ISO Emerging Issues:

Insurance Perspectives on Evolving Risks

Verisk

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Eyes Open to Emerging Risks and Opportunities

Risk never sleeps: new trends appear, new technologies develop, and new markets grow—sometimes changing the world suddenly, other times percolating near the surface for years without obvious impact. The question of how to best grapple with this constantly evolving landscape of risk continues to be one of the greatest challenges facing many risk managers and insurers today.

We believe Verisk's combination of robust data analytics and deep domain expertise can empower our customers to help mitigate associated risks and maximize their potential value—to effectively and holistically confront threats head-on and harness them for new business opportunities.

"Holistic" is the key term here. Risks don't exist in silos—they often cross business verticals and frequently manifest themselves in surprising ways. To help address and capitalize on the risks of the future, we think creatively about risks from many perspectives. That's one of the reasons why we employ teams that include diverse disciplines, from climate scientists to general liability insurance experts to data management analysts.

Verisk's ISO sits at the core of this mission, tapping into the data sets and domain expertise from across Verisk companies to address the emerging risks facing the property/casualty insurance industry today. With nearly 50 years of data management, analytics, and insurance knowledge at our fingertips, we can help our customers tackle some of their most complex and pressing problems.

In keeping with that theme, the ISO Emerging Issues team has assembled this report to highlight just a few of the more significant risks and trends that could profoundly impact the businesses of insurers and risk managers. In consultation with other Verisk companies, we've chosen ten issues that Verisk teams have been monitoring. The items run the gamut of risk categories, from environmental changes and technological developments to human and societal impacts.

Environmental changes pose new exposures around the globe. Together with Verisk's AER and AIR Worldwide, we look at climate-related risks and how they could impact insurance, including the increasing frequency and severity of coastal flooding, increasingly volatile atmospheric and seasonal changes, and disruptive precipitation in some areas and intensifying drought in others.

We also discuss resource scarcity, tapping into the expertise of Verisk Maplecroft. We particularly focus on the potential impacts of food and water scarcity on business operations and supply chain vulnerabilities around the globe.

Lastly, we examine the risks of induced seismicity, impacted water resources, and workplace exposures related to hydraulic fracturing. Verisk's Wood Mackenzie and AIR Worldwide have been performing analysis and modeling to better understand some of these issues.

It has become something of a cliché to say that **technological developments** continue to disrupt business operations and to introduce new risks and opportunities. In this section of the report, we first discuss the Internet of Things (IoT)—how this technology is leading to the development of telematics, connected vehicles, and connected building technologies and how insurers can begin to harness these tools for their operations. We also discuss some concerns, including cybersecurity and data collection issues related to IoT.

We then take it to the next level and examine the current state and concerns of autonomous vehicle technology. What are the potential safety and liability concerns? How might underwriting and rating respond?

With input from Verisk's Geomni, we then provide an update on some of the current and future applications of drone technology, including insurance use cases.

Finally, we give a brief overview of blockchain, a technology many believe could transform data transactions and information storage as we know it. We discuss, at a high level, how the technology works and some of its limitations, including cybersecurity concerns.

Most of these topics have some impact on **human health and society**. But in this section, we wanted to focus in on three issues in particular: nanotechnology, marijuana, and opioids.

Toxicologists and industrial hygienists with Verisk 3E and ISO Engineering & Safety Service (E&S™), respectively, have been monitoring potential workplace exposures related to nanotechnology. Of particular concern is whether certain types of nanomaterials could cause health effects similar to those of asbestos. We also discuss current research and risk management developments related to nanotechnology.

Next, we examine some potential exposures related to commercial marijuana markets in U.S. states that have enacted laws designed to permit them, including crop cultivation, product manufacturing, and retail sale.

To close out our report, we briefly discuss the opioid crisis in the United States and potential liability concerns.

This report touches just the surface of the changing landscape of risk. Our position in providing independent data and analysis for the insurance and risk management industries gives us a unique perspective into the interrelationships of risk and how to help seize upon opportunities they present. We look forward to continuing to share that perspective.

Many of today's novel risks might seem commonplace—even quaint—tomorrow. That's why our work is always ongoing. Risk doesn't stand still. Neither do we.

Sincerely,

Mark Anquillare
Chief Operating Officer
Verisk

About ISO Emerging Issues

The ISO Emerging Issues team currently monitors more than 40 emerging risks and trends to help risk managers and insurers address critical developments affecting insurance—both now and in the future. The team provides to its customer base industry-relevant research and supports ISO product development teams in creating innovative insurance solutions for the risks of the future. You can learn more about the ISO Emerging Issues team and its product offerings at **verisk.com/ei**.

Environmental Changes

Climate and Weather Events: Increasing Frequency, Rising Costs

The scope and impact of climate change remain uncertain. But some climate-related risks facing insurers are already looming on the horizon.

Take coastal flooding.

Sea levels are rising and will continue to rise in future decades as a result of climate change—and this can affect the frequency and severity of coastal flooding. For example, a study from Verisk's AER business projects dramatic increases in flood durations and magnitudes along the East Coast of the United States over the course of the next century due to both sea level rise and changes in North Atlantic basin tropical cyclones.[1]

Unfortunately, it's not just the frequency and magnitude of coastal flooding that could increase—the costs of such flooding are also escalating. Verisk's AIR business, which specializes in catastrophe modeling, estimates that until the onset of the Great Recession beginning in 2008, the value of properties in coastal areas of the United States grew annually by roughly 7 percent. The increase in value alone translates to a doubling of insured losses every ten years, regardless of any climate change-related effects.

AIR has also noted that the number of coastal properties is expanding, with coastal populations often growing at a faster pace than noncoastal areas, making coastal development one of the largest factors influencing hurricane risks.[2] Severity, therefore, is affected as well.

