SAE INTERNATIONAL

UPDATE

NEWS & INSIGHTS FOR MOBILITY PROFESSIONALS

Qubit control

Mobility industries are part of the equation in quantum computing.

OFFICIAL SAE MEMBER MAGAZINE
August 2022 | sae.org/update

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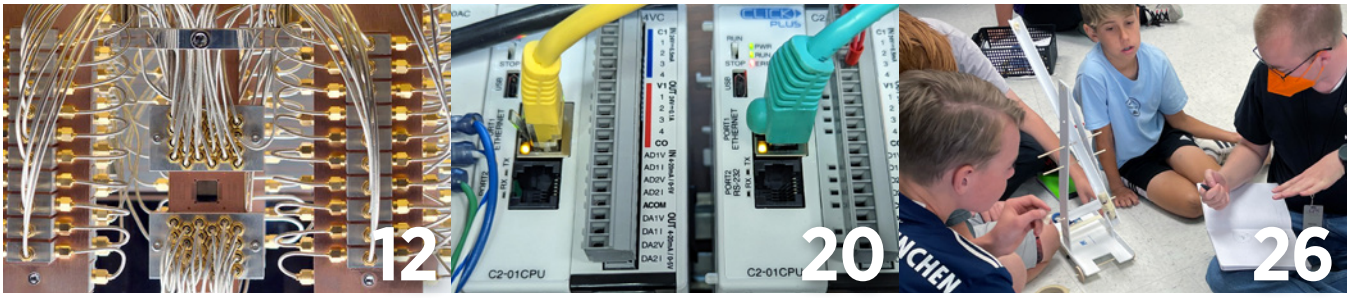
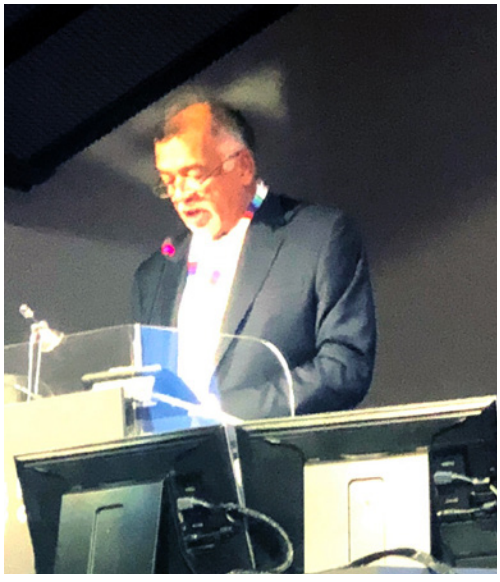


On the cover

Quantum computers are extremely sensitive to vibrations and other input and so must be treated with great care.

IBM



SAE International

SAE President Sri Srinath delivers the opening/welcome address at the June 21 kickoff of the "CO2 Reduction for Transportation Systems Conference – The Road to Decarbonization," which was hosted by the SAE Turin Section and the Italian Association of the Automotive Industry.

SAE International

Srinath (middle) also visited PUNCH Torino, a company with the mission of leading the engineering of innovative propulsion and control systems in turnkey solutions.

Italian sections offers benvenuto to SAE President

In his first overseas trip to retain tight bonds between SAE International and the organization's far-flung global chapters, President Sri Srinath in May took part in various activities with leaders of the SAE Naples and SAE Turin Sections in Italy.

His first activity was the Turin Section's June 21-22 "CO2 Reduction for Transportation Systems Conference – The Road to Decarbonization." He spoke to those gathered for about a half hour as the event's opening speaker and also exchanged ideas with many section members and industry representatives one-on-one.

This was the fourth such conference, which is hosted in even-numbered years by the Turin Section and in odd-numbered years by the Naples Section.

Proceeding to the Naples Section, Srinath met with SAE leaders in that city and enjoyed a special afternoon with graduate students at Consiglio Nazionale delle Ricerche, Istituto di Scienze e Tecnologie per l'Energia e la Mobilità Sostenibili (STEMS).

Dr. Eng. Ezio Mancaruso, Senior Researcher at STEMS, wrote the following note to Srinath following his visit:

"It is always an honor and a pleasure to host the President of SAE International and his delegation in STEMS institute and in our beautiful city.

The success of the visit is the result of

SAE International

Istituto di Scienze e Tecnologie graduate students and Naples Section members pose with the students' Formula SAE car. Srinath is in middle of back row.

both the enthusiasm and passion we put into our work, and the spirit of service of the people who voluntarily participate in the activities of the SAENA section.

Your recognition is even more important and is an encouragement for the section's future and for the many students who have participated.

Looking forward to meeting you at the next WCX. I wish you all good health."

In his return letter, Srinath wrote, among other things:

"It was wonderful to visit the Institute, spend time with the students on their project, and with the researchers in their labs. You are doing outstanding work and advancing sustainable mobility for the world.

The discussion with the team working on alternative energy sources, particularly the organic materials was very interesting and informative. Good luck to all those who are involved in the cutting-edge research."

Srinath also visited PUNCH Torino, a company with the mission of leading the engineering of innovative propulsion and control systems to realize turnkey solutions. ■

SAE International

Signing the deal are (left to right) Andy Maher, IAQG president and Member Company Representative for BAE Systems, and David Alexander, Senior Director, Standards, SAE International.

Landmark agreement for global aerospace standards

The International Aerospace Quality Group® (IAQG) formally announces SAE International (SAEI) as the organization's international standards publisher. The IAQG/SAE Standards Development and Publications Agreement takes effect on all new and newly revised standards moving forward. The first standard to fall under this new agreement will be the IAQG 9137 (IA9137), scheduled to be released later this year.

Under the IAQG/SAE Standards Development and Publications Agreement, the aerospace industry will be able to turn to SAE or one of its many global resellers to purchase new and/or newly revised standards. This agreement is designed to streamline the development and publication process using a single, common workflow that increases speed to market while improving global distribution management.

"The IAQG/SAE Standards Development and Publications Agreement is based on a 25-year partnership between SAE and IAQG," stated Andy Maher, IAQG President and Member Company Representative for BAE Systems. "Their solid reputation and proven process of global standards development makes

this agreement a natural evolution."

"This is a great example of SAE's recognition as a global standards developer," said David Alexander, Senior Director, Standards, SAEI. "We are excited to partner with IAQG on the global development, publication, and distribution of some of the most recognized standards in the aerospace industry."

Currently, published standards will remain under the same sector-related distribution channels. In addition to having a single, global publisher, the new and newly revised standards will have a consistent look and format. For example, the naming structure for newly developed and released standards will follow the standard naming prefix of IA (for International Aerospace). Previously released standards will transition from sector designations of AS, EN, SJAC or JISQ to the new singular designation at the time of revision.

SAE standards include almost 10,000 documents created through consensus development by more than 240 SAE Technical Committees which are used to advance mobility engineering throughout the world. For more information on SAE's standards, visit https://www.sae.org/standards. ■

Does Connexion+ sound familiar?

It's the latest and greatest SAE Member benefit, not to mention of great value to SAE volunteers as well: a true one-stop shop for you to network, share technical knowledge, and find new volunteer opportunities all in one place. Join a live Webex with SAE staff to showcase the new site on August 17 from 1-2 p.m. EST. Register here.

SAE Connexion+ is a combination of SAE Member Connection and SAE Propel. As a reminder, Member Connection was an exclusive member benefit. It provided a virtual space for discussing technical content, managing your membership, building your network around the globe, and more. SAE Propel was an online platform that aggregated all of the SAE volunteer opportunities available to you. You could also sign up for alerts via the volunteer pool and customize your profile for the pool, choosing the amount of time you have to give back, any technical area interests, etc.

Because the SAE Membership and Engagement Team is working toward providing a seamless, one-stop-shop experience for our members and volunteers collectively, a tangible change to our platform was necessary. Now you can access the member-only communities, as well as the volunteer opportunities, in one place via Connexion+. The navigation has been improved, the personalization has been improved, and most importantly, your experience has been improved!

Check out the new site and don't forget to register for the upcoming Webex on August 17 to learn more! ■

Check out the upcoming events hosted in SAE Connexion+

SEPTEMBER

- **Membership Information Session:** September 21. Learn about the latest member benefits.
- **Virtual Mentor Mixer:** September 27–28; theme TBD

OCTOBER

- **New book releases Chat with the Expert** (authors of new SAE books)

NOVEMBER

- **Virtual Mentor Mixer:** November 15–16; Theme: burnout

DECEMBER

- **Membership Information Session:** December 14. Learn about the latest member benefits.
- **Diversity, Equity and Inclusion Chat with the Expert**, Cheryl Thompson, Founder and CEO, Center for Automotive Diversity, Inclusion, and Advancement

Schedule subject to change. For the latest schedule of activities in Connexion+, click on the 'Events' tab. ■

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Fully Customizable Mentor/ Mentee Experiences

Save time with a guided mentor experience or create your own.

connection.sae.org

There is no better way to learn than by example. SAE's Mentor Program offers students and professionals in the mobility industry an opportunity to connect directly with experienced industry veterans willing to share their knowledge and expertise.

