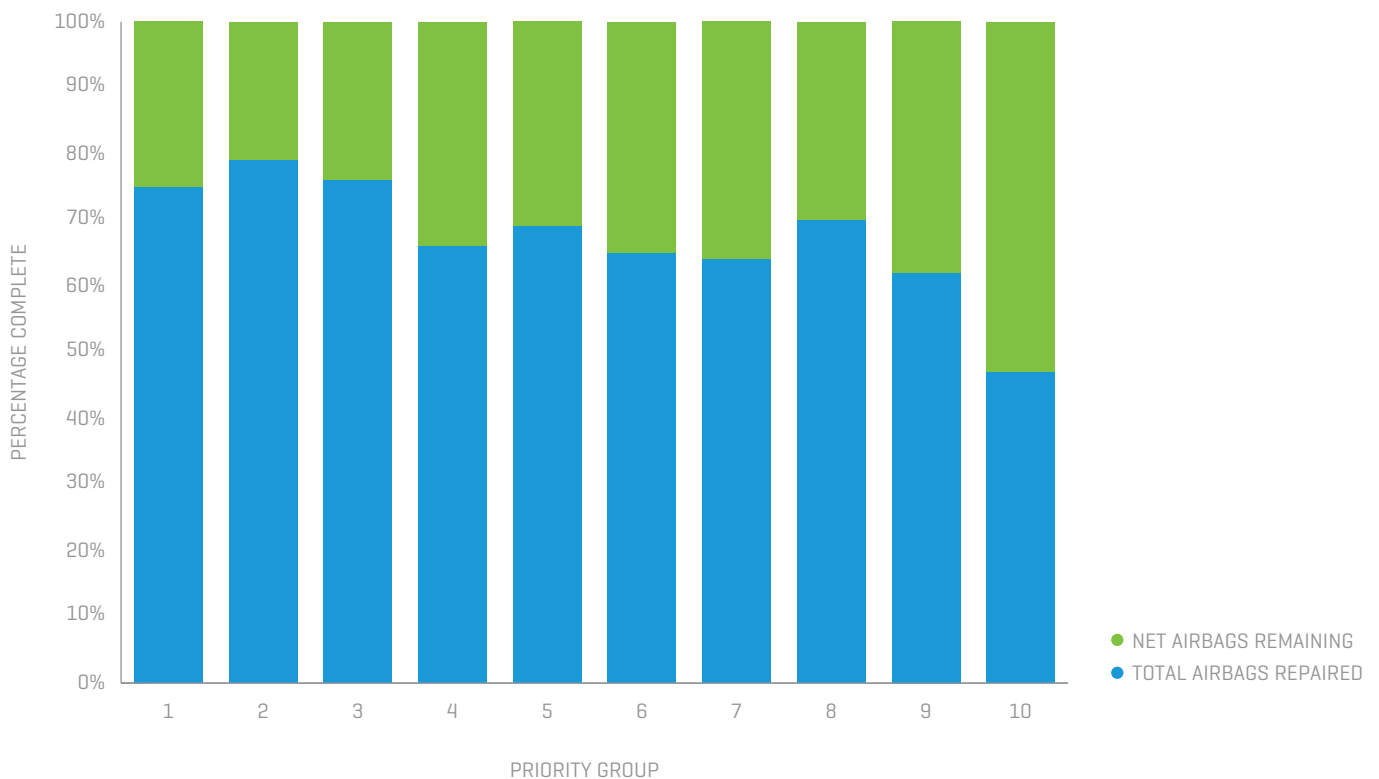
An Update On The Takata Recalls

As of October 2018, approximately 17 million vehicles from 19 different manufacturers still had unrepaired, defective Takata airbag inflators. Consistent with the scheduled expansion developed in 2016, Takata issued its fourth defect information report on December 31, 2018 which increased the number of defective Takata inflators under recall in 2019.⁷ Additional recalls regarding like-for-like Takata replacements previously completed are scheduled to commence in 2020, although many OEMs have already begun making these repairs.⁸

In December 2018, the Independent Monitor of the Takata Recalls issued a second report titled “Update on the State of the Takata Airbag Recalls.” This report detailed a variety of tactics implemented by affected vehicle manufacturers that have resulted in unprecedented recall completion percentages for older vehicle recalls, especially for the highest-risk vehicles (*Figure 10*).

In 2018, the average completion percentage for Takata-related recalls increased by 30 percentage points.⁹

FIGURE 10 / AIRBAG REPLACEMENT COMPLETION BY PRIORITY GROUP FOR GROUPS 1-10*



IN THIS REPORT, *THE MONITOR* LISTED “KEYS TO FURTHER RECALL SUCCESS” AS:

IMPROVING DATA QUALITY

Supplementing vehicle owner information from the DMV with non-DMV sources and consistently updating vehicle owner databases to reflect current contact information.

SEGMENTED ANALYSIS

Identifying different segments of a vehicle owner group and crafting targeted communications that directly address their unique recall needs and obstacles.

COMMUNICATIONS

Using simple language, personalizing outreach tactics, and providing information in languages other than English.

OVERCOMING OWNER INCONVENIENCES

Implementing strategies like mobile repairs, extended service hours at franchise dealers, free towing, and free rental vehicles.

DEALER ENGAGEMENT

Including and activating franchise dealers as agents to assist recall completion. Purposefully engaged dealers are more likely to understand recall services and help assist vehicle owners overcome their barriers to getting repairs done.

THIRD-PARTY ENGAGEMENT

Engaging with third parties, including state DMVs, independent repair facilities, automobile insurers, vehicle auction facilities, and independent used car dealerships to provide vehicle owners with additional points of recall information and repair.

CANVASSING

Giving out information, verifying contact information, and scheduling repairs by visiting specific high-risk owner populations, including owners of older vehicles and/or those who have been unresponsive.

2018: Conclusions and Observations

Stout observed more light vehicle recall campaigns in 2018 than in any prior year.

Despite a record number of passenger vehicle recall campaigns in 2018, the number of vehicles affected by recalls has now stabilized between

25M & 30M
VEHICLES ANNUALLY.

This means that the size of recall campaigns continues to shrink, a sign that the industry is more proactively identifying and responding to defects.

THERE WERE SEVERAL MASSIVE RECALLS IN 2018:

6
CAMPAIGNS *[excluding Takata inflator recalls]* involving more than 1 million vehicles
ACCOUNTED FOR 50%+ OF ALL VEHICLES RECALLED IN 2018.

This is the greatest concentration of vehicles affected by non-Takata campaigns involving more than 1 million vehicles since 2009.

MORE THAN
20%
OF VEHICLES AFFECTED

[excluding Takata recalls] for the entire year were
INVOLVED IN A SINGLE RECALL OF 4.8M VEHICLES (FCA),
the 3rd-largest recall since 2000.

NEARLY 8M VEHICLES
WERE AFFECTED BY SOFTWARE-BASED DEFECTS,
more than 3 times any prior year, and more than the prior 5 years combined.

MORE THAN
3X
ANY PRIOR YEAR

MORE THAN
5
YEARS COMBINED

The release of the second report from the Independent Monitor of the Takata Recalls highlights the industry's increasing emphasis on improving vehicle-owner outreach. The Report detailed a number of key strategies for effective communication that can be adopted by manufacturers moving forward.

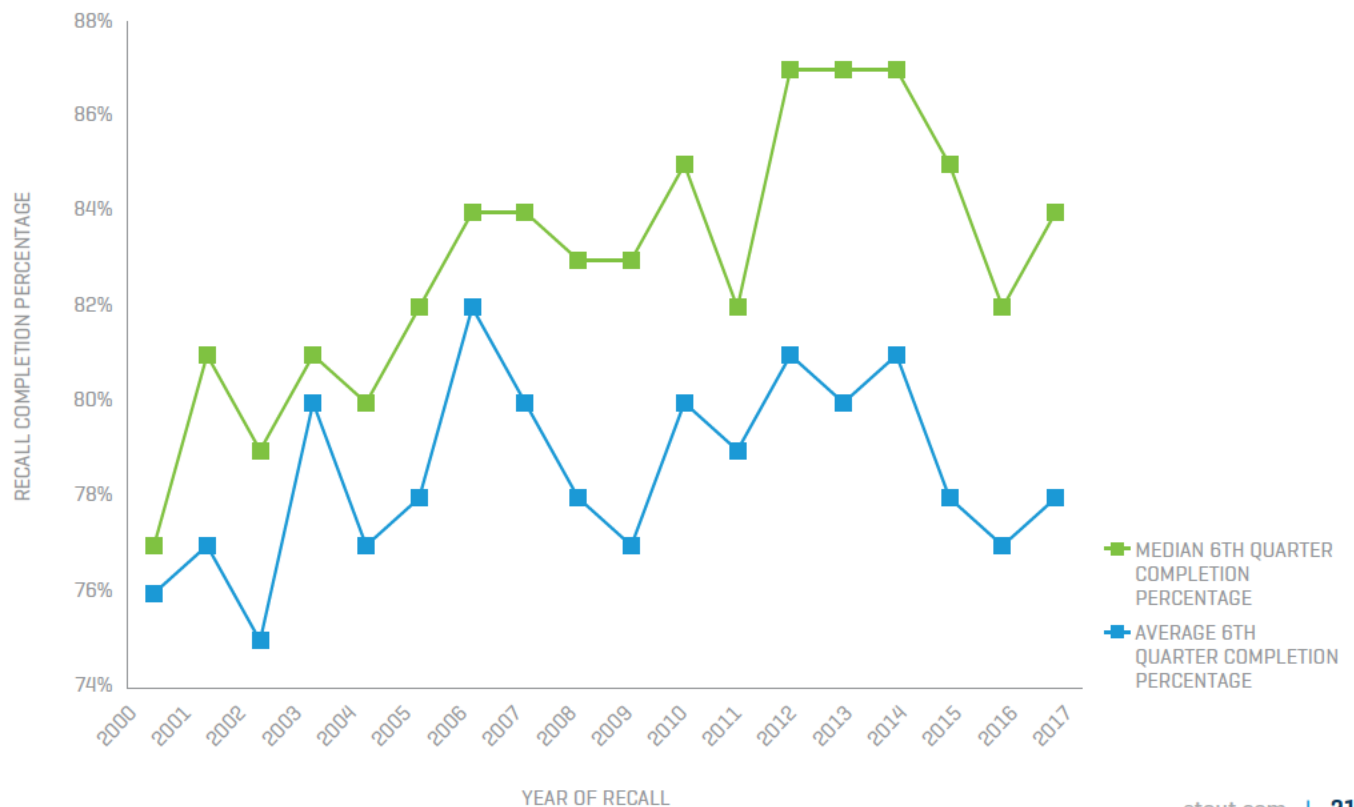
RECALL COMPLETION PERCENTAGE

Federal regulations related to Defect and Noncompliance Responsibility and Reports at 49 CFR Section 573.7 require manufacturers to submit Quarterly Progress Reports for six consecutive calendar quarters after a safety recall is initiated. Although information may be available for later periods, for the purposes of this report Stout only includes analysis of the first six consecutive quarters of data reported.

To complete this analysis, Stout linked Quarterly Progress Reports submitted by manufacturers to NHTSA's recall database. This methodology enabled Stout to identify industry trends in completion percentages across the entire population of unique recall campaigns.

As *Figure 11* indicates, both average and median rates of recall completion have increased over the past year. The industry's ongoing vigilance and willingness to adopt new methods of consumer outreach, like the ones highlighted by the Independent Monitor of the Takata Recalls, helped contribute to this upward trend.

FIGURE 11 / OVERALL MEDIAN AND AVERAGE COMPLETION PERCENTAGE BY YEAR



2018 CAMPAIGNS THAT ACHIEVED 100% COMPLETION:

2016 HONDA CLARITY



2019 SUBARU ASCENT



2018 ROLLS-ROYCE GHOST



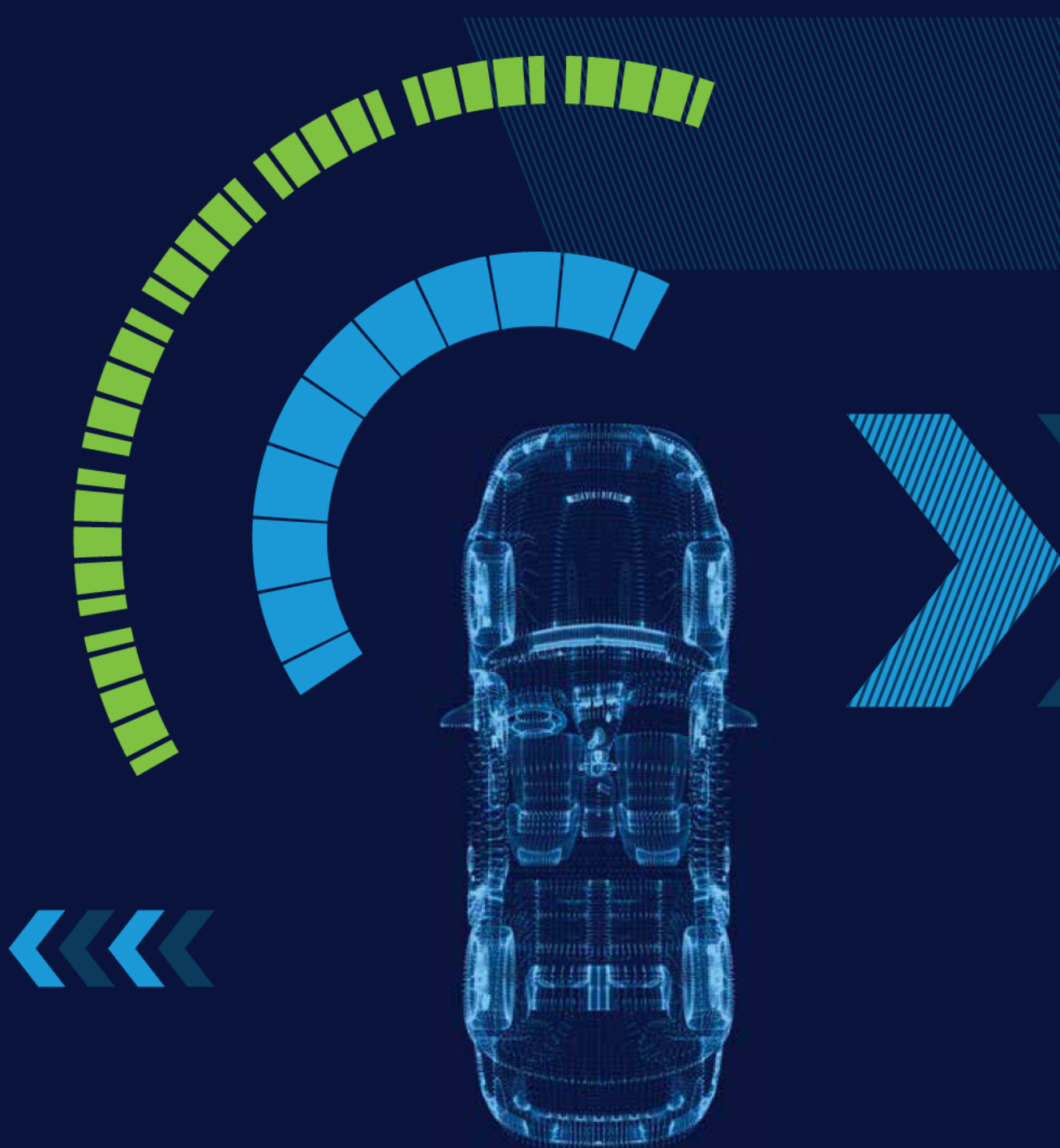
2018 CAMPAIGNS THAT ACHIEVED GREATER THAN 90% COMPLETION:

2017 CHRYSLER PACIFICA



2018/2019 CHEVROLET, GMC, BUICK & CADILLAC





48% of the recalls* that have achieved a **90% completion percentage** in the last 5 years have been for vehicles 3-years-old or younger.



52% 4-years-old or older



**Excluding Takata and GM ignition switch recalls*

Recall Completion Percentage

INFLUENTIAL FACTORS

In December 2018, NHTSA submitted a Congressional report that analyzed recall completion percentages. The purpose of the report included the following objectives:

» COMPLETION PERCENTAGE FACTORS

Identify factors influencing completion percentages

» BENCHMARK MODEL

Produce a model of benchmarks for future completion percentages

» RECALL SAFETY RISK FACTORS

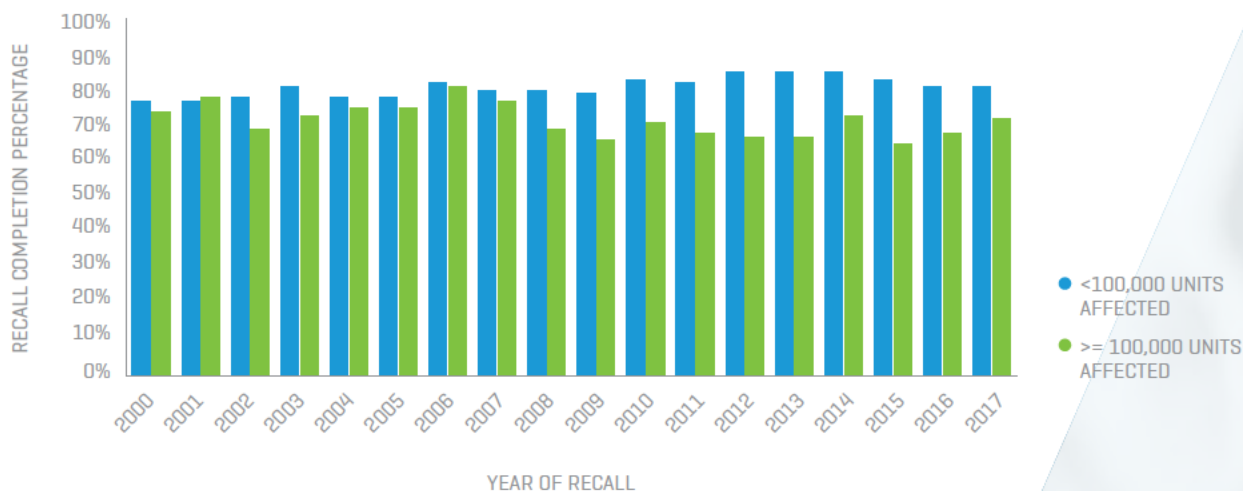
NHTSA considered several influential factors including indicators of recall safety risk, i.e. defect descriptions containing terms like “crash,” “fire,” “death,” or “injury;” year of recall; and number of vehicles affected. Their model ultimately utilized three predictive factors — vehicle age, component type, and vehicle manufacturer.

» VEHICLE AGE EFFECTS

Based upon this study, NHTSA notes that vehicle age plays a significant role in recall remedy completion, and acknowledges that factors associated with vehicle age, including owner demographics and vehicle warranty programs, may play a significant role.¹⁰

NHTSA’s findings are consistent with Stout’s observations contained in this report. In addition to the factors indicated by NHTSA, Stout has identified additional factors that influence recall completion percentages, including vehicle age, recall size, component type, vehicle type, and owner self-diagnosis.

FIGURE 12 / SUMMARY OF AVERAGE COMPLETION PERCENTAGE BY RECALL SIZE



VEHICLE AGE

Vehicle age is the most significant indicator of likely recall completion percentage. Particular challenges in the completion of older vehicle recalls include:

DATA QUALITY / The integrity of vehicle-owner data quality used for outreach as a result of vehicle turnover, owner mobility, unrecorded end-of-life transactions, and registration/title lapses

DIVERSITY OF DEMOGRAPHICS / Diversity of vehicle-owner demographics including income and education as well as different language and cultural preferences in communication

REPLACEMENT PARTS / The prompt availability of replacement parts

DEALER RELATIONSHIP / Lack of a franchised dealer relationship and, in some instances, apprehension towards franchised dealers

OTHER NON-WARRANTY ITEMS / Presence of other vehicle operational or safety features in disrepair

RECALL SIZE

Recalls involving fewer vehicles are easier to manage, contain a less diverse group of owners, require fewer replacement parts, and put less strain on dealer capacity — all of which has generally resulted in higher completion percentages. However, as *Figure 12* demonstrates, the gap in completion percentage between recalls of more than 100,000 vehicles and less than 100,000 is shrinking. The latest data shows the difference between the two is under 10%, the smallest gap since 2007.

COMPONENT TYPE, VEHICLE TYPE & OWNER SELF-DIAGNOSIS

Figure 13 highlights the percentages of the highest and lowest performing component groups between 2000 and 2017. Variations in vehicle type and component classifications combine to report different recall completion percentages. For example, when examining recalls involving the anchoring systems used to secure car seats into vehicles, substantially lower recall completion percentages are observed for compact vehicles as compared to minivans (see Figure 14). The difference in recall completion percentages correlates with the use of the vehicle. Minivans are commonly used by families with young children, whereas compact vehicles generally have a more diverse usage. This suggests that an owner's perception of whether they are affected by a recall influences remedy completion. If owners believe they are not affected by a defect, such as owners of compact vehicles without children, they are less likely to comply with a recall notification.