Nor does climate change pose only flood risks. It seems also to be exacerbating regional meteorological events, resulting in adverse consequences in the United States, including:[3]

Volatile freeze/thaw cycles and increasing polar vortex disruptions: There's an increase in the incidence of so-called "false springs," during which earlier blooms are followed by damaging frosts and freezes. Additionally, a warming Arctic is resulting in more polar vortex disruptions. According to the National Oceanic and Atmospheric Administration (NOAA), polar vortices occur when an expansion of colder Arctic air breaks into more southern climes. Severe winter weather is more frequent for extended periods after such disruptions.[4]

A shortening and intensifying of winter in some areas: A joint AIR/AER analysis found evidence suggesting that climate change may result in shorter winters; however, such winters may be more intense, with increasingly heavy snowfalls, particularly in the northeastern United States.

Disruptive precipitation and resulting inland flooding: Heavy precipitation isn't limited to snowfall. Precipitation extremes, including rainfall, are increasing in the northeastern United States and elsewhere, leading to a heightened risk of inland flooding.

Intensifying droughts: Climate change also appears to be having the opposite—but no less adverse—effect in other regions, such as California. Droughts are expected to intensify over the course of the 21st century, with potentially significant food and water supply shortages that put greater pressure on feeding a growing global population.

Addressing climate change is complicated by its interrelationship with economic development and the energy deficit facing many people around the world, particularly in emerging economies. Serious consideration must go into designing and assessing options that balance care for the climate with economic progress and rising standards of living, and those plans must be based on the best data and analysis available.

Verisk's **AER** business leverages diverse modeling, remote sensing, simulation, and analysis capabilities to help governments and businesses understand, anticipate, measure, and manage climate-related risk. AER monitors climate indicators and has developed:

- climate models and risk indices in collaboration with Verisk Maplecroft
- targeted assessments of specific climate risks, including sea level change, hail, and severe thunderstorms
- ground-based systems for monitoring and risk analysis of greenhouse gases

AER is also participating in the development of technologies for global space-based measurements.

Verisk's **AIR Worldwide** business specializes in catastrophe modeling, including for climate change–related risks. AIR develops catastrophe models that incorporate the latest effects of climate change and conducts impact studies for various entities, such as the Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI) and the Association of British Insurers (ABI). Its insights—including climate change's impacts on extreme weather and insured losses—are also communicated to client companies. AIR provides governments and nongovernmental organizations with resilience solutions to help better prepare for potential climate change–related disasters.

Contributors

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Alternative Energy: The Road Ahead

Renewable energy technologies, including wind and photovoltaic solar, continue to attract investment and development as concerns related to climate change increase and manufacturing costs decrease.

In 2017, nearly 100 gigawatts (GW) of photovoltaic solar installations were developed globally, which is significantly more than other sources of power-generation technology. An additional 48 GW of wind capacity were also installed around the world.[1]

The increase in total installations may be driven in part by the decline in renewable energy manufacturing costs: Photovoltaic solar costs have dropped nearly 90 percent since 2005, while wind turbine costs have fallen 45 percent over the same period.[2]

Much of these cost decreases are due to technological and manufacturing efficiency improvements, as well as an increase in manufacturing capacity in certain regions.

Renewables still provide only a small percentage of total power (in the United States, electricity generation from wind and solar, respectively, accounts for 6.3 percent and 1.3 percent of the total).[3] But many expect this share to rise in the coming years.

As intermittent renewable energy supplies increase as a share of the power supply mix and older coal, gas, and nuclear power plants are retired, the challenge of keeping the lights on will necessitate the use of new technologies, most notably energy storage systems.

Wood Mackenzie's Greentech Media business delivers market analysis, business-to-business news, and conferences for the clean energy industry, with a particular focus on solar power and electric utility markets evolution.

Additionally, **Wood Mackenzie's GTM Research** offers market analysis for renewable energy, and **MAKE** offers strategic consulting and research for the wind energy market.

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Resource Scarcity: Not Just a Problem for the Developing World

The interconnectedness of today's global supply chains practically ensures that food and water shortages in one part of the world can have globe-spanning impacts. While poorer people in poorer nations disproportionately bear the brunt of resource scarcity, today's world is too interdependent for countries with greater economic advantages to ignore these risks.

Access to adequate, affordable, acceptable food and water resources is a complex development issue influenced by numerous factors, ranging from population growth to climate change to civil unrest and mass migration. In some countries, scarcity is part of day-to-day life; in others, it can result from periodic disruptions, such as political instability, economic downturns, or adverse weather events.

Food and water insecurity can pose consequences for global and domestic business, such as:

Direct interruptions to operational continuity: Water scarcity can acutely affect many business activities, including agri-commodities. Take California, the leading agricultural producer in the United States by value,[1] where a combination of water scarcity, increasing drought levels, and extreme vulnerability to climate change indicate that current methods of food production could become too costly to sustain. The statewide economic cost of drought alone in California in 2014 was estimated at $2.2 billion.[2]

At-risk energy production: Water scarcity in regions dependent on hydropower can destabilize electricity supplies and increase energy costs because utilities may be forced to import more expensive alternatives. For example, drought caused Kenya's reserve electricity levels to fall to just 4.4 percent in mid-2017. To meet the country's power needs, Kenya increased its use of thermal power, resulting in higher electricity prices.[3] The increased electricity costs, together with the drought's impacts on the agricultural sector, were contributing factors in the Kenyan government's decision to revise down its growth forecast for 2017 from 5.5 percent to between 5.0 and 5.1 percent.[4]

Supply chain vulnerabilities: Chronic food and water access issues may drive conflicts between business users and other groups. They may also spark civil unrest, which could disrupt business operations and contingent supply chains. Nations that depend heavily on food or water imports, including wealthy nations such as Singapore and Japan, are especially exposed to political, social, and environmental disruptions occurring in the nations that export to them.

