Autonomous Vehicles

Considerations for Personal and Commercial Lines Insurers
Executive Summary

Since the early 1960’s the insurance industry has been a major force behind the most significant advances in highway and vehicle safety including electronic stability control requirements, seat belt use, and automobile crash worthiness. Now, autonomous vehicle (AV) technologies offer an opportunity for us to reach another milestone in vehicle safety, going beyond keeping people safe in a crash to avoiding the crash altogether.

According to the National Highway Transportation Safety Administration (NHTSA), an estimated 35,092 fatalities occurred in the US as a result of vehicle crashes in 2015, with human error as a primary cause. Analysts agree that autonomous vehicles have the potential to dramatically reduce human error and, therefore, the frequency of vehicle crashes. Savings related to economic costs, including accident-related, fuel, and productivity, are estimated to be as much as US$1.9tr by 2025.

In October 2010, Google publicly announced plans to develop automated vehicle technology with the aim of preventing traffic accidents, reducing carbon emissions, and helping people make better use of time spent commuting. Since then much has been written and reported with regard to autonomous vehicles, resulting in a wide range of estimates attempting to predict the timing of their widespread adoption and quantify their impact.
There are uncertainties: How will autonomous cars perform amongst a mix of autonomous and manually-operated vehicles? How will autonomous vehicles impact people whose livelihoods depend on driving, like truck and taxi drivers? Will driving skills diminish and, if so, what will be the impact to road safety—if any?

As the debate about the social and economic benefits of autonomous vehicles continues, the insurance industry is contemplating the impact, particularly as it applies to liability exposures.

Who will be liable when an AV is involved in an accident? Will liability shift from driver to manufacturer as vehicle control shifts from human operator to autonomous systems? Will accident-related liability exposure all but disappear? How will we manage cyber liability exposures that arise from the cameras, sensors, and computers integral to AV technology, or from vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) systems?

Besides liability, how will autonomous vehicles impact the tools underwriters use to evaluate risks? What new products will be needed, both for traditional auto manufacturers and suppliers faced with new risks and for new entrants into the AV supply chain?

Regulation and legislation will also be important factors for insurers as AV technology evolves. In an effort to accelerate the integration of autonomous vehicles, on September 20, 2016, the US Department of Transportation (US DOT) announced the Federal Automated Vehicles Policy, a new regulatory framework to provide consistency in safety standards for automated vehicles and build on the existing division of responsibilities between federal and state agencies.

While regulation and legislation continues to evolve, the building blocks of AV technology are moving forward as demonstrated by the March 2016 announcement by major auto manufacturers stating they will install automatic emergency braking systems in nearly all US vehicles by September 2022. Although this is a critical step in moving towards AV technology, several industry analysts note that wide scale adoption of autonomous vehicles will not be fully realized for at least 25 more years.

Our role as insurers is twofold: to enable a technology that has the potential for significant positive impact on vehicle and highway safety while also helping our clients to recognize and manage the impact of AV technology on their businesses. Insurers and reinsurers who understand the issues will be in the best position to stay ahead of market disruptions and capitalize on opportunities.

Working with a network of knowledge partners that include research, industry, and academic organizations, combined with Munich Re’s vast knowledge network, we aim to anticipate these changes, educate our stakeholders, and develop innovative insurance solutions to manage the impacts of AV technologies for ourselves and our clients.
Autonomous Vehicle Technology: Evolution of Insurance Exposures

Analysts agree that AV technology has the potential to create significant safety benefits by reducing driver error. There is debate over the timeframe for complete integration of fully autonomous vehicles on US roadways. However, data from tests conducted by the Insurance Institute for Highway Safety show vehicle safety systems, considered the building blocks of fully autonomous vehicles, have been successful at reducing accidents.
At the same time, AV technology could give rise to new and potentially costly liability exposures with characteristics that emerge along with the technology’s evolution from partially to fully autonomous.

With no historical data on which to base any firm conclusions, our examination of these evolving exposures, the parties that might be affected, and how the interested parties might address these exposures is based on reasonable assumptions regarding the technology, the distribution channels used to get the product to market, how the product will ultimately perform, and how it will be used by the consumer.

In addition, our analysis aligns with the five levels of automation outlined by NHTSA, in which vehicles operate progressively more autonomously.

We believe the exposures will change over time as AV technology is adopted by the public. In general, as control of the vehicle shifts from manual operator-controlled to automatic computer-controlled, liability may shift from the operator to the manufacturer of the technology.

In 2015, several vehicle manufacturers and Google announced they will assume liability for AV accidents. The distribution of liability however, will be decided by the courts on a case-by-case basis.