TECH FOCUS: **QUANTUM COMPUTING**

Though current quantum computers are too small to outperform usual (classical) computers for practical applications, they are believed to be capable of solving certain computational problems, such as integer factorization, substantially faster than classical computers.

"It is time to place quantum computing in our strategic plans."

-Ales Alajbegovic

Volkswagen

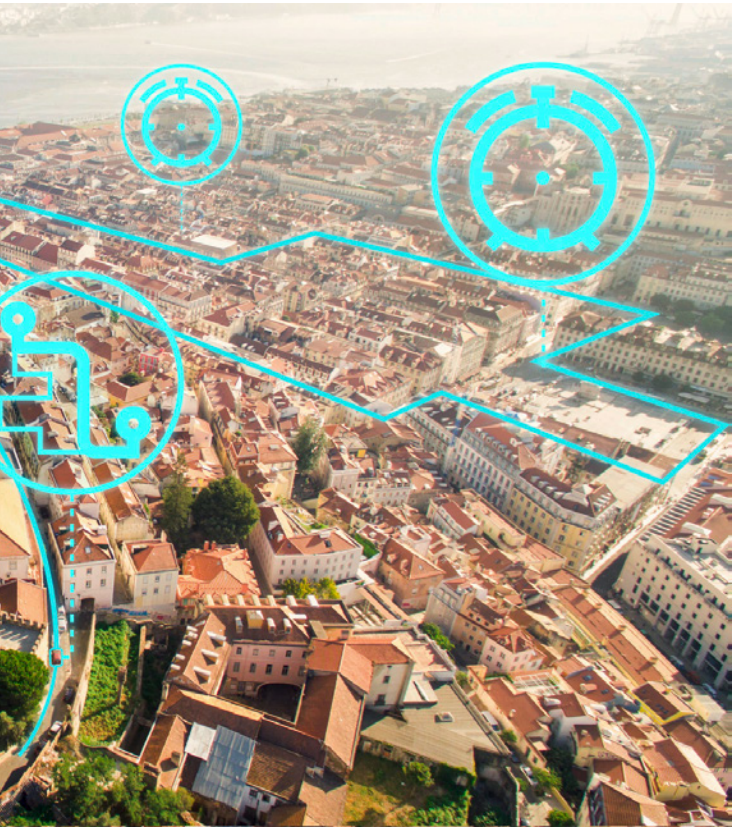
Volkswagen is exploring the possibility of using quantum computers

QUBITS AND COMPUTING: THAN SCIEN

IN THIS SECTION

ABOUT THE AUTHOR

Ales Alajbegovic, Ph.D., wrote this article for *Update*. He is Chief Executive Officer of Four Elements Technologies. He spent his career developing and deploying Virtual Twin solutions for the world's largest automotive OEMs. He is a 16-year SAE Member.



in the optimization of road traffic.

QUANTUM "MORE CE FICTION"

It suddenly appears that the news about quantum computing is everywhere. The number of companies working on quantum computers is running into dozens. There are already several solutions available for testing on Amazon Cloud.

The overall investment in these companies has reached $15B since 2010. This progress is hard to be ignored. We have come very far since I first heard Richard Feynman's ideas about quantum computing during my undergraduate studies in physics. At that time, they sounded more fictional than the science fiction books I was reading. I touched on it again during my time at General Dynamics in the early 2000s when my colleague was applying for research grants on quantum computing. At that time it was clear that there was much more to quantum computing than science fiction; however, I never expected the rapid progress since. So, how did we come to this point and where are we heading?

The basic motivation behind quantum computing is two-fold. First, we are approaching the limit of how small classical integrated circuits can be manufactured. Further reduction in size leads towards the physics governed by quantum mechanics. Second, there is a class of problems which are not suitable for traditional integrated circuits. Phenomena where quantum mechanics dominates are very difficult for them. These are critical for the design of complex molecules and drugs. For this and other problems listed below, quantum computing really represents an ideal solution (Analytics Insight):

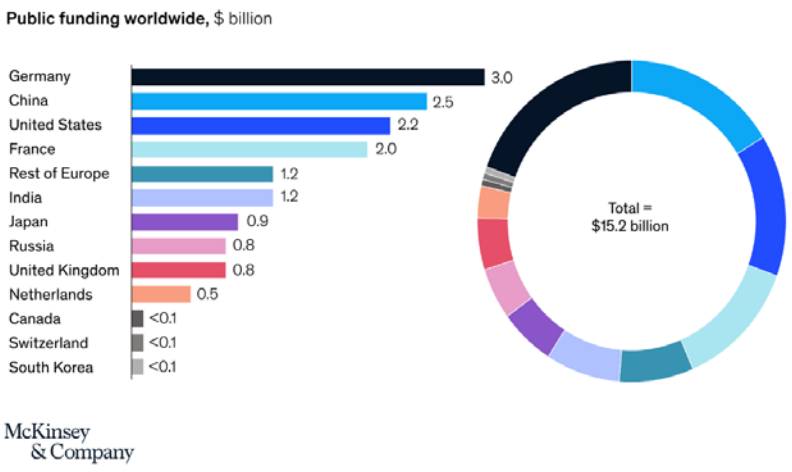
- Quantum encryption
- Simulation of quantum systems

- Difficult combinatorics problems
- Supply chain logistics
- Finance markets
- Drug development
- Data analysis of large datasets
- Weather prediction

How can quantum computing help with these and other similar problems? The advantages are the result of the basic nature of information storage. The bit in classical computing has only two states: 0 or 1. For the quantum bit, or qubit as it is known, things are more complicated. The qubit is of physical size where the laws of quantum physics dominate and as a result it deals with the following phenomena:

- Superposition
- Qubit is in a state between 0 and 1 with certain probability
- Its value is established during the measurement step
- Entanglement
- The probability state of the qubit is affected by the states of other qubits

As a result of these phenomena, the size of information that can be stored in the qubit scales exponentially with the number of qubits N,



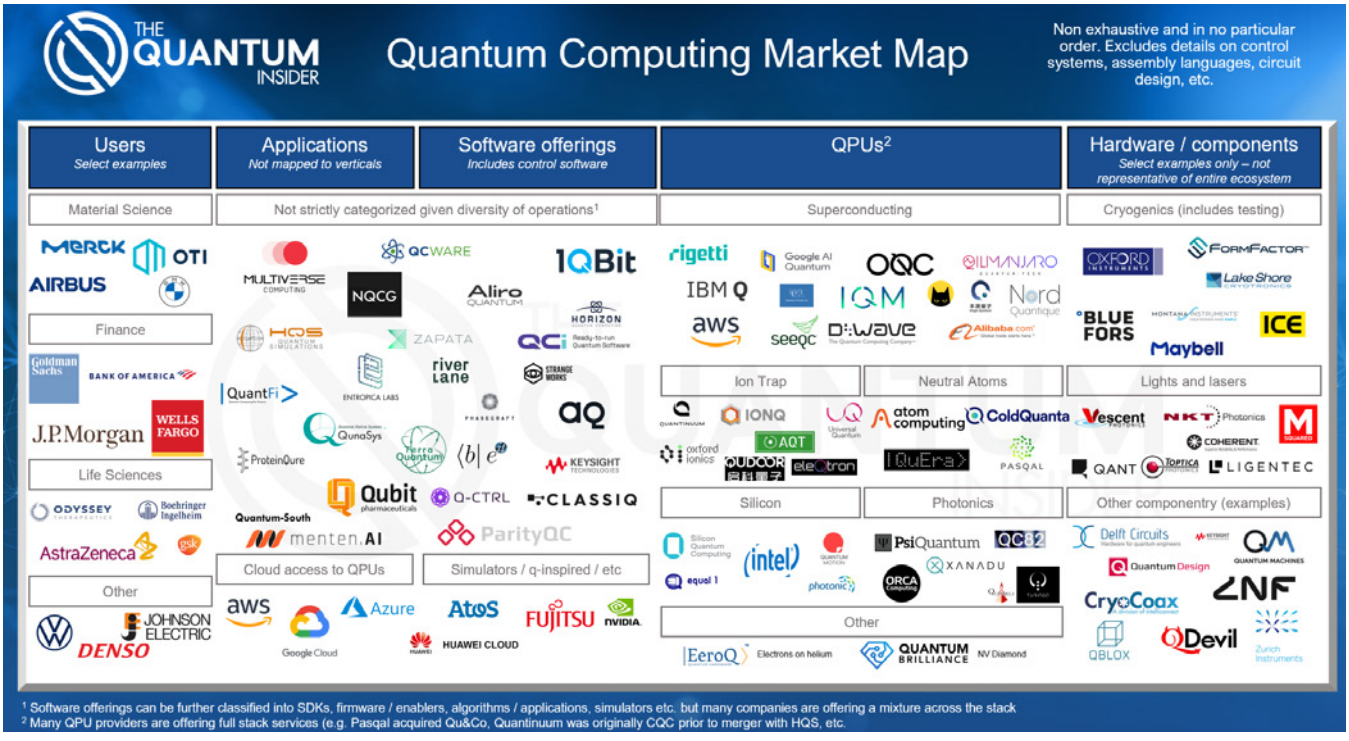
McKinsey & Company

Public funding in Quantum Computing since 2010

making it very suitable for the problems listed above.