Potential reputational and legal damages: Companies or their supply chain partners operating in regions with insecure food and water access may face reputational and legal risks if they are implicated in adverse social or environmental consequences. This is particularly the case if such companies consume large amounts of water or use fertile lands for their operations that would otherwise be cultivated for food production. In many developing countries with inadequate land rights protections, acquiring natural resources could expose commercial entities to additional reputational and legal risks.

Crucially, resource security risks exist in a wider context that can influence their consequences. Organizations vulnerable to business interruption likely need such context to better understand the potential for supply chain disruptions to arise. For example, analysis using Verisk Maplecroft indices shows that areas susceptible to food security risks are also often highly exposed to wider issues likely to exacerbate the threat. According to Verisk Maplecroft, those countries scoring as the 20 riskiest in the Food Security Index also score poorly in its Climate Change Vulnerability Index; Land, Property, and Housing Rights Index; and Corruption Index.

Verisk Maplecroft produces annual resource security indices that provide a national-level picture of vulnerability to help multinational organizations with their risk and supply chain management.

Verisk Maplecroft produces indices for both food and water security looking at a one-year to three-year time horizon across 198 countries globally on a 0-to-10 scale (where 0 indicates greatest risk). The indices consist of indicators capturing the environmental, social, and political factors driving these risks.

Organizations can use this data to help mitigate strategic, operational, and reputational risks along their supply chains.

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The Risks of Hydraulic Fracturing

Hydraulic fracturing, also known as "fracking," is a process that involves stimulating underground reservoirs to extract dispersed hydrocarbons from shale or other tight rock formations. It has permitted the extraction of previously inaccessible or not commercially viable hydrocarbon deposits, particularly in the United States.

The benefits that stem from hydraulic fracturing are wide-ranging and well-documented. However, concerns have also been raised with respect to induced seismicity, reduced drinking water resources, and human exposure to silica dust and hydrogen sulfide.

Hydraulic fracturing involves the injection of a pressurized fluid mix of water, proppant (usually a mix of sand or ceramic materials), and chemicals into a well to create fractures in tight rock formations that releases otherwise trapped hydrocarbons. The internal pressure of the rock then pushes the hydrocarbons, as well as the injected fluid, back into the well, where they return to the surface and are stored in tanks for treatment, disposal, or recycling or injected back into underground wastewater disposal wells, a process known as "wastewater injection."[1]

Wastewater injection has emerged as the primary concern relating to induced seismicity. Injecting high volumes of wastewater back into the earth near existing fault lines has been reportedly correlated with the rapid increases in seismic activity in drilling-intensive states, especially Oklahoma and Kansas. Regulators in both states have begun limiting injection rates in certain areas, and those areas have experienced a subsequent reduction in seismic activity.[2] More recent reports suggest hydraulic fracturing itself may contribute to seismicity in certain areas.

Concerns have also been expressed that fracking and wastewater injection operations may contaminate groundwater and drinking aquifers. This issue has been the subject of more than one study at the U.S. Environmental Protection Agency (EPA).[3] The most recent findings demonstrate that instances of contamination are a result of faulty equipment or process error but are not inherent to the practice of hydraulic fracturing.

Surface spills are a particular concern. Such spills can result from mishandling of fracking fluids or wastewater at the surface or during disposal of wastewater in inadequately lined water ponds. Additionally, faulty wells can allow chemical seepage into aquifers or up to groundwater sources.

In March 2015, the U.S. Bureau of Land Management (BLM) published a rule regulating, for the first time, hydraulic fracturing on public and Indian lands.[4] The proposed measures addressed wellbore integrity, water quality protection, wastewater management, and public disclosure of chemicals. However, in December 2017, the BLM announced a final rule rescinding the 2015 rule; the BLM noted that the rule had never gone into effect due to its involvement in pending litigation.[5]

Further, drilling and well completion work is dangerous and demanding, with significant health and safety risks for employees of such operations. For example, employees at the well site may be exposed to elevated amounts of silica dust due to fracking's reliance on sand-based proppant. Exposure to silica can increase

the risk of developing diseases and disability. The U.S. Occupational Safety and Health Administration (OSHA) recently revised its respirable crystalline silica standards, reducing the allowable amount of worker exposure to a permissible limit of 50 micrograms of respirable crystalline silica per cubic meter of air as an 8-hour time-weighted average for all industries covered by the rule.[6]

Workers may also face an increased risk of exposure to hydrogen sulfide (H_2S), a flammable and toxic gaseous by-product of completion operations. Both OSHA and the U.S. National Institute of Occupational Safety and Health (NIOSH) have published various worker exposure limits to hydrogen sulfide gas.[7]

Verisk's **AIR Worldwide** catastrophe modeling business maintains an earthquake model for the United States, which includes an induced seismicity module to capture the effects of human activity on earthquake occurrence. The model's induced seismicity module intends to reflect the effects of human activity—especially wastewater injection associated with practices in the oil and natural gas industries—on seismicity rates in regions of the central and eastern United States.

Verisk's **Wood Mackenzie** is a leading research and consultancy business that performs independent analysis across global energy sectors, including upstream oil and gas, refining, chemicals, power and renewables, and metals and mining industries.

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Technological Developments

Internet of Things: Smart, Connected, and Full of Risks

The Internet of Things (IoT) generally refers to the aggregation of "smart" network-connected physical devices that can gather, communicate, and react to data. IoT includes everything from smart home thermostats that automatically adjust temperature settings based on environmental data to connected vehicles that can collect and communicate driving data.

And IoT is heating up: One estimate predicts that there will be more than 55 billion IoT devices in 2025, up from about 9 billion in 2017.[1]

Insurance industry use cases for IoT promise to better align the costs of risks, allowing for more strategic and efficient insurance operations as well as cost savings and risk mitigation for insureds.

