TECHNICAL NEWSLETTER

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INTELLIGENT MACHINES RISKS AND OPPORTUNITIES FOR (RE)INSURANCE

"Human life and society as a whole are undergoing a deep transformation, driven by the accelerating impact of new technologies entering into daily life, with artificial intelligence and machine learning being at the forefront of this transformation. Because of the dependencies on data and connectivity the risk landscape is rapidly evolving. Protection needs are changing, as are the ways and means to access, purchase and distribute products and services. This transition will lead to certain business models and lines of business becoming less relevant and others obsolete. At the same time, it will offer opportunities for new business models and new products. At this juncture, the challenge for the (re)insurance industry is to adapt and bring to market innovative solutions for regenerating the business. SCOR is fully mobilized to address these challenges, partnering with its clients in new ventures to assess and anticipate the structural changes to come."



INTRODUCTION

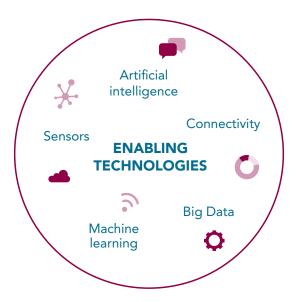
Strong advances in technology, algorithms and infrastructure have accelerated the development of intelligent machines. With the latest technological improvements, they are now becoming a daily reality.

Better sensors, digital infrastructure that support hyperconnectivity, Big Data, strong algorithms enabling artificial intelligence, machine learning features, all these new technologies are leading to the arrival of increasingly powerful and autonomous machines.

An intelligent machine can:

- analyse and react to information about its surroundings;
- self-manage over a long time with no human intervention;
- take decisions.

Bringing new possibilities, intelligent machines will affect people's behaviour and transform the insurance and reinsurance business in many ways. Besides the topical self-driving cars and drones, intelligent machines will take their place in a wide range of areas such as marine, aviation, mining, agriculture, manufacturing, and healthcare.



Intelligent machines will profoundly alter the insurance and reinsurance risk profiles and business models:

- they will create new business opportunities: corporations will increasingly need protection against new exposures and business interruption risks;
- they will create new tail risks: a single point of failure can bring an entire global operation to a halt;
- they will introduce transformative trends: these will create shifts in insurance business and transform the legal, social, economic and operational environments for insurance.



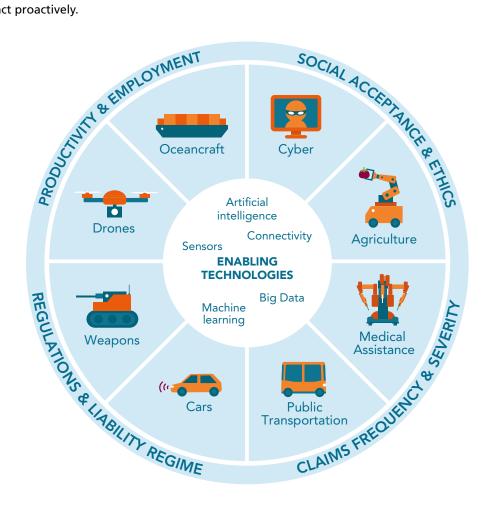




RISKS AND OPPORTUNITIES

As new opportunities come along with machine intelligence, the risk landscape is evolving for the insured persons, insured goods, insurers, and reinsurers. The insurance industry must anticipate the impact on risk profiles and lines of business and be set to react proactively.

The following illustration provides enabling technologies (inner circle), affected industries (pie chart), and overarching affected topics (outer circle).



AUTONOMOUS MACHINES REPRESENT IMPORTANT EXAMPLES OF TECHNOLOGICAL DEVELOPMENTS THAT ARE OCCURRING QUICKLY, AFFECTING ALMOST ALL SECTORS OF THE ECONOMY, AND LEADING TO IMPORTANT NEW LEGAL, REGULATORY, SOCIETAL AND ETHICAL CONSIDERATIONS. IN PARTICULAR, AUTONOMOUS MACHINES MAY HAVE PROFOUND IMPLICATIONS FOR (RE)INSURANCE.

