



SAFETY AS A MISSION

THE FUTURE BELONGS TO THOSE WHO ACT

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AT HUMANETICS, OUR PURPOSE IS CLEAR: PROGRESS ONLY MATTERS IF IT PROTECTS PEOPLE.

Every solution we deliver to our customers is grounded in what we call Safety Intelligence: the integration of human-centered design, real-world data, and biofidelic devices that act as surrogates for the human body. By placing humans at the heart of industrial design, we ensure that every innovation in vehicle safety reflects the complexity, diversity, and dignity of the people it serves.

Safety Intelligence is more than a philosophy - it is the practical foundation of modern mobility. Our crash test dummies, human body models, digital avatars, and advanced sensing systems are not just tools; they are data-generating instruments that mirror the reality of human experience. They allow automakers, researchers, and regulators to design vehicles and systems that anticipate risk, respond to real-world conditions, and minimize the likelihood of injury or fatality. In short, they transform raw data into actionable insights that save lives.

The "Safety as a Mission" series reflects our conviction that safety is not incremental: it is urgent, systemic, and mission-driven. By harnessing the power of Safety Intelligence, and by working in partnership across the industry, we can accelerate innovation, reduce harm, and ensure that safety keeps pace with the speed of technological change. Our mission is simple yet profound: to give every traveler the confidence that their journey is safeguarded by design, because protecting people is the ultimate measure of progress.

Thank you for your partnership in this mission.



Christopher O'Connor
President & CEO, Humanetics

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CHAPTER 1

EMBRACING SAFETY AS A MISSION

IN THE TIME IT TAKES YOU TO READ THIS ARTICLE, ONE MORE FAMILY WILL BE MOURNING THE LOSS OF A LOVED ONE - DEALING WITH THE MONUMENTAL, UNFATHOMABLE, FUTURE AHEAD OF THEM.

Another 15 families will be coming to grips with the reality of supporting someone with a severe, life-changing injury. Over 40,000 people lose their lives in the U.S. every year in automobile-related crashes, and a further 1,000,000 suffer severe injury. While Europe has largely succeeded in driving road deaths downward, the U.S. has failed to buck the trend.

SAFETY AS A MISSION

A large proportion of these lives could be saved if we treated Safety as a Mission. Humanetics does - as do many other companies, manufacturers, and vehicle designers. Every day we wake up and ask ourselves: what more can we do to protect humans in motion?

Since its inception in Sweden in the 1990s, Vision Zero has expanded across Europe and is gaining momentum in major American cities. Central to this commitment is the Safe Systems approach which addresses the entire traffic system: human behavior, vehicle design, road infrastructure, and emergency response. This approach emphasizes safety as a shared responsibility and integrates multiple layers of protection to accommodate human errors and prevent severe outcomes. The rapid pace of technological advancements presents exciting possibilities for saving lives. Regulators and engineers are working together to harness this potential, accelerating the adoption of new technologies. OEMs are rising to the challenge of balancing faster production with enhanced safety and cost efficiency.

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The hardest work is yet to come. We're not going to experience a significant reduction in fatalities or injuries unless we get uncomfortable. We need to get uncomfortable at this point to save more lives."



CHRISTOPHER O'CONNOR
President & CEO, Humanetics

...BUT, are we collectively doing enough? Are we moving fast enough to meet any of the goals of Vision Zero? It's becoming increasingly clear that we cannot effectively reduce traffic fatalities and injuries without implementing additional regulations and safety measures.

In this multi-part series, we will explore our understanding of Safety as a Mission.

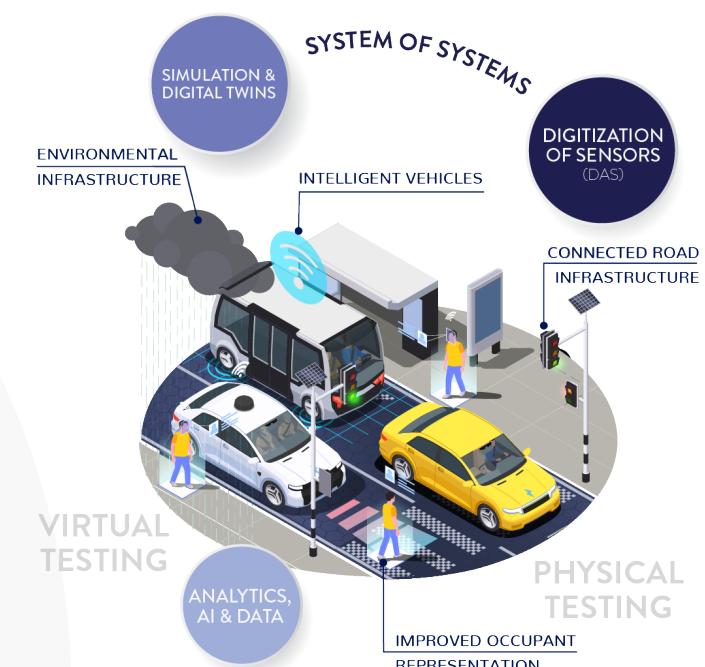
WHAT WE MEAN BY SAFETY AS A MISSION

In the first part of this series, we will explain what we mean by Safety as a Mission. We will review what we have achieved so far and consider the challenges ahead of us.

We will explore exciting technology developments offering new ways to improve safety, as well as some of the challenges and changes we face in implementing them to achieve better outcomes, while not increasing costs burdens across the industry and on consumers.

ACCELERATING INNOVATION

In the second part, we will examine specific areas of innovation we can accelerate if we align behind the biggest issues to develop a shared vision to improve processes, efficiency and investments. We will look at how to improve equitable representation in vehicle comfort and safety through the use of improved digital human representations and human body models.



We will investigate the challenges and opportunities in generating and managing data across the physical crash test process and how to correlate and configure those results with data from simulation and data models.

Lastly, we will look at how software in the crash test lab and on the proving ground can help drive efficiency and simplify the test process, enabling car makers to bring better products to market faster, with significantly reduced development costs.

AN AUTONOMOUS FUTURE

In the final part, we look further ahead to a world where human-controlled and fully autonomous vehicles share roadways. We will ask questions about the skills and systems we need to develop to ensure power, management and control is ultimately in human hands in this promised autonomous world.

OUR EVOLVING PERSPECTIVE

Our perspective has evolved over time. It is clear to us that we need to look at the end-to-end process required to bring a new vehicle to market from design to production. An integrated ecosystem offers numerous advantages beyond just our products, benefiting users across various sectors by creating a cohesive environment that enhances efficiency, performance, and user convenience.

"We have an ambitious vision to better integrate simulation and data management tools with the physical crash testing process. This 'virtual-real closed loop' is critical to both advancing occupant safety and vehicle development efficiency."



KARSTEN NEWBURY
President of Humanetics Digital

Products are designed to work together to eliminate compatibility issues, reducing setup time, and simplifying maintenance. When products operate as part of a unified system, they communicate and share data more effectively, leading to optimized performance and greater overall capabilities. Simplified workflows and centralized management make operations more straightforward, enhancing the user experience and maximizing resource utilization.

CRITICAL FACTORS OF INDUSTRY SUCCESS

The critical factors for our success hinge on several key strategies: integrating new life-saving technologies into our tool portfolio, reducing development costs to allow for reinvestment in innovative technologies, and unifying data across siloed systems related to vehicles, roads, occupants, and the environment.

One example, is more use of adaptable restraint systems that recognize and accommodate the diverse physical characteristics of passengers. By acknowledging that individuals vary greatly in terms of size, age, body composition, and physical abilities, manufacturers are developing innovative restraints that can adjust in real-time to provide optimal protection for each occupant, regardless of their unique physical attributes. These types of innovations can go a long way in protecting and accommodating every vehicle occupant.

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The vision for our future is to bridge the physical and digital worlds, support our customers' decision making, simplify product development, and ensure that when we innovate, humans thrive."



CHRISTOPHER O'CONNOR
President & CEO, Humanetics

Additionally, we aim to combine physical and virtual testing to enhance biofidelity and address fragmentation, expand the representation of occupants in safety design, and accelerate technologies that safeguard pedestrians, cyclists and road users.



CHAPTER 2

OUR SHARED MISSION IS TO PREVENT MILLIONS FROM DYING

CHANGE WON'T HAPPEN WITHOUT A
REVOLUTION.

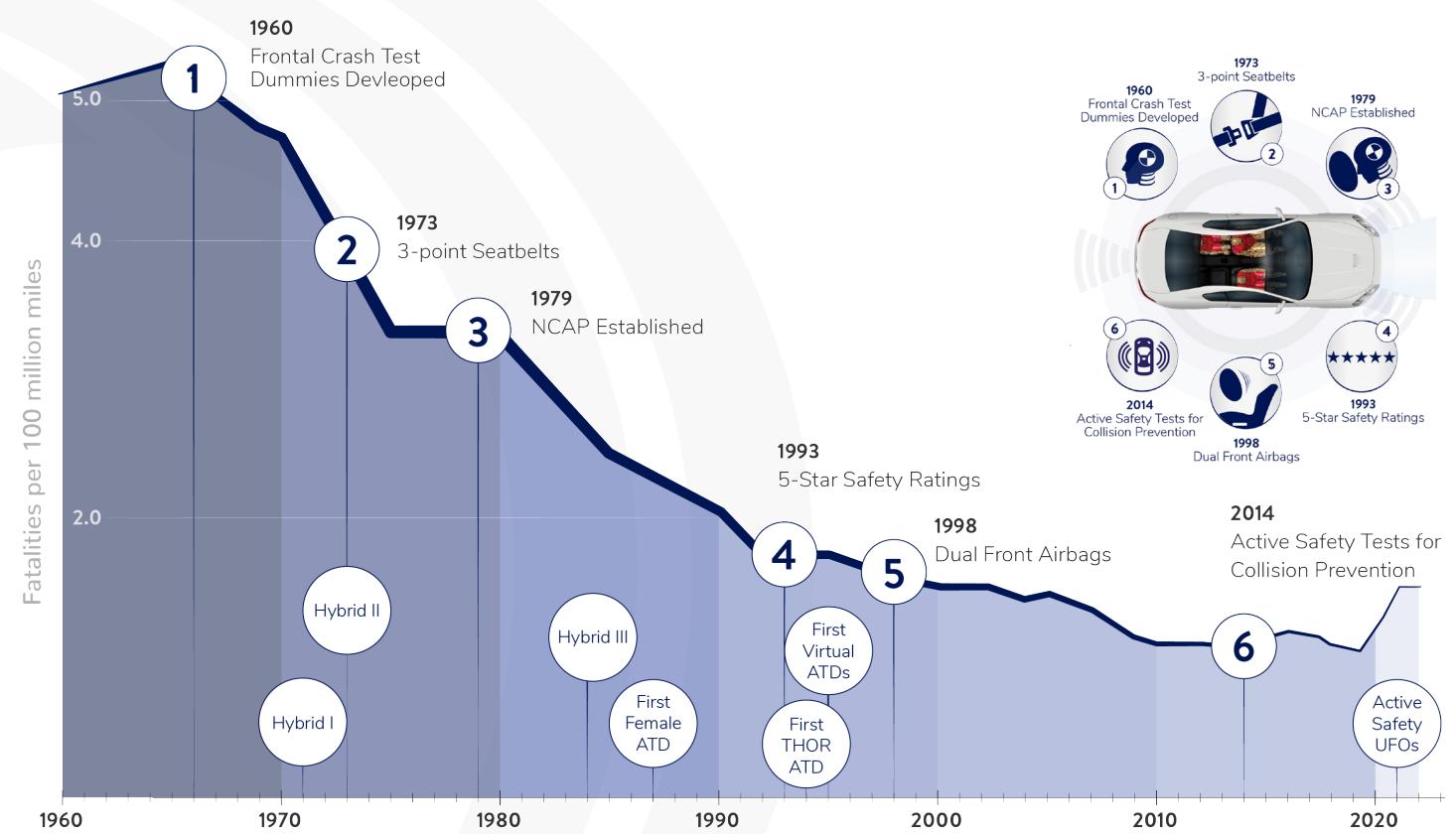
The euphoria of the 1950s and 1960s driving culture gradually gave way to the shocking realization of the human tragedy left in its wake.