IoT offers insurers the opportunity to harness never-before-seen amounts of data to innovate new solutions and price risks more accurately. And insurers and insureds alike have begun to integrate IoT technology in both personal and commercial lines.

Telematics and connected vehicles: An increasing number of insurers have begun offering usage-based insurance (UBI) to insureds, which may offer premiums based on telematics data from vehicles to better reflect driving behavior. From a commercial auto perspective, such technology allows for greater fleet operational safety, efficiency, and compliance—all of which encourage greater underwriting and rating transparency and risk mitigation.

Many UBI programs have been based on mobile applications or in-vehicle dongle connections to send driving data to insurers. However, with increasingly connected vehicles operating on public roads in the United States, a growing opportunity exists to capture even more vehicle data points for better underwriting and rating. Such technology also promises to help insurer loss experience because these vehicles are expected to reduce crash frequency by encouraging safer driving habits.

Connected buildings: Commercial buildings and homes equipped with IoT technology also offer underwriting, rating, and risk mitigation opportunities. IoT can promote worker safety in manufacturing operations through wearable sensors to communicate and prevent potential safety-critical events. IoT technology also allows for predictive maintenance, in which industrial and manufacturing machinery can be remotely monitored and can provide alerts about potential failures.

The sheer amount of data generated by IoT can allow insurers and risk managers to reward policyholders with discounts, premium cost savings, and risk mitigation and safety strategies. By analyzing the data, insurers can more accurately align rates with each individual risk. And insurers' use of IoT could be used to improve the retention of safer risks.

However, the perceived benefits come with potential challenges.

Cybersecurity: A possible concern to both insurers and their insureds, IoT devices and networks may be particularly vulnerable to cybersecurity breaches. Such breaches can result in the compromise of personal information. Compromised IoT devices can also be used to launch further cyberattacks—so-called "botnets." Perhaps most worrisome, hackers may be able to compromise certain IoT systems to cause physical damage and bodily injuries.

Data collection: Insureds may be wary about consenting to insurer access to potentially vast amounts of data, either because of personal privacy concerns or because of the negative impact such data may have on their premium costs.

Insurer costs: In some situations, the costs to insurers of adopting IoT may exceed the potential benefits, particularly if IoT fails to provide sufficient or useful data for actionable insights.

The **Verisk Data Exchange™** is the single hub for connected vehicle and smart home data for both insurers and connected-data providers, including automakers, telematics service providers, mobile service providers, and operators of connected products and services for homes and businesses. For insurers, Verisk's IoT solutions help refine underwriting and rating, achieve proactive mitigation services, and accelerate first notice of loss in both personal and commercial lines.

The Verisk Data Exchange has partnered with leading IoT domains and automotive manufacturers for personal auto underwriting and claims use cases. The exchange is also in the process of expanding its offerings to include commercial auto.

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Autonomous Vehicles Advance, But Liability Questions Still Stalled

Semiautonomous and fully autonomous vehicles hold the promise to dramatically reduce accident frequency, but unanswered questions remain for insurers.

Many commercially available cars already incorporate aspects of autonomous technology—for instance, adaptive cruise control, self-parking and crash-avoidance mechanisms, and other "advanced driver-assistance systems" (ADAS). Some are semiautonomous, meaning they can operate autonomously in limited situations, subject to the human driver being able to take control. Fully autonomous vehicles, which can operate in all situations and do not require a human operator, are being tested in regions across the United States.[1]

Driver error is currently the cause of more than 90 percent of vehicle accidents in the United States.[2] Vehicles equipped with ADAS and other automated features are expected to enhance vehicle safety and lower the frequency of accidents and the severity of those that may still occur. Some also expect autonomous vehicles to reduce congestion and pollution while increasing road-use efficiency and mobility. With new technology often comes new data sets, which may be analyzed for insight into real-world driver and vehicle behavior, potentially improving safety and better informing insurance rating and underwriting.

However, risks and concerns remain.

The safety of semiautonomous vehicles operating in autonomous mode has been highlighted by several high-profile fatal traffic accidents. Some of these accidents may suggest human operators in self-driving vehicles may trust too much in the vehicle's capabilities and can become complacent and easily distracted. When required to take control, human operators exhibit response times that are actually measurably slower than in traditional driving situations.[3]

This has led some manufacturers to speculate that skipping semiautonomy and focusing on producing fully autonomous vehicles may be the safer route—although it's anyone's guess how long it will be before commercially available, fully autonomous technology is ready to deploy.[4] Some have argued that even the sensor technology crucial to autonomous vehicle operation is still very much a work in progress.[5]

But perhaps the most common question is about liability in the event of a crash involving a vehicle operating without human control. Consider a scenario in which an autonomous vehicle maneuvers out of its lane to avoid a collision but in doing so hits another car. Who can be held liable? The vehicle manufacturer? The software engineer? The vehicle owner? These and other questions are of primary concern to insurers.

Factor in the possibility of cyberattacks against these connected vehicles and the concerns mount even further. Researchers have already successfully taken control of various aspects of a connected vehicle, including steering and braking.[6]

From an underwriting and rating perspective, some key elements currently used for auto policy underwriting and rating—including age, years licensed, and driving experience—may be replaced with other risk proxies as the role of the human driver changes or ceases to exist. Additionally, ADAS and other automated systems may present exposures not traditionally contemplated under an auto policy, including cybersecurity. Increasingly sophisticated technologies, reliance on software and coding, and new data sets may also create new exposures for insurers or shift coverage needs.

ISO is monitoring the potential impacts of semiautonomous and fully autonomous vehicles on both personal and commercial insurance, including evaluating changes related to coverage and rating for personal and commercial auto. And this evaluation takes into account cyber-related impacts from these types of vehicles as well as general impacts to data, underwriting, and claims.

