That the automotive industry is in a period of flux like never before seen is not in doubt. Autonomous vehicles, electrification and smart mobility have become focuses for all automotive companies. And the growing use of software is seeing a tenfold increase in the number of lines of code in each generation vehicles, a trend that is likely to continue.

It was against this background that engineers gathered in Plymouth, Michigan, for this year’s IESF Automotive conference, run by Mentor, now part of Siemens.

“The whole market is evolving quickly,” said Don Kurelich, a Mentor vice president, as he opened the one-day event. “In the next ten years, the business is going to be dominated by the electrical content of vehicles. We need a hundredfold improvement, we have to get the size down, we have to get the power down, we have to get the functionality up. We are going on a journey that will last the next twenty or so years.”

Thus, he said, the industry was seeing new sensors with higher resolution, new microprocessors and digital signal processors, and every few years a new process technology.

“Every time that happens, you need to relook at the architecture,” he said. “And we are going to have to do that time and time again.”

He predicted that in twenty years time that autonomous driving would no longer be that interesting as the problems of integration, compactness and extremely low power would have been solved. But what is unknown is who by then will own the IP, whether it will be the OEMs, the tier-one suppliers, or even tier twos with unique offerings. And who is going to own the data? Could it be Google, Apple or Amazon, people not traditionally in the automotive space?

But that journey will not be easy, especially for new entrants who have to bring ideas to fruition.

“The valley of death is between an idea and getting a product to market,” said Mouse McCoy, co-founder of digital industrial start-up Hackrod. “With a car, that is a billion dollar journey with all the prototyping, testing, marketing, manufacturing. The compromises that make great designs fail need to be eliminated. We are going to a future where kids with a dream can build what they want.”

But when it comes to electric vehicles, the sheer volume of new entrants creates its own challenges.

“There are over 345 companies that have announced in the last year that they are going to introduce electric cars and trucks,” said Wally Rhines, CEO
of Mentor. “They are not all going to be successful but they challenge what we do. Electric cars are going to be a very exciting part of the business going forward.”

And, as Tony Hemmelgarn, CEO of Siemens PLM, pointed out, an automobile has 20,000 to 30,000 requirements.

“You can’t do that with a spreadsheet,” he said, adding that with autonomous vehicles everything would need to be validated in a virtual world.

“You can’t drive eight billion miles to test all this,” he said.

Thermal

One of the highlights of the event was the announcement by parent company Siemens that it had pulled together three separate software components into an offering for design-centric thermal simulation in autonomous electric vehicles. The Simcenter software combines Flue FD cad-embedded computational fluid dynamics (CFD), the Motorsolve electric motor designer and the Flomaster powertrain thermal energy manager.

Puneet Sinha: “Thermal design will play a vital role.”

The combination has been designed to tackle critical thermal problems such as extending electric drive range, optimising in-cabin comfort, designing sensors and improving the reliability of autonomous drive systems.

“Thermal design will play a vital role in the market adoption of autonomous vehicles,” said Puneet Sinha, MAD automotive manager at Mentor Graphics.

“Existing software tools cannot just be glued together to solve these issues.”

He said improper thermal design was a leading reason for electrical failure. And he said with this tool thermal design could be achieved without ever leaving the cad environment.

The package uses CFD technology for mainstream automotive engineers, generating accurate thermal digital twin simulations of the powertrain, processors, sensors and other enabling technologies.

Capabilities include co-simulation of thermal and electric powertrain performance, connectivity between simulation of electric motor performance and system simulation for electrical and thermal management, and design space exploration using thermal digital twin models. It also features seamless connectivity to electronic design automation tools and cad design platforms, helping engineers account for design co-dependencies across electronic, electrical and mechanical domains from the earliest stages of development.

“You are not going to change an electrical engineer into a mechanical engineer,” said Rhines. “You have to exchange the data you need so both groups can work together.”

Doug Burcicki, automotive director at Mentor, described the architectural challenges as “monumental”.

“It is not an electrical challenge, it is not a mechanical challenge, it is not a software challenge,” he said. “It is combining them all together. This is where the concept of a digital twin comes in.

Don Kurelich: “We are going on a journey.”

You are implementing and changing the design before ever implanting it in a physical vehicle. And you can feed back real-time data into the design.”

An area where thermal management is vitally important is the battery, both for its functionality and its lifetime.

“Model-based system engineering is supporting growing complexity in systems engineering,” said Katrien Wyckaert, director of automotive industry systems at Siemens.

“You need to have a balancing act between range, fuel economy and emissions while driving performance and passenger comfort. You have to apply generative concepts early in the design stage. When you look at subsystem design you also have to look at the effects on the system design.”

For batteries, she said it was possible to provide scalable models for choosing the cell chemistry and size to build integrated system and show how they will function.

“Model-based engineering supports this battery design method,” she said. “You can test cell balancing, state of charge, integration and so on. The battery pack then needs to be integrated into the vehicle design.”

Generative design can also help reduce the amount of wiring in a vehicle.