Therefore, our examination of exposures during Levels 1–3, where the vehicle may be operated manually or autonomously, focuses on vehicle operators. At Level 4, where the vehicle operates in autonomous mode, we focus on exposures to the manufacturer. We explore coverage implications, liability, underwriting, and data and analytics from these perspectives.

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NHTSA’s Five levels of automation

**(Level 0) No automation**
The driver is in complete control of brakes, steering, throttle, and motive power at all times.

**(Level 1) Function-specific automation**
Automation of one or more specific control functions. Example: electronic stability control or pre-charged brakes

**(Level 2) Combined function automation**
Automation of at least two primary control functions designed to work in unison. Example: adaptive cruise control in combination with lane centering

**(Level 3) Limited self-driving automation**
Full control of all safety-critical functions transitioned between driver and vehicle, depending on conditions

**(Level 4) Full self-driving automation**
Vehicle can perform all safety-critical driving functions for entire trip. Driver provides destination or navigation input, but is not required for control at any time during the trip.

Source: National Highway Transportation Safety Administration, Preliminary Statement of Policy Concerning Automated Vehicles
Implications for manufacturers

To date, California, Florida, Louisiana, Michigan, Nevada, North Dakota, Tennessee, Utah, and Washington DC have passed legislation related to autonomous vehicles. Arizona’s governor issued an executive order related to autonomous vehicles. Florida took its AV legislation a step further by enacting a bill that allows a person with a valid driver’s license to drive an autonomous vehicle on public roads. Generally, test vehicles are dual control and can be operated fully automatically, or operated manually by the operator. Most of the states require a licensed operator to be in the car and ready to take over the controls at any moment.

As autonomous vehicles move out of research and testing environments and into the consumer marketplace, consumer and commercial insurance coverage will likely be impacted, particularly liability coverage.

Liability increases with autonomous functionality

As public acceptance grows and autonomous vehicles progress from partially to fully autonomous, liability for loss caused by the AV may shift from the operator of the AV to the manufacturer of the AV technology. Assigning liability, in turn, will likely hinge on whether the driver or the component part/technology caused the accident, or some combination of the two. Whether current automotive product liability case law will apply remains to be seen and outcomes difficult to predict. In any case, it could be costly for manufacturers to defend against lawsuits.

Assigning liability may be more complicated during Levels 1–3, when the operator is more likely to be driving the vehicle, than at Level 4 when the computer is likely to operate the vehicle.

The exposure to liability may depend on the amount of control allowed to the operator: the more autonomous the vehicle, the more exposure to the manufacturer. Operators of fully autonomous vehicles will need to make sure that they maintain the AV properly and avoid tampering with the AV operating system to avert assertions of liability against them. How actual liability scenarios play out will, of course, be decided by the courts on a case-by-case basis.

Increased scrutiny leads to greater reputational risk

Recent surveys of public acceptance with regard to fully autonomous vehicles indicate that while drivers would consider purchasing autonomous vehicles (especially if they could reduce insurance premiums), many are skeptical that a computer can make better decisions than a human behind the wheel. Therefore, any serious loss involving an AV will likely be carefully scrutinized and widely reported in the news media, which presents a potential reputational risk to the technology manufacturer.

Cyber liability exposures arise

The potential for hacking a vehicle’s computer system to gain information or to cause injury or disruption presents significant data security exposures. While those exposures exist today, the auto industry has acknowledged the growing potential for cyber security threats as vehicles become more connected to each other and to the Internet or other networks.
Liability exposures could arise, for example, from the collection and storage by the AV systems of data and personal information that is protected under state or federal laws. The potential also exists for widespread harm from hacking or cyber attacks.

Currently, auto manufacturers require indemnification from their “downstream” vendors and subcontractors including dealerships, repair/installation facilities, etc. This practice may be carried forward and extend to AV manufacturers of the future, however their vendors and subcontractors may change as the technology evolves.

**Liability shift may occur**

During Levels 1–3, there may be little change in terms of the necessary products liability and/or products recall/withdrawal coverage to protect the manufacturer’s interest. Traditional general liability coverages that clearly distinguish parts and components the manufacturer produces from those that are outsourced and that contain products-completed operations coverage may prove to be sufficient.

Additionally, vehicle manufacturers may require hold harmless agreements with autonomous component suppliers. A scenario in which the autonomous system is “bolted on” to an existing production vehicle may be no different from any new technology introduced into a car today, i.e., new braking systems, new transmissions, etc. If the technology can impact safe operation of the vehicle, the manufacturer of the component may have a traditional products liability and product recall/withdrawal exposure.