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Drones Elevate Hopes and Concerns

The Federal Aviation Administration (FAA) estimates that there are more than 1 million recreational small drones in the United States and projects this number will increase to more than 2 million in the next five years. Over 110,000 commercial drones were registered with the FAA by the end of 2017, and the agency expects commercial drone use to accelerate rapidly.[1]

While drone package delivery continues to generate headlines,[2] the capabilities—both from a technological and a regulatory standpoint—are in their infancy. Questions like *How can a company safely and effectively operate drone deliveries in various population densities and environments?* and *How will air traffic control accommodate delivery drones in the national airspace?* remain unanswered—as do questions about the possible development of "drone taxis" for human transport.

Instead, according to the FAA, the current top commercial uses for drones are aerial imaging and data collection, industrial and utility inspections, and agricultural applications. Emergency services are also increasingly employing drones—they were used to assess property damage in the aftermath of recent hurricanes and wildfires in the United States and reportedly to aid in rescue efforts as well.

Drone adoption is also accelerating in mining and construction, including fully automated workflows, in which drones can process data throughout the day without human intervention.[3]

For insurance-related services, particularly for inspection purposes, drone use is just taking off. For example, according to Verisk's **Geomni** business, of the millions of property and roof inspection data packages produced in 2018, only a few thousand are predicted to be based on inspections conducted by a drone. However, this is expected to change. Drones offer significant efficiencies for claims adjusting, risk management, and underwriting operations, in part due to their ability to gather previously inaccessible data safely and cheaply.

Some potential may exist for liability and property damage exposures from commercial and recreational drone use. Operators could face potential liability if their drone injures a bystander or causes property damage, for instance. Or homeowners may perceive overhead drone operations as nuisances, violations of their personal space, or trespassing.

These exposures can be expected to shift over time as drone technology and regulations change and develop. For example, current FAA rules require most drone operators to maintain a visual line of sight with their drones. But if additional beyond-line-of-sight operations or autonomous drones become permitted in U.S. airspace, underwriting and rating considerations may have to shift to accommodate new exposures, including potentially increased cybersecurity vulnerabilities and software malfunctions.

Verisk's **Geomni** business offers aerial imagery, dimensions, and structure history for residential and commercial roofs and properties in support of various markets, including insurance, commercial property, and emergency response. Geomni also offers drone-specific services, including:

- An on-demand inspection service using drones, which has been used as a supplemental workforce during recent hurricanes, as an imagery and virtual inspection tool, and as a survey tool for wide-area automated damage detection.
- Geomni Mobile, an application for iOS devices that facilitates property inspections with ready-to-go drone integration interfaces and autonomous flight planning.
- Image-to-Scope, a tool that allows aerial imagery and data from planes and drones to flow directly to Geomni business-critical applications for processing, segmenting, and delivery of useful property information. The tool uses this imagery and data, along with 3D sketches, construction logic, and customizable tools, to help estimators more quickly, consistently, and accurately write estimates in Verisk's Xactimate® repair-estimating platform.

ISO continues to evaluate drone exposures as they evolve and has developed drone-related insurance coverage options for the following lines of business: commercial general liability and commercial liability umbrella/excess, commercial inland marine, commercial property, capital assets and Agri-CAP®, businessowners, and homeowners.