OUR SHARED MISSION

People realized the perils resulting from speed, reckless unbound behaviors, and design that prioritizes seduction over safety. The impact of thousands of lives lost and countless more people injured on the roads was reaching virtually every family. Something had to be done to focus on safety.

The rallying cry was Ralph Nader's "Unsafe at Any Speed" which detailed the need for a system approach to safety. It resulted in the 1970s with the formation of the U.S. Federal agency for Safety – the National Highway Traffic Safety Administration (NHTSA).

Since that time, a combination of regulation, engineering innovation, consumer education and legislative enforcement has been effective in driving down fatality and injury rates. The deaths per million miles driven have been more than halved, showcasing relentless safety innovations and improvements.



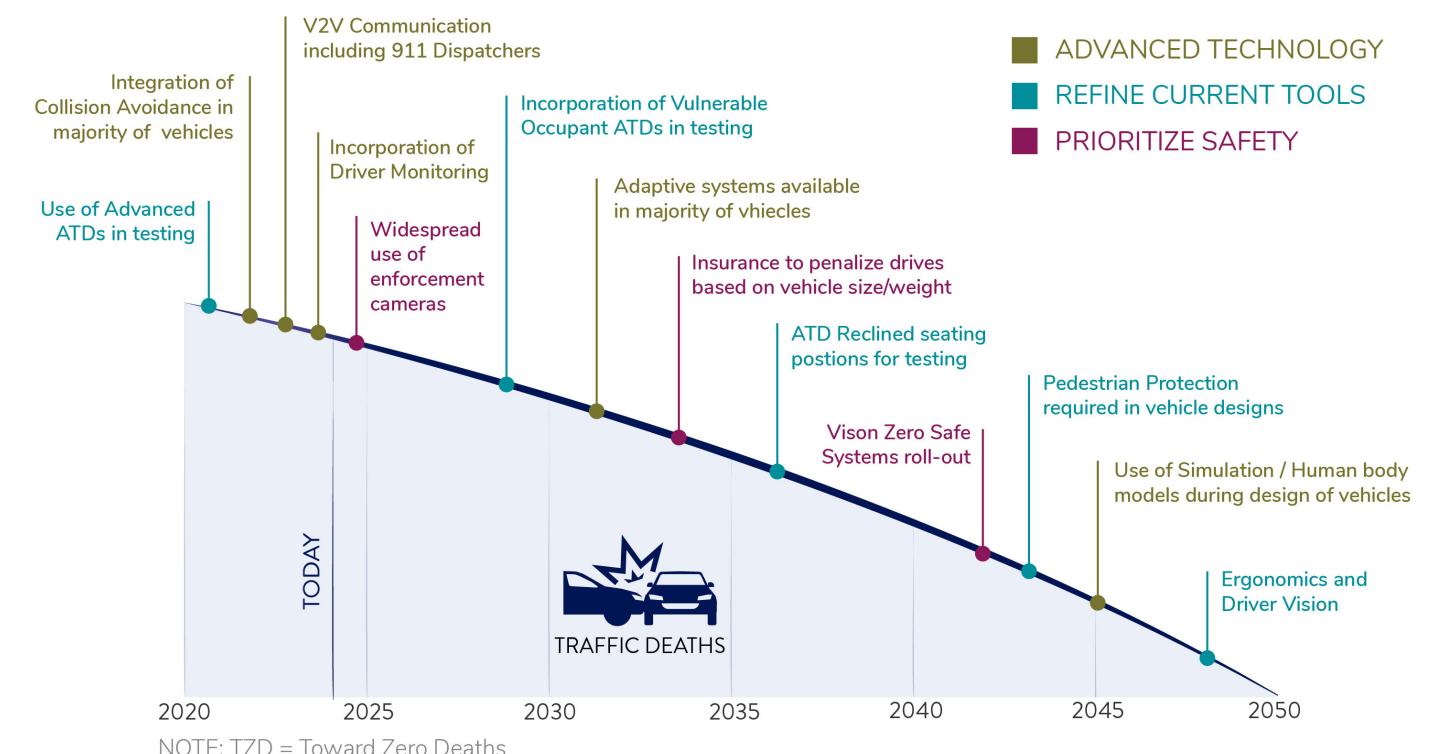
A brief history of automobile safety in the U.S. from 1960 to today and how safety technology has helped reduce the number of road fatalities throughout the years. SOURCES: TitleMax (2013), NHTSA (2015), CNBC (2018)

INCREASE IN US ROAD DEATHS

However, in the last decade, road deaths in the U.S. have risen by 30%, and the commitment to continue reducing these numbers has not been matched by new regulations or outcomes. Globally, 1.4 million people still die and tens of millions suffer serious injuries each year.

A holistic methodology, known as the Safe System Approach, has gained popularity in recent years, particularly in transportation safety. At the core of the methodology is the belief that everyone has the right to be safe while traveling, whether by car, bike or foot. The paradigm recognizes that safety is a shared responsibility requiring cooperation from all stakeholders, including policymakers, road designers, vehicle manufacturers and road users themselves.

The United Nations (UN) Economic Commission for Europe (ECE), World Health Organization (WHO), and Global NCAP organizations recognize the huge challenge ahead with any safety approach and have laid out a shared mission under Vision Zero, committed to eliminating traffic fatalities and severe injuries to zero by 2050.



Vision Zero is a strategy to eliminate all traffic fatalities and severe injuries, while increasing safe, healthy, equitable mobility for all. The graph depicts the necessary steps to meet this goal by using advanced technology, prioritizing safety, and refining current tools.

SUPPORTING VISION ZERO

The safety community is actively engaged in numerous initiatives to achieve significant advancements toward Vision Zero.

These efforts are organized into three main categories: refining existing tools and practices through improved crash test dummies and air bag systems; advanced technology in automatic braking, crash avoidance systems, simulations and Human Body Models (HBM); and prioritizing safety as a policy and politically.

...Unless we have new regulations being introduced and new goals that are required, we are not going to reach Vision Zero."

CHRISTOPHER O'CONNOR
President & CEO, Humanetics

A community with a shared vision and an industry with a shared mission is what we need to make progress in saving lives. While we can debate whether it is one regulation or technology over another, we must commit to deciding on action measured by outcomes. Prioritizing safety is essential to achieving Vision Zero.

HELP OF INNOVATIVE TECHNOLOGIES

In the coming years, innovative technologies will significantly enhance road safety and efficiency. Cameras will improve traffic law enforcement by automatically detecting violations like speeding and illegal parking, increasing accuracy and efficiency. Driver behavior tracking systems will monitor driving patterns, allowing insurance companies to adjust policies based on safe driving and vehicle characteristics, such as size and weight. By prioritizing safety, these technologies can drive progress toward the goal of zero traffic fatalities, promoting safer driving habits, and encouraging policies that prioritize the well-being of all road users.

CHAPTER 3

A VISION INSPIRES HOPE. MISSION DEMANDS ACTION.

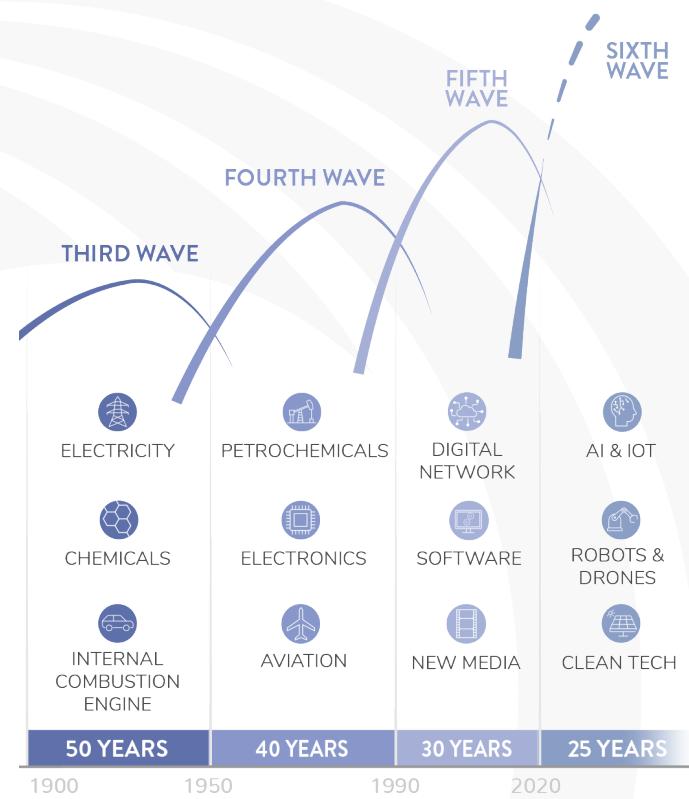
EVERYTHING HAS CHANGED.

“Safety is the U.S. Department of Transportation’s top priority... In 2024, the estimated number [of roadway fatalities] was a stunning 39,345. This is unacceptable,” said Secretary of Transportation, Sean Duffy. The digital, data and artificial intelligence revolutions demand that we take stock as an industry on how to raise our innovation to the level commensurate with the opportunity to save lives.

A VISION INSPIRES HOPE

As we look to the future, we need to radically re-imagine how to set the expectation for long term development in the context of generative artificial intelligence. Engineering groups designed to deal with changes over a 25-year generational period now need to adopt agile product development processes and set expectations for multiple changes in any given year.