Chief Risk Officer, SCOR

(Foreword to the CRO Forum Emerging risks initiative paper on autonomous machines)



REDUCTION IN ACCIDENT FREQUENCIES

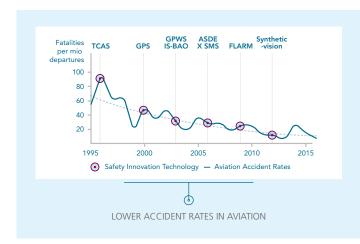
The reduction in human error will reduce the frequency of losses.

93% of car accidents result from human error¹. In the marine sector, Allianz estimates that 75% to 96% of accidents are caused by human error². Overall, the automation of human operations is expected to bring more safety and reliability in many lines of business.

For insurance, lower risk of human error means that the frequency of claims is likely to be reduced. With a move away from attritional risks, pricing in the tail may become more difficult, as data loses relevance and becomes scarcer. The remaining causes of accidents will probably be machine features leading to errors in human decision making or unsafe human behaviour that machines did not foresee.

THE EVER-GROWING DEMAND TO BE FASTER, SAFER AND TO PROTECT THE ENVIRONMENT ARE ONLY A FEW REASONS WHY TECHNOLOGY DOES NOT STAND STILL IN A BUSINESS LIKE AVIATION. IN THE INSURANCE AND REINSURANCE INDUSTRY WE HAVE TO TAKE THESE FACTORS INTO ACCOUNT WHILE EVALUATING A RISK AND ANALYZING THE IMPACT ON THE FREQUENCY AND SEVERITY.





LOWER FATALITY RATES IN AVIATION DUE TO SAFETY IMPROVEMENTS

The progressive introduction of innovative safety technologies and processes in aviation helped reduce passenger fatality rates by 5% to 10% per year over the past 20 years. This has led to lower (re)insurance rates as well as lower plane ticket prices.

Source: ICAO & planecrashinfo.com. Safety innovations systems (TCAS: Traffic Collision Avoidance System; GPS: Global Positioning System; GPWS IS BAO: Ground Proximity Warning System; ASDE X SMS: Airport Surface Detection Equipment; FLARM: Traffic awareness and collision avoidance technology)

BIGGER LOSS ACCUMULATIONS

Massive loss events due to single points of failure, system breakdowns and systemic malfunctions have higher risks of occurrence.

New technologies enable the wide-ranging arrival of intelligent machines, with a downside: the machines' reliance on such systemic technologies will create new forms of accumulation.

- High dependence on data service providers GPS, communication networks or live data feeds means that single points of failure could bring a whole operation to a halt.
- An identical dysfunction a programming mistake or an inadequate software update in mass-produced machines could generate simultaneous and repeated deficiencies.
- One defective machine could autonomously execute the same erroneous activity numerous times.

^{1.} KPMG LLP & Center for Automotive Research, 2012. Self-driving cars: The next revolution

^{2.} Allianz Global Corporate & Specialty, 2012. Safety and Shipping 1912-2012: From Titanic to Costa Concordia



In essence, increasing interconnections between data and workflows will shift the impact – whatever the cause of the event – from physical damage impact to business interruption loss. Human fall-back solutions will most likely be scarcer, as machines designed to be autonomous are more difficult to replace or operate manually.

Business interruption risk can be reduced through redundancies and business continuity plans, but some of the risk will have to be transferred to insurers and reinsurers.

BRITISH AIRWAYS IT FAILURE – BUSINESS INTERRUPTION – MAY 2017

The airline industry relies heavily on digital infrastructure and connectivity. Due to a massive power surge, the company's data centre and its back-ups failed catastrophically. Consequently, 726 flights had to be cancelled, affecting 75,000 passengers over three days. The physical damage was minimal, but this business interruption cost the company around €100m. In the future, more local events with global implications could be foreseen.