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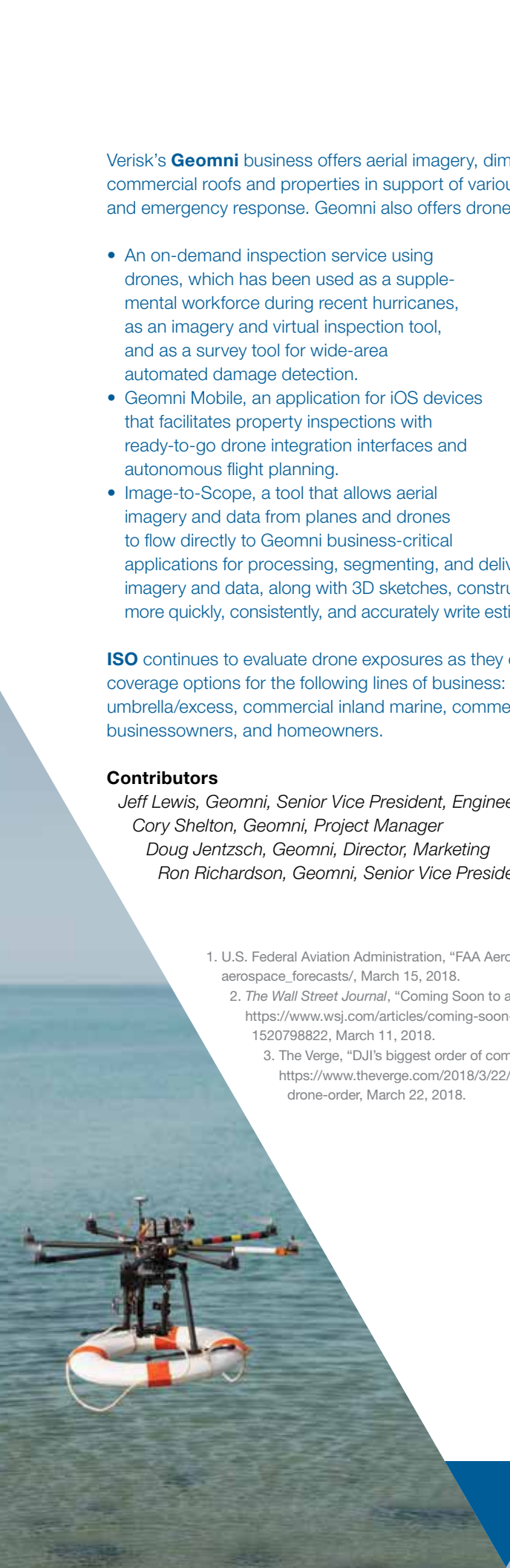
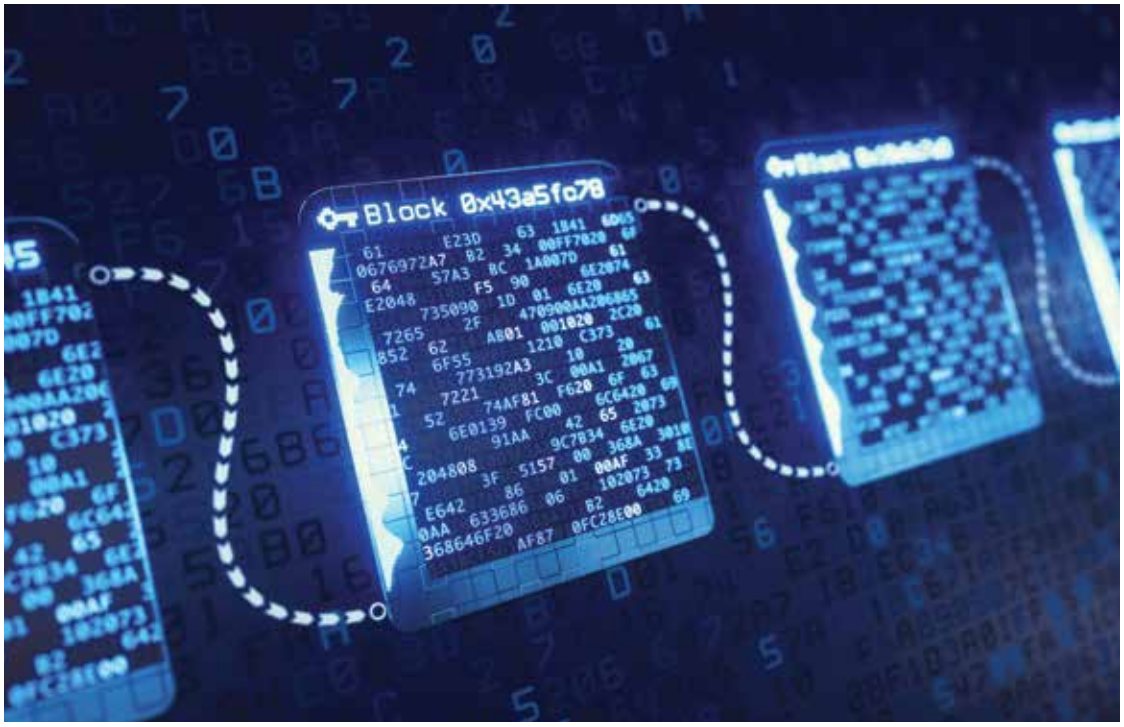


Blockchain: It's Technology, Not Magic

Blockchain is getting a lot of attention for applications beyond just virtual currencies, including so-called "smart contracts." But while it promises the possibility of more efficient and secure data transactions, blockchain technology still faces a number of hurdles and limitations.

At a basic level, a blockchain is simply a distributed ledger—a database that records transactions. Each entry is called a "block" and is connected to past blocks with a cryptographic signature called a "hash." String these blocks together and you get the blockchain.

Unlike traditional ledgers, blockchains are digitally *distributed* networks of data. That is, blockchains operate through a system of networked computer systems that use cryptographic software to verify proposed data transactions in a consensus-based manner.



If a party to the blockchain wants to execute a data transaction, the distributed network will run certain algorithms to ensure that the transaction is valid based on previous transactions and external data sources. To encourage network participants to run validation algorithms, some type of reward mechanism is typically required. Take the virtual currency Bitcoin as an example: So-called "miners" are rewarded in Bitcoin payments for their efforts to validate currency transactions.

Once a transaction is deemed valid, a block is added to the chain and linked to previous transactions with the hash, the cryptographic signature. The new block then becomes yet another entry in the distributed ledger and includes a time stamp for when the transaction occurred. Crucially, this time stamp is theoretically immutable because no single participant of the blockchain can execute a change on the chain. In other words, the absence of a central authority to enforce transactional validity creates the trust needed to transact along the chain.

Apart from its use as an infrastructure for virtual currencies, blockchains have generated quite a bit of excitement because of their potential application for smart contracts. Smart contracts can automatically verify

or trigger contract provisions based on various input data to a blockchain. For example, from an insurance perspective, smart contracts are reportedly being considered for use in automated claims processing.

Imagine a personal insurance policy that has been coded as a smart contract. In this scenario, the policy's coded provisions reside on a blockchain ledger ("on-chain"); the participants, in addition to the insured and insurer, are various third-party data sources ("off-chain") that will verify actions related to the "smart" policy. Depending on the policy, these sources might provide police reports, hospital admission records, and so on. If the policyholder were involved in a covered loss, the policy could verify the submission of a claim and would initiate, without human interaction, the claims resolution process based on validations from the off-chain sources. If the claim were deemed valid, the claim could be settled expeditiously and transparently to all parties to the smart policy.

Other use cases for blockchains include:

- supply chain management and provenance verification
- data authentication, authorization, and storage
- digital identification and reputation management
- Internet of Things management
- sensitive data custody, including medical and financial data

Blockchains can be both public and private. Public, "permission-less" blockchains typically include virtual currencies such as Bitcoin, in which the blockchain is open to anyone who would like to participate. Private, permissioned blockchains, on the other hand, limit those who can view and record transactions on them. That is, participants on the blockchain are known and vetted—as would be the case in the smart personal auto policy example.

Unfortunately, blockchain technology is neither magic nor a panacea. The technology comes with many limitations and potential risks.