One of the questions that often arise is how the implementation of quantum computing in practice will be. There are many options for the design of qubits. One can expect specific problem-tailored computers. However, they will probably not operate independently, since they are not that good for classic control operations. Nor will they replace existing computers. One can expect that they will be connected to the classic computer, which will manage the operation of the quantum computer. This will be very similar to how GPUs work with CPUs today.

The most interesting are the potential applications. Volkswagen is exploring the possibility of using quantum computers in the optimization of road traffic. They are investigating the perspectives for single driver or urban traffic planning. Ford is working on a similar problem, exploring optimization of the diesel delivery truck routes to reduce pollutants while also optimizing vehicle range. Toyota is trying to make progress on the design of solid-state batteries, the Holy Grail of battery design. This problem is very well suited for quantum computing since the phenomenon of consideration

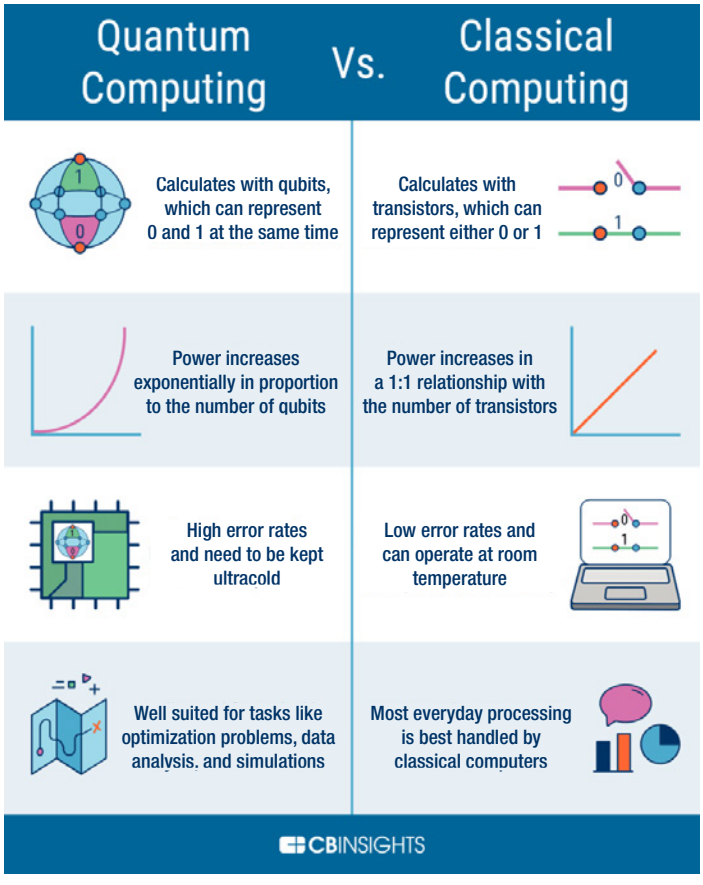


The Quantum Insider

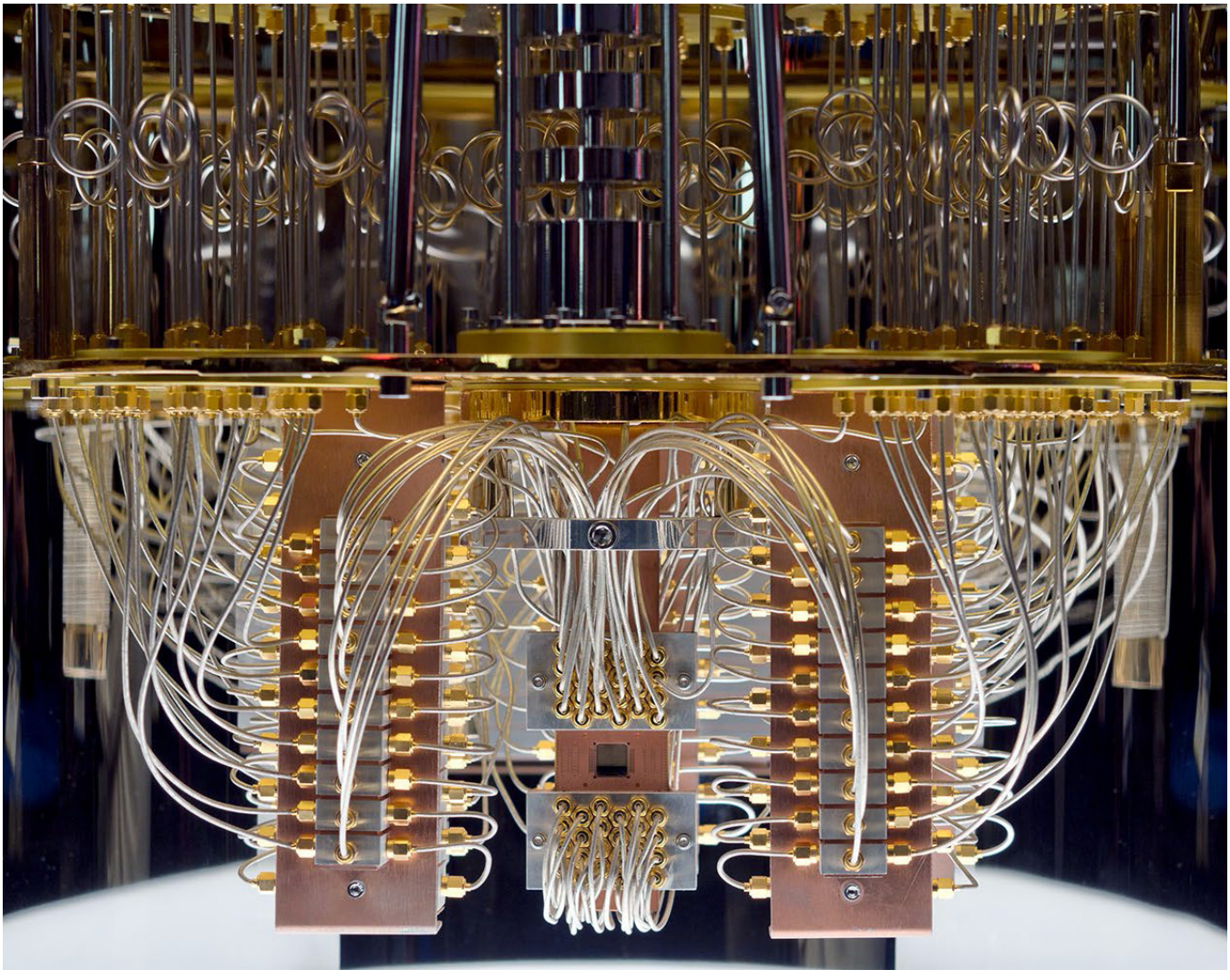
Quantum Computing Market Cap

is governed by quantum mechanics. BMW is testing the use of quantum computing for metal-forming processes. As can be seen, there are many interesting and meaningful projects that have started already in the automotive industry. There are similar activities in other industries, led by companies such as Boeing and Airbus.

Quantum computing has come a long way since the initial ideas more than 50 years ago. Entire ecosystems of companies exist today, working on hardware and software solutions. In addition, the industry is already exploring the possibilities for first engineering applications. It is time to place quantum computing in our strategic plans. ■



CB Insights



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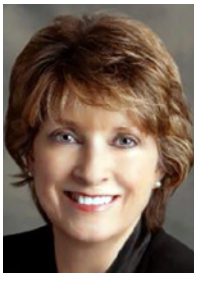
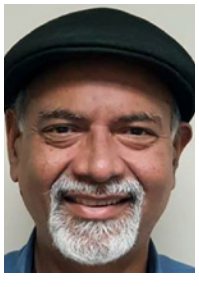
Typical image of a modern quantum computer similar to the D-Wave and IBM quantum computers.