The impact to liability will likely become more apparent as vehicles transition to Level 4, when fault may be more clearly attributed to the technology. Since the autonomous system is operating the vehicle, liability exposure may, in turn, shift from the operator to the manufacturer.

**Underwriting classes revisited**

Underwriting for products liability and/or products recall/withdrawal covers during this stage of the product may be the same as for any other product. Currently class codes exist for computer manufacturing and auto manufacturing. However, since there is computer technology involved within the auto manufacturing process, there is potential for a hybrid insurance classification to be developed that contains features of both classes.

Generally speaking, underwriters classify vehicle parts into either “critical” or “non-critical” depending on their function in the vehicle. For example, brakes are considered a “critical” component whereas interior lights would be considered “non-critical.” The computer component that allows the vehicle to act independently will likely become more critical and be classified as such, especially as the vehicle becomes more fully autonomous.

**Product knowledge ramps up**

The underwriter will need some comfort level with—and understanding of—the vehicle’s reliability and functionality. In order to gain consumer acceptance, autonomous vehicles will need to handle situations like construction zones, road and bridge closures, all weather conditions, and more. But if, in certain conditions, the car will not function autonomously, i.e. blizzard conditions, the underwriter will likely want to have a complete understanding of those conditions and their impact on vehicle operation.

The underwriter will also need to understand the shelf life of the autonomous system and what diagnostics are in place to keep the AV running as intended, and will likely rely on those diagnostics to notify the vehicle owner when the vehicle must be maintained or, eventually, replaced.

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<th>Liability comparison</th>
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<td><strong>Level 1</strong> — <strong>Level 2</strong> — <strong>Level 3</strong></td>
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<td>As long as AV systems and operator share control, liability hinges on determining which was in control at the time of an accident</td>
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**Risk management considerations & recommendations**

Any problems with the operation of the product would likely be a setback to adoption of the technology. If losses occur, it will likely be critical to determine whether the vehicle was being operated by a human driver or the AV system, since this technology may eventually impact everyone who operates a vehicle on public roads. Media coverage will likely be extensive as the technology evolves from experimental to a consumer product.

Therefore, from a risk management perspective, manufacturers should consider:
- Creating simple and conclusive schemes to record when the driver overrides the AV computer.
- Reputational risk insurance coverage as media focus on autonomous technology grows.
- A disabling function as a response to any attempts to alter or enhance the software.
- Requiring hold harmless, defense, indemnification, and additional insured language on all contracts with downstream vendors and sub-contractors.
- Clearly defining maintenance procedures to be followed by the operator. If the AV operating system detects a problem that is not addressed by the owner, it should disable autonomous functionality to prevent potential loss.
- Preventing the moral hazard that arises when the operator has little or no exposure for a loss by developing an insurance product that includes both the manufacturer and the operator on the policy in order to align the financial interests of the operator and the AV manufacturer.

**Implications for commercial and personal operators**

By reducing accidents caused by human error, the market for liability coverage, and perhaps the coverages themselves, may be impacted significantly, not just for manufacturers but also for vehicle owners and operators.

Personal auto insurance providers have publicly acknowledged that advancements in vehicle technology and safety features including the development of autonomous or partially autonomous vehicles represent a significant business risk.

Regardless of the impact on the size of the market for liability coverage, participation in the liability market may change significantly.

**Liability shifts with autonomous functionality**

As with manufacturer liability, responsibility for loss will likely be assigned based on whether a human driver or the AV system was operating the vehicle at the time of loss. Exposure for loss may still be largely borne by the owner/operator during Levels 1–3, as the vehicle will more likely be controlled manually. No substantive change in coverage for the driver/owner of the vehicle is anticipated.

At Level 4, the majority of responsibility will likely shift to the manufacturer in circumstances where the operation of the vehicle is handled solely by the AV system. However, the operator may still be required to maintain the vehicle, and liability could attach to the operator for a loss arising out of a failure to maintain it properly.

There is also a potential for the vehicle to be considered a permissive user or an agent of the operator, thus making the operator responsible for a loss.

As with manufacturer liability, personal and commercial liability ultimately will be decided by the courts on a case-by-case basis and, as such, is difficult to predict with certainty.
Cov e rages shift with liability
As vehicle safety improves during Levels 1–3 of AV
development, traditional bodily injury and property
damage liability coverage as well as optional and
mandatory physical damage coverages, uninsured/
underinsured motorist coverages and personal injury
protection (no fault) coverages may not change
significantly. This is because it may still be necessary
to determine whether the driver, the component part/
technology, or some combination of the two, caused
an accident.

One may envision that any shift in the coverages,
may not occur until automation reaches Level 4.