INTELLIGENT MACHINES COMBINED WITH AUTOMATION AND INCREASING INTERCONNECTIVITY WILL ADD AN ADDITIONAL LEVEL OF COMPLEXITY TO INDUSTRIAL PROCESSES INCLUDING THE SUPPLY CHAINS, RISK ENGINEERS MAY UNDERESTIMATE POTENTIAL EXPOSURES. ON THE UPSIDE, PROCESSES BECOME MORE EFFICIENT AND PROBLEMS ARE DETECTED FASTER. ON THE DOWNSIDE, COMPLEXITY AND ATTACK SURFACES ARE CONSTANTLY INCREASING WHICH CAN RESULT IN LOSSES DUE TO MALICIOUS OR UNINTENTIONAL INCIDENTS.



A SHIFT TOWARDS MORE SEVERE CLAIMS

Increased event complexity raises attritional loss severity.

The costs of claims may severely increase, owing to a growing complexity of machines and higher interconnectivity of the machinery that impact the overall sequence of accidents.

Repairs of advanced technologies will be more expensive and time-consuming. Events themselves will have a greater physical impact, with larger numbers of people being affected.

Thus, as incidents increase in complexity, the insurance industry will still have an essential role to play by offering appropriate cover in case of unforeseen events. In the longer term, new policies could specifically cover injuries and damage from machines.

In the meantime, the transition period from human action to intelligent machine operation will likely be a period of intensified risk. New and unexpected fault sequences will come from the learning process of the human-machine coexistence and interaction.



AIR FRANCE 447 CRASH – LOSS OF CONTROL INCIDENT – JUNE 2009

The disaster resulted directly from failed interaction between a sophisticated autopilot and human pilots. The plane's airspeed sensors failed, causing the autopilot to disengage, which changed other control systems settings as well. The pilots lacked a clear understanding of the real state of the aircraft and were unable to prevent the crash.

Such loss of control incidents still represent the main cause of fatalities in commercial aviation – up to 43% of fatalities in 37 separate incidents between 2010 and 20143.

SHIFT IN LIABILITY REGIMES

The increased complexity of the manufacturing process and the increased number of parties involved will make assigning liability more difficult.

Value chains for intelligent machines will undoubtedly grow more intertwined, blurring the boundaries between personal liability, product liability and professional liability. Determining the cause and assigning responsibility for accidents will therefore become more challenging.

Different concepts in the establishment of liability will possibly be favoured in the future:

- No-fault liability: the insured is covered whoever is at the origin of the claim;
- Negligence liability: this covers the action (or inaction) of an individual, and can be extended to vicarious liability;
- Strict liability: the responsible party is liable without a finding of fault such as negligence or tortious intent.

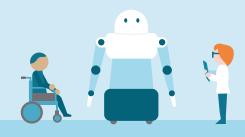
Legislation which regulates cohabitation and interaction between humans and intelligent machines is currently being introduced, as the GDPR (European General Data Protection Regulation) as well as the changes to Wiener Motor convention and German Motor regulation illustrate. Laws changing the liability rules and liability insurance regulation may follow afterwards.

Inside the vehicle, the notion of driver and passenger will disappear in favour of the notion of occupant. All victims on board a vehicle will be compensated regardless of whether the driver is potentially at fault or not.

THE INCREASING COMPLEXITY OF THE VALUE CHAIN IN THE AUTOMOBILE INDUSTRY, THE CONVERGENCE OF LIABILITY REGIMES IN TRAFFIC LAW, PRODUCT SAFETY LAW, AND THE INHERENT UNCERTAINTY **DURING A MULTI-YEAR** TRANSITION PHASE WILL CHALLENGE EXISTING PRICING AND EXPOSURE MANAGEMENT APPROACHES OF (RE)INSURERS.







FUTURE EVOLUTION IN MOTOR THIRD PARTY LIABILITY

Traditional model: With human-operated cars, the owner drives the car and is liable for any accidents.