“There is a limit to the amount of wiring.”

Doug Burcicki: “Architectural challenges are monumental.”

Wally Rhines: “You are not going to change an electrical engineer into a mechanical engineer.”

Don Kurelich: “We are going on a journey.”

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Connected vehicles and smart cities

Bart Vandenplas: “We are proposing an integrated approach.”

not a problem with electric vehicles.

“Another is road noise cancellation, which is new and we are working very hard on that,” said Anil Khanna, director of audio technologies at Mentor. “You can also create new sounds to give a new experience. As cars stop being cars and become rooms...”

Connected vehicles and smart cities go hand in hand, according to Priscilla Boyd (pictured), senior product manager at Siemens Mobility. A big driver behind this is safety.

In the USA, the Department of Transport wants to replace non-impaired crashes by four-fifths; these accounted for nearly 27,000 deaths in 2016 compared with 10,500 death caused by drivers impaired by the effects of alcohol.

The second problem is congestion, estimated at costing $305bn in the USA in 2017 with an hour per week being the average time per person spent on commuting. And the third challenge is poor air quality, often a result of congestion.

“Connected vehicles can help with these challenges,” said Boyd. “Here is where you start talking about vehicle-to-infrastructure (V2I) technology.”

Dynamic short-range communications can see vehicles talking with each other. “This can help quite significantly with safety by predicting crash situations,” she said. “Vulnerable road users such as cyclists and pedestrians can link into this through their smartphones.”

Next is linking the traffic system to vehicles. This can keep cars travelling at an optimal speed to hit green lights always.

“All of this can be linked into a traffic management system,” said Boyd. “However, there are no mass-market produced cars with this technology, so should cities deploy the infrastructure now? Cities have very tight budgets.”

Funding though is available from government for trials and public-private partnerships are becoming common as car makers and infrastructure providers want to test their technologies. Also, connected vehicle technology could replace the vehicle detection technology that cities already deploy.

Tony Hemmelgarn: “You can’t drive eight billion miles to test.”

of wiring you can put in a car,” said Martin O’Brien, senior vice president at Mentor. “Printing the wires directly onto the panels could see harnesses produced in an entirely different way. That is part of the prototyping work that is going on today. Generative design can shorten the design cycle. The opportunity is being driven by new entrants. You need people who think laterally about this. Introducing a generative system takes a year with a new car maker but can take five years with an existing car maker.”

Martin O’Brien: “There is a limit to the amount of wiring you can put in a car.”

Noise

One area that is attracting a lot of interest with electric vehicles is noise. Electrical engines are much quieter than internal combustion engines but when the noise is low, other noises become more prominent.

“You don’t have the noise of the engine, but you have new noises to deal with,” said Hemmelgarn. These can include wind noise and road noise.

“These can be more annoying,” said Wyckaert. “Daimler has invested in a wind tunnel to look at how to reduce wind noise using simulation technology.”

The quietness also causes safety problems in urban driving. Pedestrians often rely on engine noise to alert them of nearby vehicles, which is why legislation is coming into play in the USA and Europe to ensure a minimum sound level.

“Some are looking at putting speakers in the bumper to give out a sound that sounds like a car,” said Wyckaert. “Also, companies are looking at generating sound inside to give the impression of power. You need to look at where to put the loud speakers and Simcenter can help with that.”

One challenge with this is joining together active and passive noise reduction technology.

“We are proposing an integrated approach using testing and simulation,” said Bart Vandenplas, team manager at Siemens PLM. Passive methods block the noise using physical materials. These have the disadvantage of adding weight to the car.

Active noise cancellation creates an anti-noise that is 180 degrees out of phase.

An example would be engine noise cancellation, though this is...”

Katrien Wyckaert: “You need to have a balancing act.”
on wheels, the sound level will be important.”

He said it was important to have a combined approach looking at passive and active methods much earlier in the design cycle.

“Doing it all at the beginning can help improve weight issues,” Khanna said.

He said there was also work taking place on predictive maintenance. Parts of a car can generate specific sounds when things start to go wrong. Training the system to listen for these sounds can be used to trigger an alert to the driver to have the car checked.

Safety

The use of model-based systems engineering is also affecting the functional safety field, according to Kyle Post, technical lead for functional safety at Ford, who discussed the draft ISO 21448 standard that is looking at the concept of safety of the intended functionality (sotif).

“You need to integrate and implement different safety standards. You are always going to have risk, but you have to analyse and minimise the risk.”

He said people worked in silos and were good at what they did but that brought connectivity constraints.

“You have buckets of data and these come from different places and are in different formats,” he said. “You have to bring this together and you need to automate the process.”

Doing this, he said, brought added benefits such as more informed decision-making, higher efficiency and more confidence in the work.

Conclusion

Never in the IESF’s 18-year history have the challenges for designing the electronic and electrical systems in vehicles been higher than they are today. But when more than a thousand engineers gather as they did last month in Michigan then it is clear that the best minds are working at solving the problems to bring forth the next generation of vehicles as the industry continues its path to autonomous driving.