We're currently in the sixth wave of innovation, often referred to as the fourth industrial revolution, which began around 2020 and is anticipated to continue until 2045, focusing on sustainable technologies like renewable energy, electric mobility and robotics. This wave is driven by advancements in digital, clean and human-centered technologies including automation, artificial intelligence (AI), sustainability initiatives, and the Internet of Things (IoT). These innovations are also expected to transform products and processes by integrating machine intelligence into cognitive roles traditionally held by humans.



Within the sixth wave's quest to enhance vehicle safety, it's crucial to innovate at the "speed of data" by rapidly leveraging information. Achieving this requires a seamless connection between the physical and virtual worlds through sensors, simulations, and analytics.

The success of this approach depends on the integration of the entire system - comprising the occupant, vehicle, road infrastructure, and environment.

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In an era of rapid technological advancements and increasing complexity in ADAS tests and features, the demand for efficient and holistic software solutions has never been greater."



MARK WESTEN
President of Humanetics Safety

Generating data quickly also streamlines development cycles, reduces the need for redundant physical tests, and ultimately saves both resources and costs. By accelerating data collection and analysis, safety solutions can be optimized more efficiently.

"

We continue to deliver the digital roadmap that we laid out several years ago to not only advance virtual testing, but to integrate virtual with physical testing. We've partnered with many technology companies and formed defined programs with OEMs to jointly realize our digital vision."



KARSTEN NEWBURY
President of Humanetics Digital

Humanetics is at the forefront of driving safety advancements by leveraging data to accelerate improvements through both physical and virtual testing. This comprehensive approach not only adapts to varying road and environmental conditions but also considers interactions with other road users, paving the way for more accurate and effective safety solutions.

UTILIZING DATA FOR SAFETY ADVANCEMENTS

The complexity of today's safety mission also demands a system-of-systems (SoS) approach, which strategically manages complexity in organizations, particularly in digital product development, by viewing infrastructure projects as collections of interdependent systems with unique functions and connections. While these systems can operate independently, their interactions can reveal emergent properties that are crucial for optimizing overall project performance. This holistic approach fosters a new mindset for addressing challenges driven by technology, policy, and economics.

With an SoS methodology, the vehicle safety industry will find value in data that enhances the accuracy of safety testing, addressing gaps in existing methods, and integrating both physical and virtual environments. This valuable data helps in refining testing processes and improving overall safety measures.

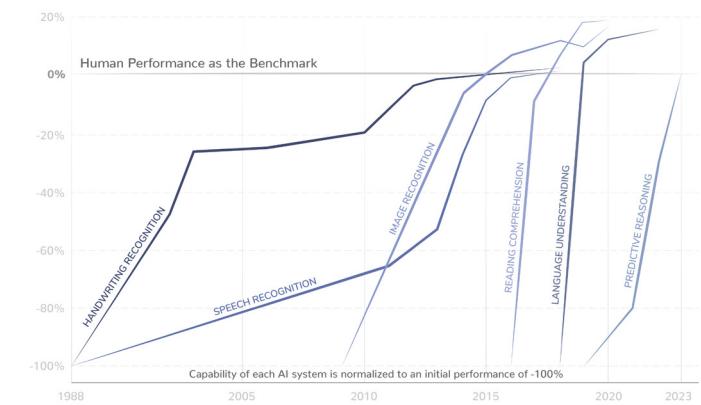
Data provides critical insights into various aspects of vehicle and occupant safety, road conditions and environmental factors. Analyzing this comprehensive data enhances overall safety analytics, leading to better-informed decisions and more effective safety interventions.

At Humanetics, we employ a range of data types to drive safety innovations:

- Real-Time Test Data: Captured during physical tests to provide immediate insights.
- Simulation Data: Generated through virtual models to predict safety outcomes.
- Environmental Data: Includes information about weather, road conditions and other external factors affecting safety.

RAPID IMPROVEMENT OF AI

As AI and machine learning continue to advance, the quality of models is improving at an unprecedented rate. What once took decades to achieve, such as reliable handwriting recognition, is now evolving rapidly, with predictive reasoning becoming increasingly human-like within just a few years.



This accelerated progress brings both significant responsibility and remarkable possibilities. Adaptable algorithms are crucial to this rapid growth, particularly in ensuring flexible and effective safety measures. These algorithms go beyond just considering the occupant and vehicle, they also account for important factors such as road conditions, ambient variables and the actions of other road users. This versatility allows AI systems to swiftly adapt to changing real-world conditions, thereby enhancing road safety and efficiency.

EMERGING MOBILITY MODES

Advancements in digital data and emerging mobility modes, alongside vehicles such as Electric Vertical Takeoff and Landing (eVTOL) aircraft, are driving transformative technologies. These include dynamic algorithms capable of delivering adaptive safety systems. These systems go beyond traditional occupant and vehicle-centric approaches by integrating real-time assessments of road conditions, environmental variables, and the behaviors of other active road users. This integral approach promises enhanced safety and efficiency in the evolving landscape of transportation.





CHAPTER 4

EQUITABLE DESIGN: DESIGN FOR EVERY BODY

THERE ARE ALMOST 8 BILLION PEOPLE IN THE WORLD TODAY. APPARENTLY, THEY'RE ALL THE SIZE OF AN AVERAGE MALE.

Humans come in all shapes, sizes, and ages, but apparently, not every industry has gotten the memo. This oversight is particularly evident in the vehicle safety landscape, where a 'one-size-fits-all' mindset often prevails - with 'all' typically meaning 'average male'. However, equitable design is crucial across all safety domains serving human beings. Protective clothing and Personal Protective Equipment (PPE), like head protection, respiratory equipment, fall protection systems, and ergonomic workstations are just some areas where diversity is underserved. The further an individual deviates from the 'ideal male' body type, the higher their risk of inadequate protection. Consequently, women, older adults, and anyone not fitting the 'standard' mold may face increased safety challenges. A deeper exploration of vehicle safety, equitable design across industries, and the digital world is necessary to address these disparities.

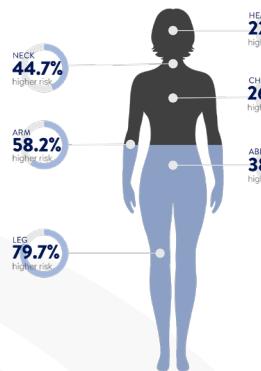
PURSUIT OF EQUITABLE SAFETY

Despite massive advances in simulation, the paradigm of safety is measured by a single body size. Why?

The pursuit of equitable safety in vehicle design and urban environments presents significant challenges across various dimensions, including gender, body size, and age. Safety design in vehicles and workplaces has historically been biased towards average male dimensions, leading to significant disparities in safety outcomes. For example, studies have shown that women are 73% more likely to be seriously injured in car crashes compared to men, primarily due to safety features designed based on male anthropometry.

**WOMEN ARE
73%
MORE LIKELY
TO BE INJURED**

and 17% more likely to die than a man in a frontal impact crash

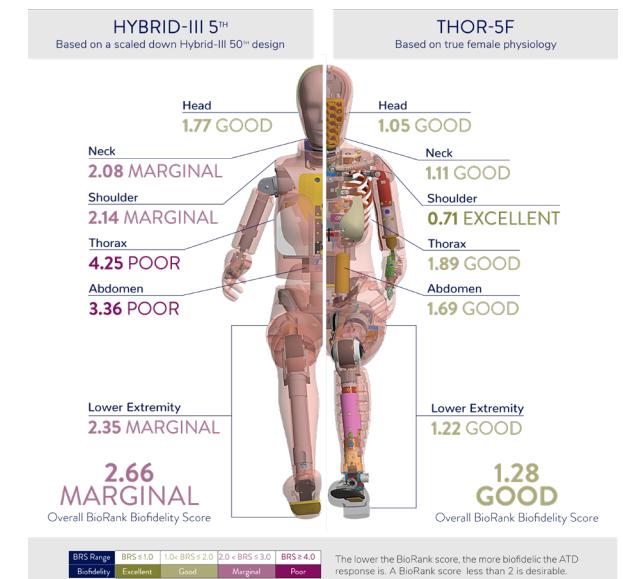


To help mitigate this disparity, new Anthropomorphic Test Devices (ATDs) such as the THOR-5F have been introduced, but have yet to be implemented in regulation.

To further understand today's world of vehicle crash testing, we need to recognize that ATDs are designed to mimic human beings as their test surrogates. For adult testing, they are designed to represent human body sizes using percentiles, primarily the 5th, 50th, and 95th. While this system covers a range of body types, it has limitations. It may overlook vulnerable groups such as the elderly, obese, or those with disabilities, who may respond differently to crashes. Additionally, this method might miss important variations and outliers that could impact overall vehicle safety.

Child safety testing faces its own challenges, exposing gaps in age physiology of up to four-years between dummy sizes. These gaps could result in less effective safety features for children who fall between the tested age ranges, highlighting the need for more comprehensive and nuanced testing protocols for child occupants in vehicles.

However, the real issue lies in the discrepancy between regulatory tests and voluntary 5-star safety tests. While regulatory tests establish minimal safety thresholds for a broader range of occupants, the highest safety standards are still measured against an average male driver. The female "dummy" used is not anthropologically representative nor technologically capable of measuring data where women are vulnerable to injury. However, progress is on the horizon, with Euro NCAP planning to introduce a more advanced Female ATD in 2029.



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INDUSTRIAL DESIGN MUST ADAPT TO EVERY BODY

This disparity extends beyond vehicles. The world of design often favors average male dimensions, leading to potential discomfort and injury for women and those with non-average proportions. This bias extends to various fields, including industrial ergonomics and personal protective equipment.

Caroline Criado Perez's acclaimed book "Invisible Women" highlights numerous examples of this male-centric design, from vehicle safety to medical research and urban planning. She cites vehicle safety as a key example of structural inequity, whose history is rooted in an era when women didn't drive, and regulation perpetuates the inequity. She

explains how women are prevented from driving buses because they are not designed with pedals that can be used by people under a certain "average male height. Industrial vehicles are not regulated to accommodate female operators.

However, solutions exist to address diverse body types in industrial design. The iSize database, which contains 3D scans of hundreds of thousands of people from Germany, France, Italy, China, and the U.S. have been analyzed and used by designers to achieve optimal fit for various products.



Industrial Designers rely on the iSize database to shape and customize the avatars utilized in Ergonomics software, specifically RAMSIS. This software creates detailed virtual space for designers to ensure that pilots, drivers, captains, surgeons, mission controllers and operators of critical environments have full functionality, visibility and comfort no matter their size.

Great design should accommodate every individual, not just the average. Companies excelling in product design hold themselves accountable to this standard, and safety regulations should follow suit.