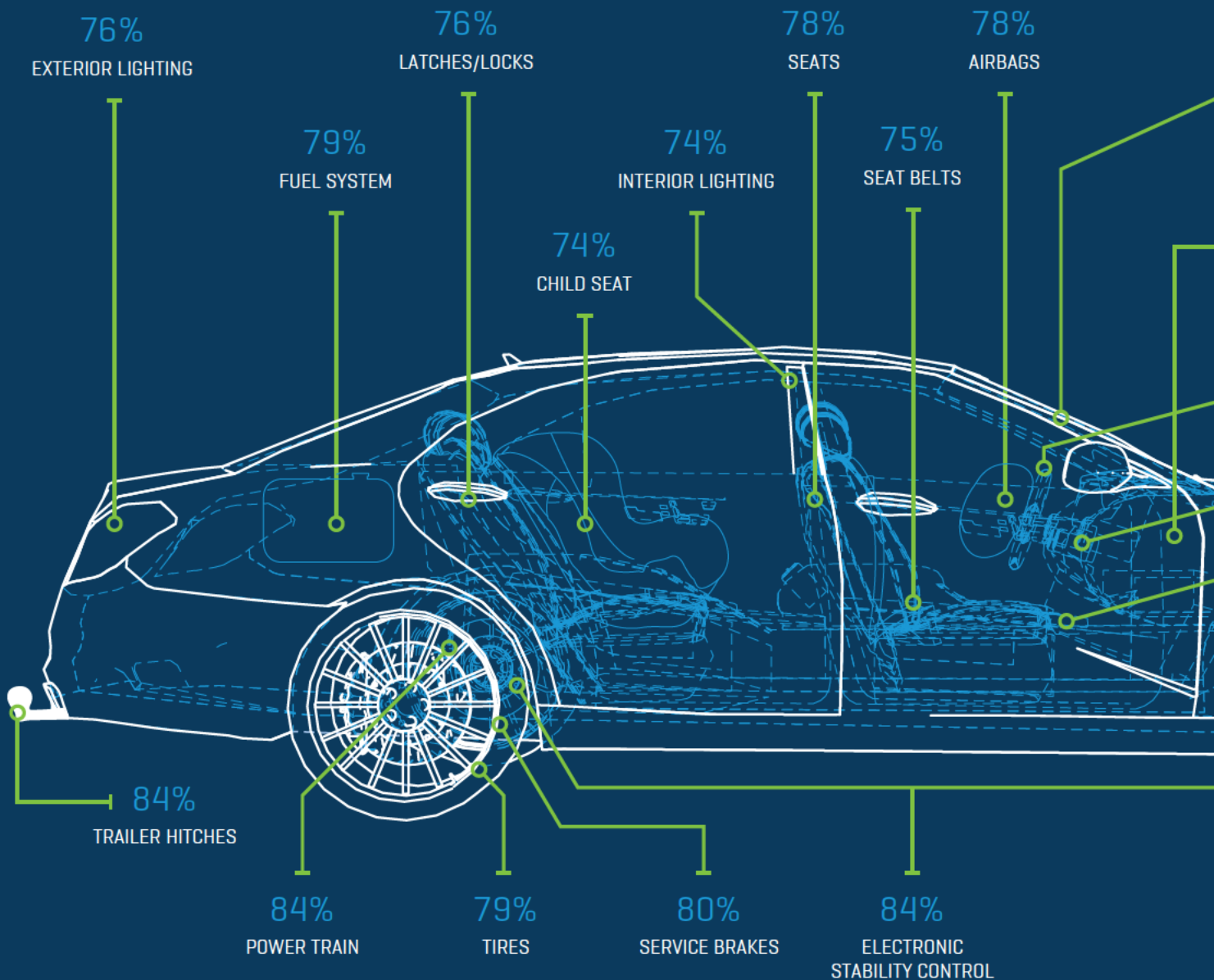


FIGURE 13 / SUMMARY OF AVERAGE COMPLETION PERCENTAGE BY COMPONENT GROUP

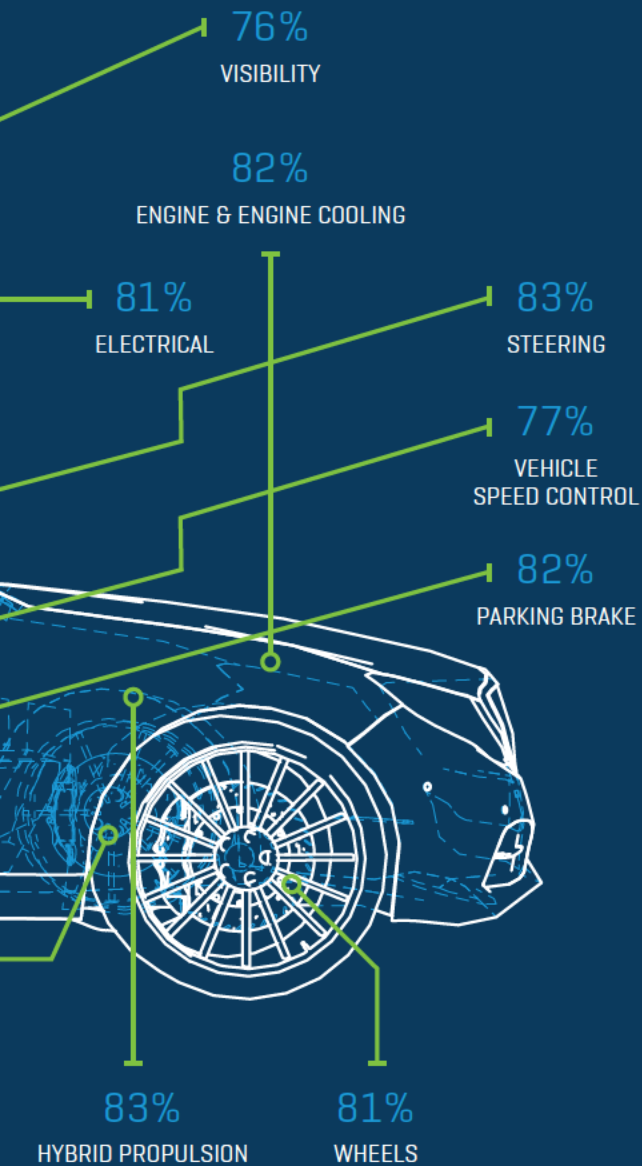
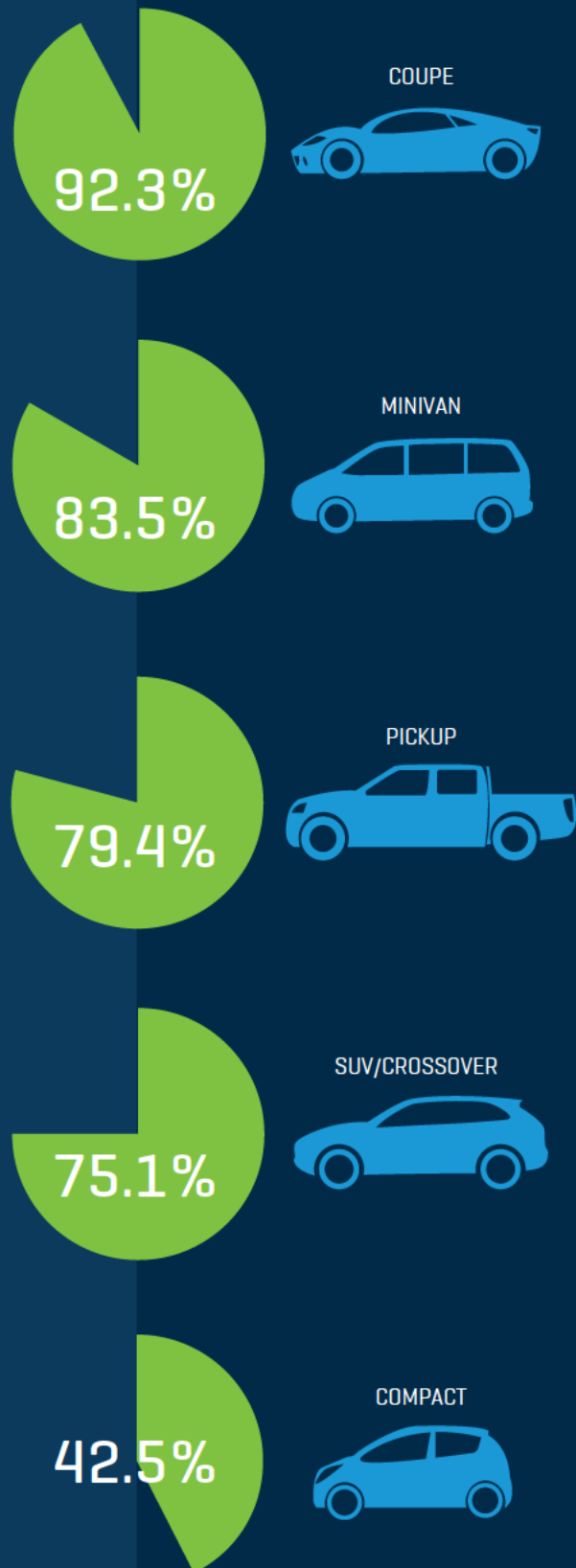


FIGURE 14 / SUMMARY OF AVERAGE COMPLETION PERCENTAGE BY COMPONENT GROUP (CHILD SEAT ANCHOR SYSTEMS)





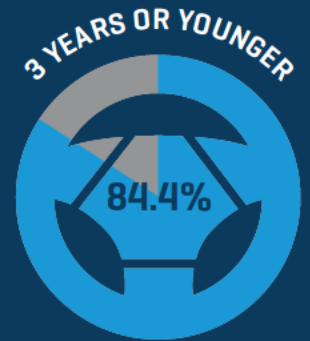
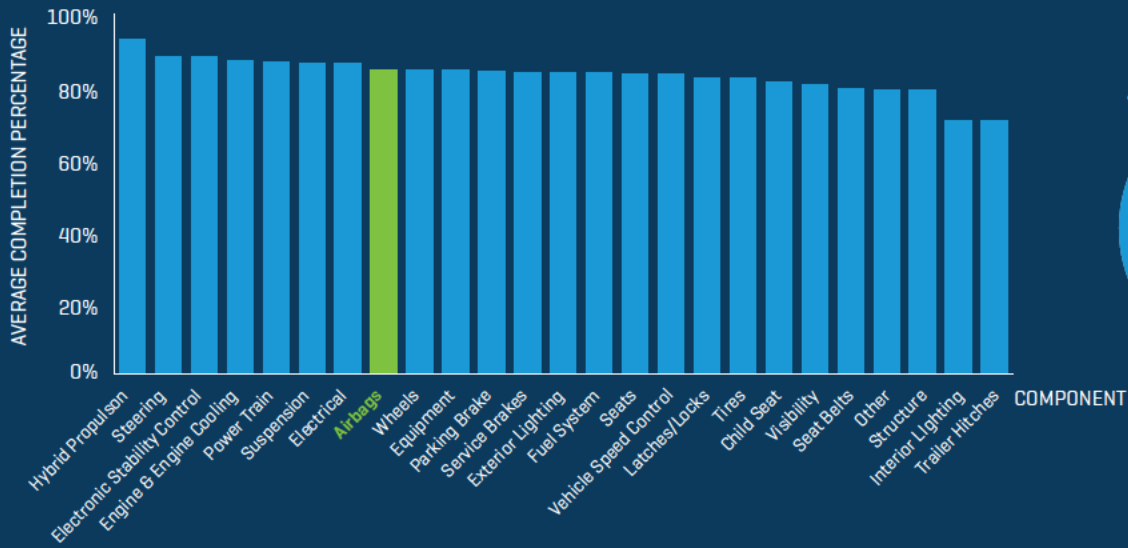
different completion patterns emerge.

For example, excluding Takata recalls, airbag recalls initiated within the first three years of vehicle life result in a nearly 85% completion percentage as shown in *Figure 15*. *Figure 16* shows that as vehicles age into the 5 – 8-year-old vehicle grouping, airbag completion percentages drop disproportionately to other component groups by approximately 25%.

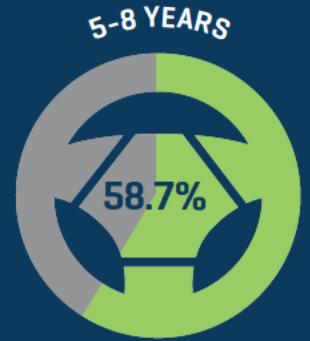
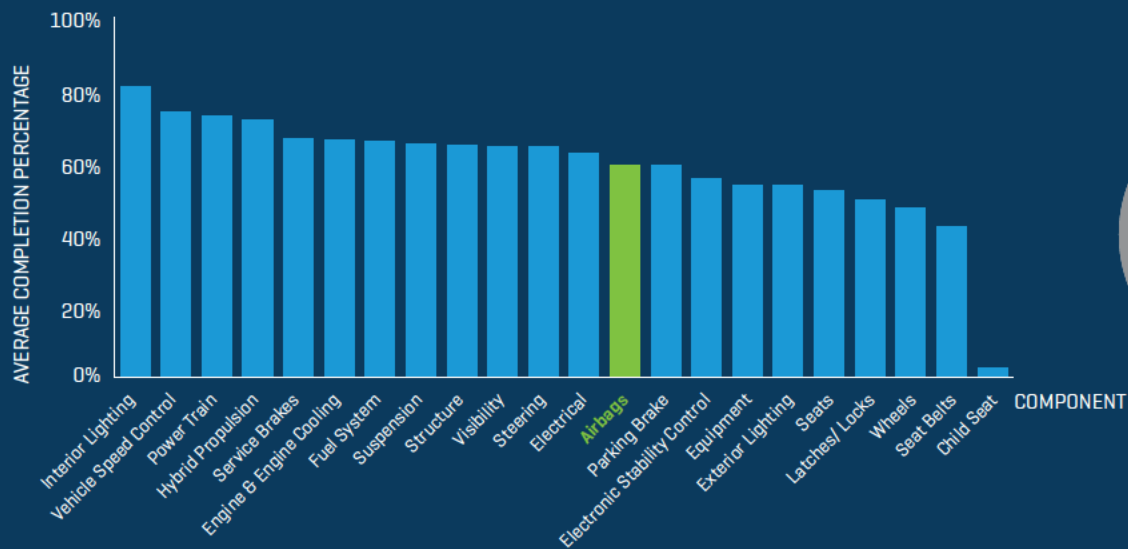
In recalls of vehicles 8 years old and older, *Figure 17*, the completion percentage continues to decline disproportionately relative to other component groups, to below 40%.

FIGURE 15-17 / SUMMARY OF AVERAGE COMPLETION PERCENTAGE BY COMPONENT GROUP (AIRBAGS)

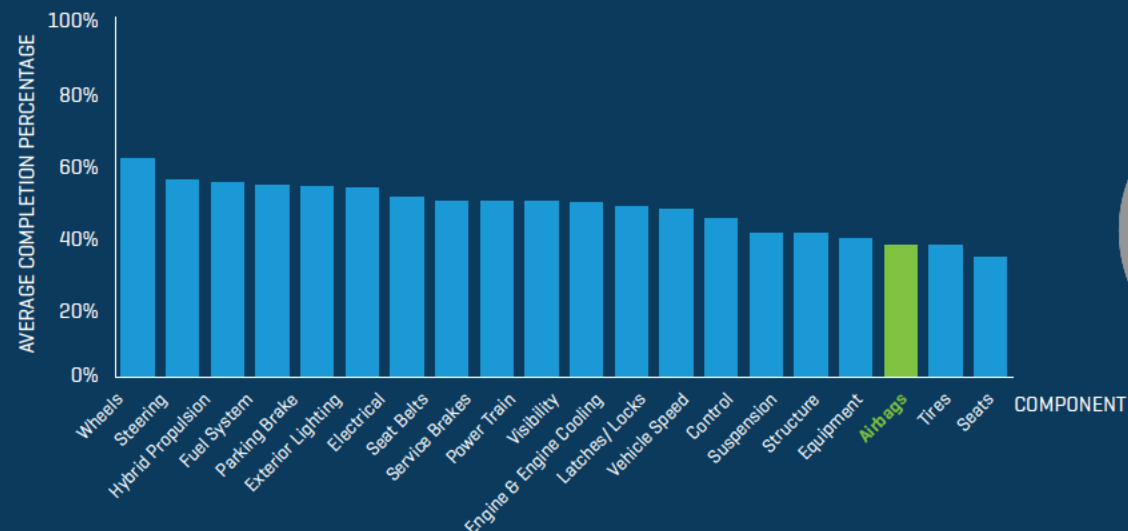
3 YEARS OR YOUNGER



5-8 YEARS



8 YEARS OR GREATER



In contrast to airbags, seat belts show a much different trend as vehicles age. Recalls of seat belts conducted early in a vehicle's life, i.e. vehicles 3 years old or younger, have higher completion percentages (79%) as demonstrated in *Figure 18*. However, as vehicles age, completion percentages of seat belt vehicles demonstrate a minimum recall percentage between 40% to 50%, as demonstrated in *Figures 19 – 20*, whereas airbag completion percentages continued to decline as vehicles age.

The differing trends in these components further demonstrates possible owner perceptions and the potential of self-diagnosis. While both components are critical safety features, airbags have a one-time use and need to be replaced if an accident occurs, while seat belts have a repeated and required use. Moreover, airbags are only deployed in the event of a crash, an event which many drivers believe they can prevent.

Different component failures at different vehicle age markers can present unique risks and recall completion challenges. In order to prevent the potential misperceptions of vehicle owners, OEMs should communicate differently across different types of recalls.

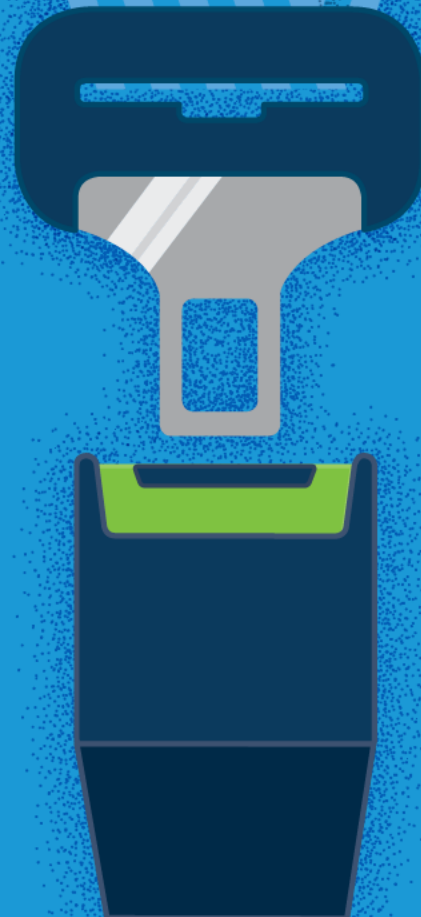
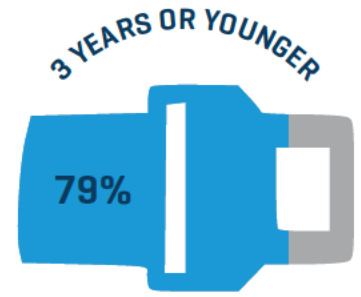
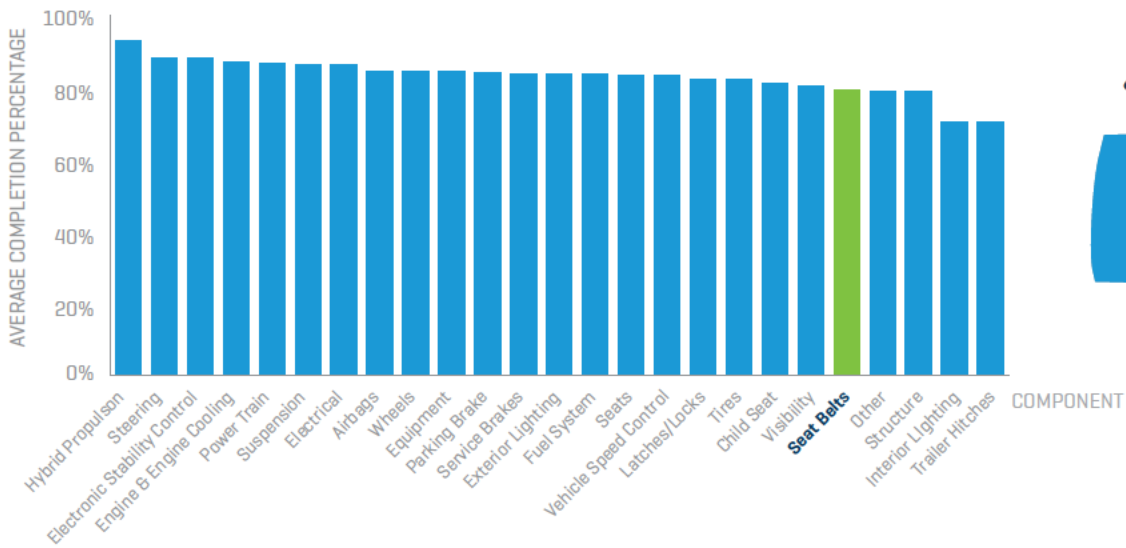
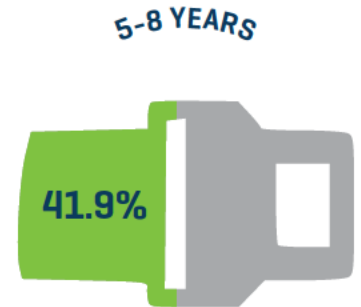
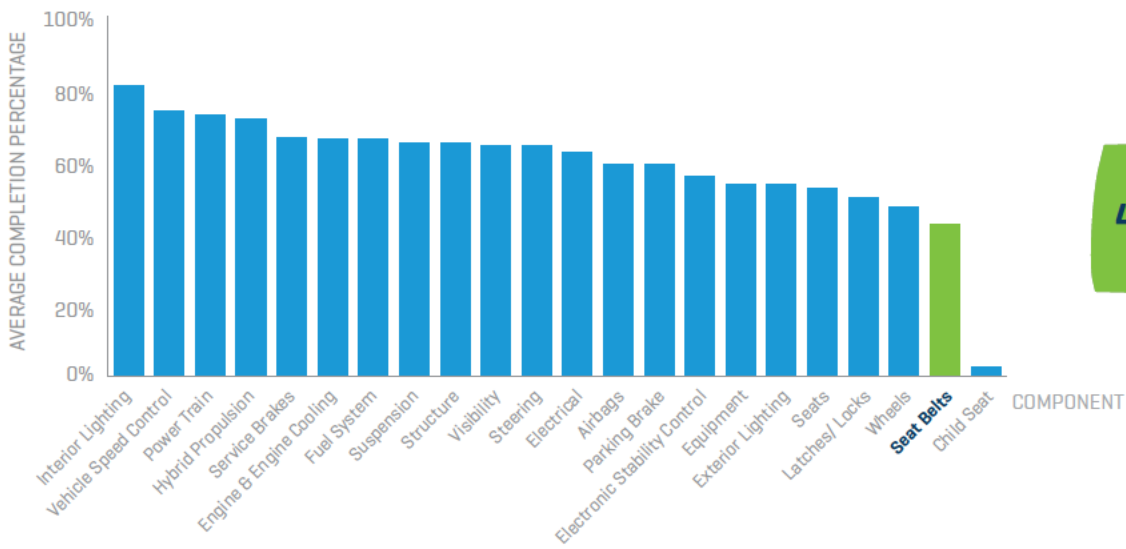