Getting an "EDGE" on the competition



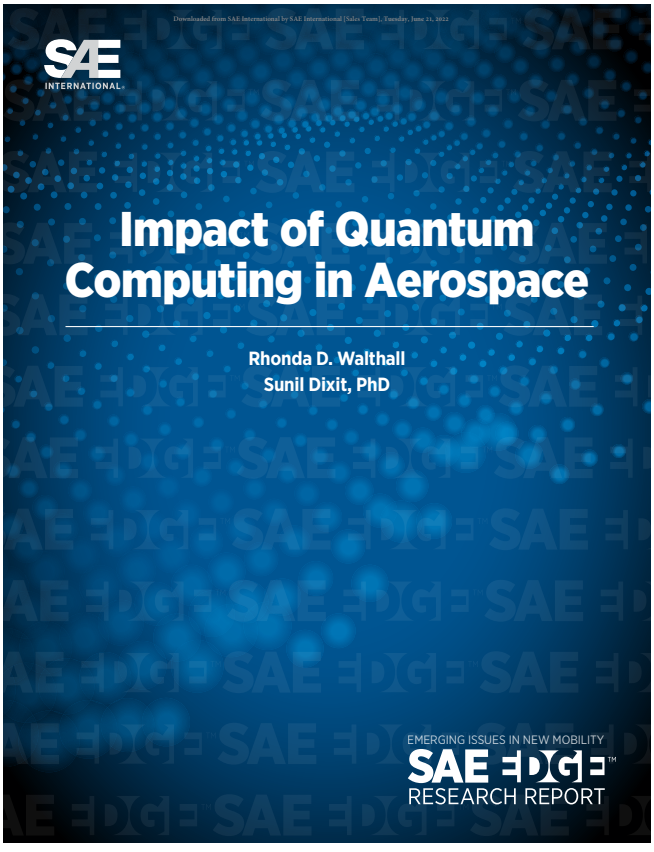


ABOUT THE AUTHORS

Rhonda D. Walthall (left) of Collins Aerospace and Sunil Dixit, Ph.D., right, of Northrop Grumman Space Systems.

In the introduction to their SAE EDGE Research Report, Impact of Quantum Computing in Aerospace, the authors write:

"We have all imagined—at some point in our lives and in some way or another—traversing the macroscopic realm into that of the microscopic and wondering what this universe may look like as we dissect smaller and smaller pieces of space and particles. With our current understanding, we find that this microscopic universe is filled with mysteries and paradoxes that not only provide



evidence of the building blocks of the universe, but also infinite possibilities of the quantum phenomena that can harness the power of the quanta for the next generation of computing: quantum computing (QC). QC is no longer science fiction, but rather a foreseeable reality within the next few decades."

The reports co-authors are SAE Board Director Rhonda Walthall and Sunil Dixit, Ph.D. What follows is the remainder of the report's introduction.

"To understand this microscopic quantum universe and how QC works, we must first understand the quantum phenomena by comparing what we know from classical physics, classical limitations, and what we observe in nature for the quantum phenomena. In fact, the study of quantum physics reveals that "cause and effect" are not linear in time.

This is because time is not a fundamental part of the universe. There are limits to the amount of information and precision that one can extract from a quantum system (i.e., limited by the uncertainty principle). Measurements in the quantum realm are probability distributions while precision is limited by Planck's constant in the Heisenberg Uncertainty Principle. For instance, a measurement of time is precise to Planck's constant while the simultaneous measurement of energy cannot be precisely known (this statement is also true for simultaneous measurements of momentum and position).

Light has dual properties in nature known as the "wave/particle duality." Light can behave as particles (i.e., as photons in the photoelectric effect) or as waves (i.e., described as de Broglie waves producing interference patterns); waves and particles are not distinct in quantum physics. Similarly, photons, electrons, protons, neutrons, and the entire particle zoo behave both as particles and waves.

The paradox where a quantum system such as the "quantum bit" or "qubit" can simultaneously exist in separate quantum states is known as the "quantum superposition principle." A qubit can be formed, for instance, by two entangled (i.e., intertwined) electrons in opposite spin

states. Albert Einstein called the entanglement "spooky action at a distance" as it appeared to violate the speed limit of information transmission in his theory of relativity (i.e., "c" the velocity of light).

Since the qubit has both particle and wave properties, linear superposition of the qubit separate quantum state wave functions (e.g., addition and subtraction of these state wave functions) are also wave functions of the new qubit quantum states. This is true for all known particles in the universe. The computational power of quantum computers comes from the exponential superposition of separate quantum state computing that occurs simultaneously. Paradoxically, any measurement of the qubit quantum states (i.e., entangled) results in an irreversible collapse of the wave functions of quantum states."

The report goes on to note that there are numerous advantages and disadvantages to using QC in the aerospace industry. Some of them identified in the report are cryptography, lifecycle simulations, computations & algorithms, and classical computers.

"The application of QC has advantages in multiple domains and, hence, it is very difficult to single out the most influential use cases. Identifying real-world use cases is a very active field of research. Any application that requires physics-based computations (e.g., design, evaluation, diagnostics, prognostics, and health monitoring) could potentially benefit from quantum algorithms."

Among the use cases identified in the report are large-scale optimization and operational research problems; secure and faster communication; unmanned aerial vehicles with impenetrable air-to-ground quantum data links; and better encryption of confidential data.

"The greatest barriers to the adoption of QC in aerospace aretackling the challenges associated with lack of expertise, shifting the mindset from classical to quantum computers, funding high-infrastructure costs, and developing technology readiness to build scalable quantum computers to address the targeted problems. The cost and economic benefits of QC are not expected to be spread equally."

"There will be the need to push the inertia of cultural and traditional cumulative mindsets toward accepting the new frontiers of QC. Classical processes are based on full access to data generated by the computation, although it is often the case that only extracted reduced data sets are sufficient to guide process flow, decision flow, and resulting actions. The risk of never having the full solution data, or the cost of reverting to a classical process when it is needed, may be a barrier to adoption. When QC truly surpasses the current breadth and depth in available functions in classical computing, it may be impossible to revert to legacy classical solutions." ■

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- 2021 BRAKE Attendee

Its Good to be Back in Person

This year's Bake Colloquium will feature a combination of organized networking opportunities, an interactive exhibition, and leading subject matter experts participating in technical presentations, interactive panels, tutorials, keynote roundtable, and more.

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- Brake Emissions Measurement and Characterization
- Brake Mechatronics and Controls Products
- Brake Systems for High Performance and Racing Application
- Critical Braking Issues Related to the Performance and Safety of Commercial Vehicles
- Developments and Innovations in Friction Materials and Friction Couples
- Fundamental Mechanisms of Friction and Vibration
- Improving Brake NVH (Noise, Vibration and Harshness) Performance
- Innovations in Wheel Bearing and Seals and Their Impact on Brake Corners
- Latest Advancement in Simulation Technologies
- Testing and Measurement Methods for New Braking Technologies
- Wind Turbine, Railway, and Heavy Machinery Brakes

sae.org/brake

P22950750

Quantum considerations for engineering decision-making

Engineering practice routinely involves decision making under uncertainty. Much of this decision-making entails reconciling multiple pieces of information to form a suitable model of uncertainty. As more information is collected, one expectedly makes better and better decisions.

However, conditional probability assessments made by human decision makers, as new information arrives, does not always follow expected trends and instead exhibits inconsistencies. Understanding them is necessary for a better modeling of the cognitive processes taking place in their mind, whether it be the designer or the end-user. Doing so can result in better products and product features. Quantum probability has been used in the literature to explain many commonly observed deviations from the classical probability such as: question order effect, response replicability effect, Machina and Ellsberg paradoxes, and the effect of positive and negative interference between events.

So write the co-authors of an SAE WCX 2022 technical paper, Quantum Explanations for Interference Effects in Engineering Decision Making. Co-authors Vijitashwa Pandey of Oakland University and Moscow-based independent researcher Irina Basieva present results from a survey demonstrating responses that while difficult to explain using classical probability, can be explained using a quantum formulation — highlighting its potential in engineering applications. Since quantum formulism is more general and

While engineering simulations and accelerated testing methods can alleviate some of these uncertainties, the engineers have to reconcile these into an understanding of the system so that go no-go decisions can be made regarding its development.

can also match the predictions of classical probability, it serves as a richer paradigm for modeling decision-making behavior in engineering practice.

Consider the design of a car suspension system, the authors write. "An engineering firm may decide to use existing designs or pursue a new fully active suspension system, such as through the use of magnetorheological fluid. This could be done for performance, reliability, or comfort reasons. There are multiple sources of uncertainty that inform this decision.