While physical testing remains crucial for final validation, virtual testing is revolutionizing the product development process. It allows engineers to explore thousands of design iterations quickly and cost-effectively, optimizing performance and identifying potential issues long before a physical prototype is built."



KARSTEN NEWBURY
President of Humanetics Digital

CAN SIMULATION TEST MORE "EDGE CASES?"

The integration of physical testing using ATDs and virtual anthropomorphic test devices (vATDs) has revolutionized safety design processes. This approach allows for faster and more cost-effective evaluations of design iterations, testing of a broader range of body types and sizes, and more comprehensive insights into human-product interactions.

vATDs complement physical ATDs by simulating diverse human anatomies and behaviors. This approach not only accelerates product development but also enhances safety and performance assessments across a broader spectrum of users.

CAN HUMAN BODY MODELS IMPROVE DESIGN?

Human Body Models (HBM) represent a significant advancement in understanding biomechanics and injury prediction across diverse populations. These sophisticated models integrate data from anatomical variations and physiological responses, facilitate predictive simulations for products ranging from automotive interiors to medical devices, and allow designers to account for variations in age, gender, and body size more effectively.

HBM enable strain-based injury prediction, simulation of pre-crash and low-g events, and are more adaptable to new vehicle designs. They provide cost and time efficiencies in the development process and are increasingly recognized by regulatory bodies. With their improved biofidelity and potential for integration with AI and machine learning, HBM are poised to revolutionize vehicle safety design and occupant protection strategies, complementing and potentially surpassing traditional crash test dummy methods in many aspects of safety assessment.

And with advancing technology, new specialized HBM like HBM Connect® are essential for refining and optimizing future safety systems and meeting NCAP protocols. Future advancements in HBM technology promise even greater precision, ensuring that designs are not only safe and functional but also inclusive, catering to the needs of all users.

CHAPTER 5

PEDESTRIANS TAKE A HIT

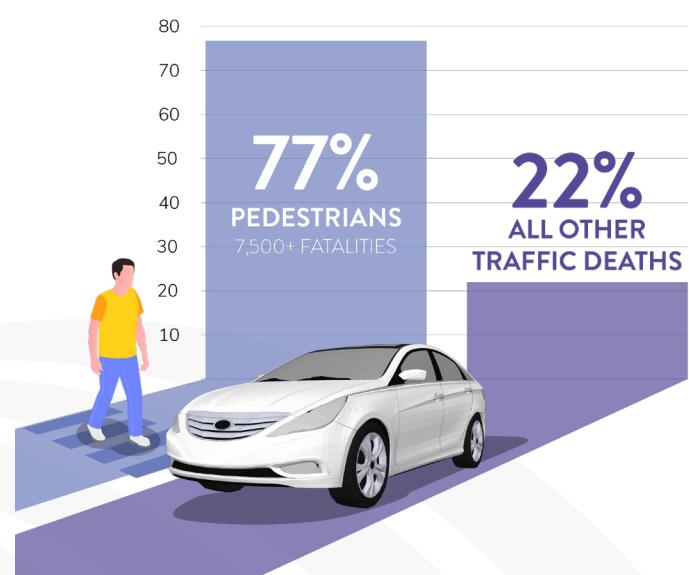


**CROSS AT YOUR OWN RISK: WHERE
'PEDESTRIAN SAFETY' MEETS 'SURVIVAL OF
THE FITTEST' ON THE STREETS.**

Safety design is not just for occupants. Pedestrian injury can be minimized by smart engineering and regulation. As vehicle safety improves, attention has increasingly shifted to pedestrian safety, particularly in urban environments. The urgency of this issue is underscored by alarming statistics: pedestrian fatalities have increased by over 70% in the past decade, with more than 7,500 pedestrian deaths reported in the U.S. in the previous year.

PEDESTRIAN SAFETY CRISIS

The pedestrian safety crisis in the U.S. is a complex issue with multiple contributing factors. The rise in vehicle miles traveled, coupled with the increasing prevalence of larger and heavier vehicles on the roads, has created a more dangerous environment for those on foot. This danger is exacerbated by infrastructure that often prioritizes cars over pedestrians, a recent decline in traffic enforcement, and a widespread lack of adequate pedestrian-friendly infrastructure.



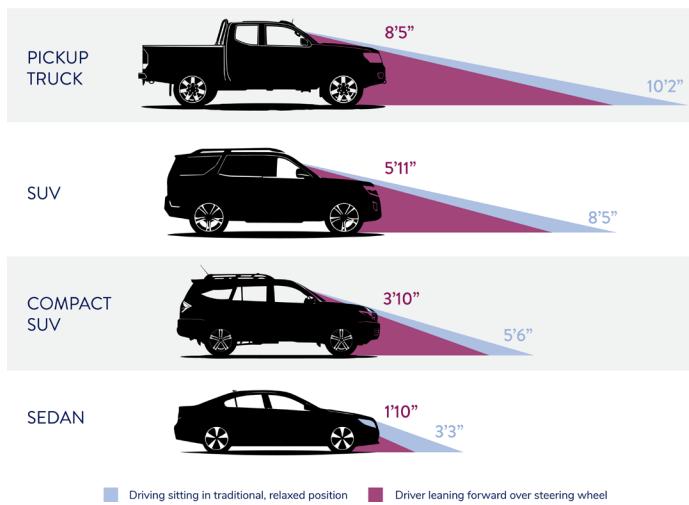
Addressing this crisis demands urgent and comprehensive action from policymakers, urban planners, and communities alike. Their collective efforts are crucial in prioritizing pedestrian safety and transforming our urban landscapes into more walkable, people-friendly environments that protect and encourage foot traffic.

FACTORS CONTRIBUTING TO PEDESTRIAN RISK

Several factors contribute to the growing problem of pedestrian safety. Larger vehicles, such as trucks and SUVs, have bigger blind spots and higher front-end profiles, making it more difficult for drivers to see pedestrians. Increased urban traffic density, coupled with distracted driving and insufficient pedestrian infrastructure, further exacerbates the risks faced by pedestrians.

Europe has addressed this issue over the past year, introducing collision avoidance tests in its Euro NCAP and

by requiring vehicle "hoods", or "bonnets" as they are called in the U.K., to be designed to absorb the impact of a pedestrian collision in order to minimize risk of leg or head injury.



The National Highway Traffic Safety Administration (NHTSA) is taking a significant step towards improving pedestrian safety by proposing new regulations aimed at large SUVs and pickup trucks. The agency has put forth a rule that would require vehicles weighing 10,000 pounds or less to undergo testing and meet performance standards designed to reduce the risk of serious head injuries to pedestrians in the event of a collision. This initiative comes in response to a 57% increase in pedestrian fatalities between 2013 and 2022, with nearly half of all fatal pedestrian collisions involving SUVs and trucks. The proposed rule would introduce test procedures simulating head-to-hood impacts using human-like headforms representing both children and adults. NHTSA estimates that these new standards could save approximately 67 lives per year. This marks the first time the agency has directly targeted vehicle design to enhance pedestrian safety, potentially leading to significant changes in how manufacturers approach the front-end design of larger vehicles.

INNOVATIVE SOLUTIONS FOR PEDESTRIAN SAFETY

Active Safety technologies are designed to reduce the likelihood of crashes caused by human error by automating vehicle safety maneuvers in the event a driver fails to react. A child darting out into the street, a distracted driver failing

to stop at a crosswalk, or even another vehicle screeching to a halt directly in front of you are examples where new technological solutions can help mitigate these dangerous scenarios.



Pedestrian detection systems on vehicles use sensors and cameras to identify pedestrians in a vehicle's path. Autonomous emergency braking technology initiates braking interventions when a potential collision is detected. Active Safety testing platforms, such as robotic Ultra-Flat Overrunnable (UFOs) robot platform, mimic pedestrian behavior for testing, allowing for the replication of multiple pedestrians at intersections.

On the Passive Safety side, since pedestrians are at significant risk of leg, thoracic, and head injury when struck by a vehicle's bumper, hood, and windshield, there are physical and virtual anthropomorphic test devices (ATDs) and leg impactors like the Flex-PLI and aPLI that provide the means to test vehicle-to-pedestrian impacts.



HIII-50M Ped

Pedestrian dummies help automotive designers in developing the forward surfaces of their vehicles, both in shape and impact response, to lessen the injurious effects of a pedestrian impact. These dummies and body components are designed to deliver information about how the body reacts to collisions - its trajectory over or beneath the vehicle and how the shape of the car and hood can minimize or exacerbate injury.

Pedestrian headforms are also gaining traction in testing for head injury and protection in the event of a collision. The spherical headforms come in a series of partial spheres designed to be launched at the windshields and hoods of cars to measure accelerations to the head of a pedestrian in a vehicle-to-pedestrian impact. The launching device is a robotic arm equipped with a magnetic or mechanical means of attachment and release.



The alarming rise in pedestrian fatalities over the past decade underscores the urgent need for innovative safety solutions in our increasingly urbanized world. As vehicle designs evolve we must leverage advanced testing technologies like active safety UFOs and sophisticated human body models to allow us to simulate a wide range of pedestrian scenarios, enabling the development of more robust and responsive safety systems."



MARK WESTEN
President of Humanetics Safety

The combination of these technologies with robust test protocols, including both physical and virtual testing, accelerates the refinement of Original Equipment Manufacturer (OEM) solutions. This approach ensures efficacy across different pedestrian demographics and conditions.

PEDESTRIANS VS AUTONOMOUS VEHICLES

With more autonomous vehicles on our roads, the pedestrian safety crisis in the United States and beyond demands immediate and comprehensive action. As our urban landscapes evolve and vehicle designs continue to change, it is crucial that we prioritize the safety of those who navigate our streets on foot. The innovative technologies and testing methods discussed here represent significant strides in addressing this complex issue. However, true progress will require a multifaceted approach that combines technological advancements with thoughtful urban planning, improved infrastructure, and increased public awareness. By leveraging cutting-edge safety systems, rigorous testing protocols, and data-driven design improvements, we can work towards creating a safer environment for pedestrians, ensuring that pedestrian safety becomes a cornerstone of our evolving transportation landscape.

CHAPTER 6

NEXT GENERATION ATDS & THE CONNECTED LAB

TECHNOLOGY HAS CHANGED.

Technology has evolved dramatically over the past 50 years, yet crash test safety standards remain anchored in the past. In 1976, the dashing Oldsmobile Cutlass led the best seller charts in the U.S.; in Europe, it was the cute supermini Fiat 127; and Apple launched the Apple 1, with its modest 1 MHz processor and 4KB RAM. Today's iPhones boast processors that are 1,800 times faster and have 500,000 times more memory.