In the future: in the case of self-driving cars, various parties can be liable in the case of an accident. The responsibility of a car crash could for instance be attributed to:

- the driver for not correcting the course of the car;
- the manufacturer who failed to implement sufficient warning signals;
- the software provider if the software was unable to detect the obstacle:
- the repair workshop for not replacing defective sensors, such as radar or cameras;
- the digital map provider who did not show the obstacle on the map;
- the hacker for manipulating software or data in the car.

NEW FORMS OF CYBER VULNERABILITIES

Exacerbated vulnerability to new kinds and higher impacts of cyber-attacks will call for further cyber risk solutions.

The widespread use of connected devices and intelligent machines in all areas of daily life exacerbates the vulnerability to cyber-attacks and cyber accidents.

Many forms of cyber-crimes exist, with effects such as security breach expense and liability, extortion, business interruption, loss of future profits, public relation expenses, and data theft or leak. The impact on companies is also manifold: tangible assets such as machines and buildings may be impacted. More importantly, intangible assets such as data, intellectual property and reputation can be damaged.

Insurance policies for cyber events cover both first party losses – business interruption, property damage, breach event management costs – and third-party losses – privacy liability, security liability, etc. The cyber insurance market is evolving quickly, with the underwriting, modelling, and pricing aspects being under development but still lacking maturity and consistency.

MAJOR CLAIMS FROM GLOBAL CYBER ATTACKS

WANNACRY - MAY 2017

The ransomware attack infected more than 300,000 computers in 150 countries. The North Korean Lazarus Group is suspected of having launched the attack.

NOTPETYA – JUNE 2017

The attack impacted several global corporations, including an oil company, an international airport, and even hospitals. For instance, the FedEx group reported a USD 300m loss from this attack.



WE SUGGEST CONSIDERING CYBER NOT SO MUCH AS A PRODUCT, BUT MORE AS A PERIL. DUE TO THE COMPLEXITY AND CONSTANT EVOLUTION OF CYBER RISKS, A COLLECTIVE EFFORT IS NEEDED TO BUILD A SUSTAINABLE CYBER (RE)INSURANCE MARKET.



DATA PROTECTION

Massive amounts of available data increase the potential of their loss, implying reputational and legal risks.

Autonomous machines generate, record, and process significant amounts of data. They increasingly enter many – if not all – daily personal activities, recording private information on identifiable individuals, such as their health conditions or their lifestyles. In the "Internet-of-Things" economy, data is not a side-aspect any more, but the enabling and value generating factor in many business models.

Available data may provide insurers with abundant opportunities to understand their customers better and personalize insurance products. However, if insurers inappropriately use such data, it could quickly turn into an intrusion of personal privacy. On the other hand, other companies such as car manufacturers are starting to amass live data, and could decide to start offering insurance products.

More available data generates more data security issues, all sectors being at risk if not appropriately managed. On the legislation side, companies' liberty to treat personal data varies with jurisdiction. For instance, the European Union regulations to protect individual privacy are becoming stricter. Starting from May 2018, the European General Data Protection Regulation (GDPR) will empower individuals to manage their own personal data, and companies failing to comply will face material fines.

ANTHEM DATA BREACH, FEBRUARY 2015

Anthem Inc., the second largest US life and health insurer, reported a massive medical data breach by its servers. Identifiable personal data was stolen from 80 million clients, including names, birthdays, medical IDs, social security numbers, street addresses, e-mail addresses and employment information, including income data.

Anthem's cyber insurance's policy limit of USD 100 mio is expected to be used up.

ELECTRONIC DATA LIABILITY IS
AN EVOLVING RISK, AND THUS A
CRITICAL INSURANCE PURCHASE
FOR COMPANIES THAT HANDLE
SENSITIVE DATA. WE SUPPORT
THE DEVELOPMENT OF THE CYBER
LIABILITY INSURANCE MARKET
BY SHARING BEST PRACTICES
IN UNDERWRITING AND CLAIMS
HANDLING WITH OUR CEDANTS.





TRANSFORMATIVE TRENDS

More indirectly, intelligent machines will bring new global trends to society, transforming the legal, regulatory and economic environments, with possible repercussions on insurance activities.