For example, there are uncertainties associated with the design itself, as well as with its performance and reliability because of the additional complexity associated with an active suspension system. While engineering simulations and accelerated testing methods can alleviate some of these uncertainties, the engineers have to reconcile these into an understanding of the system so that go no-go decisions can be made regarding its development. These decisions are also affected by the expected revenue, which in turn, is determined by the customer who must weigh the improved performance with respect to the cost they would incur." ■

We hope this TECH FOCUS section was helpful to you. If you would like to comment on any of the articles in it, email us at **update@sae.org**. Use the same email address if you would like to submit an article for an upcoming *Update* TECH FOCUS section; please refer to the editorial calendar below.

Future FOCUS Index

SEPTEMBER
Vehicle interiors

OCTOBER
Sustainable energy technology

NOVEMBER
Smart cities/IoT

SAE International expands its breadth in aerospace standards

Robert Voros, System Safety Lead at Merlin Labs, chairs the S-18H Human Considerations for Safety Assessment Committee.

Ben Murphy, Head of Sustainability Policy at Boom Supersonic, heads SAE's new Supersonic Aircraft Steering Group.

To promote the advancement of aerospace standards, SAE International announces the formation of two new aerospace entities. The Supersonic Aircraft Steering Group, which will help identify and coordinate standardization activities necessary to support supersonic aircraft applications and hypersonic aircraft applications. In addition, the SAE S-18H Human Considerations for Safety Assessment Committee will develop aerospace industry information reports, recommended practices, and standards to clarify the role of human considerations in the development and safety assessment processes.

Supersonic and hypersonic aircraft applications are being researched, developed and tested to varying degrees of maturity. The activities of the Supersonic Aircraft Steering Group are intended to harness industry stakeholders to help shape the collective effort of supersonic aircraft systems and applications; and through the collaboration of industry and government, look to how industry standards may facilitate certification and regulatory compliance.

The purpose of the S-18H committee is to bring together aviation stakeholder expertise to clarify relationships and resolve gaps involving human considerations in function development, safety assessments, and human factors processes. Reports produced by the committee will facilitate closing the gaps between these processes in civil aviation.

Robert Voros, Chair of S-18H and System Safety Lead at Merlin Labs said, "The S-18H committee, in collaboration with the G-10 Committee on Flight Deck Human Factors, has begun the work of developing and improving standards to comprehensively address

PASSENGER CAPACITY **65 TO 88**	CRUISING ALTITUDE **60,000 FT**	CARBON **NET-ZERO**
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Boom Supersonic

Specs for Boom Supersonic's Overture aircraft project.

the role of human considerations as part of the safety assessment process. SAE has gathered expertise from several aerospace committees and the industry to assure the development of timely and useful documents which will address this critical issue in civil aviation."

"Boom applauds SAE's initiative to proactively evaluate new and updated standards required for commercial supersonic aircraft certification and regulatory compliance, and we expect the work of the SASG will help facilitate the timely return of commercial sustainable supersonic aircraft," said Ben Murphy, Head of Sustainability Policy at Boom Supersonic.

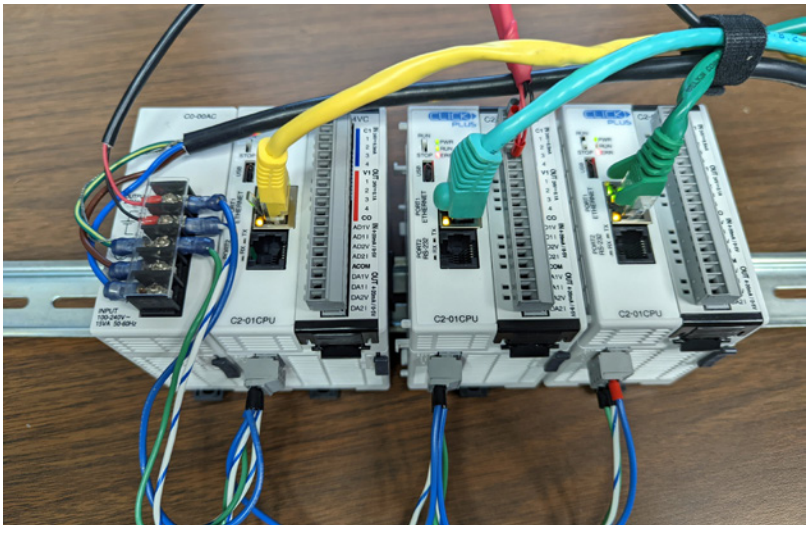
Said David Alexander, Senior Director, Standards at SAE International: "SAE International is honored to work with the global aviation community through these new SAE standards groups to develop important standards to support the growth of the exciting new supersonic and hypersonic aerospace community, and with S-18H to take on the critical role of addressing human considerations in the development and safety assessment processes."

Applications are now being accepted for volunteers to participate in the SAE S-18H Committee. If you are interested in joining, please contact Kevin Bires at Kevin.Bires@sae.org. To learn more about SAE International's standards committees, please visit: https://www.sae.org/standards/development. ■

Let's get physical: the SAE G-32 solution for the cyber-physical menace

On June 2, 2022, SAE International's G-32 Cyber Physical Systems Security Committee published its first joint Aerospace and Automotive standard, JA7496: Cyber Physical Systems Security Engineering Plan. The new standard is intended for broad industry use for both commercial and defense applications along with other high reliability and/or critical systems in aerospace, transportation, medicine, and finance.

According to Judith Ritchie, Director, Government and Industry Affairs – Aerospace for SAE International: "Before security risks of cyber physical systems (CPS) can successfully be assessed and managed, it is necessary to clearly understand the cyber landscape and define the problem statement. Threats to cybersecurity cover a broad range of attack vectors with the integration of complex hardware, software, and firmware supporting the cyber physical system. Cyber physical system security begins with the electronic parts, assemblies, software, and firmware that make up the system."



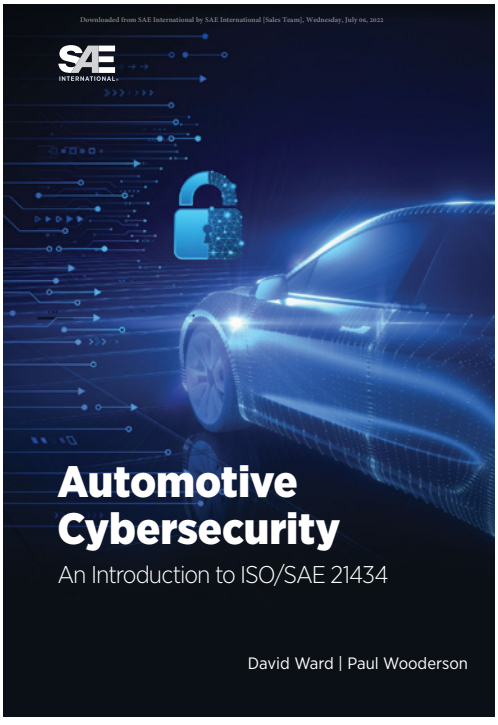
Southwest Research Institute

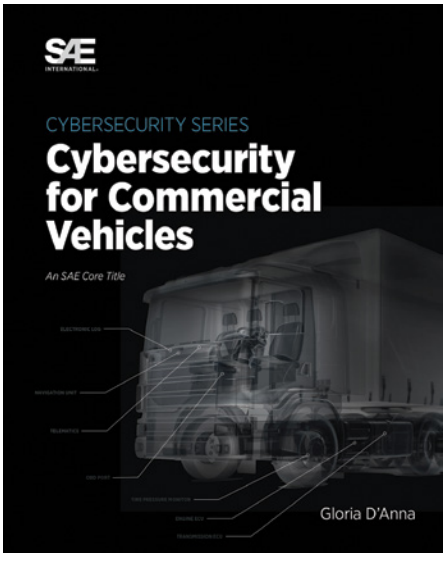
Southwest Research Institute used programmable logic controllers (PLCs) connected to input/output (I/O) modules to a test network. Algorithms scanned the network for cyberattacks through data packets transferred over the Modbus/TCP protocol.

"Attack vectors can be introduced trough hostile code at the time of software or firmware updates," she added. "Cyber physical systems are susceptible to compromising attacks due to counterfeit tampered electronic parts with embedded malware or hardware Trojans, or legitimate components with vulnerabilities due to the design. The risk analysis expands beyond the construction to the entire system."

The JA7496 standard provides the framework for a systems engineering approach to standardization of cyber physical systems security. The following goals are addressed:

- Characterize CPS risk, assess vulnerabilities, and recommend mitigating actions
- Advance knowledge of how weaknesses in CPS are introduced and exploited





Gloria D'Anna of Ford co-chairs the G-32 committee with William Scofield of Boeing. She is author of the SAE book "Cybersecurity for Commercial Vehicles."