Every conceivable facet of technology in our lives has seen decades of relentless, and impactful innovation. Ironically, in the realm of car safety for humans, the Hybrid III "crash test dummy" - also introduced in 1976 - still defines the standard of a "human" in U.S. safety regulations. How can we upgrade the vintage crash test dummy still used in the U.S. crash test today? And how can introducing a new generation of advanced crash test dummies, and a digitized end-to-end test ecosystem, drive more efficient vehicle development and safer vehicles?

WE'RE LIVING IN A DIGITAL WORLD

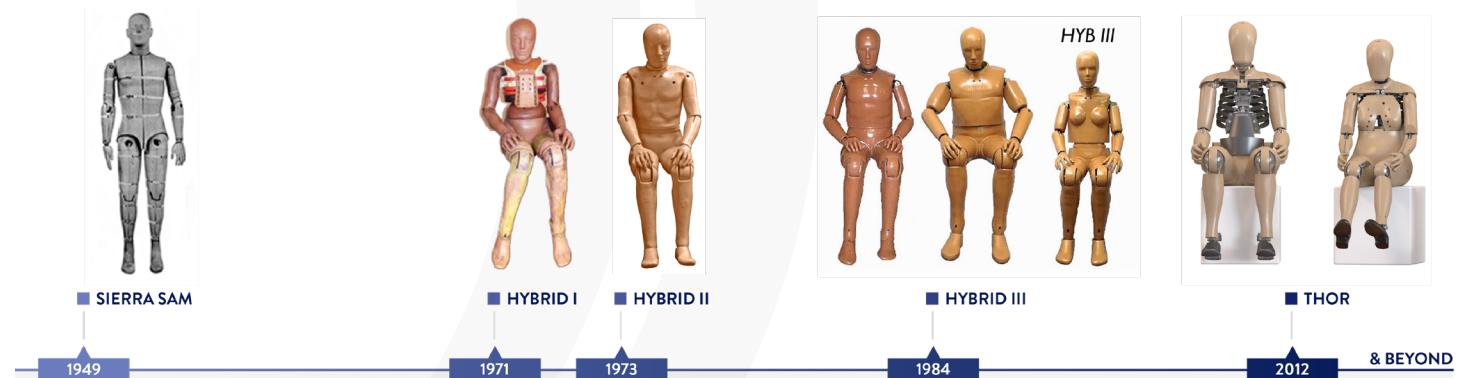
In our digitized world, where innovation has transformed nearly every aspect of life, shouldn't we demand similar progress in automotive safety? With a vision of zero road deaths, embracing cutting-edge technology in safety testing is crucial.

This call for Safety as a Mission isn't just about saving lives; it makes economic sense too. Outdated technology leads to inconsistent, variable, and duplicative processes. The automotive industry could significantly reduce costs by streamlining development and testing through digitization, improved process design, and automation.

In an era that has digitized communications, media, content, social interactions, commerce, industrial, energy, defense, and medical systems, shouldn't we demand the same level of innovation and adoption of new technology in the safety industry to address the huge numbers of injuries and fatalities on our roads? If the vision is zero deaths, then the answer must be a resounding "Yes!"

EVOLUTION OF THE CRASH TEST DUMMY

Over the years, crash test dummies have evolved into biofidelic anthropometric test devices (ATDs). The Hybrid III was the first regulated device to help engineers design vehicles to reduce the huge number of crash fatalities. It was a relatively crude device with sensors placed in places that determined fatal points of impact: the head, the neck, and the chest. It had no sensors in the face, lower legs, pelvis, abdomen, or points across the ribs and chest.



The female version of the Hybrid III was a scaled-down model of the male device, with padded breasts added to the torso. Of course, there have been some minor modifications. Digital sensors now capture the impact data. And the long, cumbersome "umbilical cord" has been replaced in Europe and Asia with tiny data acquisition systems.

The lack of innovation and commitment to continual development in safety standards is contributing to rising injuries and fatalities.

The automotive industry has made significant strides in vehicle safety over the past few decades, largely due to the development and use of ATDs, commonly known as crash test dummies. However, as vehicle technology evolves and our understanding of human biomechanics improves, there is a growing need for more advanced ATDs and sophisticated testing methodologies. The introduction of Next Generation ATDs and Connected Lab technologies is set to revolutionize safety testing and management, potentially saving countless lives in the process.

Advanced ATDs, like the THOR (Test Device for Human Occupant Restraint) and WorldSID (Side Impact Dummy) series, represent a significant improvement. These Next Generation ATDs accurately simulate human anatomy and injury responses during crashes. The THOR-5F, for example, can accommodate up to 174 channels of injury sensors, compared to the Hybrid III's 63 channels. Additionally, the THOR-5F features an anatomically correct female pelvis and spine, addressing the underrepresentation of women in vehicle safety testing.

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The THOR and WorldSID dummies provide a much more detailed understanding of how the human body reacts to crash forces. This level of details allows us to identify and address injury risks that were previously undetectable with older ATD models."

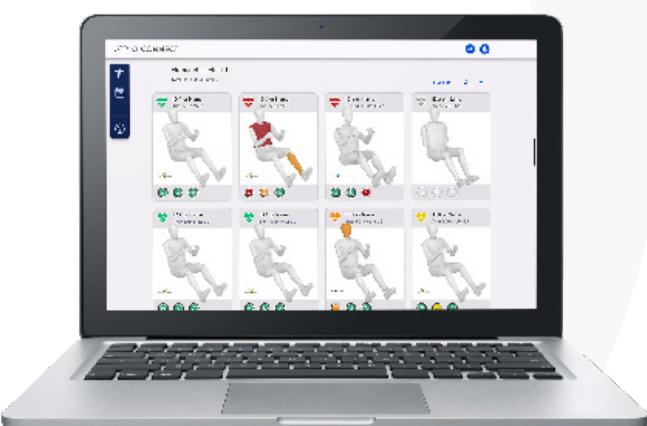


MARK WESTEN
President of Humanetics Safety

The rise of Advanced Driver-Assistance Systems (ADAS) and autonomous vehicles has necessitated the development of specialized AV test dummies to address new safety challenges. These specialized ATDs are designed to evaluate occupant safety in varied seating positions and directions that may occur in autonomous vehicles where human driver activity is reduced. They can measure forces on the body in altered environments, including reclined seating postures, new neck dynamics, and flexible pelvic structures, making them essential tools for assessing and improving occupant safety in the vehicles of the future.

CONNECTING DIGITAL LABORATORY MANAGEMENT

The full potential of these technologically sophisticated ATDs is unlocked when integrated with advanced testing and management systems. This is where Connected Lab technologies come into play. Connected Lab solutions, such as ATD Connect®, ATD-BaseWare™, and ATD Management™, work in tandem to streamline laboratory operations, reduce downtime, and enhance test result consistency.



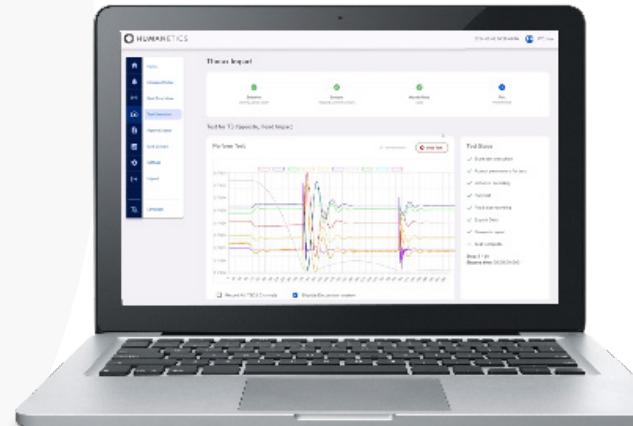
ATD Connect® serves as the central hub for data acquisition and monitoring, overseeing the entire lifecycle of ATDs from physical testing to continuous fleet monitoring. This system allows lab managers and technicians to easily track the status of their ATD fleet, including test usages remaining, days until the next certification, and sensor calibration schedules. By providing a comprehensive view of the ATD fleet, ATD Connect® enhances operational efficiency and ensures that all ATDs are properly maintained and calibrated for optimal performance.

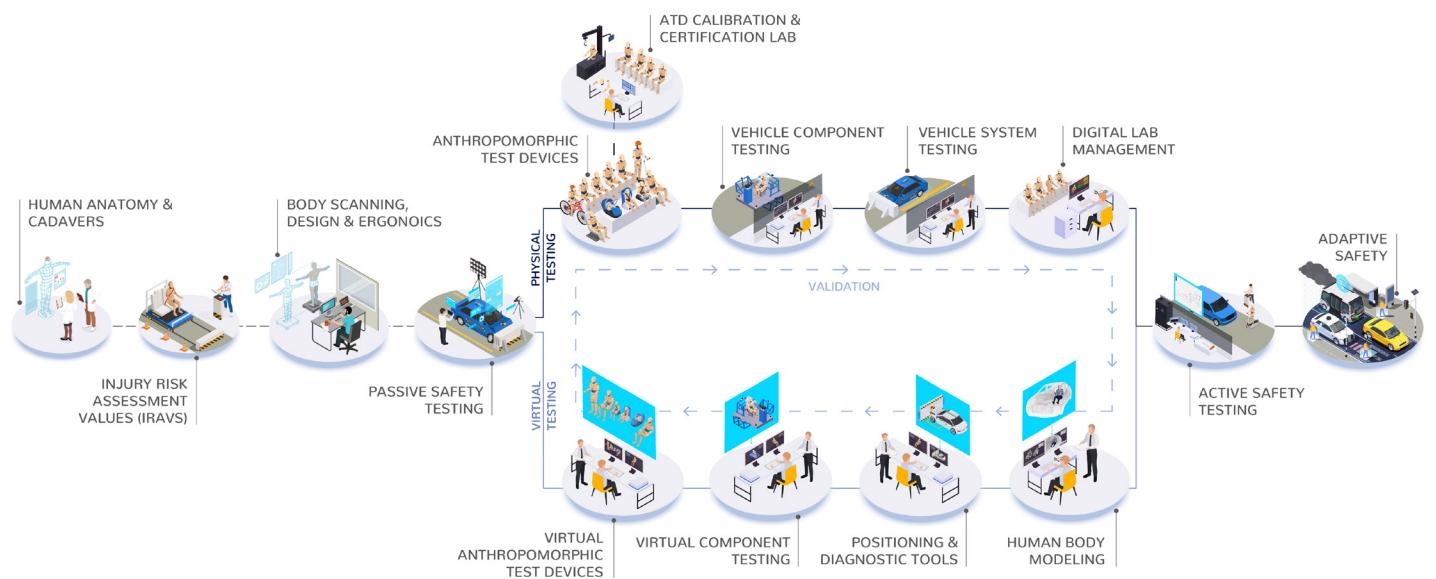


KARSTEN NEWBURY
President of Humanetics Digital

The integration of next generation ATDs with connected lab technologies is a game-changer for vehicle safety testing. Not only do we get more accurate and detailed injury data, but we can also manage our testing processes more efficiently, leading to faster development cycles and, ultimately, safer vehicles on the road"

ATD-BaseWare™ complements ATD Connect® by providing a platform for efficient data management and integration within testing labs. This software automatically processes data acquired from ATDs and their sensors, generating standardized ISO-MME data. The closed-loop process ensures that data output is repeatable and reproducible, which is crucial for consistent and reliable test results.