THE OPPORTUNITY TO UNLOCK NEW RISKS BY USING MACHINE LEARNING IS SIGNIFICANT, AS IS THE POTENTIAL TO OFFER NEW PRODUCTS TO INSURE NEW RISKS EMERGING FROM FIELDS SUCH AS PREDICTIVE MAINTENANCE.



CLAIMS PREVENTION AND MANAGEMENT

Disaster prevention will be more effective and post-event damage assessments more efficient.

Pre-catastrophe:

- satellite imagery helps assess areas exposed to natural disasters. This can be used in designing prevention, such as flood defences, or to improve the pricing process;
- networked machines can be monitored remotely. The generated real-time data can be used to predict failures, allowing firms to implement maintenance actions or part replacements at the optimum time to prevent unexpected downtime.

SMART SENSORS AND COMPLEX DATA PROCESSING CAN HELP TO OBSERVE THE BEHAVIOUR OF THE AGRICULTURAL CROPS. THESE TOOLS ARE BROUGHT TO ITS CLIENTS BY THE SCOR AGRICULTURAL TEAM IN DIFFERENT WAYS: FROM LOSS ADJUSTMENT OPTIMIZATION USING HIGH RESOLUTION IMAGES (FROM DRONES, PLANES, OR SATELLITES) TO THE DEVELOPMENT OF EFFICIENT PLANT GROWTH INDEX PRODUCTS.



Post-catastrophe, satellites and drones can support:

- disaster relief: with a degree of autonomy, drones and satellites gather data from affected areas, draw a picture of the situation and support the emergency response;
- damage assessment: drones support claims inspections, procurement of photographic evidence, identification of severely hit areas, prioritization in deployment of claim adjusters, or effective loss indemnifications.

HURRICANE IRMA IN FLORIDA – EFFICIENT POST-EVENT DAMAGE ASSESSMENTS – SEPTEMBER 2017

132 drones were licensed to fly over the damaged areas, providing data to several organisations. The Air National Guard received visual overviews helpful in quickly alleviating damage and the victims' distress. Electric Authorities were able to check their power lines to restore power. High resolution pictures were made available for insurers to efficiently assess homeowner claims.







SHIFTS IN EMPLOYMENT: THE EXAMPLE OF HEALTH CARE

Much manual labour can be automated, causing shifts in employment and a significant impact on society and its welfare.

Intelligent machines are employed in almost all sectors of activity to accomplish predictable physical activities or repetitive tedious tasks, such as collecting and processing data. 9% to 50% of the tasks could ultimately be automated, with variable potentiality. According to a 2017 McKinsey study⁴:

- 5% of occupations are entirely automatable;
- 60% of occupations are 30% automatable.

New jobs will be created, yet most analyses still forecast an increase in unemployment. This could produce significant social consequences, with a potential downside including social unrest, populism and amplified extremism. Insurance needs and tax regimes will need to change as well.

On the other hand, morbidity and mortality might benefit from the automation. The likelihood of accidents at work will decrease, working hours can be reduced, and working conditions will become more pleasant.

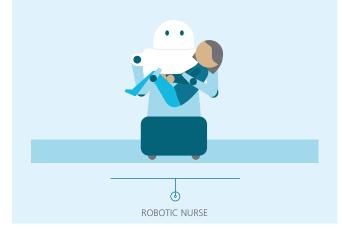
AUTOMATION HAS THE POTENTIAL TO REDUCE ACCIDENT AND DISABILITY CLAIMS FOR INSURANCE, AND TO GENERALLY IMPROVE MORBIDITY AND MORTALITY. HOWEVER, AS MENTAL HEALTH ISSUES ARE THE LEADING CAUSE OF DISABILITY IN MANY SOCIETIES NOW, THE POTENTIAL DOWNSIDES GENERATED BY JOB LOSSES AND THE CHANGING ROLE OF THE HUMAN INDIVIDUAL NEED TO BE TACKLED IN ORDER TO REAP AUTOMATIONS FULL BENEFITS.