FIGURE 18-20 / SUMMARY OF AVERAGE COMPLETION PERCENTAGE BY COMPONENT GROUP [SEAT BELTS]

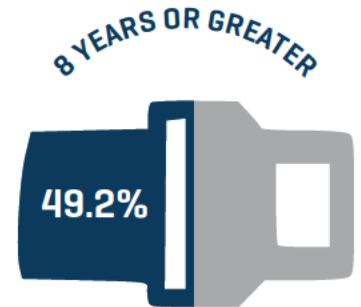
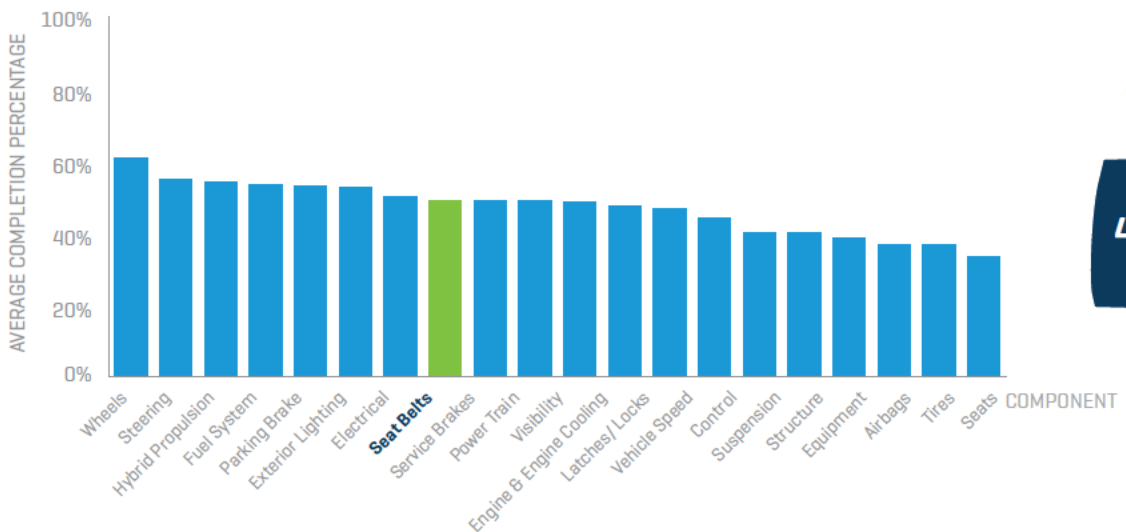
3 YEARS OR YOUNGER



5-8 YEARS



8 YEARS OR GREATER



OWNER OUTREACH

As evidenced in the Takata Monitor's State of the Recalls report, OEMs are changing the way they are communicating with vehicle owners by incorporating more targeted modes of outreach based on data-driven strategies. Understanding the age of a vehicle, type of component failure and vehicle type along with other available data attributes can be used to predict the outcome of a recall, as well as when and where escalated communication strategies are needed.

As *Figure 21* shows, remedy completion increases rapidly during the first three quarters after a repair is made available and progresses in much lower increments after that. This trend suggests the use of similar messaging in later stages of a recall without an escalation strategy. That is, the vehicle owners that are influenced

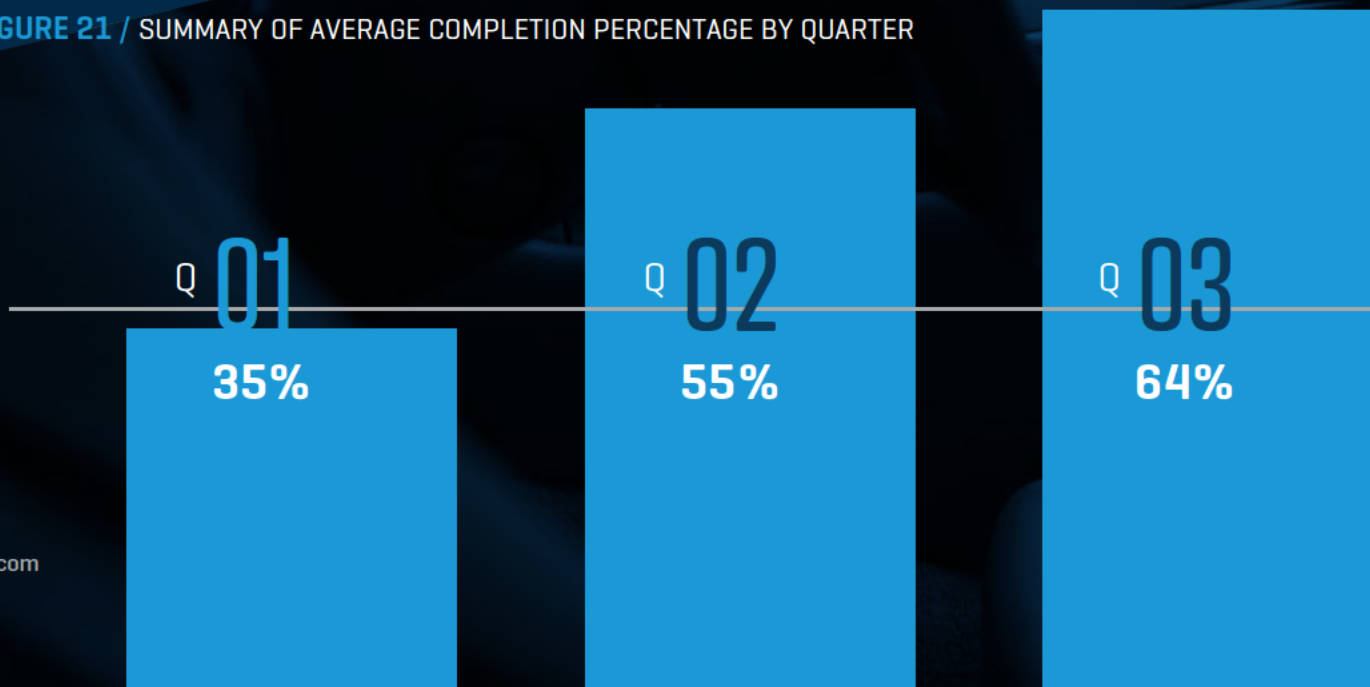
by the initial message seek a repair while the remaining owners of unrepaired vehicles need additional motivation to comply. Making rental vehicles and hotel rooms available, communicating the availability of replacement parts, and using different modes of delivery to convey the urgency of the defect in question are accommodations that can encourage an elevated level of owner compliance and remedy completion.

NHTSA is encouraging states to adopt a more creative approach regarding owner outreach, including at the time of registration and during emissions or safety testing.

In connection with the FAST Act, NHTSA launched a pilot

program to encourage states to communicate open recalls to owners at the time of registration, offering grants to those states having the capability to use VINs to determine whether a vehicle was subject to an open recall. In 2017, NHTSA awarded one such grant to Maryland, which began notifying owners and lessees of recalls in spring 2018. Since the start of the Maryland program, other states have expressed interest in participating in such a program. NHTSA is also encouraging proposals that provide for the analysis of recall completion data, particularly in relation to gauging the success of these state programs.

FIGURE 21 / SUMMARY OF AVERAGE COMPLETION PERCENTAGE BY QUARTER



The 2018 Congressional report submitted by NHTSA highlights both their own and Congress's focus on studying and enhancing recall completion percentages, consistent with the objectives of the FAST Act. As a result, NHTSA is taking the following actions to help improve recall completion percentages industry-wide:

- » Develop predictive modeling that will allow NHTSA to more quickly identify underperforming recalls and allow for the study of factors that influence successful remedy campaigns.
- » Continue sharing information, best practices and lessons learned among the industry and the agency.
- » Invest in systems and processes for better measurement and analysis of recall completion data.

Q 04
70%

Q 05
73%

Q 06
76%

The Importance of Benchmarking

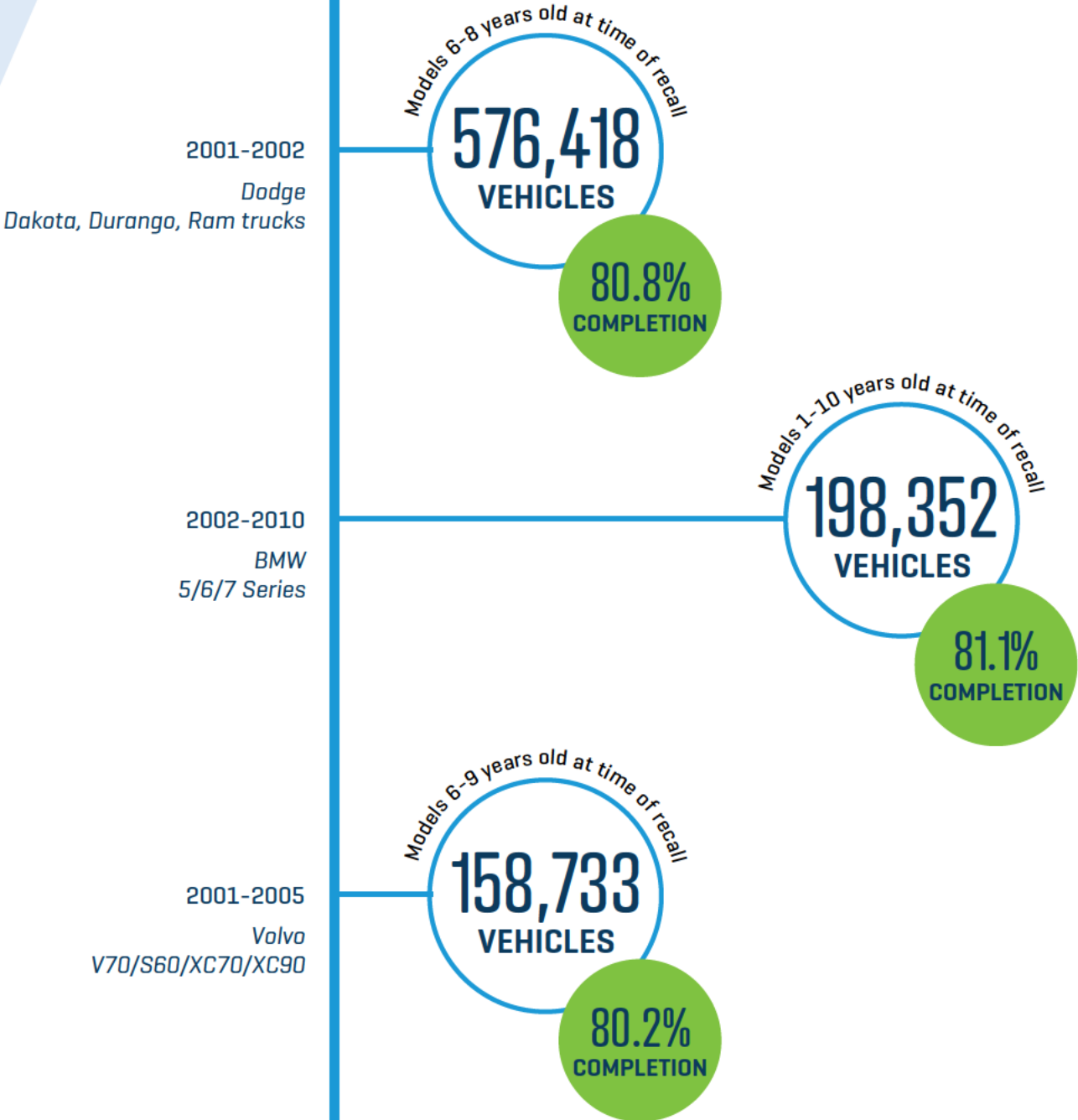
With so many variables to consider in regard to recall completion, it's important to establish benchmarking protocols in order to keep pace with the latest industry activity. If OEMs and suppliers can determine how the construct of their risk-management infrastructure compares to the best practices of the industry, they can then identify areas in need of improvement. The Takata Monitor's State of the Recalls report outlines several advances that have been made in owner outreach and demographic analysis that have yielded higher completion percentages for affected manufacturers. All manufacturers should take stock of where their own systems are in relation to the information conveyed in the Takata Monitor's report and, if necessary, incorporate the Monitor's recommendations.

OEMs can use benchmarking to achieve the following:

- » [Develop effective recall engagement strategies](#)
- » [Develop appropriate recall outreach escalation strategies](#)
- » [Monitor the pace of completion in active campaigns](#)
- » [Ensure compliance with regulatory requirements and enforcement actions](#)
- » [Maintain adequate replacement-part inventories](#)
- » [Estimate required dealer service capacity needed for recall activity](#)
- » [Identify potential risk mitigation and insurance strategies related to expected financial exposure](#)

As the data in this report indicates, smaller recalls focusing on newer vehicles provide a more likely path to higher completion percentages. However, it is possible to achieve a high percentage of remedy completion, even for older vehicles and larger affected vehicle populations.

Older and larger campaigns that achieved notable completion percentages:



SUPPLIER

IDENTIFICATION

Required sections of Part 573 letters include the following:



Manufacturer's name, including the full corporate or individual name of the fabricating manufacturer, and any brand name or trademark owner of the vehicle or item of equipment



Total number of vehicles or equipment potentially affected



Identification of the vehicles or items of motor vehicle equipment potentially containing the defect or item of noncompliance

PART 573 LETTER REVIEW

Suppliers play a key role in vehicle production, with more responsibility than ever before related to the design and suitability of components and/or equipment in new light vehicles. The depth of supplier involvement in the design and manufacturing of vehicle components reinforces manufacturers' focus on the recovery of warranty and recall campaign costs from suppliers. This identification of a supplier by a manufacturer is chronicled in Part 573 letters.

Part 573 Letters Background

For every recall they initiate, OEMs are required to submit a Part 573 Letter notifying vehicle owners and NHTSA of defective or non-complying motor vehicles and items of motor vehicle equipment.¹¹ These reports are to be submitted within five working days after a defect or non-compliance is determined to exist.¹²



Chronology of the principle events that were the basis for the determination that the defect related to motor vehicle safety



In the case of a non-compliance, the **test results and other information** that the manufacturer considered in determining the existence of the non-compliance



Percentages of vehicles containing defect or noncompliance



A description of the **manufacturer's program** for remedying the defect or non-compliance

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. This 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 a future cost recovery action. Indeed, the shift in warranty claims expense data between OEMs and suppliers since 2014 indicates that manufacturers have been successful in recovering warranty and recall costs from suppliers.¹³

Part 573 Letters Analysis and Observations

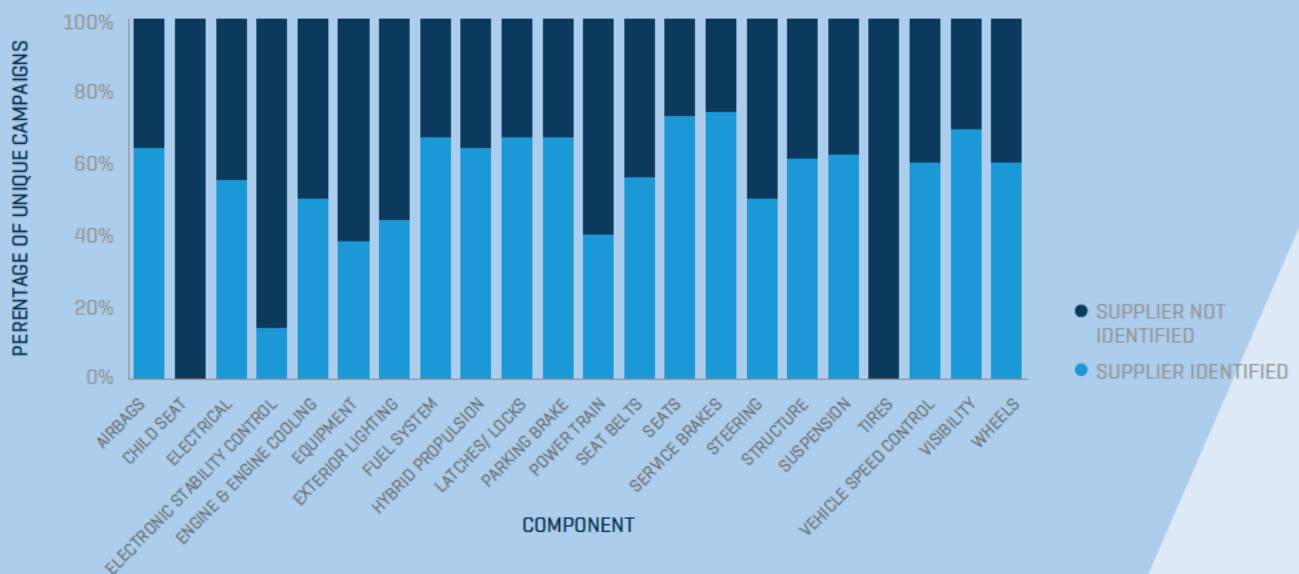
Stout has analyzed every Part 573 letter submitted in relation to light vehicle recall from 2000 through 2018 to better identify the trends and patterns of reported supplier involvement. This analysis can help industry participants, and suppliers in particular, understand the components and vehicle systems where manufacturers have most frequently identified suppliers as being involved in the design or manufacture of failed or non-compliant component parts.

Utilizing the data from 2018 as the industry’s most recent reference point, Stout has observed that supplier identification remained at a high level throughout the year, consistent with historic levels since 2016.

Further examination, as depicted in *Figure 22*, reveals that suppliers were most often identified in campaigns involving airbags and electronic stability control, which reflects the elevated level of recall activity that took place in these two categories in 2018.

To add additional context to the increasing frequency of suppliers being identified in recall actions, there were 39 suppliers identified in 2018 recalls who had not been identified in a recall in the previous five years, 35 of which had not been identified in a recall in the previous 10 years (*Figures 23 and 24*). Many of these actions were for the manufacturing of traditional components like airbags, seats, and steering, but they also included the suppliers of components for newer technologies like hybrid propulsion, lane departure and software components.

FIGURE 22 / PERCENTAGE OF CAMPAIGNS BY SUPPLIER IDENTIFICATION & COMPONENT (2018)



There were also a number of suppliers cited in multiple recalls in 2018 (See *Figure 25*). The majority (77%) were identified in five or less, although there was one supplier identified in 17 recalls, which involved a variety of components used for airbags & restraint, braking, and electronic components.

FIGURE 23 / SUPPLIERS NOT NAMED IN RECALL IN PREVIOUS 5 YEARS



FIGURE 25 / SUPPLIERS INVOLVED IN MULTIPLE RECALLS IN 2018



FIGURE 24 / SUPPLIERS NOT NAMED IN RECALL IN PREVIOUS 10 YEARS

Historically, the majority of recalls in which suppliers are identified are associated with manufacturing issues (See Figure 26). However, as Figure 27 indicates, the identification of suppliers in recalls where the defect was likely design-related has been steadily increasing over the past decade, an indication that suppliers are more likely to face cost-recovery linked to failures where they share or own design responsibility.