Development cycle showing how connected lab technologies facilitates real-world digital twins between physical ATDs and CAE simulations providing a reduction in development time and costs.

FACILITATING THE DIGITAL TWIN

The combination of Next Generation ATDs and Connected Lab technologies facilitates the creation of “real-time digital twins” of crash test dummies. This bridge between physical testing and computer-aided engineering (CAE) simulations offers several benefits, including significant reduction in vehicle development time and costs, maintenance or improvement of safety standards, and enhanced ability to address complex vehicle designs and emerging technologies like autonomous driving systems.

ECONOMIC AND SAFETY IMPLICATIONS

The adoption of these advanced technologies promises substantial benefits. Potential impacts include reduced development and testing expenses for manufacturers, a potential decrease in healthcare costs due to improved vehicle safety measures, and a projected reduction in road fatalities with the implementation of new technology.

CHALLENGES AND CONSIDERATIONS

While the benefits are clear, implementing these new technologies comes with challenges. These include initial costs for automotive manufacturers to adopt new testing methodologies, regulatory hurdles in updating safety standards, and the need for industry-wide training and adaptation to new systems.

STRIVING TOWARDS VISION ZERO

As we strive towards a vision of zero road deaths, embracing cutting-edge technology in safety testing is not just crucial, it's imperative. The integration of Next Generation ATDs and Connected Lab technologies represents a paradigm shift in vehicle safety testing and management. By providing more accurate injury data, streamlining laboratory operations, and bridging the gap between physical and virtual testing, these innovations are set to raise the bar for injury prevention.

The automotive industry stands at the threshold of a new era in safety. By adopting these advanced technologies, we can ensure that our vehicles become as sophisticated in protecting lives as our smartphones are in connecting them. The road to zero fatalities is paved with innovation - it's time we accelerate our journey along it.



CHAPTER 7

SMART TESTING FOR CRASH PREVENTION

THE BEST PROTECTION IS CRASH PREVENTION.

A decade ago, predictions of zero road fatalities by 2025 due to autonomous driving were overly optimistic. While this goal wasn't realistic, automated safety systems like Automated Braking Systems have become widespread in new vehicles, helping to avoid collisions.

Active Safety systems are crucial in reducing crashes and saving lives, both for vehicle occupants and vulnerable road users. Testing protocols ensure these technologies' limitations and capabilities are understood, driving innovation and safety improvements.

However, the testing process introduces new challenges to vehicle development, including increased costs, uncertainty, and time. Tests conducted on large proving grounds require meticulous time management, device utilization, and personnel safety.

To push innovation forward without compromising safety or spiraling budgets, the industry must remove as many developmental and testing issues as possible. That means finding efficiencies without cutting corners - a tightrope walk that demands smart tools, better processes, and a relentless focus on quality.

SAFETY FIRST HUMANS OPTIONAL

As autonomous vehicle technology rapidly advances, the need for comprehensive safety testing and validation has become more critical than ever. The Digital Proving Ground, coupled with innovative solutions like TrackBase Connect®, is transforming the landscape of self-driving vehicle testing, offering unprecedented capabilities to improve safety, management, and validation processes.



The Digital Proving Ground represents a significant leap forward in automotive testing methodology. By combining advanced simulation technologies with real-world testing environments, it provides a controlled, repeatable, and safe platform for evaluating autonomous driving systems. This approach allows manufacturers and researchers to push the boundaries of self-driving technology without compromising public safety.



The Digital Proving Ground allows us to test autonomous systems in ways we never could before. We can now simulate thousands of scenarios in a fraction of the time it would take on public roads, significantly accelerating the development and validation process while ensuring the highest safety standards.



KARSTEN NEWBURY
President of Humanetics Digital

TrackBase Connect®, developed by Humanetics, plays a pivotal role in this digital transformation. This sophisticated software solution optimizes active safety testing on proving grounds, offering a comprehensive tool for organizing and managing test scenarios, resources, and data. By providing a comprehensive visual representation of the entire proving

ground, TrackBase Connect® bridges virtual and physical environments. This integration enables test engineers to optimize space usage and coordinate multiple test teams at the same time.



One of the primary advantages of the Digital Proving Ground and TrackBase Connect® is their ability to simulate a wide range of scenarios that would be difficult, dangerous, or impossible to recreate in real-world conditions. From extreme weather events to complex traffic situations, these tools allow testers to subject autonomous systems to a myriad of challenges, ensuring they can handle even the most unexpected circumstances.



TrackBase Analyze™ is a key advancement for robotic platform management as well, enabling proactive health monitoring and key performance indicator (KPI) tracking - such as downtime, error states, and active testing time. By automating system diagnostics and delivering actionable insights, it reduces unexpected platform downtime by up to 25% and supports predictive maintenance, resource planning, and remote support. As part of the broader TrackBase Suite, which includes integrated test coordination and infrastructure management, TrackBase Analyze™ is a major step forward in elevating operational efficiency and reliability. This innovation supports the transformation of proving grounds into fully connected, data-driven

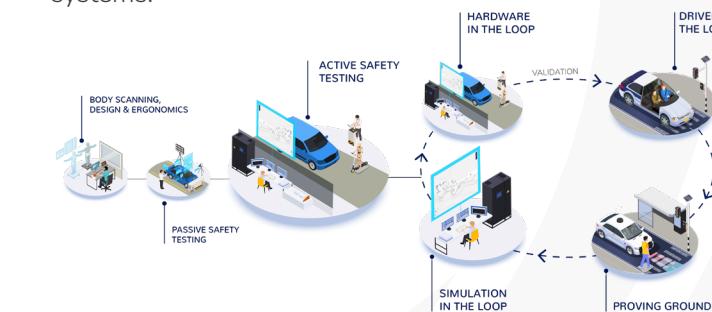
environments, accelerating the safe and efficient development of advanced ADAS and autonomous vehicle technologies.

To enhance physical control and visibility of robotic platform activities on the proving ground, TrackBase Control™ provides a centralized command platform for advanced vehicle testing. Building on the capabilities of UFObase™, it manages communication, test execution, simulation, and simple trajectory generation. TrackBase Control™ offers real-time control of Humanetics Ultra-Flat Overrunable (UFOs) robotic platforms and access to pre-configured NCAP test scenarios, ensuring efficient, consistent, and up-to-date proving ground operations.

The Humanetics NCAP Library optimizes scenario execution by offering instant access to over 1100 NCAP test scenarios. Seamlessly integrated with Humanetics' robotic platforms, this subscription-based library accelerates test setup, minimizes manual errors, and ensures up-to-date safety validation. This capability is especially time efficient, as it automates complex scenario management and empowers proving grounds to function as data-driven hubs for advanced vehicle testing. Ultimately, the NCAP Library streamlines the path to safer, more reliable vehicles, reinforcing the proving ground's role at the forefront of automotive innovation.

INTEGRATION IS KEY

The integration capabilities of TrackBase Connect® further enhance its value in the testing ecosystem. By seamlessly connecting with existing infrastructure, such as rain plants, traffic lights, and weather stations, it creates a holistic testing environment that closely mimics real-world conditions. This digital and hardware integration extends to third-party ADAS equipment that is compliant with the ISO22133 standard, expanding the range of testing possibilities and ensuring compatibility across different systems.



The predictive capabilities of the advanced testing platforms are game-changing. They don't just test what we tell them to, they learn and evolve, identifying potential issues before they become problems in the real world. This proactive approach to safety testing is invaluable as we move towards fully autonomous vehicles."



MARK WESTEN
President of Humanetics Safety

Real-time data sharing and communication features foster improved collaboration among testing teams. This enhanced coordination not only boosts efficiency but also ensures that all stakeholders have access to up-to-date information, critical for making informed decisions during the testing process.

The Digital Proving Ground and TrackBase Connect® are not just about simulating scenarios; they're about creating a more intelligent and responsive physical testing environment. By leveraging AI and machine learning algorithms, these systems can adapt tests in real-time based on the vehicle's performance, focusing on areas that require more attention and potentially uncovering edge cases that might be missed in traditional testing methods.

COMPARATIVE ADVANTAGE

Compared to traditional testing methods, the Digital Proving Ground approach offers several distinct advantages. While conventional testing is limited in the number and variety of scenarios it can recreate, digital proving grounds can simulate an unlimited number of situations. Traditional methods are often time-consuming and resource-intensive, whereas digital solutions allow for rapid iteration and efficient resource allocation. Moreover, the controlled environment of a digital proving ground significantly reduces the risks associated with testing autonomous vehicles on public roads.



INDUSTRY IMPACT

The introduction of digital proving grounds is reshaping the automotive industry's approach to autonomous vehicle development. Development timelines are being compressed as manufacturers can now conduct thousands of tests in virtual environments before moving to physical prototypes. This virtual process can play a vital role in improving the physical testing of hardware, which is the definitive requirement for validating hardware performance and safety.

This efficiency translates to significant cost savings and accelerates the path to market for new autonomous technologies. Regulators are working closely with industry leaders to establish standards for virtual testing, acknowledging its potential to enhance overall vehicle safety.

THE ROAD AHEAD

As the automotive industry continues its march towards full autonomy, the role of comprehensive testing solutions becomes increasingly crucial. The Digital Proving Ground, enhanced by solutions like TrackBase Connect®, represents a significant step forward in this domain, offering a blend of virtual and physical testing capabilities that are essential for validating the safety and reliability of self-driving technologies.

By providing a controlled yet flexible environment for testing, these solutions enable manufacturers to iterate quickly, address potential issues early in the development process, and ultimately bring safer autonomous vehicles to market. As we stand on the cusp of a transportation revolution, tools like TrackBase Connect® are not just facilitating the development of self-driving cars, they're helping to ensure that when these vehicles do hit the roads en masse, they will do so with the highest possible safety standards.

The digitization of the proving ground is pivotal in bridging the gap between simulation and real-world testing, offering a complementary solution for validating and improving the performance of hardware in self-driving technologies. As these tools continue to evolve, they will play an increasingly important role in shaping the future of autonomous vehicle safety, bringing us closer to a world where self-driving cars are not just a possibility, but a safe and reliable reality.