- Identify best practices for addressing concerns
- Close gaps in hardware and software assurance
- Develop a detailed CPS security taxonomy
- Establish and standardize methods for identifying CPS weaknesses
- Standardize a systems engineering approach to CPS security to design resilient systems that can survive attack
- Develop evaluation methods for mitigation of CPS security risk

The G-32 committee is also working on additional standards that are a response to a significant and increasing

Thales

Thales offers what it calls "a comprehensive cybersecurity value proposition specifically for the air transport sector, with cutting-edge cybersecurity solutions and services including multi-level protection (from perimeter security to the protection of core system components)."

volume of cyber physical system threats. These include JA6801: Cyber Physical Systems Security Hardware Assurance, and JA6678: Cyber Physical Systems Security Software Assurance.

The Co-Chairs of the G-32 committee are William Scofield of Boeing and Gloria D'Anna of Ford. For further information on the committee's work, contact Judith Ritchie at Judith.ritchie@sae.org. ■

SAE International

A well-attended technical session at the 2020 Hybrid and EV Technologies Symposium – the last time the event was held in-person.

Call for papers, presentations, and sessions

Deadlines for submission of papers, presentations, and sessions are on the immediate horizon for three SAE International conferences.

- **WCX World Congress Experience 2023** – September 13
- **European Electric Vehicle Charging Infrastructure Conference** – September 30
- **Noise and Vibration Conference & Exhibition** – October 10

Driving the future of hybrid and electric vehicle innovation

This is a critical moment for the electric vehicle (EV) industry. Awareness of the need for clean energy sources has never been higher, more OEMs are planning to eliminate the production of the internal combustion engine, and EV adoption rates are growing fast. The Hybrid and EV Technologies Symposium, an SAE Sustainability Event, brings key players together for the vital conversations that fuel this momentum, at a time when industry-

wide collaboration is essential for continued progress.

Scheduled for September 13-15 in Garden Grove, Calif., and now in its 18th year (and held for the first time since 2020), this event provides an unparalleled opportunity to reconnect as a professional community and technical issues and solutions, recent advancements, and so much more. Join your colleagues in the nation's hub of vehicle engineering development and help move EV technology forward.

ALL Hybrid 2022 participants will receive full access to the co-located SAE's On-Board Diagnostics Symposium-Americas (OBD-Americas), including education sessions and panel discussions.

In 2021 both SAE and DIN published initial, highly harmonized documents to define a test procedure and metric to commonize the measurement at which electric vehicles can be charged. The work continues to refine and expand the procedure in both the SAE task force (SAE J2953-4) as well as a new joint working group between SAE and ISO (ISO 12906). Matthew Hortop of AVL Test Systems Inc. will cover the topic in his scheduled September 13 oral-only presentation titled "International Test Procedures to Measure and Report Vehicle Charging Performance."

Check the SAE conference webpage for descriptions of additional presentations. ■

Hybrid and EV Technologies Symposium

an SAE Sustainability Event

September 13 - 15, 2022
Garden Grove, California

KEYNOTE

Daniel Sperling

Founding Director, Institute of Transportation Studies at the University of California, Davis

KEYNOTE

Peter Savagian

Principal and Founder, Electrified Future, Inc.

KEYNOTE

Shinichi Abe

Chief Professional Engineer, Electric Powertrain System Development Division No. 1

SI engines still kicking

Written by Allesandro Ferrari and Pietro Pizzo, a new SAE International book covers spark-ignition engines from their birth to the present day. Its title is Injection Technologies and Mixture Formation Strategies For Spark-Ignition and Dual-Fuel Engines.

Gasoline engines had dominated the market of passenger cars from the beginning of the automobile history until the 1990s. In the mid-1980s, the introduction of electronic controls for injection timing and delivered fuel mass as well as the application of turbocharging led to the opportunity of using direct injection diesel engines in passenger cars.

The introduction of common-rail technology in the late-1990s gave a decisive impulse to the penetration of direct injection diesel engines with increased specific power within the automotive market. Diesel share in total passenger cars progressively increased during the 2000s in Europe, South Korea, India, South America, and Australia, whereas North America, China, Japan, and Russia remained overwhelmingly gasoline markets.

In particular, the European community supported diesel engine development by maintaining separate emissions standards, with less severe targets than those for gasoline engines. During the early-2010s, diesel engine passenger cars sold in Europe were able to overcome those fueled with gasoline. The diesel engine became the primary resource to satisfy the progressively stringent fleet-wide targets on CO2 for passenger cars, established as mandatory regulation in Europe since 2009.

The present book could benefit automotive engineers professionally because it provides an

updated and exhaustive overview about fuel injection technologies and mixture formation strategies for spark-ignited combustion engines. It offers a full illustration of the performance of these systems and of the engines, in which they are installed, and detailed technical data pertaining to the different injection components. The book could also represent a reference for engineers that are active in the aftermarket because it is generally difficult to obtain detailed scientific information on fuel injection system solutions that are still mounted in older vehicles. ■

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P22947211

Elementary students learn STEM, compare notes with Northrop Grumman volunteers

SAE International

AWIM volunteer Cordis Cleaveland, Guidance Navigation and Control Engineer with Northrop Grumman, assists sixth-grade students with the Gravity Cruiser AWIM STEM experience at Patterson Elementary School in Gilbert, Ariz.

Sixth-graders at Patterson Elementary School in Gilbert, Arizona, weren't the only ones taking notes during their STEM class. They soon noticed a volunteer from Northrop Grumman brought his own notebook and was writing down everything during their AWIM® Gravity Cruiser STEM challenge.

Asking students to take notes and show their work is often no small feat for teachers. However, when they see engineers taking notes in real life—writing out calculations, capturing observations, and constantly referring back to their notes—that can send a powerful message, especially to the group of sixth-graders at Patterson.

Beyond modeling positive behaviors, volunteers also open the door to potential career paths. When new volunteers from Northrop Grumman are introduced to the class, teacher Jane Wood asks them all to talk a little bit about their backgrounds. Students learn there are many different types of engineers, each requiring different skill sets. As the

students soon realize, not everyone has to be an aeronautical engineer, or an engineer at all, to fully embrace a love of STEM.

As they work in teams throughout the academic quarter, students also learn firsthand about the engineering process and, most importantly, how to work together. The hands-on, team-based structure of the AWIM STEM challenge encourages collaboration between students and with volunteers. Initially students thought the engineers would just tell them the answers. Instead, they were encouraged to ask questions when they needed help.

Based on the success of AWIM for students in Patterson's Student Enrichment Program, during the 2022-2023 school year students in first, third, and fifth grade will now also participate in AWIM STEM challenges across complete grade levels. This phase 1 expansion coincides with Patterson being named a candidate for the prestigious International Baccalaureate (IB) Primary Years Programme, a student-centered approach that builds conceptual understanding through an inquiry-based, transdisciplinary curriculum framework.

"Expanding AWIM to three grade levels is taking it to another level. Gifted students will now be in the same classroom. Regardless of labels or skill sets, students will learn how to collaborate in groups and have empathy for different learning styles. High achievers will have a chance to work with special education students. By third grade, our young learners will already be pretty well versed in inquiry, and it won't be something that's scary to them," said Wood.

By encouraging social interactions with industry volunteers and classmates of all learning styles, the AWIM experience is helping to boost student confidence and improve 21st century workforce skills like communication, negotiation, and collaboration. They're also learning the value of asking questions throughout the entire process so they can keep things moving forward and stay focused on inquiry and critical thinking—crucial skills that will translate to future education, careers, and life.

"Patterson will eventually be a full inquiry model school. We will create opportunities for students to think critically, persevere, exceed expectations, collaborate effectively, and learn valuable executive functions through the use of AWIM's Engineering Design Experience™," added Lucas Blackburn, Principal at Patterson Elementary.

Additional phases planned for future years will deliver the AWIM program to all PreK – 6 teachers and students in the school. The SAE Foundation is actively raising funds to support this expansion to provide AWIM curriculum, materials, training for educators and volunteers, and support at no cost to students, families, or school. Contact joy.lancaster@sae.org to learn how you can get involved to bring the AWIM learning experience to more students as a corporate partner, donor, or volunteer. ■

SAE INTERNATIONAL

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JOB OPPORTUNITIES

RESEARCHER, Warren, MI or Remote (Anywhere USA), General Motors. Research &develop solution techniques for efficiency improvement &optimization in electric vertical take-off &landing (eVTOL) aircraft or air taxis bus. ops. Abstract &formulate mathematical models for facility location, network optimization, vehicle routing, &sys ops in air taxi ops using continuous, integer, mixed integer programming, combinatorial optimization, &machine learning (ML) models. Design solution algorithms for formulated math problems using combination of methods in ML &Ops Research (OR), incl. clustering methods, neural networks, genetic/ant colony/simulated annealing algorithms, gradient or non-gradient based algorithm, dynamic &stochastic programming. Construct mixed integer linear &potentially nonlinear programming models using math modeling software or programming language in Python, Julia, C++, Java, CPLEX, AMPL &GAMS. Implement complex algorithms &integrate developed algorithms w/ functional modules developed w/ different programming languages, open sourced or proprietary SW incl. R, Julia, SAS &SQL. Prototype stochastic system w/ queuing models &simulation models using Simpy, AnyLogic, &Simio. PhD, Industrial or Civil Engineering, Math, ML, or related. 1 mo. exp as Engineer, Researcher, Graduate Research Asst, or related, aggregating data for simulation input in Python &constructing simulation model using Simio, or related. Remote: This option does not require employee to be on-site full-time to perform most effectively. The employee's role enables them to work off-site on a permanent basis. Mail resume to Ref#886-112, GM Global Mobility, 300 Renaissance Center, MC:482-C32-C66, Detroit, MI 48265.