FIGURE 26 / PERCENTAGE OF UNIQUE CAMPAIGNS BY SUPPLIER IDENTIFICATION LIKELY MANUFACTURING RELATED

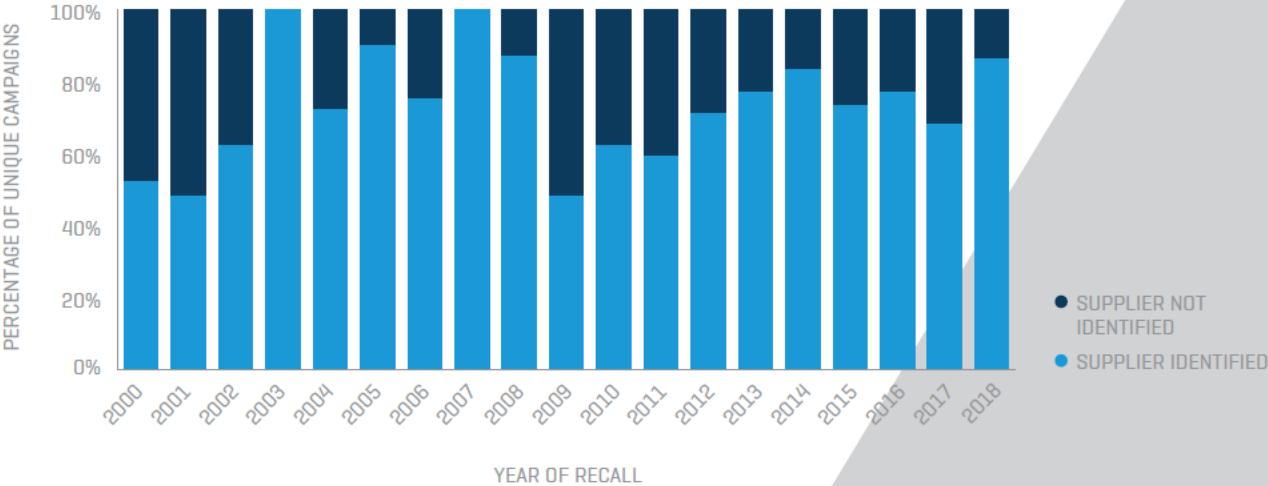
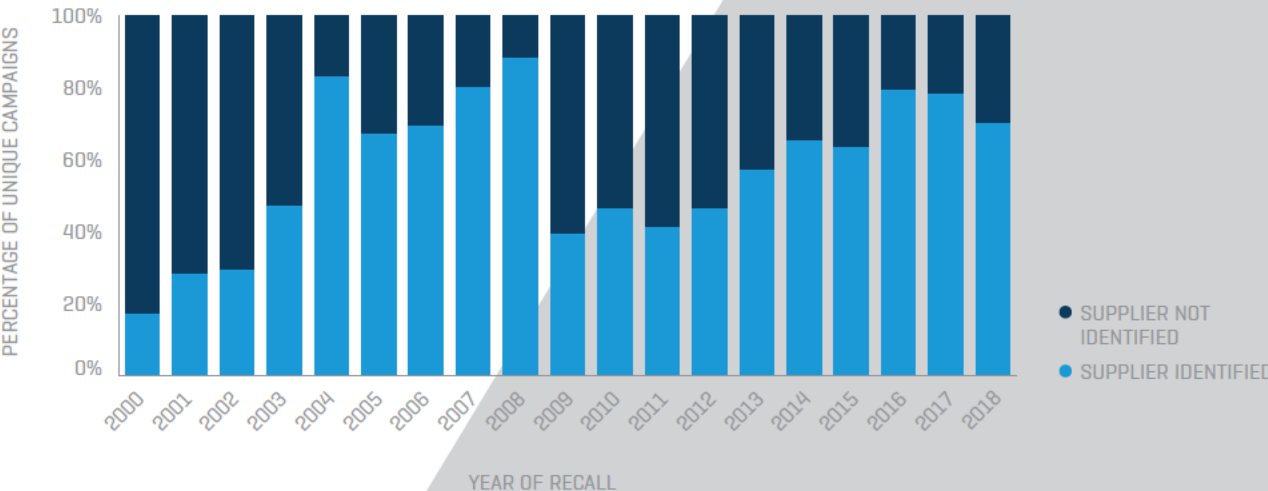
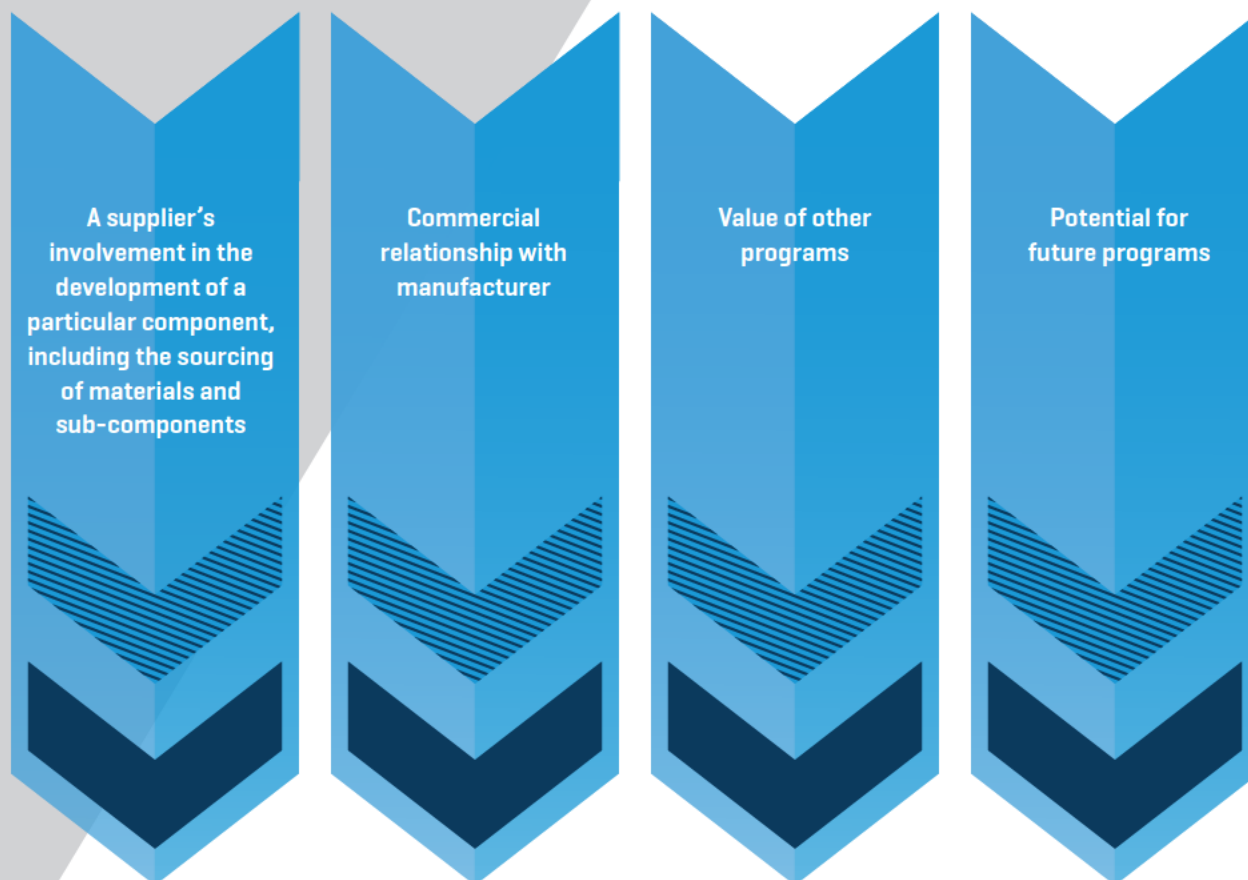


FIGURE 27 / PERCENTAGE OF UNIQUE CAMPAIGNS BY SUPPLIER IDENTIFICATION LIKELY DESIGN RELATED



Cost Recovery Actions Influencers

Cost recovery actions are influenced by a variety of factors, including the following:



Analysis by Warranty Week indicates that suppliers' share of U.S.-based industry revenues, and therefore likely warranty exposure is approximately 37%; however, suppliers represent less than 20% of net claim payments.¹⁴





Assessing Risk

What Suppliers Can Learn From Part 573 letters

Analysis of supplier identification in Part 573 letters, including correlation with other data points, can provide suppliers with unique insights about their exposure to potential cost-recovery.

Suppliers can assess the risks of cost-recovery by doing the following:

- » Evaluating their role and responsibility in the development of vehicle components (this includes design responsibility, contribution of value-added content, or building-to-print)
- » Understanding how a specialization in a particular technology or application may be perceived by manufacturers
- » Understanding of responsibility for extraordinary warranty and recall activity based upon controlling commercial documents (terms and conditions, long-term agreements, purchase orders, etc.)
- » Being aware of the role of a particular component, software, etc., in the development and implementation of vehicle systems

**EXPERTISE IN A PARTICULAR AREA MAY INCREASE
THE LIKELIHOOD AND SUCCESS OF POST-RECOVERY**



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, Part 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

As Figure 28 indicates, the overall number of recalls of electronic components and related failure modes decreased in 2018. After peaking in 2016, this marks the second consecutive year of a decline in recall activity with these failure modes.

FIGURE 28 / RECALLS OF ELECTRONIC COMPONENTS BY YEAR

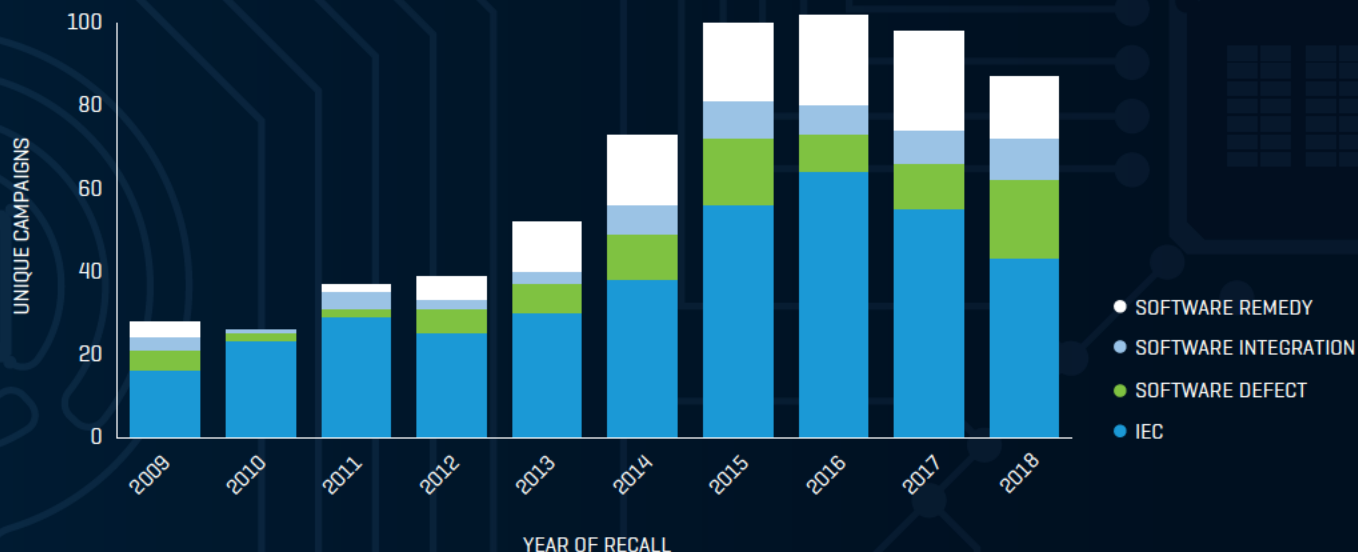


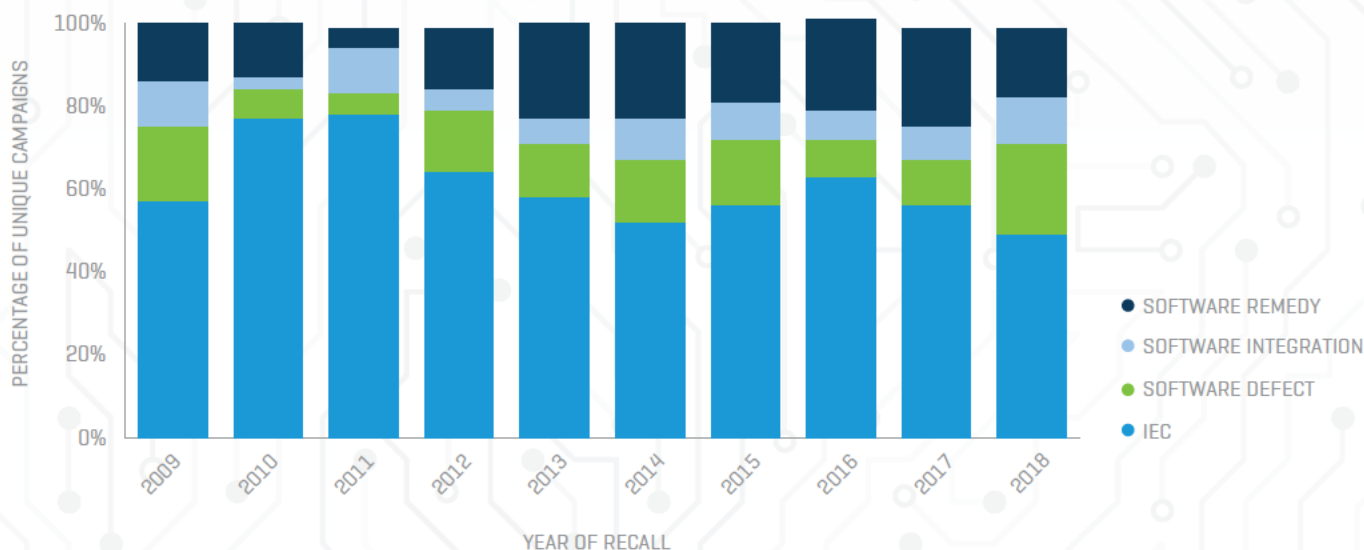
Figure 29 shows that the proportion of software-based defects, i.e. software defects, software integration, and software remedy, increased for the second year in a row. This increase was influenced by the FCA vehicle speed control system recall that affected 4.8 million vehicles. Influenced by the size of this recall, the number of vehicles involved in software-related recalls in 2018 was three times that of any prior year; this number included approximately 1/3 of all the vehicles involved in non-Takata recalls for the year. The large cross-section of vehicle models affected by the FCA recall serves as a cautionary example of how common software systems and components can create increased risk related to a single component failure.

Figure 30 illustrates the disproportionate number of vehicles affected by software-related defects in 2018 versus those affected by non-software defects.

This inverse relationship is 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 are able to replace more traditional means of remedy delivery).

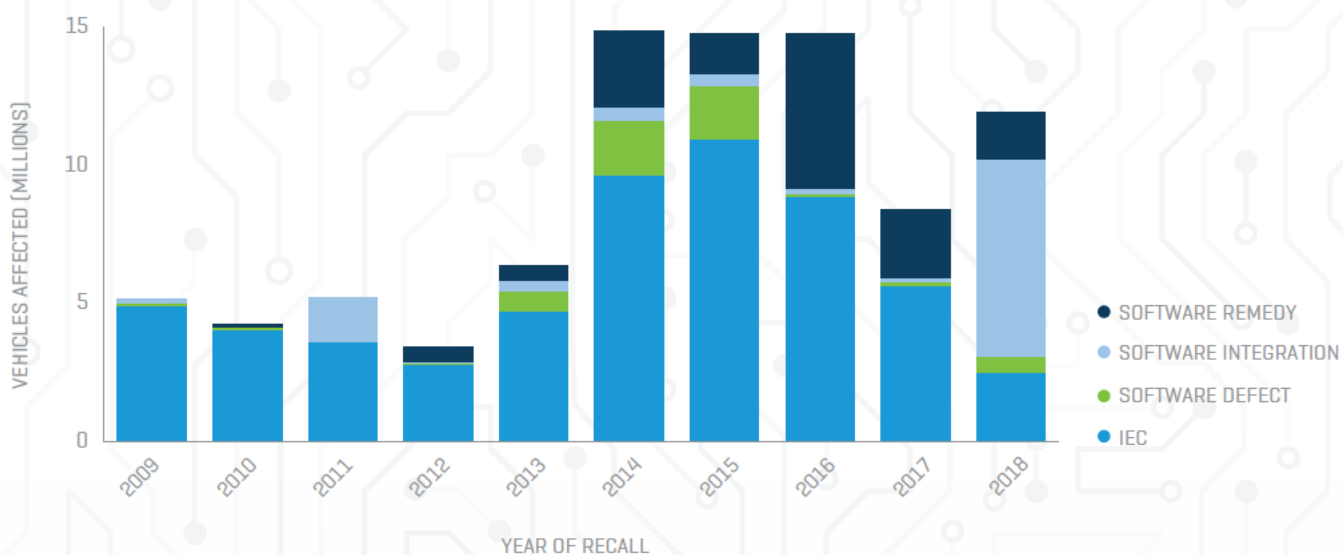
Predicting how these new and evolving components and technologies will assimilate into a vehicle will be an ongoing challenge for OEMs and suppliers. With that in mind, Stout has compiled and analyzed data to provide insight into what may happen as more advanced driver-convenience and safety technologies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

FIGURE 29 / PERCENTAGE OF RECALLS OF ELECTRONIC COMPONENTS BY YEAR



...the number of vehicles involved in software-related recalls in 2018 was **three times that of any prior year**; this number included approximately 1/3 of all the vehicles involved in non-Takata recalls for the year.

FIGURE 30 / VEHICLES AFFECTED BY ELECTRONIC COMPONENTS BY YEAR



Defect Emergence & Tail Risk

As the evolution of electronic components and advanced technologies continues, these new elements will continue to be integrated into vehicle platforms (for the first time in some cases). Thus, OEMs and suppliers are faced with the difficult proposition of predicting and preparing for patterns of component failure, which includes assessing the duration of their risk exposure (i.e., tail risk).

Stout analyzed each of its four electronic component sub-categories to identify trends in defect emergence. Specifically, Stout plotted the incidence of software and non-software-based defects by recall year and age of vehicle at time of recall, creating a heat map of the emergence of electronic defects by vehicle age.

Stout observed that software-based defects (recalls categorized in our analysis as involving software defects or software integration issues) primarily appeared early in vehicle life; these defects were observed far less frequently after the first two years. This stands to reason as software-based failures are more likely to exist in vehicles at the time of their launch instead of arising due to issues related to wear and tear or environmental exposure; therefore, they may be detected and remedied earlier. This observation will likely correlate with much higher completion percentages for these recalls. Given the increasing prevalence of these recalls, industry-wide completion percentages may increase as the average age of the vehicles recalled declines, as discussed within Recall Completion Percentage: Influential Factors, outlined earlier in this report.

Stout identified several recalls of older vehicles involving software-based defects. The defect descriptions indicate that these primarily involve software integration defects, suggesting that the software-related defects may be arising only after

other vehicle components have been exposed to wear and tear and environmental exposure. In one notable recall of older vehicles involving a software-related defect (17V-177), 51 vehicles, the oldest being nine years old, were recalled after being updated with incorrect software during service, potentially affecting the deployment of airbags in a crash. This recall achieved greater than 86% recall completion. As advanced vehicle technologies become more prevalent, this will be a trend worth watching. While not yet fully ascertainable, due to the recent expansion of vehicle technology, manufacturers should consider

how the technology may work when other components start to fail or do not perform as they did in early product testing.

Non-software defects may involve latent defects that only become known once a vehicle has been in operation for several years and/or is exposed to environmental elements and wear over an extended period. Non-software-based defects were observed to be less concentrated early in a vehicle's life, and instead presented a more varied pattern of defect emergence, consistent with what is typically considered normal for more traditional components.

The heat maps in *Figures 31 and 32* illustrate Stout's

observations. The emergence pattern for software-based recalls indicates that most activity occurs within the first two years of vehicle life, with little activity after year two, while non-software recalls present an ongoing risk of defect through all 10 years of analysis. When reviewing this analysis, it is important to note that vehicle software has proliferated in the last several years, leaving a large cohort of vehicles exposed to potential software defects that have not yet fully matriculated through the analysis. It is therefore possible that we will see new defect emergence patterns as this population of vehicles continues to age. Other factors like cyber intrusion or incompatibility of software updates with existing vehicle operating systems may have a potential impact. Stout will continue to study software defect emergence patterns and update this analysis as new data becomes available.

The emergence pattern for software-based recalls indicates that most activity occurs within the first two years of vehicle life...while non-software recalls present an ongoing risk of defect through all 10 years of analysis.