For one, the infrastructure needed to create a blockchain connected to the proper off-chain data sources could be very costly to develop, and its start-up costs could exceed the benefits. In many cases, existing mechanisms that trigger a contract's provisions and validate data may be sufficient; introducing a blockchain may bring marginal benefits but may not be cost-effective.

For another, to have all data related to a blockchain exist within the networks of all participants is a challenge that could lead to less efficient execution of transactions. There are also data privacy concerns, particularly when competing companies are validating transactions on the same blockchain.

Cybersecurity is another concern. Though the transaction history of a blockchain is theoretically immutable, the off-chain data sources and the software undergirding a network's access to a blockchain may be susceptible to breaches. Both can experience a cyberattack, which could compromise the integrity of the blockchain's transaction history.

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Human Health and Society

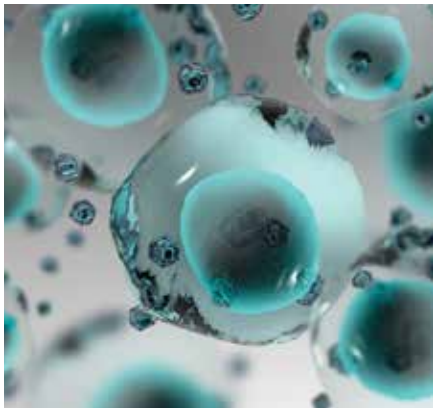
Small Things Considered: What Dangers Does Nanotech Pose?

Nanotechnology refers to scientists studying, manipulating, designing, manufacturing, and using materials on a scale between 1 and 100 nanometers.[1] To put that into perspective, a nanometer is one-billionth of a meter. A human hair is about 75,000 nanometers thick; a sheet of newspaper is 100,000 nanometers thick.

The small size of engineered nanoparticles means they often have different properties than the same material on a larger scale. It's these differences that allow scientists and researchers to create innovative products, from medical drugs to everyday consumer goods.

Similarly, material toxicity may change on the nanoscale. Take zinc oxide, a chemical often used in sunscreen lotion and other products. On the macroscale, it's relatively inert and generally considered to be of low toxicity. But on the nanoscale, zinc oxide exhibits different properties, which may increase its toxicity. Furthermore, nanoparticles may be small enough to move throughout the human body, crossing the blood-brain barrier, accumulating in certain organs, entering human cells, and causing reactive oxygen damage.

Other nanoparticles, such as carbon nanotubes and carbon nanofibers (engineered nanoparticles often used to strengthen other materials), might lead to health complications when inhaled, like those caused by asbestos.[2] In the workplace, such toxicity is of particular concern for "upstream" workers manufacturing nanoparticles in their "pure" form, often as powders or slurries (to prevent the nanoparticles from becoming airborne and subsequently inhaled). However, when combined with other materials, such nanoparticles may be less toxic.

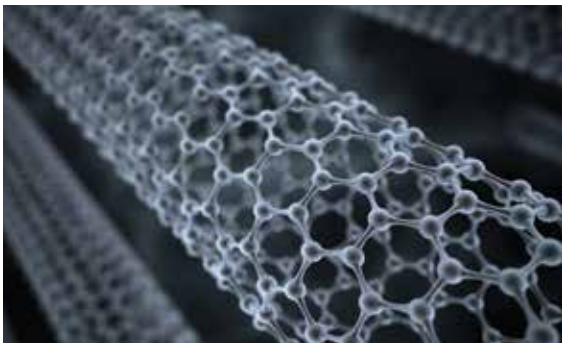


But quantifying nanoparticle toxicity, exposure, and risk is complicated. The health effects of nanoparticles depend on various characteristics, including, in part, their size, structure, composition, and ability to clump together (or agglomerate) to form larger particles. In addition, past studies generally have provided results from laboratory studies using ideal or simplified exposure scenarios, while current research is more focused on studies representative of exposures in real-world settings. To complicate matters further, health effects from nanoparticle exposures could have long latency periods. For example, if carbon nanotubes do cause asbestos-like health effects, those effects might take decades to manifest.[3]

Despite such difficulties, governments and private entities have begun taking action to mitigate nanoparticle health risks in occupational settings. For one, risk management techniques have been introduced in manufacturing operations to reduce exposures. The U.S. National Institute of Occupational Safety and

Health (NIOSH) has been conducting occupational exposure studies and publishing guidance related to nanotechnology risk management, including suggested occupational exposure limits for some nanoparticles and recommended control methods to reduce worker exposures.

For another, the large data sets generated by nanoparticle research have led to the development of "nanoinformatics" to collect, categorize, share, and mine research data on chemical and physical properties and health effects of nanoparticles, which should prove useful for risk management purposes. Epidemiological studies are being conducted based on preclinical biological markers to determine the potential for the development of a nanoparticle-caused disease, instead of waiting for it to manifest years later.



ISO's Engineering and Safety Service (E&S™) is an active member of the ASTM International Subcommittee E56.06 on Nano-Enabled Consumer Products and the American Industrial Hygiene Association's Nanotechnology Working Group. E&S interfaces with NIOSH on various aspects of nanotechnology. The unit monitors developments and publishes reports related to nanotechnology exposures and risks; it also conducts consultations related to the sampling of nanomaterials and other aspects of nanotechnology.

Verisk 3E offers compliance solutions for environmental health and safety (EH&S) requirements relating to workplace safety and product stewardship. In that capacity, Verisk 3E monitors possible effects from nanoparticle exposure (nanotoxicology) and works to characterize health effects from manufacturers' nanoparticles through testing. Verisk 3E also reviews exposure evidence and evaluates possible health outcomes related to nanotechnology.

AIR Worldwide's Arium platform maps interrelationships between liability policies across industries, a so-called "event footprint." Arium has begun quantifying potential liability losses from carbon nanotube/nanofiber risks for insurer portfolios. Based on the footprint, the total loss amount, and the loss distribution across industries and lines of business, Arium can then run thousands of simulations to determine how carbon nanotube/nanofiber losses may affect a specific portfolio.