A COMPLEMENTARY SOLUTION FOR IMPROVING SELF-DRIVING TECHNOLOGIES





CHAPTER 8

PARTNERSHIP AS AN ACCELERATOR: HOW THE AGILE MODEL OF DEVELOPMENT DRIVES INTEGRATED SAFETY INNOVATION

“GREAT THINGS IN BUSINESS ARE NEVER DONE BY ONE PERSON; THEY’RE DONE BY A TEAM OF PEOPLE.” - STEVE JOBS

To create truly integrated products, we need to work together every step of the way. When we kick off projects using Agile methods, we see real results - up to a 64% success rate, compared to just 49% with traditional approaches. It's proof that collaboration and flexibility really do make a difference.

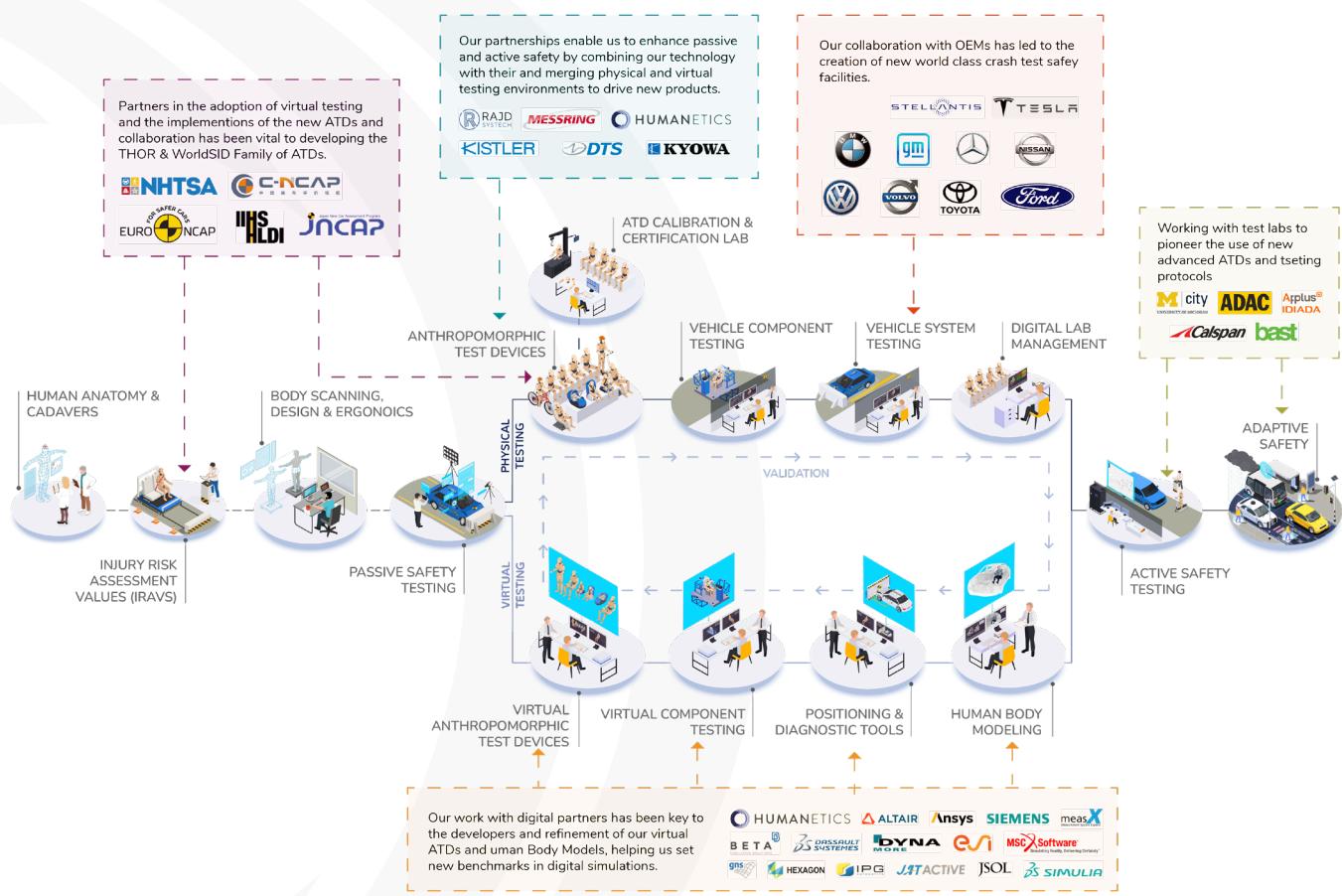
Real progress, whether improving efficiency, reducing risk, or saving lives, happens only through collaboration. No organization can solve today's safety challenges alone, which is why we eagerly partner with industry leaders, researchers, and technology innovators. We are hungry for complex problems to solve with safety and technology partners. This collaborative mindset drives the development of advanced safety solutions and keeps us at the forefront of our field.

A COMMITMENT TO COLLABORATION

Our commitment to collaboration is evident in our proactive response to the latest Euro New Car Assessment Program (NCAP) and National Highway Traffic Safety Administration (NHTSA) roadmaps, as well as our ongoing dialogue with the industry. The Euro NCAP collaborative model, in particular, exemplifies how structured, transparent, and inclusive partnerships, regularly bringing together automotive manufacturers, suppliers, research consortia, and regulatory bodies, can forge consensus on safety standards and testing protocols, as demonstrated in its Vision 2030 roadmap. By uniting diverse teams and perspectives in this way, we accelerate the adoption of advanced safety features and ensure that all industry voices contribute to shaping a safer, more innovative future for all.

AGILE PARTNERSHIPS IN ACTION

We have numerous instances of our close collaboration with a broad network of industry leaders, OEMs, Tier 1s, research institutions, and regulatory agencies, all united by the goal of advancing integrated safety innovation.



THE COHORT-BASED ADVANTAGE

Through these partnerships, we can achieve:

FASTER TIME TO MARKET

By partnering with Messring to integrate their advanced softtargette technologies with our platforms and collaborating with OEMs like Nissan and Hyundai to establish world-class crash test safety facilities, we accelerate the development, deployment, and delivery of active safety solutions to customers more quickly and efficiently.

INTEGRATED, HIGH-PERFORMANCE PRODUCTS

At Mcity, we merge physical and virtual testing environments to drive new research in active safety, resulting in robust, high-performance products validated in both real and simulated scenarios. While our collaboration with Virtual Vehicle and DSD has been instrumental in developing and refining the Human Body Model, setting new benchmarks in digital human simulation and predictive safety analytics.

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A Humanetics, we believe that true innovation happens when industry leaders, researchers, and technology experts come together every step of the way. Our agile partnership model isn't just a methodology; it's a catalyst for safer, smarter solutions that make a real difference in people's lives."



CHRISTOPHER O'CONNOR
President & CEO, Humanetics

EXPANDING RESEARCH AND EXPERTISE

Collaborations with automotive technology and research centers such as the China Automotive Technology and Research Center (CATARC) and the CAERI have enabled us to pioneer the use of our THOR-AV in crash testing protocols tailored for reclined seating and autonomous vehicles, while our support of the Ohio State University (OSU) Injury Biomechanics Research Center advances groundbreaking human safety research and helps train the next generation of safety engineers and researchers.

CONTINUOUS INNOVATION AND VALIDATION

Through our partnership with Euro NCAP, we have supported the adoption of virtual testing and the implementation of the new THOR-50M ATD; our decade-long collaboration with NHTSA has been vital to developing the THOR family of ATDs and advancing regulatory safety standards; the University of Virginia serves as an early "test lab" for our latest safety developments, providing essential validation and feedback; and our ongoing partnership with the Insurance Institute for Highway Safety (IIHS) ensures we remain at the forefront of vehicle and roadway safety, continually contributing to the advancement of industry best practices.

PARTNERSHIP-DRIVEN AGILE MODEL

Part one of our "Safety as a Mission" articles underscores how industry alignment and collaborative models are essential to accelerate progress toward goals like Vision Zero. The pace of change is now further amplified by digital transformation and AI, which enable real-time data sharing,

predictive analytics, and rapid integration of new safety technologies. These advances not only shorten development cycles but also allow for more dynamic responses to emerging risks, making it possible to meet ambitious safety timelines that were previously out of reach. In this environment, collaborative models like Euro NCAP's are more critical than ever, serving as platforms where innovation, regulation, and mission-driven leadership converge to drive the industry forward at the speed of technological change.

Partnership means more than just working together. It's about building real connections based on trust, flexibility, and open conversation. By teaming up with partners in small, diverse groups, we make sure our product development stays fast, adaptable, and truly collaborative. This hands-on, Agile way of working doesn't just feel better; it gets results, with projects seeing a 64% success rate, much higher than traditional methods.

The Agile Model of Development is a framework for building synergistic ecosystems. Startups and established companies alike leverage this model to combine the speed and creativity of emerging firms with the resources and experience of industry leaders. The result is a dynamic environment where innovation flourishes, risk is shared, and mutual growth is the norm.

THE FUTURE IS INTEGRATED—AND AGILE

In today's fast-moving world, staying ahead means being able to innovate quickly and safely. By working together in close, Agile partnerships, organizations can move faster, stay competitive, and tap into the unique expertise they need to succeed. The Agile Partnership Model isn't just a process - it's a vital approach that helps teams create the safer, smarter products that will shape our future.

As we move forward with our "Safety as a Mission" series, one thing stands out: the future will be shaped by those who dare to collaborate, adapt quickly, and keep learning every step of the way. For us, integration isn't just a box to check, it's how we move forward and make real progress together.

CHAPTER 9

WHY SAFETY MUST BE A MISSION: THE FUTURE BELONGS TO THOSE WHO MAKE SAFETY THE CORE OF INNOVATION

THE AUTOMOTIVE INDUSTRY IS FACING A STARK REALITY.

Over 40,000 lives are lost annually in the United States in automobile-related crashes, with another one million suffering severe, life-changing injuries.

Globally, the toll rises to 1.4 million fatalities, and tens of millions are severely injured each year. Despite decades of progress that halved deaths per million miles driven, the last decade has seen an alarming 30% increase in U.S. road deaths. This is not merely a statistical challenge; it is an urgent crisis demanding immediate, decisive action.

True progress - whether in improving efficiency, mitigating risk, or saving lives - is not achieved in isolation. It necessitates a fundamental shift in how we approach product development, leveraging cutting-edge technological advancements, forging collaborative partnerships across the industry, and integrating processes to an unprecedented degree.

A mission is not theoretical. It is operational, measurable, and capable of transforming the outcomes we want to avoid.

A QUICK RECAP OF THE SERIES

In our Safety as a Mission series, we have laid out the issues, the changing dynamics of our digitally connected and intelligent world, and the technology opportunities that can be applied to reduce the development costs of new vehicles, save lives and reduce injuries on our roads. Here is a quick summary of the series.