FIGURE 31 / EMERGENCE OF SOFTWARE-BASED RECALLS

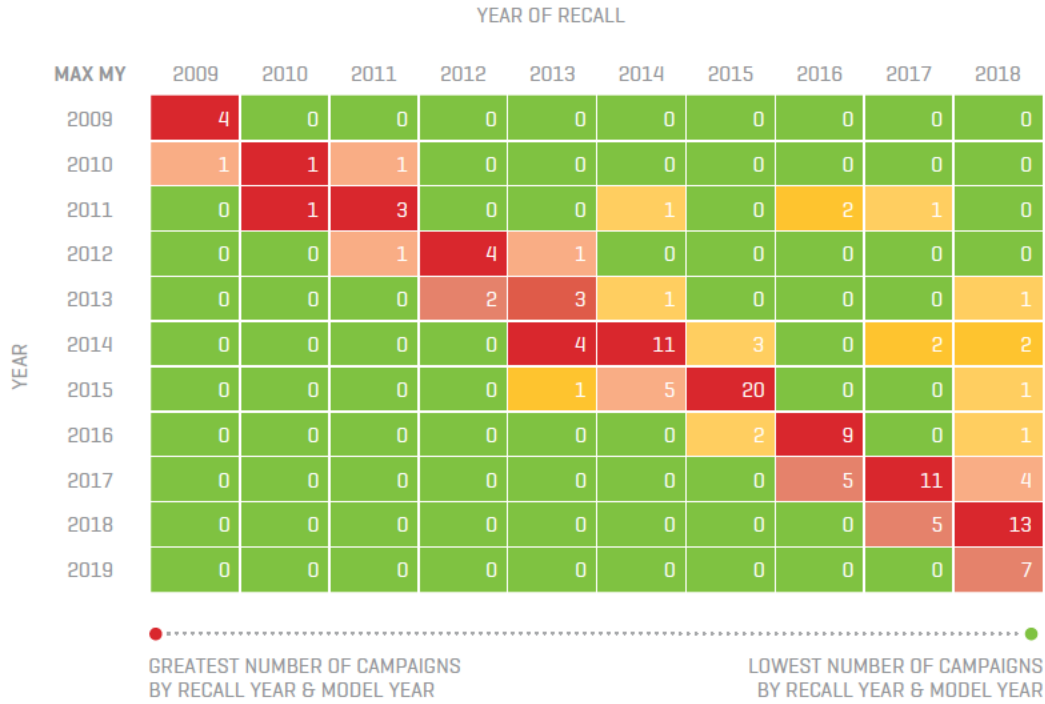
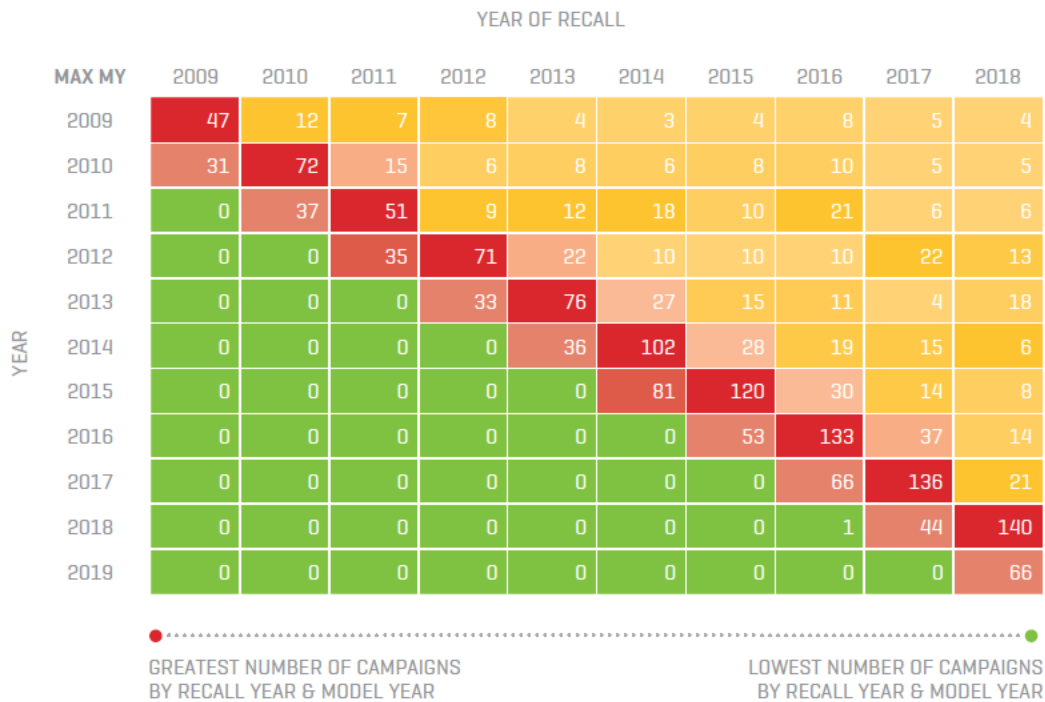


FIGURE 32 / EMERGENCE OF NON-SOFTWARE-BASED RECALLS



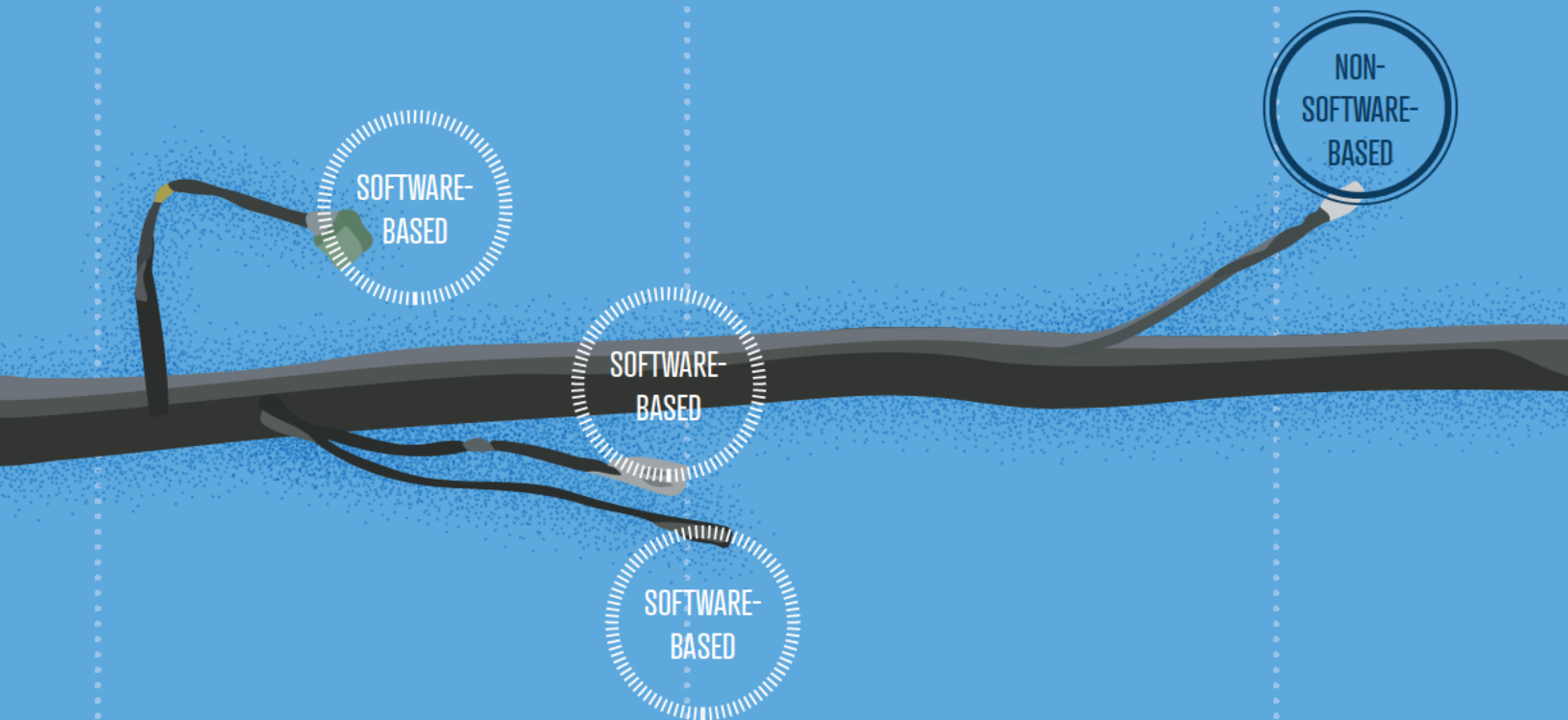
YEAR 0

YEAR 2

YEAR 4

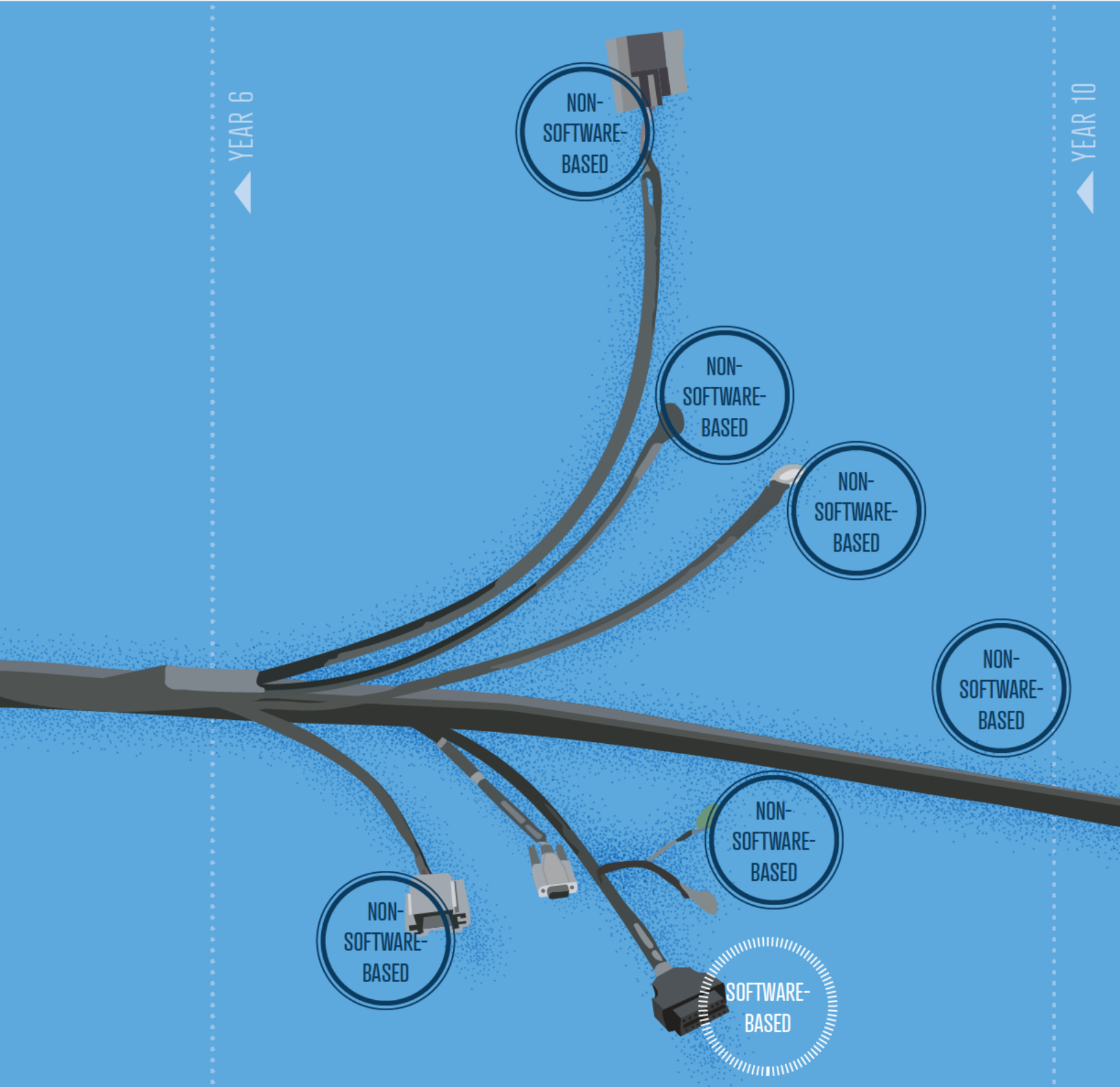
Defect Emergence & Tail Risk Conclusions

Manufacturers and suppliers can use Stout's findings to better understand the emergence patterns and nature of tail risk associated with electronic component defects, and be better prepared to manage the impact of related service campaigns.



SOFTWARE-BASED ELECTRONIC RECALLS

- » To date, almost exclusively present within the first two years of a vehicle's life, with limited tail risk
- » Involve smaller vehicle populations due to limited cohort of model years affected
- » Repairs may be simpler/more convenient for owners, and can often be performed with a software update



NON-SOFTWARE-BASED ELECTRONIC RECALLS

- » Emergence patterns indicate wider dispersion (and greater tail risk) compared to software-based defects
- » Potential for larger vehicle populations due to breadth of model years affected

Remedies for Electronic Component Defects

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.

Stout’s analysis is based on the review of thousands of electronic defect descriptions, and focuses on the following remedy characteristics:

- » REMEDY PROCEDURES
- » REMEDY TIME
- » DELIVERY METHOD
- » COMPLETION PERCENTAGES

Through its analysis, Stout identified differences in the characteristics of non-software vs. software-based remedies that provide insight into the nature of remedies for electronic component defects. This information can be used to better anticipate the potential costs of such campaigns.

REMEDY PROCEDURES

Stout reviewed narrative remedy descriptions for every electronic component recall that occurred in the past 10 years. This allowed Stout to characterize the nature of each repair and analyze its potential costs. From this analysis, Stout was able to draw the following distinctions between IEC defects and electronic component defects involving software, and their respective remedy procedures:

IEC COMPONENT DEFECTS (NON-SOFTWARE RELATED)



- Repairs are conducted at a dealership
- The financial exposure for OEMs and suppliers is directly linked to the cost of materials, retail mark-ups, handling costs, labor, and the number of vehicles involved; this follows the model for more traditional defect remedies
- Do not involve software defects or software remedies
- Involve the inspection, repair or replacement of failed components



SOFTWARE-BASED COMPONENT DEFECTS

May be conducted remotely

Costs are significantly influenced by the costs associated with the development of a software fix

May be remedied by a combination of component replacement and/or an update to the software affecting the defective component

REMEDY TIME

Stout analyzed Technical Service Bulletins and reviewed remedy instructions for every software-based recall initiated in 2018. From this, Stout observed that remedy times for software-based defects are more standardized than non-software-related defects which allows for the following quantification:

0.2-2.0 Hours // Range of Software Remedy Times Observed

0.6 Hours // Average of Software Remedy Times Observed

*Software-based remedy times typically provide for driving a vehicle in/out of the service bay, stabilizing the vehicle power supply, connecting the service tool to the vehicle's USB or data port, and performing the update. The relative standardization of software-based remedy procedures influences the narrow range of remedy times observed for electronic component defects.

Non-Software-Related Defects

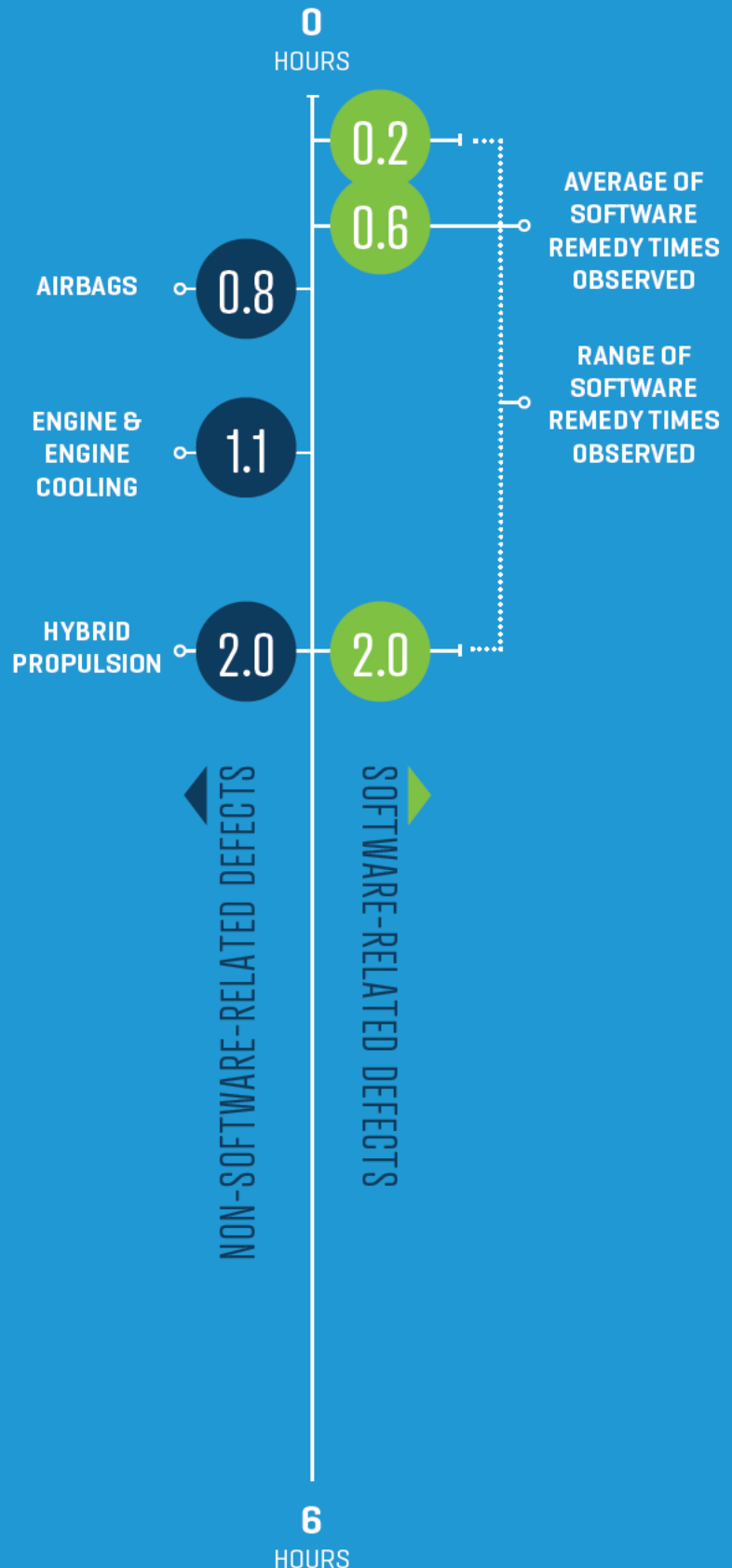
Remedy times for the inspection and repair or replacement of defective components are dependent on the type of component affected, location of the component, nature of the defect, and nature of the repair that does not allow for standardization.

Based on 2018 data, Stout observed the following average remedy times for non-software-related electronic component defects:

0.8 Hours // Airbags

1.1 Hours // Engine & Engine Cooling

2.0 Hours // Hybrid Propulsion



REMEDY DELIVERY

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

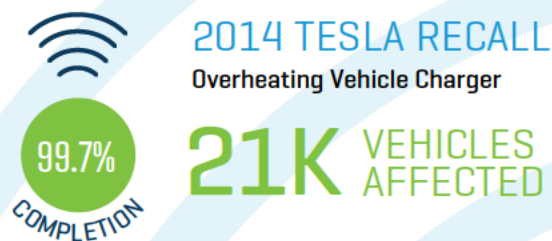
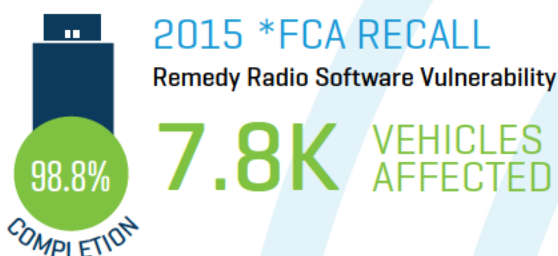
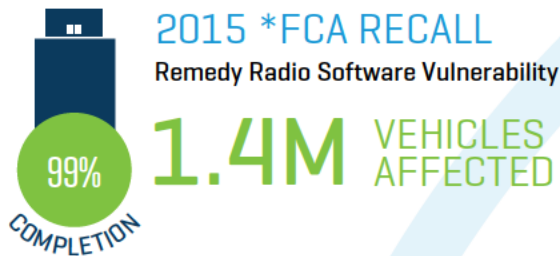
Most software remedies that take advantage of alternative delivery methods involve updates to non-safety critical functions like navigation, infotainment, and a vehicle's sound system. For this reason, the delivery of these remedies is most commonly found in field service actions other than safety recalls.

OVER-THE-AIR (OTA) REMEDIES

Software updates are pushed to vehicles over wireless networks

To date, there are limited examples of USB flash drive or OTA delivery of software remedies for component defects involved in a safety recall.

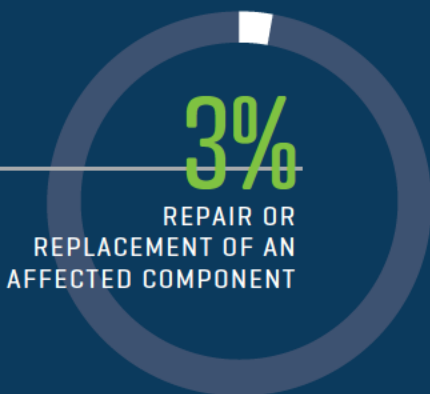
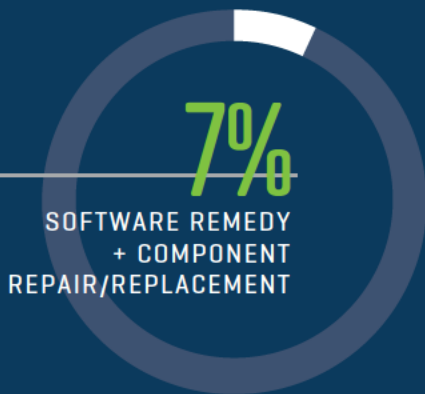
They include the following:



The ease of the USB and OTA remedies employed in these recalls indicates how successful such remedy delivery techniques may be at overcoming owners' perceptions about the inconvenience of recall repairs. It should also be noted that each of these campaigns involved vehicles that were three years old or less at the time of recall, another indicator of owners' willingness to comply with safety recalls, resulting in higher completion percentages.

*The two FCA Recalls listed above were initiated to remedy the same issue

THE PAST 10 YEARS OF REMEDY FOR SOFTWARE-BASED DEFECTS



While OTA and USB remedies offer manufacturers and suppliers a promising opportunity to minimize the financial and managerial costs associated with future recalls, they don't come without risks of their own.