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Exposures Associated with Regulated Marijuana Span the Supply Chain

The United States has come a long way in terms of public attitudes toward cannabis. An increasing number of states are passing legislation generally designed to permit commercial markets to serve medical or recreational marijuana users, often with significant variation between jurisdictions.

One analysis found that the U.S. cannabis market earned about $9 billion in sales in 2017 and that sales could reach $21 billion by 2021.[1]

Other countries have also begun passing similar legislation. For example, Uruguay now permits recreational marijuana sales from government stores;[2] Canada is expected to permit recreational marijuana markets;[3] and Germany recently passed legislation permitting medical marijuana use.[4]

The effect, or "high," induced by marijuana comes from the psychoactive chemical tetrahydrocannabinol (THC).[5] Marijuana-related products that may not induce a psychoactive response, such as cannabidiol (CBD), also exist.[6]

Commercial marijuana markets may pose new risks and exposures for insurers and reinsurers across the supply chain, including cultivating, manufacturing, dispensing, and using the drug. And it's also important to remember that marijuana is currently listed as a Schedule I drug under the federal Controlled Substances Act of 1970 (CSA), which defines Schedule I drugs as those "with no currently accepted medical use and a high potential for abuse" and "the most dangerous drugs of all the drug schedules with potentially severe psychological or physical dependence."

Indoor crop cultivation: Many marijuana businesses conduct crop cultivation indoors, allowing for a year-round growing season in a tightly controlled environment that can maximize THC content and the quality of the plant. Such operations may be exposed to higher risks from mold, fires, and dangerous gases. Crops could also be contaminated from improper pesticide use.[7]

Product manufacturing: Some marijuana businesses may take harvested marijuana and process the crop into other THC-based products, including concentrates, oils, and tinctures. Hydrocarbon-based solvent extraction

processes may be used to create products high in THC content. Hydrocarbon-based extraction can increase fire and explosion risks in such facilities.[8]

Dispensary and sale: Marijuana businesses that sell or dispense recreational or medical marijuana are furnishing potentially intoxicating substances to consumers, typically for off-premise consumption, depending on the state in question. Properly classifying such risks may be difficult. Marijuana is a high-value product, and since many marijuana businesses operate using a cash-only business model, there may be increased exposure to theft risk. Businesses may also be exposed to product liability risks.[9]

"Stoned" driving: Products containing THC are intoxicants. Some studies—though not all—have found that marijuana use correlates with the rate of automobile accidents. Others have argued that it's difficult to know when marijuana is to blame for a vehicle crash, and epidemiological research is ongoing. The length of a user's intoxication from marijuana varies widely by consumption method, the potency of the product, and the user's physiological characteristics. Identifying actual marijuana intoxication by measuring levels of THC has been a concern because, unlike alcohol, THC persists in a user's body for long periods after intoxication.[10]

The **ISO Emerging Issues** team monitors rapidly shifting marijuana-related developments, including exposure considerations, to help inform ISO customers of potential challenges and certain recent changes. For more information on marijuana supply chain risks, see the ISO Emerging Issues series "From Seed to Smoke."

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William Mauro, ISO, Director, Commercial Casualty Product Development

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Opioid Crisis: A Systemic Liability Event?

In October 2017, the White House announced a "nationwide public health emergency" to address the "opioid crisis," which generally refers to the reported increase in opioid-related deaths and addiction in the United States.[1]

The National Institute on Drug Abuse (NIDA) states that opioids are a class of pain relievers and other drugs. Prescribed opioid pain relievers are generally safe for short durations but can be misused and abused.[2] The U.S. Centers for Disease Control and Prevention (CDC) states that drug overdose deaths and "opioid-involved deaths" continue to increase in the United States.

"Most drug overdose deaths (more than six out of ten) involve an opioid," the CDC says.[3]

The U.S. Substance Abuse and Mental Health Services Administration (SAMHSA) reports that the National Survey on Drug Use and Health results from 2013 and 2014 indicate that "50.5% of people who misused prescription painkillers got them from a friend or relative for free, and 22.1% got them from a doctor."[4]

The opioid crisis could evolve into a systemic liability event because of the high number of opioid manufacturers and distributors, retailers, physicians, and hospitals that may be involved in the marketing and distribution of such drugs. Lawsuits have reportedly been filed against opioid supply chain participants, including manufacturers and distributors of opioids, pharmacies, insurers, and healthcare providers.[5]

Allegations have included failure to warn, failure to control "suspicious opioid orders," and deceptive business practices.

The primary lines of business likely to be impacted by lawsuits related to the opioid crisis are product liability, general liability, and professional liability, including medical malpractice, and possibly directors and officers liability.

AIR Worldwide's Arium platform maps interrelationships between various liability policies across industries—a so-called "event footprint." Arium has begun quantifying potential liability losses from the opioid crisis for insurer portfolios. The platform can estimate a spread of losses across industries and insurance lines of business to help gauge the total gross and net (of reinsurance) losses for a specific portfolio. Based on the footprint, the total loss amount, and the loss distribution across industries and lines of business, Arium can then run thousands of simulations to help determine how opioid losses may impact the specific portfolio.

The simulations are a way to help develop a reasonable range of estimates for potential insurable loss outcomes on a portfolio from the opioid crisis. The output of this process can help insurers with portfolio/exposure management, reinsurance buying/pricing, stress testing for capital adequacy, and reserving for potential large liability catastrophes.

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About Verisk

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As highlighted throughout this report, we provide these solutions through various industry-leading brands, including ISO, AER, AIR, Geomni, Verisk Maplecroft, Verisk 3E, and Wood Mackenzie.

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