The tyre industry is witnessing several technological changes that will enhance vehicle safety and fuel-efficiency. Dr Vladimir V Vantsevich, a pioneer in mechatronics, says the increasing use of electronics in tyres and vehicles augurs well for sustainable mobility.

The major elements in all these efforts are the emphasis on mechatronics – combined application of mechanics and electronics. It cuts across multiple engineering disciplines such as electrical, maths and computer sciences.

In an interview to Polymers & Tyre Asia, Dr Vantsevich said the introduction of intelligent tyre, which is a mechatronic system by its nature, is now the key element to improve fuel efficiency and reduce carbon emission in order to attain sustainable mobility. But it alone would not help resolve the problems facing the transportation sector.

In fact, intelligent tyre undesirably brings extra power losses generated by its electromagnetic and power electronics subsystems, argued Dr Vantsevich, who is a Professor in Mechanical Engineering and founding Director of the Master of Science programme in Systems Engineering at the Michigan-based Lawrence Technological University.

“For this reason, the problem of reducing mechanical power losses due to tyre rolling resistance and tyre slippage should gain further research attention and interest today,” he said.

At his university lab, Dr Vantsevich and his colleagues are working on optimal tyre carcass curve with the objective of improving tyre-rim interaction. “We are developing methods for the direct measurement of rolling resistance components.”

Rolling resistance

Besides recent developments in tyre-embedded sensors, he believes that self-inflated actuators, which convert energy into motion, are more feasible for commercial use.

He said one could control the vehicle dynamics and performance if one could control the tyre rolling process.

“Dynamics and performance of a vehicle manifest themselves in interaction of the vehicle with the environment.”

Practically all major forces acting on the vehicle from outside appear at the tyre-patch. This fact makes the tyre an important key element in the proper formation of the vehicle-environment interaction which results in its operational characteristics, including fuel efficiency, mobility, tractive and velocity properties, stability of motion, safety, reliability, etc.

However, something important is often missing, he said pointing out that the listed vehicle characteristics are significantly dependent on the “cooperation” among the vehicle’s tyres.

The “cooperation” itself depends on interaction of tyres with other vehicle systems. Said Dr Vantsevich: “For example, the same vehicle with a constant total power at all the driving wheels will perform differently when the total power gets distributed differently among the wheels.”

This vehicle will show different fuel consumption, different level of mobility and other properties at different power distributions among the wheels, he explained.

Such “cooperation” among the tyres of a vehicle and the tyres with various driveline systems is a subject matter of study at his university.

Research work

The course work that his engineering department is offering on “Autonomous Wheel Power Management System” was developed based on his own book Driveline Systems of Ground Vehicles: Theory and Design published by Taylor & Francis this year.

This innovative work, which comes in the series Ground Vehicle Engineering is brought out under his editorship. He has invited potential researchers and authors to join him in collaborative work.

A significant component of the course that he has launched includes studying the 4x4 vehicle chassis fitted with dynamometer with individual wheel control. It allows the study of vehicle dynamics/performance and fuel consumption depending on the power distribution among the wheels of vehicles with mechanical, individual electrical, hydrostatic, and hybrid drives.

Dr Vantsevich, who is credited with starting the first Intelligent Tyre and Reconfigurable Vehicle Mechatronics course in the United States, says it was developed in collaboration with Dr. Mukul Verma, an Adjunct Professor in Mechatronic Systems Engineering programme (see page 20).

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SENSING THE FUTURE

The programme, which is mostly attended by practising engineers, concentrates on manned/unmanned ground vehicles and robotics. The course is also well-received among OEMs and tyre companies. Currently he is collaborating with Professor Eugene Rivin of Wayne State University, Michigan, on the problem of tyre damping enhancement.

When asked how close can analytical simulations be to reality as there are many parameters that can change from situation to situation, he said his response to this was the development on what he called “inverse vehicle dynamics.”

He has developed control algorithms which have adaptive features, but he hastened to add that it does not mean “adaptive” as understood in the classical control theory.

“Such adaptive features provide “independence” from many non-linearities.

These algorithms demonstrate highly stable response within a wide change of parameters.

He also said that these do not require sophisticated sensors for sensing tyre-terrain characteristics. Some elements of his research have been included in the course Analytical and Adaptive Dynamics in Mechatronics Systems of the mechatronics programme.

When asked when ‘intelligent tyre’ be reality and a cost-effective option before consumers, Dr Vantsevich said: “The cost of electronics in 1970s did not stop the “mechatronisation” of vehicles. As a result, today’s cars are packed with electronics. On an average, a car has wires 2-2.5 km long with a mass of 30 kg.

The development of intelligent tyre is pre-determined by the human potential to invent novel concepts and implement them in proper designs. “I think the first phase of workable designs will come within next decade.”

FACT OF THE TARIFF CASE

What can the U.S. do to stem cheap imports?

The U.S. could pursue a countervailing duty (anti-subsidy) investigation against any Chinese tyre industry subsidies and impose tariffs to counteract any subsidies. Indeed, the U.S. conducted a countervailing duty investigation of Chinese off-road tyres a few years ago. At least in an anti-subsidy investigation, tariffs are imposed after a finding of “unfair” trade behaviour by the targeted country.

The problem with the special China safeguard that the U.S. invoked last year is that it leads to tariffs simply because imports are up. It doesn’t require any showing of unfair or illegal behaviour by foreign manufacturers. In my humble opinion, it is per se bad economic policy to impose tariffs on fairly traded goods.

Can WTO help create a level-playing field?

The U.S. or any other nation, could file a case at the World Trade Organisation, challenging any export subsidies or import substitution subsidies, if the Government of China provides such subsidies to Chinese tyre producers. Subsidies, of course, can distort global trade, so such cases benefit nations that can’t afford to subsidise, as well as wealthier nations that choose not to subsidise. In addition, ongoing WTO talks to lower global tariffs, including tyre tariffs, would benefit multinational trade in tyres, if these talks ever come to closure.

Obviously, tyre trade would get a boost if we could lower tariffs globally in the tyre industry.

In the near term, do you think the Chinese tariff spat would undermine the interest of American tyre companies operating manufacturing plants in China?

I do think the Chinese tyre spat hurts U.S. tyre companies, all of whom operate manufacturing plants in China. This is why, of course, not a single U.S. tyre company supported the tariff last year.

U.S. tyre companies realised long ago that they needed to supplement U.S. production with production overseas, including China. This foreign production supports U.S. jobs. U.S. companies aren’t going to reverse their long-term survival plans in response to a temporary tariff on one country.

How to soften the political and economic impact of the punitive tyre tariff?

The Obama Administration can, of course, reverse itself and lower or eliminate the punitive tyre tariff. That is unlikely, though. The President himself has touted the punitive tyre tariff. That is unlikely, though. The President himself has touted the punitive tyre tariff. Not surprisingly, the White House is not inclined to admit that it made a policy mistake.

The political and diplomatic damage has, frankly, been done, at least within the tyre sector. It would be bad for the U.S. - China relationship if the Obama Administration used the special China safeguard again, to impose tariffs on other Chinese products, but, so far, the U.S. Government has refrained from doing so. Indeed, although China was angry about the tyre tariff, I think the lack of other safeguard cases has eased the diplomatic situation over time.