YEAR 1

YEAR 10

In 2019, GM unveiled a new OTA system for its vehicles that will be capable of handling 4.5 terabytes of incoming data per hour.¹⁶

When the Remedy Is the Problem

OEMs and suppliers should be wary of how software updates, including those provided OTA and via USB, integrate with other vehicle systems. Stout analyzed several recent Technical Service Bulletins that specify OTA updates as the problem source and observed the following manifestations:



FCA
1 OTA ATTEMPT CAUSED VEHICLE RADIOS TO BECOME INOPERATIVE

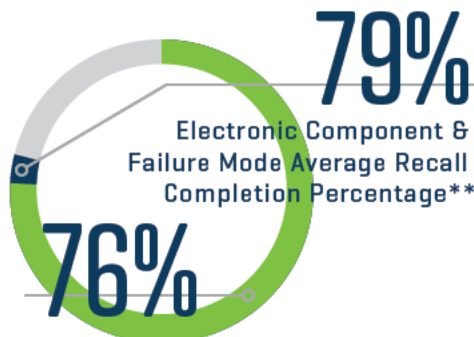


HONDA/ACURA
3 SEPARATE OTA ATTEMPTS CAUSED ERROR CODES TO DISPLAY

Even though advanced delivery of remedies via USB and OTA come with their own potential for risk, they also present opportunities for increased recall remedy participation and reduced remedy costs related to replacement components and service labor. In accordance with these benefits, several OEMs have made public their plans to expand their usage of these delivery methods in the near future. GM and Ford plan to have most of their vehicles accept OTA updates by 2020.¹⁵

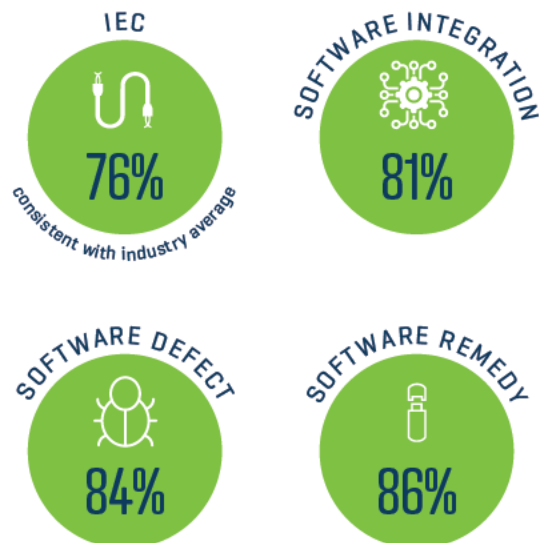
Remedy Completion Percentages *Electronic Defects and Failure Modes*

Remedy completion percentages for electronic component defects and failure modes are higher than the overall industry average. Software-related defects have a higher average completion percentage due to a newer, smaller vehicle population, the relative convenience of the remedies available (including the few instances where USB flash drive and OTA remedies were employed), and the increased likelihood of successful outreach to the owners of these vehicles.



Industry Average Recall Completion Percentage

Stout observed a disparity in completion percentages between recalls involving IEC defects and those focusing on software-related defects. Since IEC defects receive traditional remedies (on-site inspection and repair/replacement) and are typically associated with an older and larger vehicle population, it follows that the completion percentage for IEC defects would align more closely with the industry average, as the numbers below indicate:



*2008 – 2017

** Excludes Taka Recalls

Automated and Autonomous Ve

Automated and autonomous vehicles continue to be both highly scrutinized by the automotive industry, consumers, and highly scrutinized by the automotive industry, consumers. While Stout expects incremental progress to continue in the near future, the complex interconnectivity required to make autonomous vehicles a reality from both a safety and performance perspective makes manufacturers to proceed with caution.

That said, there were new developments in the progress of autonomous vehicles in 2018. Noteworthy developments included the following:

In September, the DOT released Automated Vehicles 3.0: Preparing for the Future Of Transportation¹⁷ (“AV 3.0”) which contained principles to guide future policy, including:

- » Multi-modal safety guidance
- » Clarification of policy and roles
- » How to work with DOT as technology evolves
- » Integration of DOT administrations

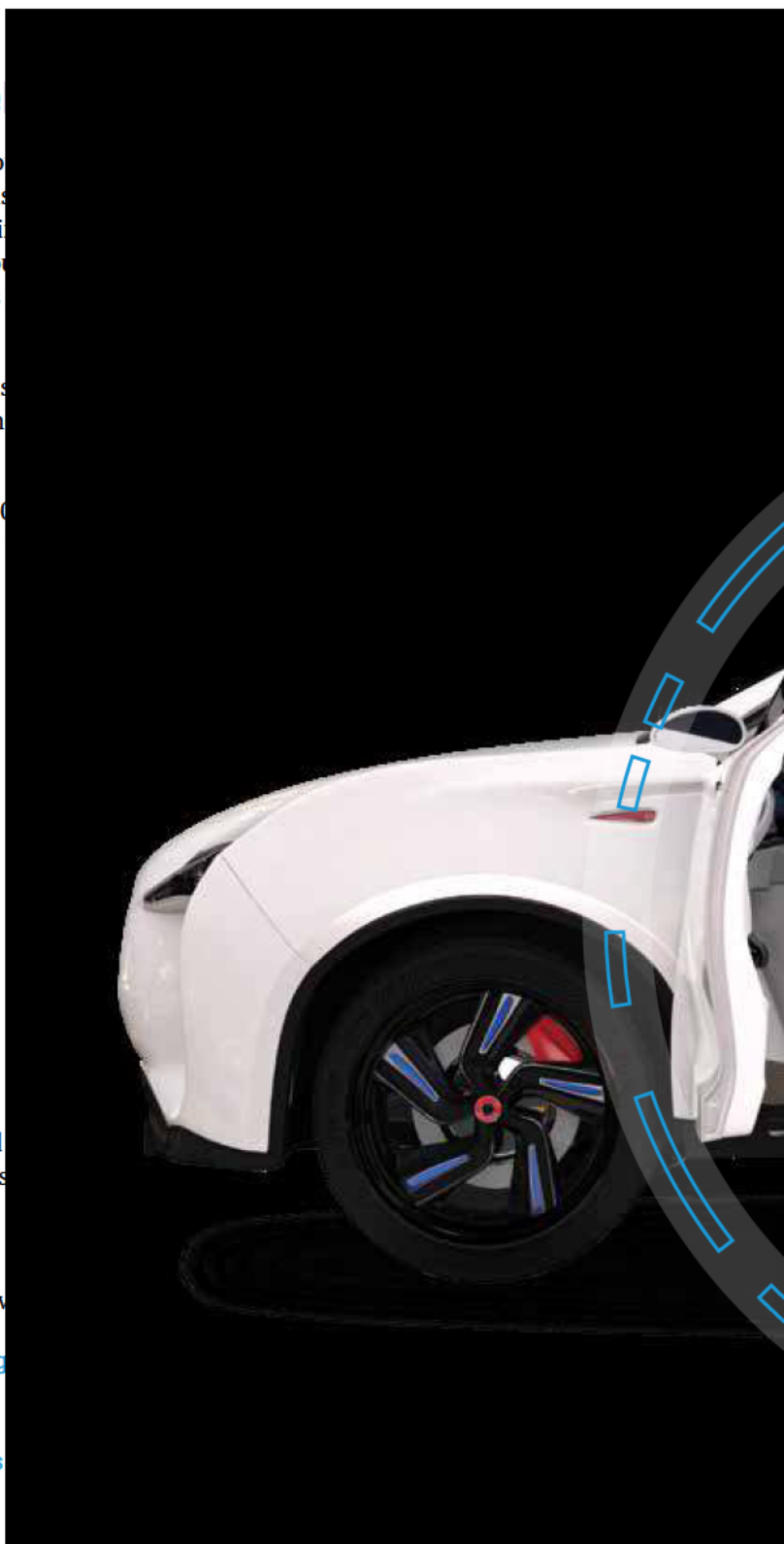
In addition to the above principles, AV 3.0 also makes key clarifications of DOT policy, describes opportunities for industry stakeholders to collaborate, and reinforces the collaborative focus on safety of DOT’s administrations.¹⁸

In October, the Governor of Pennsylvania signed an act allowing the “platooning” of two or three buses, military vehicles, or motor carriers. The vehicles would employ a combination of V2V communications systems and vehicle automation to control acceleration and braking, and enable traveling in close proximity.¹⁹

The benefits of this signed legislation include the following:

- » A reduction in aerodynamic drag, resulting in fuel savings and reduced emissions
- » Less excessive braking, which would lessen the impacts on infrastructure and congestion

In 2018, GM submitted a petition to NHTSA to waive certain features required by NHTSA in order to put zero-emission, driverless vehicles on public roads by the end of 2019. Public comment on the petition closed in May of this year.







Electronic Component Defects *Conclusions*

01

The gap in recall activity between non-software and software-related defects was one of the significant trends of 2018. Recalls involving software-based defects, and the number of vehicles affected by these defects, reached record levels in 2018. As more sophisticated electronic components and systems continue to be integrated into more vehicles, Stout expects the elevated level of software-based defects to continue.

02

Stout's analysis also revealed that software-related defects demonstrate a more predictable emergence pattern than non-software defects, which includes a much shorter tail of exposure. Again, it is important to note the relatively young age of a large number of vehicles equipped with these technologies, and to allow for the possibility of new emergence patterns as these vehicles continue to age.

03

Non-software defects present with a less concentrated emergence pattern, and a longer tail of exposure, which is consistent with the defects of traditional components.

04

Software-based defects are more commonly addressed by software remedies, which significantly reduce the inconvenience for vehicle owners and increase recall compliance. Software remedies also typically reduce repair costs.

05

Currently, most alternative delivery methods like OTAs and USBs are being used for non-safety-critical functions, but several major manufacturers have publicized plans to make these delivery methods a more significant part of their future vehicles.

06

Remedy times for software-based defects indicate less variability than those of non-software-related defects, which are often influenced by the type & location of component affected, nature of the defect, and nature of repair.





TIRES

In 2017, **738**
people died in tire-related
traffic fatalities.²²

Every year, there are approximately **33,000 tire-related passenger vehicle crashes**, resulting in **19,000 injuries**.²⁰ Despite the fact that tires are critical to driver and vehicle safety, **many vehicle owners are not as diligent as they could be in regard to tire maintenance**, and that includes compliance with tire recalls.

In 2014, the National Transportation Safety Board addressed the issue of tire safety and identified the following concerns and areas for improvement:

- » Problems with the tire registration and safety recall system
- » Failure to establish the current level of crash risk posed by tires aging and lack of consumer guidance on the issue
- » Poor tire maintenance by consumers
- » Barriers to technological innovation that could prevent or mitigate tire-related crashes²¹

Stout conducted a comprehensive analysis of tire recalls to better understand the root causes of tire defects, the challenges faced by manufacturers and dealers in executing tire recalls, as well as the resulting levels of remedy completion. Stout's analysis includes a review of the properties of tires and factors that lead to their degradation and failure, the challenges of owner registration/identification and their effect on completion percentage, owner notification requirements, and remedy requirements specific to tire manufacturers. The insight gleaned from the data and analysis in this section can help manufacturers develop a thoughtful and targeted strategy to better engage stakeholders in the effort to enhance safety and improve the performance of tire recalls.

Tire Recalls: Tire and Vehicle Manufacturers

It is important to note the difference between tire recalls initiated by tire manufacturers and recalls initiated by vehicle manufacturers that involve tires:

» TIRE RECALLS INITIATED BY **TIRE MANUFACTURER**

Typically involve an issue of safety or non-compliance related to the manufacturing, materials or labeling of the tire itself

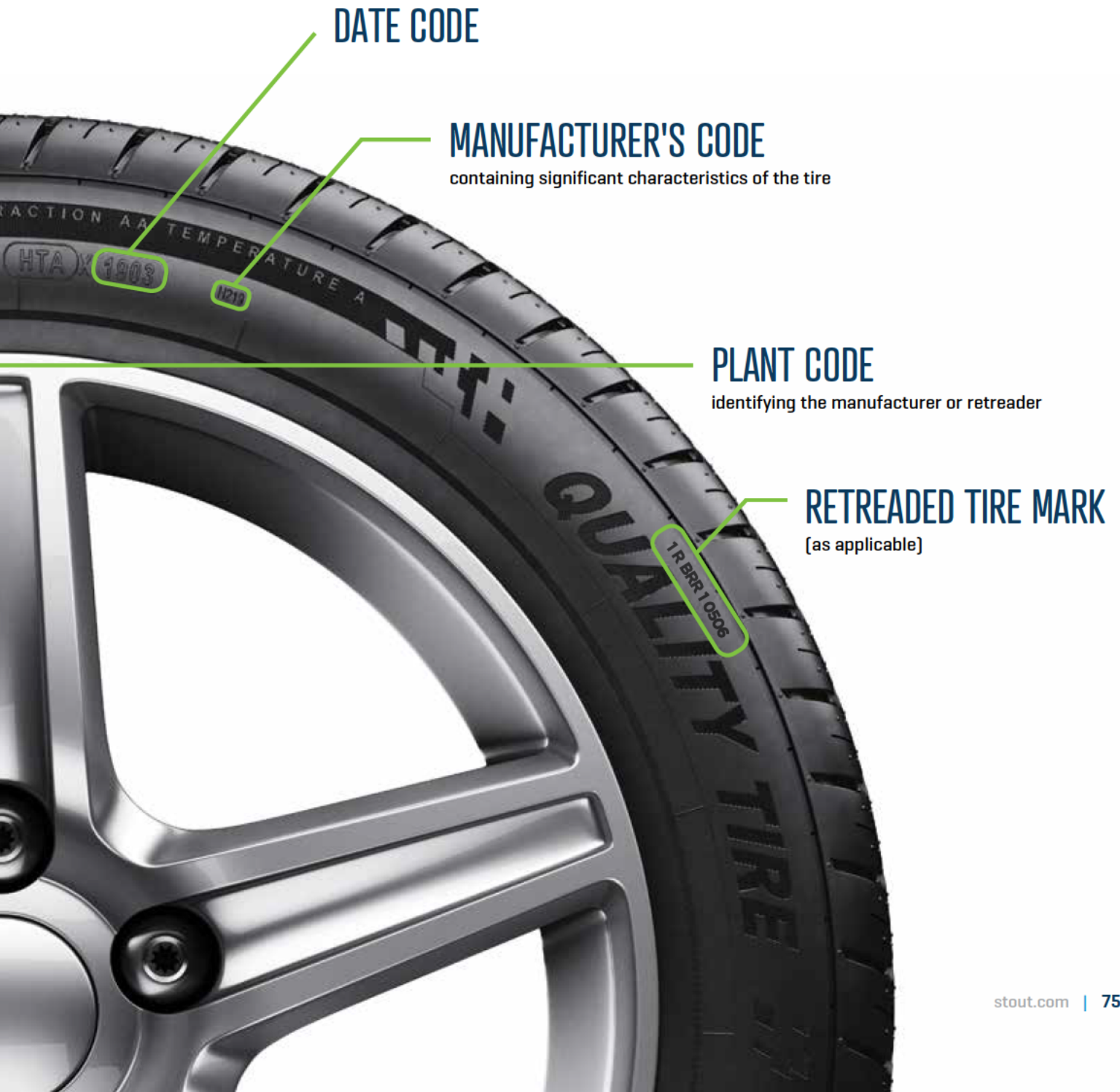
» TIRE RECALLS INITIATED BY **VEHICLE MANUFACTURER**

- ▶ Tires are damaged during vehicle assembly
- ▶ A defect exists with the tire pressure monitoring system
- ▶ The installation of incorrect tires



Both tire and vehicle manufacturers are subject to the reporting and notification requirements of Parts 573 and 577 of the Federal Motor Vehicle Safety Standards. Tire manufacturers must also adhere to the tire identification and record keeping requirements of Part 574.

Part 574 requires tires sold in the U.S. to have labels that include the following information:



Tire Deterioration

Tires are susceptible to age, use, and climate-related deterioration, with a significant amount of evidence indicating that tires exceed their useful life after six years on the road.²⁵ This is due to a combination of factors that can have a deleterious effect on the condition of a tire over time. Some of these factors include the following:

OXIDATION

The oxygen within a tire's structure causes the tire to lose its elasticity, become brittle, and degrade. This degradation occurs from the inside out, which makes it challenging to diagnose, especially for vehicle owners. In particular, oxidation affects the rubber between and around steel belts. Cracks that form along the belts continue to widen until they eventually lead to tread separation, which is a significant cause of tire failures.

HIGH TEMPERATURES

Under-inflation and ambient heat both generate high temperatures within a tire's structure, which exacerbates tread separation failures and accelerates aging.

STRESS FROM SERVICE

Lack of safety awareness and deficient maintenance practices by vehicle owners can expedite tire degradation. When a defect is present, these practices exacerbate the impact of the defect, especially in older tires.

As *Figure 33* shows, the majority (55%) of tire recall campaigns that have been initiated over the past 10 years are related to tread/belt defects, which include the following conditions:



INSUFFICIENT
TREADING



CHUNKING/
CRACKING



TREAD
SEPARATION

FIGURE 33 / PERCENTAGE OF UNIQUE CAMPAIGNS BY COMPONENT & YEAR

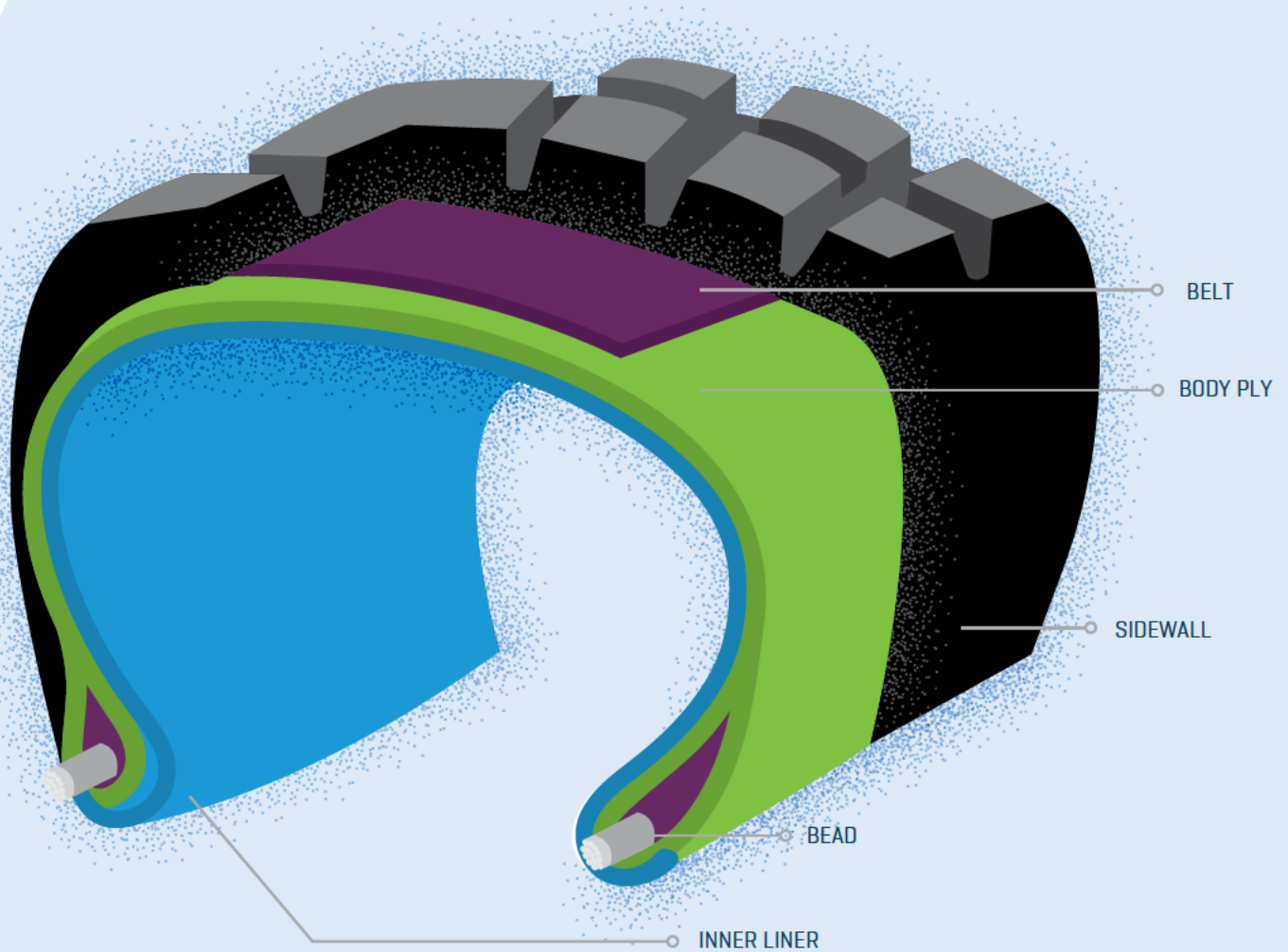
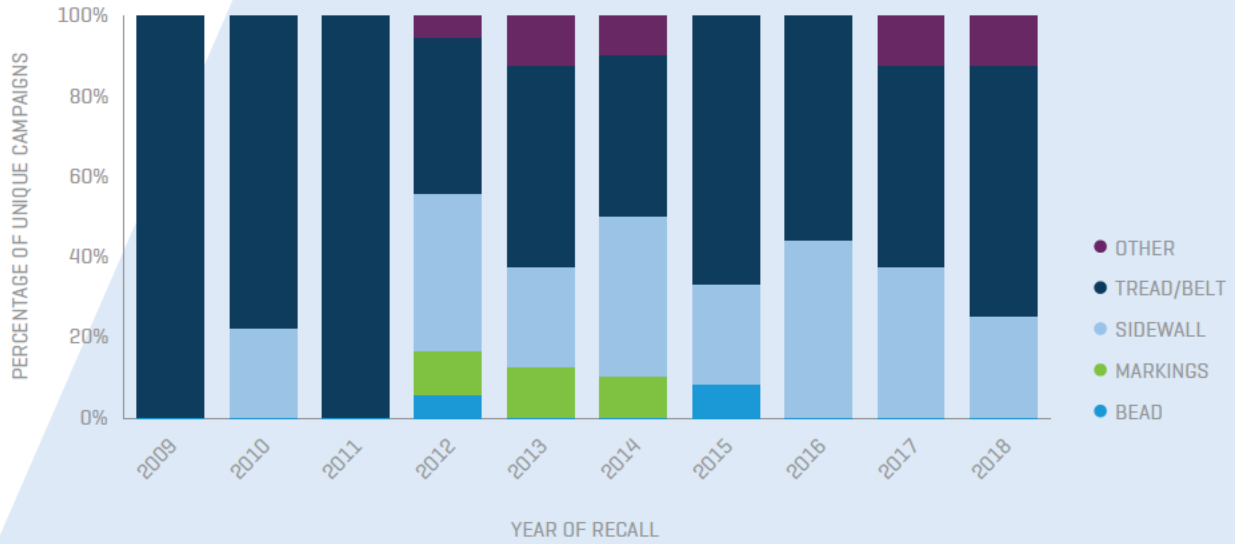