IMPROVEMENTS IN THE MEDICAL SECTOR

The use of robotics in medical care shows potential in several aspects:

- Autonomous wearables and genetic testing will help to prevent or detect diseases at an early stage and monitor a patient's health status, allowing for faster and more individualised interventions. For instance, chronic diseases such as diabetes can be supervised in real time.
- Automation will enable remote medical care and remote operations, e.g. by the introduction of robot nurses benefitting patients' wellbeing and moral. This will also alleviate difficulties such as lack of staff in hospitals and care homes, and reduce the physical strain on carers.
- Robot arms have the potential to perform surgeries much better than human doctors. As of now they still need to be remotely controlled, but will likely be improved to gain autonomy.
- In the future, nanorobots in the blood stream might be able to operate autonomously, diagnosing and delivering drugs from within the human body. Such treatments will be more responsive, better tailored to the individual patient and will help prevent risks of infections from surgical procedures.



Overall, the introduction of autonomous machines in human society aims at improving people's life. Some noticeable advantages should be an extended life expectancy from improved human wellbeing and better health into old age.



SHARING ECONOMY

Machine-as-a-service shifts risk from physical damage to business interruption.

New economic models based on autonomous technologies will enter the landscape, remodel personal behaviours and affect insurance. Notably, the 'Sharing Economy' will carry forward the concept of machine-as-a-service, with an expectable shift from "just in case" ownership to "just in time" rental.

Successful sharing economy business models already exist such as accommodation providers without hotels (Airbnb, ebookers), taxi companies without taxis (Uber, Lyft), and movie companies without cinemas (NetFlix).

These new models imply a shift in insurance needs away from insuring vehicles and machines in traditional ownership structures, to insuring:

- the service provider: business interruption, forensics, and infrastructure;
- the service buyer: privacy liability, failed or delayed service, security and media liability.

This opens up opportunities for insurers to engage in partnerships with new players -FinTech, HealthTech and InsurTech companies. On the other hand, these new business models will increase some risks. For instance, the enabling networking software is likely to be held by a small number of companies, which represents an accumulation risk.

EVOLUTION OF MOBILITY TOWARDS MULTI-MODALITY

Personal mobility will become more complex, with more than just personal car, bicycle, or public transport. Technological developments - such as connectivity, remote sensing tools, machine-to-machine communication and the supporting infrastructure - will facilitate options such as automated taxis and trains, shared cars and pay-as-you-ride features.

Instead of coverage for the vehicles, customers will be insured along their multi-modal journeys. For instance, a simple insurance product could offer compensation in case of transport delay.

THE COMPLEXITY OF FUTURE INTERRELATIONS BETWEEN TRANSPORT MODES, DRIVERS, PASSENGERS AS WELL AS CONNECTED INFRASTRUCTURE WILL TRIGGER A WHOLE NEW SET OF PERILS THAT ARE NOT WELL UNDERSTOOD AT THE PRESENT TIME. BY SHARING KNOWLEDGE AND EXPERIENCE WITH OUR CLIENTS, SCOR WILL BE CROSS-FERTILIZING OUR EXPERTISE ACROSS MARKETS TO HELP SECURE A CONTROLLED TRANSITION TOWARDS THE BEST INSURANCE PRACTICES OF THE FUTURE.



ETHICAL CONTROVERSIES

What happens with liability once there are truly intelligent machines which can learn and decide by themselves?

Major ethical concerns and societal implications will rise as machines gain more autonomy. One major uncertainty is the potential ability of a machine to take a decision by itself without human intervention and what it would mean for liability. Could autonomous machines get the same legal responsibility as humans? If yes, would it be possible to "sue" an intelligent machine or would it be ethical to "kill" one? Will machines have to buy insurance coverage?

Even defining rules to frame the learning process and decision-making of intelligent machines will be difficult, all

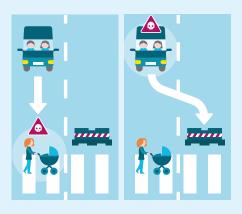


the more since ethics are different from laws and related to the cultural background. According to Insurance Europe, at the present state of machine autonomy, amending current liability regimes or creating specific liability rules for new technologies would still be premature⁵.