DESIGN RELEASE ENGINEER-AFTERTREATMENT & EXHAUST, Warren, MI, General Motors. Engineer, develop, validate, release, &assure strategic direction according to regulatory reqmts, of U.S., global &emerging market psgr vehicle aftertreatment &exhaust components, incldg gasoline Split-Volume Catalytic Converter &Catalytic Filter, DOC, DPF with pressure lines, SCR, urea mixers, EGR cooler, valves, exhaust manifolds, according to program timing reqmts, from concept to production, &aligned to meet performance, emission &safety &technical &regional reqmts &standards, using MATLAB, Simulink, ETAS INCA, NX, Tc, Tc Vismockup, ECM, &ECR tools. Conceptualize, design, validate &release aftertreatment &exhaust cmpts to meet Subsystem Technical Specification of propulsion sys projects. Assure electromechanical integration of aftertreatment &exhaust cmpts on CSS family gasoline &Duramax V8 family of diesel engines. Benchmark critical emission control technologies &recommend aftertreatment &exhaust cmpts to meet emission regs -US EPA, CARB, &UNECE. Required U.S. &intl travel to supplier plants in U.S./CAN/MEX, &CHN to support part dvlpmt, review tests, &resolve engine assy issues, ~ 3 weeks P/A (= ~6% annual travel). Master, Mechanical, Automotive or Mfg. Engineering or related. 12 mos exp as Engineer, validating or releasing psgr vehicle aftertreatment or air delivery cmpts, incldg DOC &EGR cooler, from concept to production, using MATLAB, INCA, Tc, &Tc Vismockup tools, or related. Mail resume to Ref#1474, GM Global Mobility, 300 Renaissance Center, MC:482-C32-C66, Detroit, MI 48265.

JOB OPPORTUNITIES

VIRTUAL PERFORMANCE INTEGRATION MANAGER, Warren, MI, General Motors. Define &set VDDV team virtual validation vision incl. reduction of time &cost of controller HW testing &implementation strategy for controller &plant modeling (encompassing mechanical, thermal, &electrical behaviors) sys, subsys, &cmpnt simulation, analysis &validation of ICE, HEV &BEV passenger vehicles. Provide technical direction for dev. of Virtual Hardware in the Loop (VHiL) based validation of Engine, Transmission, Body, Battery, Chassis &Electric DU Control Modules of vehicle embedded ECUs in C, utilizing MATLAB &Simulink tools, Synopsis Virtualizer, dSPACE VEOS platform, CANape &CANoe tools, to verify end-user reqrmnts, incl. system design, &control module development, calibration, optimization, &validation. Collaborate w/ customers &partners, owning &prioritizing VDDV VHiL virtual validation team's work. Lead team working with Virtual Electronic Control Units (VECUs) &sensor &actuator models for VHiL virtual validation. Produce virtual validation environments by integrating virtual ECUs, sensors, actuators, &plant models, &validate them as system. Master, Mech., Automotive, or Electrical Engrg. 36 mos exp as Engineer, using MATLAB &Simulink, &performing sys modeling, simulation &analysis of HEV or BEV syss, &developing sys level models of controls encompassing mechanical, thermal, &electrical behaviors, or related. Mail resume to Ref#42952, GM Global Mobility, 300 Renaissance Center, MC:482-C32-C66, Detroit, MI 48265.

DETROIT DIESEL CORPORATION SEEKS A SIMULATION AND ANALYSIS ENGINEER II in Detroit, MI. This position will analyze software requirements, develop test plans software test scripts, among other duties. Bachelors degree in Mechanical, Electrical or Electronics, or any closely related Engineering degree required. 36 months of experience in the job offered or related engineering position required. Must have experience with: commercial heavy duty vehicles, powertrain and engines; HiL and model based validation of powertrain, engine and aftertreatment controls features; engine and aftertreatment thermodynamics, and vehicle dynamics; MATLAB and Simulink; and GT-Power or other modeling approaches for vehicles and powertrain. To apply email resume to Rachel Rawson at rachel.rawson@daimler.com; reference job number DT-2650.

HARDWARE IN THE LOOP (HIL) APPLICATION ENGINEER, Milford, MI, General Motors. Design, set up &maintain HIL test benches to perform real-time simulations for testing software on Engine Control Module (ECM). Collect ECM HW I/O specifs from System Engineers to create an electrical design of HIL test bench. Work w/ vendors including dSPACE to procure test benches based on design specs. Coordinate plant model rollout by Simulation team to support apps &features requested by user community. Design &create wiring harnesses &load boxes, &source ECMs from HW teams & verify test bench setup for basic function. Make changes to plant models using MATLAB &Simulink &dSPACE Configuration Desk when users request minor changes to simulation. Set up &configure instrumentation including ETAS 600.1 &592 devices, Lauterbach debugger, Intrepid neoVI FIRE2 &Vector HW devices on test benches. Configure FIU hardware using dSPACE Control Desk based on ECM I/O pins & properties in Interface Control Documents &I/O matrix docs to perform Electric Failure Simulation. Bachelor, Electrical Engineering or related. 12 mos exp as Engineer, designing, setting up &maintaining HIL system to perform real-time simulations for testing software on module, or related. Mail resume to Ref#39672, GM Global Mobility, 300 Renaissance Center, MC:482-C32-C66, Detroit, MI 48265.

END OF LINE (EOL) ASSEMBLY VERIFICATION DEVELOPMENT ENGINEER, Milford, MI, General Motors. Develop, troubleshoot, &validate EOL assembly test apps using C in Visual Studio IDE for static, / alignment, &dynamic vehicle tests, using test head tool, for current/future ICE psgr vehicles, &Hybrid/Battery Electric Vehicles. Code, maintain, &debug test apps using C/C++. Debug &perform root cause of psgr vehicle ECUs affecting test apps using Controller Area Network (CAN) ISO15765, UDS ISO14229, &DoIP ISO13400 serial data protocols. Perform EOL validation in sys test benches &support pre-production vehicle builds. Test &troubleshoot CAN &LIN bus, &Automotive Ethernet messages on each test vehicle &on test bench during devlpmnt &verification phases &in vehicle on production lines that fail EOL assy tests. Support team members in system verification process. Bachelor, Electrical Engineering or related. 12 mos exp as Engineer, testing &troubleshooting CAN bus messages in vehicle &on test bench, or related. Mail resume to Ref#310, GM Global Mobility, 300 Renaissance Center, MC:482-C32-C66, Detroit, MI 48265.

RESEARCHER, Warren, MI or Remote (Anywhere USA), General Motors. Identify market opportunities &quantify tradeoffs btw. market share, profit, &engrg complexity throughout global vehicle dev process. Utilize Discrete Choice Models &Markov Chain Monte Carlo methods to enable to convert market research data, historical dealer sales, &inventory data into quantitative predictions of market share &profit. Solve Combinatorial Optztn probs via developing Nonlinear Integer Prgrms to perform order guide optimization &find efficient frontiers of optimal order guides for future vehicles, using combo of SW &programming languages including C, Python, CPLEX &AMPL. Develop robust solution frameworks for modeling problems, based on AI, dimensionality reduction, statistical hypothesis testing, &nonlinear Machine Learning (ML) models including Gradient Boosting (GB), Bagging, Recurrent Neural Networks (RNN), Autoencoders (AE), &Deep Learning (DL), manipulating problem-specific information to tailor the algorithms via customized regularization, model architecture &objective function. Implement the proposed methods in parallelized &modular Python programs. Utilize Monte Carlo sim techniques for stochastic problems. Master, Industrial or Civil Engrg, ML, or related. 12 mos exp as Engineer, Researcher, Grad. Research Asst/Associate, Graduate Services Asst, or related, developing solution framework for modeling problem, based on AI, dimensionality reduction, &nonlinear ML model including GB, RNN, &DL, to tailor algorithm, or related. Remote: This option does not require employee to be on-site full-time to perform most effectively. The employee's role enables them to work off-site on a permanent basis. Mail resume to Ref#151-309, GM Global Mobility, 300 Renaissance Center, MC:482-C32-C66, Detroit, MI 48265.