FIGURE 34 / UNIQUE TIRE CAMPAIGNS AND UNITS AFFECTED BY YEAR



FIGURE 35 / TIRE RECALL SEVERITY (2009-2018)

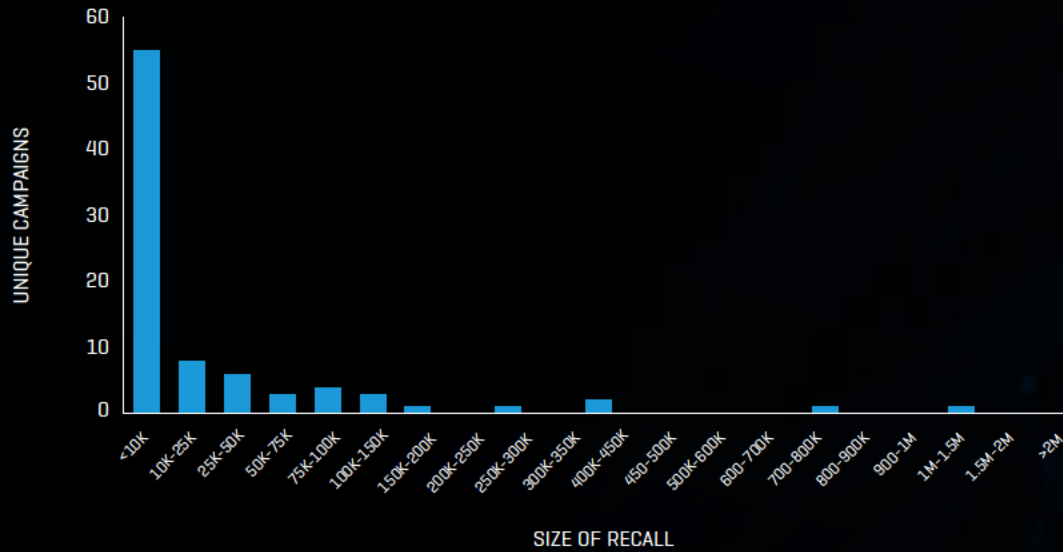
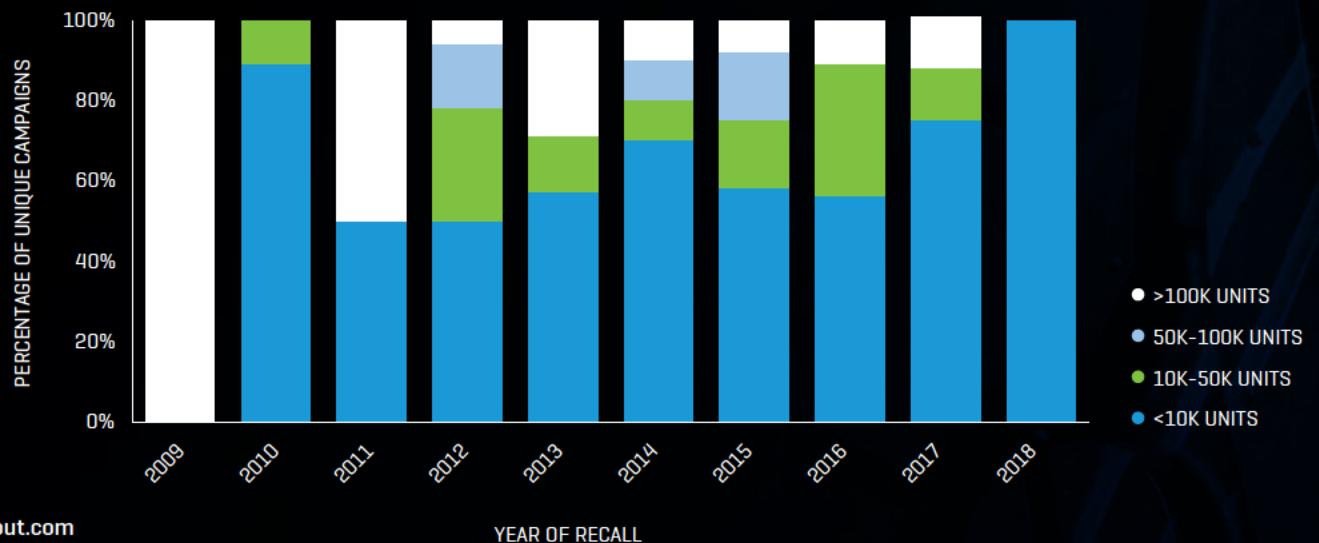


FIGURE 36 / PERCENTAGE OF UNIQUE CAMPAIGNS BY SIZE OF RECALL



Stout has reviewed recalls initiated specifically by tire manufacturers from the past 10 years to analyze particular trends, separate from recalls initiated by vehicle manufacturers. In order to focus on conditions specific to light vehicles, Stout has excluded data related to trailer tires, motorcycles, and other vehicles outside the light vehicle category.

As *Figure 34* illustrates, tire recalls are relatively infrequent, with an average of nine unique campaigns each year. In 2018, there were eight tire recalls, which affected 18 thousand units.

These smaller recall sizes indicate that they are often related to the manufacturing of tires or specific materials used, which means they can be narrowed down to specific dates and production lots.

As *Figures 35* and *36* reveal, the large majority of tire recalls affect less than 10,000 units, a trend that has increased over the last two years. These smaller recall sizes indicate that they are often related to the manufacturing of tires or specific materials used, which

means they can be narrowed down to specific dates and production lots.

The relative infrequency of tire recalls shouldn't prevent tire manufacturers from implementing safety and risk-mitigation protocols, especially considering how critical tires are to the safety of vehicle occupants and vehicles themselves. Affecting successful tire recall campaigns can increase vehicle safety and reduce exposure to potential future litigation.

Tire Recalls *Completion Percentage*

30%

Since 2009, the **average completion percentage for tire recalls involving light vehicles is 30%**, far below the overall light vehicle average of 76%.

There are several variables that impact the completion percentages of tire recalls:

LIMITED REQUIREMENTS TO COLLECT REGISTRATION INFORMATION

The success of a tire recall depends in large part on collecting accurate contact information from vehicle owners during the tire registration process at the time of purchase. This enables manufacturers to compile a more comprehensive database of owner contact information and tire location data in the event of a future tire recall. Dealers and distributors controlled by a manufacturer are required to register newly purchased tires for their consumers and to forward the registration information on to the tire manufacturer. However, only a small percentage of tire dealers fall into this manufacturer-controlled category. Independent dealers and distributors are only required to provide tire purchasers with a registration form containing their business ID and the TINS of the tires being purchased. Independent dealers and distributors may elect to complete and mail these forms to manufacturers on behalf of their customers, but tire registration is often left to the vehicle owners themselves, and some don't follow through. This leaves manufacturers in a tenuous position. Without a database of names and addresses, the effectiveness of direct notification to affected tire owners is limited when a tire recall occurs.

LIMITATION ON MANUFACTURER'S REQUIREMENT TO REMEDY

Tire manufacturers are required to remedy defective or nonconforming tires within the first 180 days after a vehicle owner's receipt of a notification letter or the vehicle owner's receipt of notification that a replacement is available. A robust vehicle-owner database would enhance a manufacturer's ability to notify affected owners, re-stock (if necessary) affected tires and replace recalled tires within the prescribed timeframe. However, due to the difficulties that manufacturers have with obtaining registration information from tire owners, this period often passes without significant remedy completion. After 180 days, it is up to a manufacturer's discretion whether to remedy defective tires or not.

TIRE AGE/ REPLACEMENT

As tires age, they are more likely to be replaced in the course of ownership. Therefore, when a tire recall involving older tires is initiated, there's a reasonable likelihood that some of the tires affected will no longer be in service on a vehicle. Instead, the affected tires may have already been removed from the population without being remedied. This poses a dilemma for manufacturers. Without a comprehensive database, it is a significant challenge to account for the tires that have been taken out of service so they can then be reflected in any tabulation of completion percentage. This hurdle is in addition to the challenges these manufacturers face when trying to conduct outreach with owners of an older vehicle population, some of whom may have relocated or changed owners since the original registration.

Figure 37 shows the average completion percentage for tire recalls by quarter, and also illustrates the relationship between age and remedy completion.

The average completion percentage for tires older than 5 years is **LESS THAN 5%.**

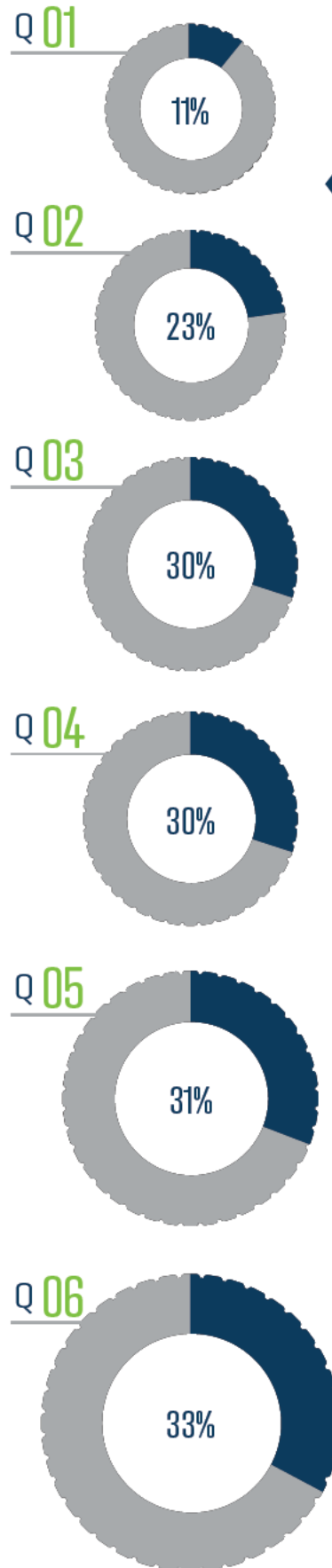
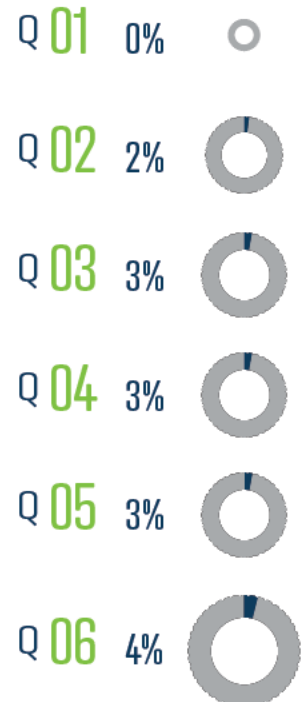


FIGURE 37 / SUMMARY OF AVERAGE COMPLETION BY QUARTER

◀ **Recalls with model years 3 years & younger**

Recalls with model years 5 years & older ▼



Increasing Tire Recall Completion Percentage

Without an enhanced registration requirement for purchasers of tires, manufacturers must explore other avenues to encourage the participation of affected owners in tire recall campaigns. These opportunities include the following:

ENHANCED VEHICLE OWNER OUTREACH

Similar to the strategies identified in the Takata Monitor's Report, tire manufacturers must embrace new and progressive means of outreach in order to communicate with tire owners. An escalation strategy of communication tactics could be utilized in which new modes of contact are introduced at different points throughout a campaign in order to combat a deceleration in compliance. [See *Figure 38.*]

INCREASED DATA SHARING

An increase in the level of collaboration between tire manufacturers, dealers, and maintenance facilities could enhance manufacturers' ability to locate and communicate with vehicle owners in the event of a tire recall. For example, when a vehicle is in a dealership or maintenance facility for service, there is an opportunity for the identification number of the tires to be checked and recorded to make sure they are not under recall. This type of collaboration would give manufacturers additional points of contact with vehicle owners throughout a tire's lifespan.

RAISING AWARENESS AMONG VEHICLE OWNERS

In an effort to address low levels of owner participation and communicate a sense of urgency about tire defects, manufacturers could enhance their attempts to educate vehicle owners about the importance of tire maintenance and safety, as well as the risks associated with driving on a potentially defective tire.

SEGMENTED ANALYSIS

Following the examples detailed in the Takata Monitor's Report, it may be important for tire manufacturers to identify the different segments of their owner populations in order to create customized, and therefore more effective, methods of outreach.



FIGURE 38 / SUMMARY OF AVERAGE COMPLETION PERCENTAGE BY QUARTER



FIGURE 39 / OVERALL MEDIAN & AVERAGE COMPLETION PERCENTAGE BY YEAR



The lack of viable owner information, collaboration between manufacturers and dealerships/maintenance facilities, and owner awareness about tire safety are impediments to implementing effective tire recalls. However, the latest recall completion percentage data in *Figure 39* reveals an improvement in remedy completion rates. It is likely that NHTSA's industry-wide, results-oriented focus on recall completion has contributed to the increase. An elevated emphasis on tire safety directed at vehicle owners by NHTSA, the industry and consumer advocacy groups could also be a contributing factor, but more can be done to focus owners' attention on the specifics of tire maintenance and the importance of recall compliance.

ADDITIONAL SOURCES OF DEFECT DATA

NHTSA's recall database offers a great deal of invaluable recall-related information regarding component defects, defect consequences, and prescribed recall remedies, as well as information about vehicle models and production populations affected by particular recalls. While NHTSA's database is a critical source of information for Stout's analysis of automotive component defects, it is important to note that this data contains only those component defects that result in safety recalls in the United States.

In order to gain a more comprehensive view of overall industry activity and trends, Stout identified, collected, and analyzed additional sources of defect data that extend beyond the information available in the NHTSA recall database. The defects identified in these data sets may not result in safety recalls, but the information provides perspective and insight into emergence patterns and defects not provided in NHTSA recall data.

Early Warning Reporting (EWR)

In 2000, Congress passed the Transportation Recall Enhancement Accountability and Documentation Act (TREAD) which included a provision that required NHTSA to establish early warning requirements for all motor vehicle manufacturers. In response to TREAD, NHTSA issued new rules in 2002 that required automobile manufacturers to promptly report information that could indicate the existence of a component defect. This information includes production information, information on incidents involving death or injury, aggregate data on property damage claims, consumer complaints, warranty claims, field reports, and copies of field reports (other than dealer reports) involving specified vehicle components, a fire, or a rollover on a quarterly basis.²⁴

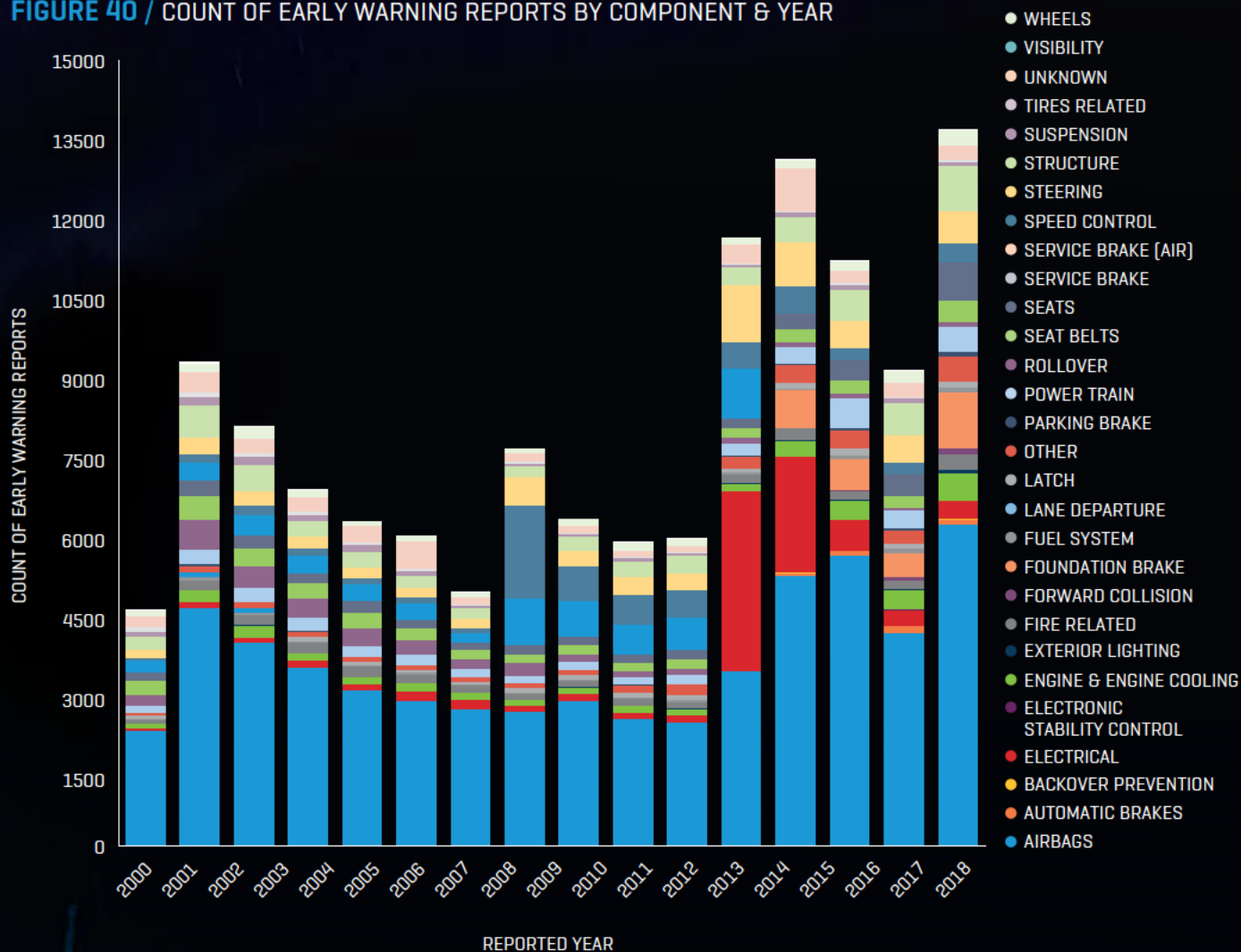
The 2018 activity mirrors that from recent years (See Figure 40). Airbags continue to be a category for increased EWR activity. Other observations include the following:



» Advanced driver assistance is beginning to appear in data:

- Automatic brake first observed in 2015 increased by more than 2.5x through 2017
- Forward collision first observed in 2016 increased by 3.5x in 2017

FIGURE 40 / COUNT OF EARLY WARNING REPORTS BY COMPONENT & YEAR



NHTSA Investigations

NHTSA's Office of Defect Investigations (ODI) analyzes owner questionnaire data, in combination with other available information to determine whether an unusual number of safety-related complaints have been lodged in regard to specific vehicles, components or equipment. There is no set number of complaints that must be received before NHTSA investigates a potential safety defect. Instead, when evaluating whether to initiate an investigation, ODI considers the number of reported complaints and the severity of the consequences against the number of vehicles manufactured and how many years the vehicles have been in service.

DIFFERENT TYPES OF NHTSA INVESTIGATIONS

PRELIMINARY EVALUATION (PE)

In the initial phase of a NHTSA investigation, a PE is prompted after a review of consumer complaints and/or manufacturer service bulletins to suggest a safety defect may exist. The results of a PE determine whether the investigation will be upgraded to an Engineering Analysis or closed. Most PEs are resolved within four months.

ENGINEERING ANALYSIS (EA)

In the second and final phase of a NHTSA investigation, an EA is undertaken if data from a PE indicates further examination of a potential safety defect is warranted. The results of an EA determine whether a safety recall should be initiated or the investigation should be closed. Most EAs are resolved within one year.

RECALL QUERY (RQ)

NHTSA monitors active recalls to ensure that the scope, completion percentage, and remedy are adequate. If recall adequacy comes into question, an RQ is opened to determine if the scope of the recall should be expanded or an adjustment in existing remedies is required.