Until it becomes necessary, regulators, manufacturers and insurers are nonetheless interested in defining the most ethically acceptable outcomes, which will enable them to develop the right insurance products.

DECISION-MAKING WITH LIVES AT STAKE

For driverless cars, ethical questions are clearly important, as the deadly accident involving a self-driving car in March 2018 illustrates. Consider a scenario in which a self-driving car faces a potential collision with pedestrians and it is too late to brake. The only alternative is to change course, which would lead to a collision with an obstacle:



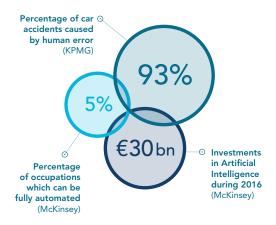
- option 1: continue its route and drive into the pedestrians, probably killing all of them;
- option 2: deviate into the obstacle while avoiding the pedestrians, probably killing the passengers.

The most tolerable outcome is not obvious and differs depending on cultural acceptances.

AS ALGORITHMS INCREASINGLY TAKE OVER HUMAN TASKS, SOCIETY MUST DECIDE WHICH MORAL FRAMEWORK WILL GUIDE OUR AUTOMATED FUTURE. THIS IMPLIES RE-DISCUSSING KEY QUESTIONS FOR MAKING SURE INTELLIGENT MACHINES REFLECT ETHICAL PRINCIPLES WELL ACCEPTED WITHIN OUR SOCIETY. THE LEGAL FRAMEWORK AND LIABILITY INSURANCE MARKET WILL BOTH NEED TO EVOLVE ACCORDINGLY.



The following illustration shows how intelligent machines and related technologies are heavily invested in, which will affect everyone's life at some point in the near future.







CONCLUSION

Intelligent machines will affect everyone and all business models.

They bring numerous opportunities, but there are also new and increased risks related to the growing complexity of technologies and hyper-connectivity. Challenges will come from the arrival of new drivers of insurance.

Insurance is a business enabler, protecting against existing, evolving, and new types of risks.

New risks and bigger accumulation risks threaten individuals and corporations. The cause of an accident and whether it is malicious will become harder to determine, but the potential impact could be considerably stronger.

By providing protection against these risks, insurance and reinsurance remain business enablers - allowing new business models to evolve and to take advantage of the various new possibilities that intelligent machines offer.

SCOR is able to provide its clients with tailored reinsurance solutions to optimally manage and transfer these evolving risks.

Big Opportunities to be seized by the insurance industry, requiring evolution in underwriting and digital capabilities.

Overall, the loss potential – severity and accumulations – related to cyber risks and intelligent machines is equivalent to what is expected from natural catastrophes.

Such risks are, of course, insurable, but some liability regimes may change, and pricing will be challenging. This is a big opportunity for insurers and reinsurers, who need to embrace these new types of risks in order to be able to engage in new risk solutions.

Relying on its extensive knowledge, SCOR is available to work on finding adequate solutions and providing insurance solutions for clients by understanding and embracing the evolving risk universe. SCOR supports the development of the transforming insurance market by sharing best practices with its clients.

This article is written by:



PHILIPP ARBENZ Risk Manager parbenz@scor.com

CLAIRE HUGO Risk Analyst

Based on the CRO Forum Emerging Risks Initiative position paper on "Autonomous Machines"

Business contacts:

Didier PARSOIRE - Cyber Chief Underwriting Officer dparsoire@scor.com

Stefano LASSA – EMEA Motor Practice Leader slassa@scor.com

Ronald KOCH, Ralf ROESCH, Lois WINCHESTER - Casualty Practice Leaders

rkoch@scor.com - rroesch@scor.com - lwinchester@scor.com

Simon DEJUNG – Senior underwriter Engineering

sdeiung@scor.com

PLEASE FEEL FREE TO VISIT US AT SCOR.COM

SCOR P&C

5, avenue Kléber - 75795 Paris Cedex 16 scorglobalpc@scor.com



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