NPT RESEARCH CALLS FOR CULTURAL SHIFT

News Bureau

The Clemson Engineering Design Applications and Research (CEDAR) Group of Clemson University in South Carolina in the US is researching many ground-breaking tyre designs. It is recognised as one of the world's leading institutions that is literally reinventing the wheel. In an interview, Professor of Mechanical Engineering *Dr Joshua D Summers,* who co-directs the CEDAR Group, shares his thoughts on his project experience in non-pneumatic tyre development

LEADING THE RESEARCH: *Joshua D. Summers, Professor in Mechanical Engineering and named College IDEaS Professor at Clemson University, co-directs Clemson Engineering Design Applications and Research Group*

South Carolina-based Clemson University's Clemson Engineering Design Applications and Research (CEDAR) is a dedicated to research and development collaborating with the tyre industry to innovate and improve designs of automotive products, including tyres.

Heading the team is Dr Joshua D Summers, Professor of Mechanical Engineering, who is working with colleagues on issues related to functional, usable and environmental designs, with secondary emphasis on artistic design.

His areas of interest include collaborative design, knowledge management, and design enabler development with the overall objective of improving design through collaboration and computation. The work has resulted in well over 220 peer reviewed publications.

Sharing his thoughts on various tyre development research projects, he told ***Polymers & Tyre Asia*** in an interview that CEDAR Group is dedicated to work with the industry to help them innovate, improve their designs, and learn relevant approaches.

"We have extensive project experience in non-pneumatic tyre (NPT) development based on past work with NASA, Jet Propulsion Lab (JPL), Michelin, and the National Institute of Standards and Technology (NIST. His specific research interests are actually engineering design, where he uses projects to motivate and inform research, he said.

Commenting on recent developments in the design and production of NPT, Dr Summers acknowledged that there is a delay in NPT's introduction to passenger vehicle market because it is an extremely critical product of safety.

"Introducing a revolutionary concept such as an NPT requires extensive testing and safety vetting. Moreover, there are governmental laws and regulations associated with tyres that create obstacles to commercial introduction," he felt.

Many of these are focussed on regulations with respect to tyre inflation pressure. Without changes to these laws and regulations, the NPT would not qualify for integration into passenger vehicles. "I believe that is why Michelin has focussed first on introducing their Tweel NPT to the skid steer market first."

Other issues might relate to high speed aspects such as acoustic and vibration issues, endurance issues etc. Materials and geometry are key to this. Next, consumer acceptance of this new paradigm is critical. Asking consumers to trust NPTs that do not look as "strong" or "solid" as regular pneumatic tyres is a big challenge.

"Finally, working with automotive companies to redesign their suspensions and other subsystems to capitalise on the potential benefits of NPTs is a cultural shift. This is going to take time to work with OEM's and other suppliers to best integrate NPTs," he said.

Rolling resistance

If NPT can offer lower rolling resistance, it will certainly be a major contribution to the environment because of lower carbon emission. But it will only really be realised with passenger tyre design. "Initial offerings of these NPTs might not achieve the full potential, because the NPT design is still only years old when compared to the century old tyre design," Dr Summers said.

Explaining his work, the design professor said: "Our research was focused on developing the next generation NPT's. This was inspired by the work on developing non-terrestrial tyres for lunar exploration. We worked with JPL and Michelin to develop many different meso-structures that could be made from metallic materials, but behave with the same shear deformation as polymers"

These meso-structures included honeycombs, auxetic honeycombs, chiral, cylindrical springs, helical coils, and others. Through physical prototyping and testing and extensive simulation, Dr Summers' team was able to show that they can achieve performance that is comparable to the polyurethane based Tweel of Michelin but with the use of linear-elastic materials (avoiding issues of hysteretic loss).

Moreover, other aspects of low rolling resistance related to NPTs might include reduction in the tread size based on wear improvements from more uniform contact patches.

Regarding the research on properties of 'vertical stiffness and rolling energy loss' that could contribute to greater fuel efficiency of vehicles, Dr Summers said that If a vehicle can be developed that can have the current ride comfort of pneumatic tyres, but have a higher contact patch pressure, then rolling resistance can be reduced. It is similar to running vehicles with over inflated tyres – but without the stiffness issues.

"Ultimately, the greatest potential savings will likely be through the material changes that are possible with the meso-structures. A challenge to this will be the manufacturability tradeoffs with performance," he commented.

On CEDAR's research on hyperelastic and viscoelastic material models and use of finite element analysis techniques to study the effect on vertical stiffness and RR response, he said that extensive research on these models was carried out by his former post-doctoral researcher and colleague Dr Jaehyung Ju. In this work, Clemson researchers had extended previous models of honeycombs (compressive and tensile strength) to include shear stiffness.

LUNAR TWEEL: *Clemson University student-designed and built lunar tweel being inspected by Joshua D Summers and undergraduate student Samantha Thoe*

There is intense interest among natural rubber growing Asian countries whether NR will get replaced with synthetic polymers when non-pneumatic tyres are extensively commercialised. Commenting on that Dr Summers said: "I think that natural rubber will still play a role in tyres as the alternative materials are still expensive both in processing and in forming/manufacture."