CHAPTER 1 | EMBRACING SAFETY AS A MISSION

There is a crisis on our roads which could be reduced if safety were treated as the prime mission, measured by actions, not words.

CHAPTER 2 | OUR SHARED MISSION IS TO PREVENT MILLIONS FROM DYING

The adoption of updated regulation, advanced safety technologies, driver behavioral change, and enforcement has worked historically, and is working in Europe and Asia.

CHAPTER 3 | A VISION INSPIRES HOPE. A MISSION DEMANDS ACTION.

The new wave of intelligent, autonomous, electric, generative, and data technologies provide a huge opportunity for system wide innovation. Innovation in this environment will require a more integrated and collaborative approach.

CHAPTER 4 | EQUITABLE DESIGN: DESIGN FOR EVERY BODY

The world we design needs to address the needs, safety and comfort, of every body. One “average-sized” male occupant, is not adequate, or effective for safety tests. So, safety standards must use a range of occupant sizes to better represent the driving population.

CHAPTER 5 | PEDESTRIANS TAKE A HIT

The needs of pedestrians and other road users must also be addressed to impact overall death rates. Vehicles designed to improve driver visibility and reduce the impact severity on pedestrians and road users, help reduce injury and fatality rates.

CHAPTER 6 | NEXT GENERATION ATDS AND THE CONNECTED LAB

Modern, advanced ATDs have improved biofidelity and collect more impact data where occupants are vulnerable to injury. Improved data management and software tools make the development process much more efficient, driving down development costs.

CHAPTER 7 | SMART TESTING FOR CRASH PREVENTION

Active Safety systems are most effective in a range of complex road scenarios which need the support of software and integrated systems to make the testing process on proving grounds efficient.

CHAPTER 8 | PARTNERSHIPS AS AN ACCELERATOR: HOW THE AGILE MODEL OF DEVELOPMENT DRIVES INTEGRATED SAFETY INNOVATION

The complexity of integrating new hardware, software, digital data technologies, coupled with OEMS, Tier 1s, and other industry partners means that partnerships and simplified processes are the only way that progress will be made.

SAFETY AS A MISSION: FIVE PRIORITIES

The core message from our Safety as a Mission series is that the future of automotive safety is no longer piecemeal or incremental. It is strategic, system-wide, and urgent. Our five takeaways are not talking points—they are executive priorities, primed for action. They define where innovation must go, how collaboration must function, and why integration must be built into every layer of product development. Most importantly, they are a direct call to leadership: lead the charge or become the problem.

1

ROAD SAFETY IS AN URGENT CRISIS DEMANDING IMMEDIATE ACTION

With over 40,000 annual U.S. road fatalities and a 30% increase in the last decade, the current trajectory is unsustainable and demands a revolutionary commitment to Safety as a Mission.

2

TECHNOLOGICAL ADVANCEMENT IS THE FOUNDATION OF FUTURE SAFETY

Vehicle safety testing has progressed to advanced next generation anthropomorphic test devices (ATDs) which accurately simulate human anatomy and capture complex injury data. By integrating physical ATDs with virtual models, real-time digital twins bridge crash testing and engineering simulation, accelerating development and meeting the demands of autonomous vehicles. Together with Human Body Models, Connected Labs, and Digital Proving Grounds, these advances enable rapid, data-driven tests to achieve breakthroughs in both occupant and pedestrian safety, and shift from reactive to proactive crash prevention.

3

COLLABORATIVE PARTNERSHIPS ARE NEEDED FOR INNOVATION

No single entity can solve today's complex safety challenges alone. Forming agile partnerships based on trust and flexibility with industry leaders, researchers, and regulatory bodies is essential for shared growth, risk distribution, and accelerated innovation.

4

INTEGRATED PROCESSES DRIVE EFFICIENCY AND PERFORMANCE AND REDUCE COSTS

Unifying data across physical and virtual testing environments, streamlining lab operations, and adopting a system-of-systems approach are paramount for reducing development costs, shortening time to market, and ensuring that products work cohesively for optimal performance.

5

THE FUTURE OF SAFETY IS AGILE

To lead in this fast-moving world, organizations must embrace Partnership as a core strategy, transforming innovation from a stand-alone concept into actionable, collaborative efforts that deliver

CHANGING THE WAY WE WORK: INTEGRATING PRODUCT DEVELOPMENT

Delivering against these opportunities will demand that we change the way we work and operate within our companies, as well as across our companies, partners and customers.

The ultimate competitive advantage lies in the seamless integration of these technological advancements and collaborative partnerships into every facet of product development. An integrated ecosystem offers numerous advantages beyond just product synergy; it creates a cohesive environment that enhances efficiency, performance, and user convenience across various sectors.

The critical factors for success hinge on integrating new life-saving technologies into tool portfolios, reducing development costs to reinvest in innovation, and, crucially, unifying data across siloed systems related to vehicles, roads, occupants, and the environment. This means:

1

END-TO-END SYSTEM INTEGRATION

Products are designed to work together, eliminating compatibility issues, reducing setup time, and simplifying maintenance. The complexity of today's safety mission demands a system-of-systems (SoS) approach, managing infrastructure projects as collections of interdependent systems that reveal crucial emergent properties when integrated.

2

HARMONIZING PHYSICAL AND VIRTUAL TESTING

To truly accelerate safety advancements, it is vital to combine physical and virtual testing to enhance biofidelity, address fragmentation, and expand the representation of occupants in safety design. This comprehensive approach not only adapts to varying road and environmental conditions, but also considers interactions with other road users, paving the way for more effective safety solutions.

3

DATA-DRIVEN DESIGN AND VALIDATION

This integrated approach is not just an aspiration; it's being implemented to tackle specific, urgent challenges. Whether in the "Connected Lab" or the "Digital Proving Ground", modern systems can simplify the complex needs to manage data, analyze it, and drive actionable insights and decisions.

THE TIME TO LEAD IS NOW

The message is clear: waiting is no longer an option. Regulatory pressures are intensifying, consumer demands are evolving, and the cost of inaction, through reputational damage or product failure, is only rising.

The foundation for change must include inclusive design, agile collaboration, and fully integrated ecosystems. But that foundation is only the beginning. It is now the responsibility of leadership to embed safety into every layer of product development, across every function and partner. The directive is simple: lead with bold collaboration, move with speed, and commit to continuous improvement.

**IF SAFETY IS NOT YOUR MISSION, IT IS YOUR LIABILITY.
THE FUTURE BELONGS TO THOSE WHO ACT—TOGETHER AND WITHOUT DELAY.**



WE ARE HUMANETICS

Humanetics is a high-tech global industrial technology group. We engineer extraordinary safety, digital, and sensor solutions for critical environments to put humans at the heart of industrial design.

We are the pioneers of crash test dummies and a leading provider of virtual simulation software, integrated crash test systems, precision sensors, specialized fiber optics, and laser-based material engineering.

Our highly specialized solutions are used in the development of every car on the road today, space missions, aerospace and defense projects, guidance systems, operating theaters, biomedical devices, haptic surgery, energy generation, semiconductor chip manufacturing, and many applications at the cutting edge of human innovation. Our sensor and measurement capabilities create data from critical environments and deliver precision tools to enable customers to answer critical questions and empower decisions that drive performance.

OUR COMPANY

Our company is structured into three groups: Safety, Digital and Sensors.

Humanetics has been the most trusted partner in vehicle safety solutions for over 70 years. In the last decade we've extended our solutions to include the world's leading human simulation platforms, engineered sensors and precision engineering. Putting human well-being at the center of industrial design is our guiding principle.

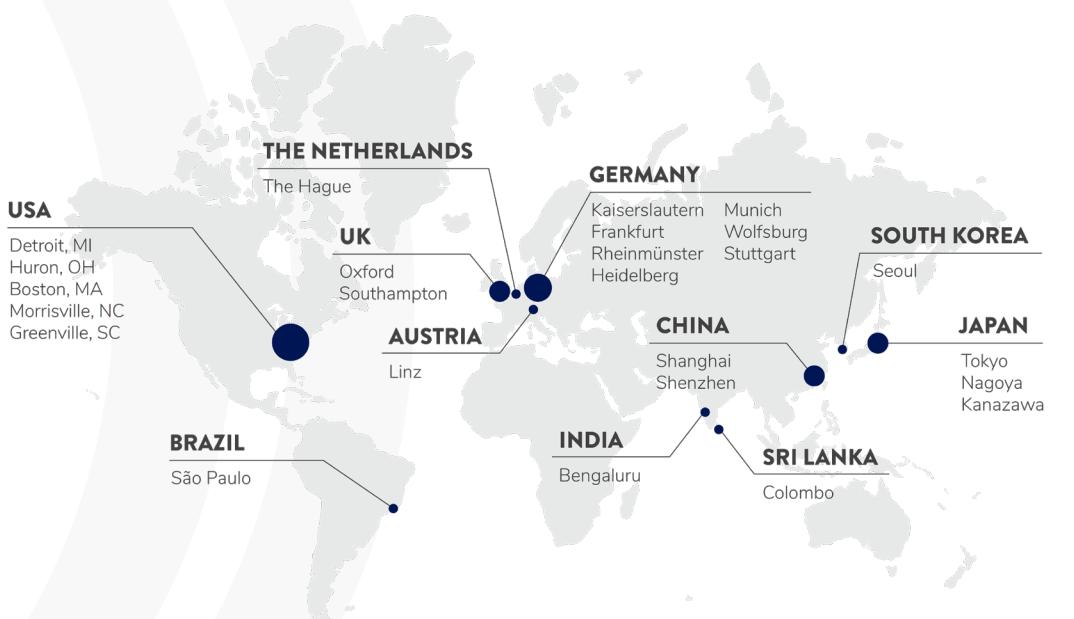
HUMANETICS SAFETY is comprised of ATDs, active safety robotic platforms, test equipment, and ATD lab management.

HUMANETICS DIGITAL encompasses CAE, ergonomic software, anthropometric 3D body model databases. We have an incredible set of digital technologies that make Humanetics the world's leading provider of human-based avatars, data models and simulation software. These digital body models complement our anthropomorphic test devices and robotic platforms.

HUMANETICS SENSORS, combines the capabilities of HITEC, Fibercore and OpTek into an advanced Sensor Technology group. Much of our extraordinary innovation comes from our sensor technology group. A sensor is the interface between the digital and physical world, needed to control, optimize and engineer solutions. The next generation of safety technology, beyond simulation, will be driven by fiber optics, laser engineering and sensor technology.

OUR LOCATIONS

- 1000+ employees
- 27 locations worldwide
- 10 manufacturing facilities
- 12 sales & customer, design & service Centers
- 9 Centers of Excellence
- 350,000+ sf total manufacturing space



WE ARE  HUMANETICS



www.humaneticsgroup.com