During this phase liability to the operator or owner
may decrease significantly. Auto physical damage
coverage may increase due to costlier after market
replacement parts.

Development of this phase and the nature of insurance
coverages will likely be heavily regulated, perhaps
bolstering coverage requirements.

New coverage options may emerge
Physical damage covers are designed to protect the
vehicle owner from losses that cause damage to the
vehicle, including collision, theft or vandalism, and other
perils. Some notable coverage considerations that may
emerge as vehicles add parts and systems that make
them more autonomous include:

Physical Damage Coverages (First Party)
- Stated amount physical damage coverage: This
valuation method, which pays the lesser of actual cash
value, repair cost, or limit listed as a result of a covered
accident, may become more prevalent due to the
potentially high replacement and/or repair cost as a
result of an accident.

- Exceptions to the “mechanical or electrical breakdown
or failure” exclusion: Traditional personal and
commercial auto policies generally exclude loss due and
confined to mechanical or electrical breakdown.

- Revamping of the audio, visual, and data electronic
equipment coverage exclusions: Traditional personal
and commercial auto policies generally exclude any
electronic equipment that reproduces, receives or
transmits audio, visual, or data signals, with an
exception for equipment permanently installed. The
original focus of this exclusion was sound systems and
communication devices (i.e. citizens band radios,
cellular phones, etc), however, since visual and data
signals are a major component of autonomous vehicles
and will likely be costly to replace, revisions to the
exclusion are likely.

- Custom equipment/furnishings: As the technology
evolves and less input from an operator of the vehicle
is necessary for safe operation, the “living space” of the
vehicle could start to resemble living quarters, complete
with entertainment systems and furnishings not
typically associated with a traditional auto.

Liability Coverages and Physical Damage Coverages
(Third Party and First Party)
- Weather-related exclusions: Due to potential weather-
related limitations of autonomous vehicles on snow or
ice covered roads, insurers could implement weather-
related operation limitations and exclusions.

- Radius of operation and road-type limitations and
restrictions: Insurance coverage may specify certain
distances or types of roads, such as public roads.

- Failure to maintain or adhere to self-driving
AV protocols: Since these vehicles are highly technical
and complex, they will likely be held to rigorous
technical standards that may require maintenance
on a routine basis.

- Cyber liability coverages: Autonomous vehicles employ
wireless communications systems to communicate with
other vehicles or networks. Manufacturers may need
coverage for the risks of cyber attacks, hacking, and
breeches of data privacy.

- Resurgence of no-fault type coverage: If assigning
fault in an auto accident involving autonomous vehicles
proves difficult and time consuming, resulting in delays
in compensating injured victims of auto accidents, there
could be a resurgence of no-fault type coverage.
Tools of the trade may change

Underwriting tools will also likely be impacted as autonomous vehicles become more common. Today’s underwriter relies on a number of tools to evaluate a risk. One such resource, a driver’s motor vehicle record (MVR), is very important when underwriting an account requiring automobile insurance. As manually operated vehicles (MOV) and AV technologies merge, will certain infractions shown on an MVR be seen more frequently? Will others decline? Is a traffic violation such as running a red light treated differently for an MOV versus an AV? Until vehicles become completely autonomous, MVRs will likely remain a key tool in analyzing the exposure any driver presents.

Just as certain losses among today’s MOVs may lead an underwriter to decline an account, the same will likely be true of autonomous vehicles in the fleet of the future. Is a fender-bender between two MOVs different from one between two autonomous vehicles? What if, when MOV meets AV, the AV is at fault? Does this claim indicate a systemic problem that the underwriter should analyze further? Careful observations and analysis of any emerging trends will be critical to expanding or restricting the underwriter’s appetite.

Like any new technology, the cost of repair or replacement is typically higher initially, which, in theory, will increase the cost of coverage. However, this will likely be offset by the drop in frequency of claims. Over time the cost to produce the technology should decline. In the long run, many analysts agree that safer roads will likely lower the cost of insurance significantly.

Data remains key

Industry analysts seem to agree that an AV will be inherently safer than a MOV and, as such, would generate a lower frequency of crashes. Assuming severity remains stable or declines, pure premium (the product of frequency and severity) would decline and it would cost less to insure the vehicle.

However, in order to properly determine how much safer an AV is and to calculate the appropriate insurance premium, one needs to analyze a sufficient sample of accurate historical data to compare to MOVs.

One method that insurers may use to collect a sufficient sample of historical data is through telematics. Recent advances in telematics systems, which record driver behavior and other data electronically, offer new and more reliable sources of data compared to driver-reported information.