DEFECT OR RECALL PETITION (DP OR RP)

NHTSA may be petitioned by the public to investigate an alleged safety defect or whether a manufacturer has successfully carried out the requirements of a recall. If the petition is granted, NHTSA opens an appropriate investigation. If the petition is denied, the reasons for denial are published in the Federal Register.²⁵ The petition process is described in greater detail in the following section of this report.

The number and emphasis of NHTSA investigations should be a significant area of interest for OEMs and suppliers in order to understand the agency's safety priorities and focus on categories of potential defect, which may result in risks to safety. As *Figure 41* shows, 2018 marked the third consecutive year that NHTSA investigations increased. However, the number of NHTSA investigations conducted in recent years hasn't approached the higher numbers of years prior, a trend that coincides with the industry's efforts to initiate recalls quickly, thus limiting the need for NHTSA intervention.

Recent Notable Recalls Involving NHTSA Investigations

In February 2018, Hyundai recalled over 154,000 2011 Sonata vehicles due to a potential short circuit in the airbag control unit (ACU). NHTSA opened a PE on March 16, 2018 to evaluate the scope of the recall, evaluate the root cause analysis performed by the OEM, and determine whether other manufacturers may potentially be involved. In April 2018, Hyundai expanded the recall to include an additional 425,305 2012 – 2013 Sonata and 2011 – 2012 Sonata Hybrid vehicles.

2011-2012 HYUNDAI SONATA HYBRID

2011-2013 HYUNDAI SONATA

425K+ VEHICLES AFFECTED

Potential short circuit in the airbag control unit

In August 2018, Ford initiated a recall affecting over 1.6 million F-150 Regular Cab and SuperCrew Cab vehicles due to a potential fire hazard associated with the deployment of a front seatbelt pretensioner. NHTSA had previously opened a PE on June 18, 2018, to investigate similar consumer complaints.

FORD F-150 REGULAR & SUPERCREW CAB

1.6M+ VEHICLES AFFECTED

Potential fire hazard associated with the deployment of a front seatbelt pretensioner

In January 2019, Chrysler recalled nearly 800,000 2013 – 2018 Ram 3500 and 2014 – 2018 Ram 3500 Chassis Cab and Ram 2500 vehicles in response to the possibility that an outboard steering linkage jam nut could loosen, thereby allowing one end of the drag link to separate. Prior to the recall, NHTSA had opened a PE to evaluate the cause, consequences, scope, and frequency of the alleged defect after identifying relevant consumer complaints.

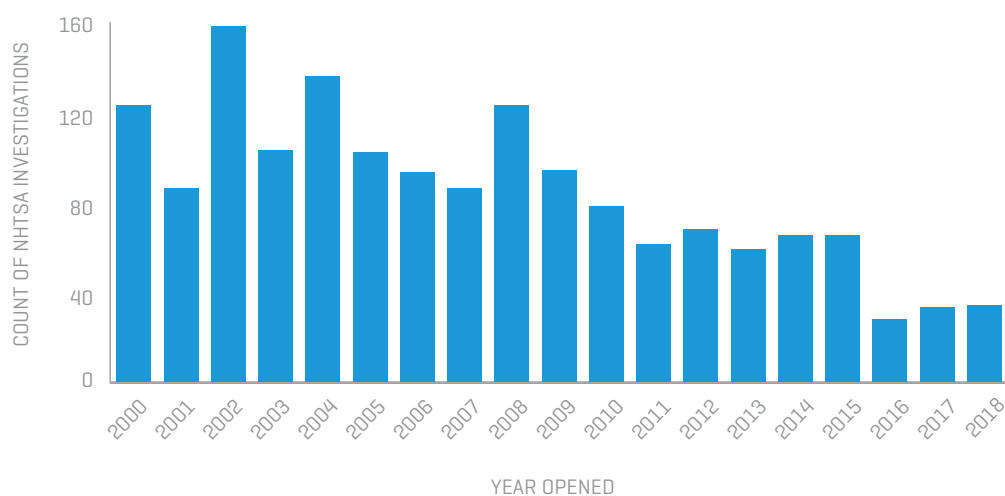
2018 CHRYSLER RAM 3500

2014-2018 RAM 3500 CHASSIS CAB & RAM 2500

800K VEHICLES AFFECTED

Possibility that an outboard steering linkage jam nut could loosen, thereby allowing one end of the drag link to separate

FIGURE 41 / COUNT OF NHTSA INVESTIGATIONS BY YEAR OPENED



Motor Vehicle Defect Petitions [MVDPs]

Under the Safety Act, the public has the ability to petition NHTSA to open an investigation into a suspected defect or to determine whether a manufacturer has appropriately conducted the recall notification and remedy process.

KNOWN AS MOTOR VEHICLE DEFECT PETITIONS [MVDPs], THESE SUBMISSIONS:

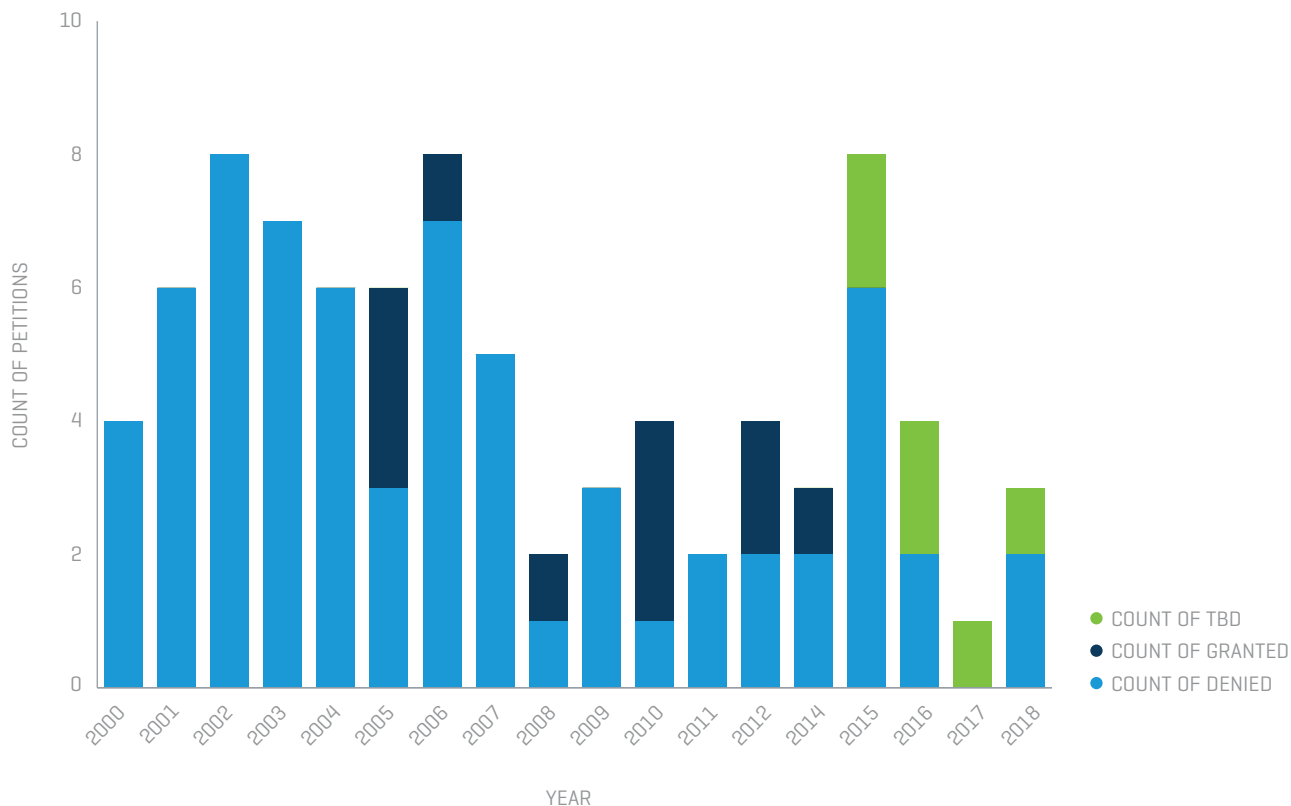
- » Provide unique insight into issues identified by the public
- » Highlight how NHTSA evaluates these potential safety concerns
- » Identifies whether a defect affects vehicle safety

The filing, granting, and denial of MVDPs may also be an early indicator of defects, field service actions, and recalls. (See *Figure 42*.)

NHTSA's denial of such a petition in May 2018 is instructive. An owner of a 2007 Jeep Patriot had previously requested that NHTSA open an investigation into an alleged defect resulting in a stalled engine after refueling. To evaluate the merits of this request, NHTSA analyzed other consumer complaints, reviewed two prior evaluations of the same apparent defect issue, and reviewed FCA technical and field information before issuing a petition denial. In its denial explanation, NHTSA explained that it considers several factors when evaluating safety risks related to engine stalling conditions, including speeds at which the stalling may occur, the driver's ability to restart the vehicle, warnings to the driver, vehicle controllability, when and where the stall may occur, and the impact of the stall on other safety systems of the vehicle. In reaching its conclusion, NHTSA stated that "conditions resulting in engine stall during low-speed operation at idle such as when slowing to a stop, and where the engine may be restarted right away, are considered by NHTSA to be among the least hazardous types of stalling problems and, absent other risk factors, are not considered to be unreasonable risks to safety."²⁶ This MVDP denial provides insight into NHTSA's framework for the evaluation of potential stall-related defects and describes how this framework may be applied to the issues raised by this petition. The denial also provides insight into what factors related to potential stall-related defects may pose an unreasonable risk to safety.

Another petition of note from 2018 was filed by the Center for Auto Safety (CAS) in response to non-crash fires that were occurring in multiple model years of Kia Optima, Sorento, and Hyundai Sonata and Santa Fe vehicles. The CAS petition cited hundreds of Vehicle Owner Questionnaire (VOQ) reports that were prompted by fires, melted wires, and smoke and/or burning odors taking place in these vehicles. After reviewing the VOQs, Early Warning Data, and other pertinent materials, NHTSA granted the CAS petition on March 29, 2019 and opened preliminary investigations to assess the scope, frequency, and potential safety-related consequences of non-crash fires in Hyundai and Kia vehicles. In its explanation, NHTSA said the following: "In addition to engine compartment fires, ODI has received allegations of vehicle fires affecting other components, including taillight housings, taillight wire harnesses, and/or light bulbs."²⁷ NHTSA's granting of this petition appears to reflect the severity of the potential defect, including the risk of fire elsewhere in the vehicle, and the significant number of owner complaints that had been submitted. Hyundai initiated two recalls in connection with the resulting investigation, affecting nearly 170,000 total vehicles (recalls 18V-934 and 19V-204); Kia initiated two recalls involving more than 450,000 vehicles (18V-907 and 19V-120).

FIGURE 42 / STATUS OF MOTOR VEHICLE DEFECT PETITIONS BY YEAR



170,000

Hyundai initiated two recalls in connection with the resulting investigation, affecting nearly 170,000 total vehicles.

Kia initiated two recalls involving more than 450,000 vehicles.

450,000+

Petitions for Inconsequential Noncompliance (PINs)

Vehicle and component manufacturers can request an exemption from the notification and remedy requirements of the Safety Act if their non-compliance doesn't pose a safety risk. If NHTSA grants a petition, the manufacturer is relieved of any further responsibility to provide notice or remedy of the defect or noncompliance.

As *Figure 43* shows, exceptions for all four of the following PINs submitted in 2018 were granted by NHTSA:

GM

Parking lamps not meeting activation requirements under certain conditions

NHTSA's grant of the petition considered that the condition has a low probability of occurrence, and if it did occur, it would be not be long lasting, and unlikely to occur when parking lamps are in use. In its decision, NHTSA also emphasized that "compliant parking lamps are important safety features of vehicles."

GM

Wheel manufacturing date labeling

NHTSA agreed with GM's assessment that the marking of wheels has no impact on the operation, performance, or safety of the affected vehicles, and that other date markings on the wheels can provide for accurate tracing of the components in the event of a defect.

TOYOTA

Removal of rear head restraints

NHTSA agreed with Toyota's position that the required degree of travel beyond the head restraint's adjustment position may minimize unintended removal of the rear head restraints, and indicate to the user that the restraint is being removed instead of merely adjusted to a different position. NHTSA also states in its grant of this petition that the decision does not change the agency's view that head restraints should not be able to be removed "without the use of deliberate action distinct from any act necessary for adjustment..."

TOYOTA

Front and rear seat materials do not meet burn rate requirements

NHTSA's grant of the petition notes several factors which mitigate the risk of fire related to the seat material as well as the insignificant quantity of the identified material in relation to overall interior materials and explains that the subject material is covered by other materials, which together, conform with the relevant standard.

PINs provide suppliers and manufacturers with useful insights into when NHTSA believes non-compliance poses a safety risk, as well as NHTSA's tolerance for different levels of risk in relation to components, types of failures, and their impact on driver and vehicle safety.

Technical Service Bulletins

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.

As *Figure 44* indicates, there were a significant number of TSBs involving electrical systems, engine and engine cooling systems, and equipment in 2018.

INTERNATIONAL

RECALL INFORMATION

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 2018 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 45* shows, Germany had more unique campaigns than the U.S. but saw a decrease in airbag activity, which is a definitive change from U.S. activity.

The number of vehicles recalled in Brazil has continued to increase since 2016, approaching a level consistent with the elevated number of vehicles recalled in 2014. A substantial proportion of the vehicles recalled in Brazil during 2018 involved engine related defects (See *Figure 46*).

FIGURE 45 / GERMAN RECALL CAMPAIGNS BY COMPONENT & YEAR

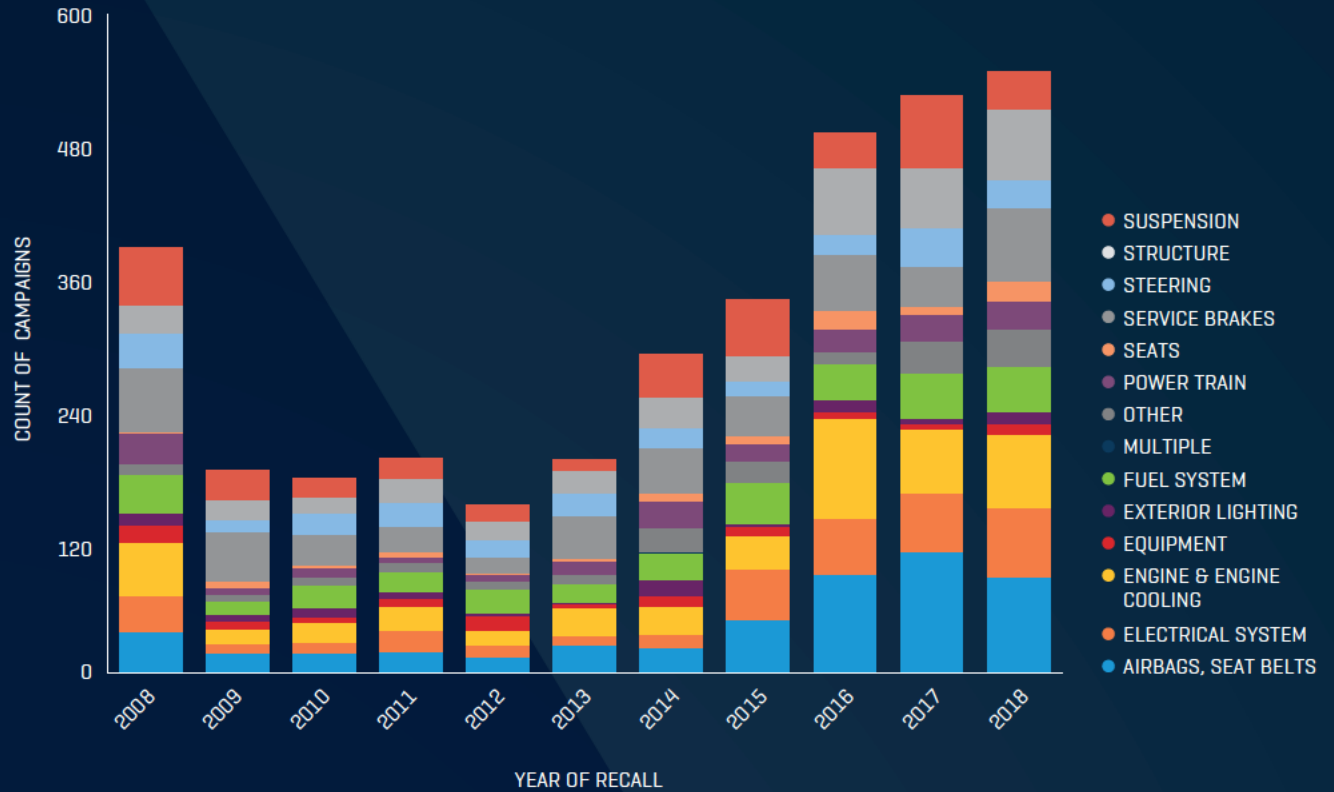
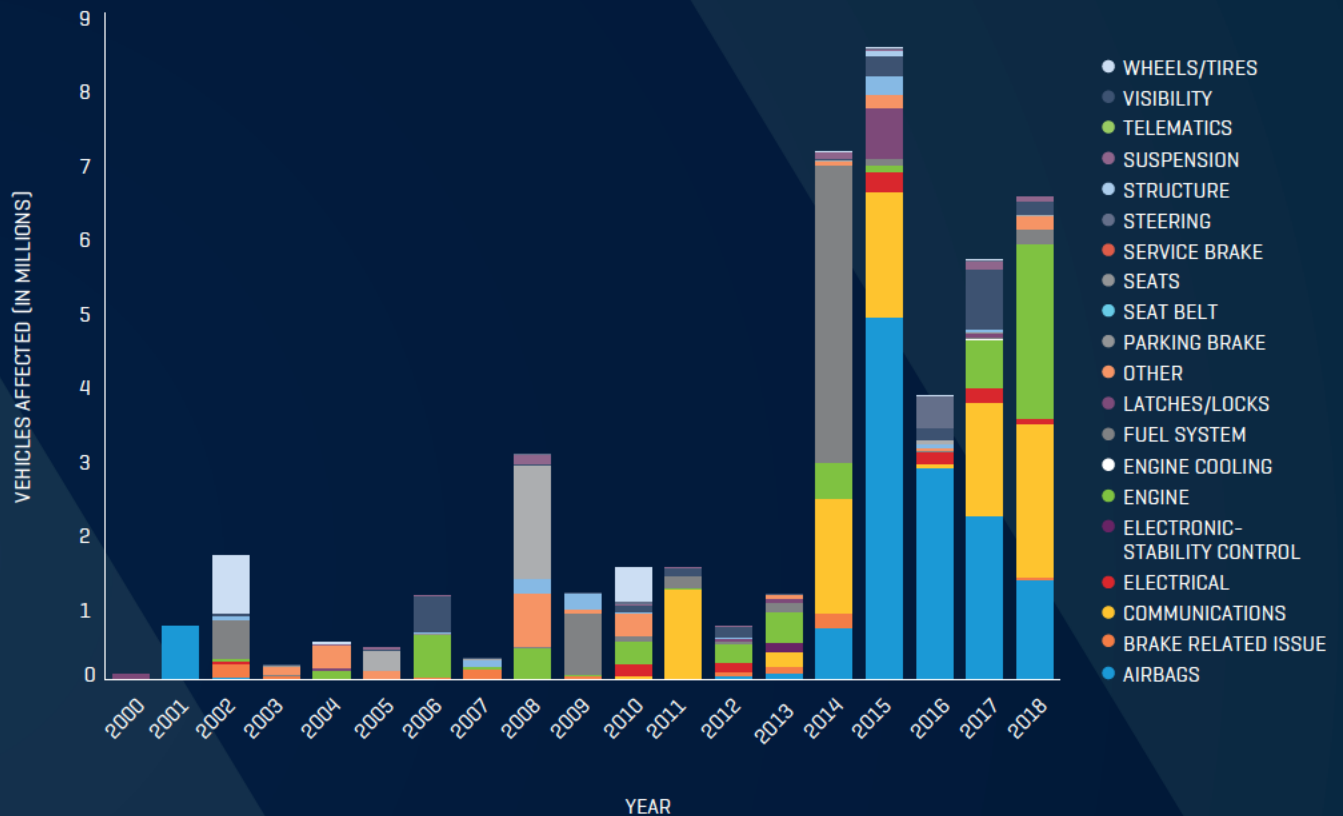


FIGURE 46 / BRAZILIAN VEHICLES AFFECTED BY KEYWORDS IN RECALL TEXT & YEAR



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.

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 2018 were affected by recalls involving software-based defects than the previous five years *combined*. While software-based recall activity in 2018 was influenced by one particularly large recall, the increasing significance of software-based defects is a trend we expect to continue, and become more prevalent, in years to come.

To date, the patterns of defect emergence involving these technologies implicate, almost exclusively, newer vehicles that are more likely to involve smaller vehicle populations. Often, these remedies are less-costly, indicating less significant OEM and supplier financial exposure related to the potential defects associated with these components. However, how these advanced technology components fare as vehicles age, and how they withstand prolonged exposure to environmental conditions and other integrated components, remains to be seen. It is also important to consider that the majority of vehicle recalls in the U.S., measured both in terms of the number of unique campaigns as well as the vehicles affected by those recalls, involve defects associated with a variety of more traditional vehicle components that may lead to far different patterns of defect emergence and very different exposures to risk and costs of potential failures.

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, 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 more important now 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.



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 assessment, 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 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 over 20 data sets containing recall and other defect campaign 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

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