THERMAL SYSTEMS SIMULATION INTEGRATION ENGINEER, Warren, MI, General Motors. Set technical objectives &tasks for virtual engrg, dvlp &integrate full vehicle cross functional co-simulation packages integrating conventional ICE gasoline psgr vehicle, HEV, BEV models incldg Battery models, Driveline models, Vehicle Dynamics models, HVAC/cabin models, &Electric DU models into single model, using MATLAB/Simulink tool. Perform vehicle level virtual simulation for powertrain cooling, HVAC cooling, Battery pack cooling, Electric motor, High voltage power electronics cmpt &thermal protection. Work on BEV programs w/ a focus on process efficiency &innovation. Dvlp &perform 1D &thermal control simulations for new programs based on vehicle content &functional objectives. Perform vehicle level energy consumption simulation &implement suitable energy &thermal control strategy to meet vehicle performance attribute &vehicle range EPA &other fuel economy drive cycle using MATLAB/Simulink. Ensure Computational Fluid Dynamics (CFD/1D) model validity &correlation on a continuous basis. Perform simulation using 1D &CFD tools, incldg MATLAB/Simulink, AMEsim Kuli, GT-SUITE, &AVL-CRUISE. Ensure delivery of integrated co-simulation packages to enable virtual thermal syss design, dvlpmt, &validation. Master, Mechanical, Automotive, Electrical Engrg, or related. 12 mos exp as Engineer, performing vehicle level CFD simulations to support thermal dvlpmt &assessment, incldg powertrain cooling, HVAC cooling, &thermal protection, or related. Mail resume to Ref#4617, GM Global Mobility, 300 Renaissance Center, MC:482-C32-C66, Detroit, MI 48265.

SENIOR SOFTWARE ENGINEER, Milford, MI, General Motors. Gather technical requirements, engineer, develop, validate &release embedded State Estimation &Optimization &Wireless Battery Management System ECU SW in BEV Electrification Control Processor, using IBM DOORS/ Rhapsody tools. Focus on modes of communication, diagnostics, &HW &SW interfaces w/ Vehicle Integration Control Module (VICM) &VICM Radio (VRFM)/Battery Radio (BRFM) Frequency Modules. Design &develop interface related functionality btwn Wireless Cell Sensing Ring &Low level wBMS Interface Library supplied by supplier as part of ECU_BS11 Low level Embedded Code in C language, using conventional handcode, MATLAB &Simulink tools for nextgen electrification products in compliance w/ GM vehicle drivability standards, U.S. EPA, CAFE Regs &CARB emissions standards incldg GHG, CO2 &NOx. Bachelor, Electrical or Electronics Engrg, or related. 60 mos exp as Engineer, developing or testing vehicle or aircraft Wireless Battery Management System (WBMS), Remote Power Distribution System, or Power Distribution Remote Controller app SW, or related. Mail resume to Ref#36081-203, GM Global Mobility, 300 Renaissance Center, MC:482-C32-C66, Detroit, MI 48265.

JOB OPPORTUNITIES

SENIOR PROCESS ENGINEER - TRANSMISSION &DRIVE UNIT ASSEMBLY, Warren, MI, General Motors. Engr, design, define mechanical drawings, assy processes, tooling, eqpt &machinery build reqmts &processes, &tooling alternatives, &integrate &assure plant installation, launch &continuous improvement of conventional ICE psgr vehicle 10 speed (RWD) transmission &BEV Electric Drive Unit (DU) assy &machining eqpt &tools to produce GM transmissions/DUs in high volume transmission &DU mfg plant environment. Define transmission/Electric DU plant layouts &assy (tooling, eqpt, machinery, hand tools, &gauges) processes &implement gap closures in Statements of Requirements (SORs), Bills of Equipment (BOEs), Bills of Process (BOPs), Bills of Material (BOMs), &Bills of Operation (BOOs). Support assy process engrg at Romulus (MI), Toledo (OH) &Silao (MEX) 10 speed transmission plants from product design through to Start of Regular Production (SORP). Define &implement corrective actions required in all Transmission Assembly areas (carriers, case assemblies, valve body assemblies, Main Line &Bottom up). Required travel to GM transmission plants in U.S. &MEX to evaluate &improve mfg processes &facilities layouts, &support launches, up to 10 wks P/A (equal to ~18% annual travel). Master, Mechanical Engrg; Industrial Engrg; Engrg w/ Specialization in Qlty Syss &Productivity; or related. 12 mos exp as Engineer, defining transmission or Electric Drive Unit plant layouts &assy (tooling, equipment, machinery) processes &implementing gap closures in SORs, BOEs, BOPs, BOMs, &BOOs, or related. Mail resume to Ref#12928, GM Global Mobility, 300 Renaissance Center, MC:482-C32-C66, Detroit, MI 48265.

RESEARCHER, Warren, MI or Remote (Anywhere USA), General Motors. Use statistical choice models trained on customer survey data by Markov Chain Monte Carlo methods, &simulation-optimization algorithms to run bundling &pricing scenarios for subscription services &inform strategic marketing decisions on new products through extensive data anlys, visualization, &processing in Python. Dvlp large-scale dynamic real-time stochastic optimization models to solve production, supply chain, logistics &marketing problems. Use approximate model-based &approximate simulation-based heuristics to solve problems &implement solution methods in Python. Present results of anlyss &insights to business stakeholders. Identify high-impact business problems &translate them into machine learning &optimization modeling tasks. Collect data required to solve problems. Formulate &solve problems. Implement solutions in Python. Evaluate performance of proposed solutions &communicate results &insights to business stakeholders. Doctorate (PhD), Industrial Engrg, Data Analytics Engrg, Civil Engrg, Applied Mathematics, Machine Learning, or related. 6 mos exp as Engineer, Researcher, Graduate Research Assistant or Associate, or related, dvlpg large-scale, dynamic real-time stochastic optimization models to solve problems, &using approximate model-based or simulation-based heuristics to solve problems &implement models &solution methods in Python, or related. Remote: This option does not require employee to be on-site full-time to perform most effectively. The employee's role enables them to work off-site on a permanent basis. Mail resume to Ref#200-413, GM Global Mobility, 300 Renaissance Center, MC:482-C32-C66, Detroit, MI 48265.

ENGINEERING GROUP MANAGER - POWER &SIGNAL DISTRIBUTION SYSTEMS (PSDS), Warren, MI, General Motors. Lead, mentor &manage a team of 20 PSDS Design Release Engrs &Lead Engrs responsible for engrg deliverables &objectives, to dvlp &release conventional ICE, BEV &AV psgr vehicle wiring harnesses &battery cable assemblies. Provide technical leadership &guide team to successful execution of psgr vehicle program deliverables for wiring sys parts to meet vehicle program deliverables across vehicle architectures based on vehicle content &functionality reqmts specified in Product Program Content, &in accordance with Global Vehicle Dvlpmt Process w/ adherence to U.S. &glbl safety, functional, crash, durability, N&V performance criteria, &serviceability &manufacturability reqmts incldg ergonomics, part clearances, assy process methods &cycle times. Define &ensure wiring sys &cmpt conformance according to Component Technical Specification (CTS), Subsystem Technical Specification (SSTS), Vehicle Technical Specifications (VTS), Mfg Reqmts, Post-Crash Electrical Integrity (PCEI) &certification compliance w/ regs (Australia, U.S., Europe, Asia, Middle East &Latin America) defined by FMVSS, UN ECE, NCAP, &Latin NCAP crash, &durability standards. Bachelor, Electrical, Electronics, Communication &Electronic, Automotive Engrg, or related. 60 mos exp as Engineer, defining or ensuring wiring sys conformance according to CTS, SSTS, VTS, PCEI &certification compliance w/ regs defined by FMVSS, UN ECE, NCAP, &Latin NCAP crash &durability standards, or related. Mail resume to Ref#491, GM Global Mobility, 300 Renaissance Center, MC:482-C32-C66, Detroit, MI 48265.

SAE International Sections

SAE International Sections are local units comprised of 100 or more SAE International Members in a defined technical or geographic area. The purpose of local Sections is to meet the technical, developmental, and personal needs of the SAE Members in a given area. For more information, please visit sae.org/participate/membership/sections.

Collegiate Chapters at SAE International

Collegiate Chapters are a way for SAE International Student Members to get together on their campus and develop skills in a student-run and -elected environment. Student Members are vital to the continued success and future of SAE. While your course work teaches you the engineering knowledge you need, participation in your SAE Collegiate Chapter can develop or enhance other important skills, including leadership, time management, project management, communications, organization, planning, delegation, budgeting, and finance. For more information, or how to find your local Chapter, please visit students.sae.org/chapters/collegiate/.

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