Before premium will decline, insurers must collect enough data to understand the impact that autonomous technology has on loss avoidance. The types of data below can be collected from both driver and driverless vehicles, and analysis of the data could potentially be used in rating.

*Miles driven*

More time on the road indicates higher risk of loss. A subset of this may be “miles driven in AV mode” versus “miles in operator mode.” Fewer miles driven in AV mode may require the insurer to revert to more traditional rating of the operator.

*Time of day*

Regular driving in heavy (or light) traffic could impact a risk’s rating.

*Location*

Analysis of location data may be blocked by regulators concerned about privacy. Location might also include the percentage of driving time spent on mapped vs. non-mapped roads.

*Speed*

Instances where a driver may take the vehicle out of AV mode to drive at excessive speed could be recorded.

*Driver identification*

If lawmakers only authorize the use of an AV if a licensed driver is in the driver’s seat, telematics could be used to identify that a licensed driver is in the vehicle before starting.

*Hazards/Near-misses*

Validation of how well the AV avoids hazards that a human would not avoid could support claims that autonomous vehicles are safer and lead to lower insurance rates.

*Weather data*

In the event that autonomous vehicles may prove to be better in certain weather conditions, knowing what driving conditions were like at the time of an accident could help with claims handling.

*Crash sensor data*

Sensor data that can be used to re-construct a crash can also be useful in determining fault.
Data quantity. A sufficient number of road miles should be logged in order to create a credible data set for analysis. What is sufficient? A large auto insurance company can easily rely on a historical data set of 100–150 billion miles driven to produce credible results. Small insurance companies typically don’t have that quantity of data, and will likely pool their experience data (with the Insurance Services Office, for example) to create data sets large enough to perform credible analysis.

Data availability. A number of regulatory practices may need to change in order to realize the full impact of autonomous vehicles on insurance. Regulators currently prohibit insurers from using certain data in their rating models, including location, speed, or other data considered private. This limits the usefulness of the data captured by the AV. The more insurance companies must rely on traditional pricing information, the more insurance is likely to remain the same.

Shared vehicles
The future of autonomous vehicles goes beyond individual vehicle owners to shared vehicles, and to fleets of autonomous vehicles that include cars, trucks, and public transportation. Shared autonomous vehicles, for example, could be available for rental on an as-needed basis. Insurance might be included as part of the price of rental, thereby easing consumers into the idea of the autonomous functionality in a more economically feasible manner than purchasing a fully autonomous vehicle.

Source: US DOT
Outlook: Many factors will temper development

Development of all of these visions could be impacted by a host of social, economic, and regulatory factors that make the timing of a shift to fully autonomous vehicles and the insurance implications of that shift difficult to predict.

Social acceptance

Recent surveys show the majority of people would not purchase an AV if it were available today, yet they would be willing to spend a little more equipping their next vehicles with features like crash avoidance and lane-keeping systems that are the building blocks of tomorrow’s fully autonomous vehicles. It seems a large portion of the general population may not be ready to give up control of their vehicles or trust that a computer might make better decisions at the wheel.

Legislation and oversight

The Federal Automated Vehicles Policy announced in September 2016, reflects the reality that widespread deployment of full autonomous vehicles is imminent. The policy outlines NHTSA’s commitment to utilize all of its tools to accelerate the deployment of technologies that can eliminate 94% of fatal crashes involving human error. This proactive approach in providing safety assurance while facilitating the deployment of autonomous vehicles, demonstrates the federal government’s support of technology that will significantly transform the way we travel.

Driverless vehicle laws and legislation for US states is compiled periodically by the National Conference of State Legislatures. To date, the majority of enacted legislation has primarily focused on testing of autonomous vehicles on public roads rather than envisioning autonomous vehicles in the consumer marketplace. The federal policy outlines key responsibilities that are expected at the state level, and much work lies ahead.

As autonomous vehicles get closer to the public, lawmakers will likely pay close attention and introduce legislation designed to protect the public across a wide range of AV impacts, including licensing and certification of vehicles, infrastructure, cyber security, and, of course, safety standards. In insurance, regulators may seek to prevent adverse selection and moral hazards, and protect privacy and personal information. Litigation associated with determining liability will also likely lead to legislation.

As laws are changed, insurance coverages will likely change to meet the needs of customers.

In any case, insurers will likely be impacted, and those who remain informed on AV issues will be better positioned to manage that impact successfully.
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Munich Re Contributors

Specialty Markets:
Christopher Amendo
Paul Hamm
Jim Kelly
Lauren Maerz

New Strategic Markets:
Kelsey Brunette
Michael Scrudato

Underwriting Services:
Gerard Finley

Corporate Communications:
Lory Greene