

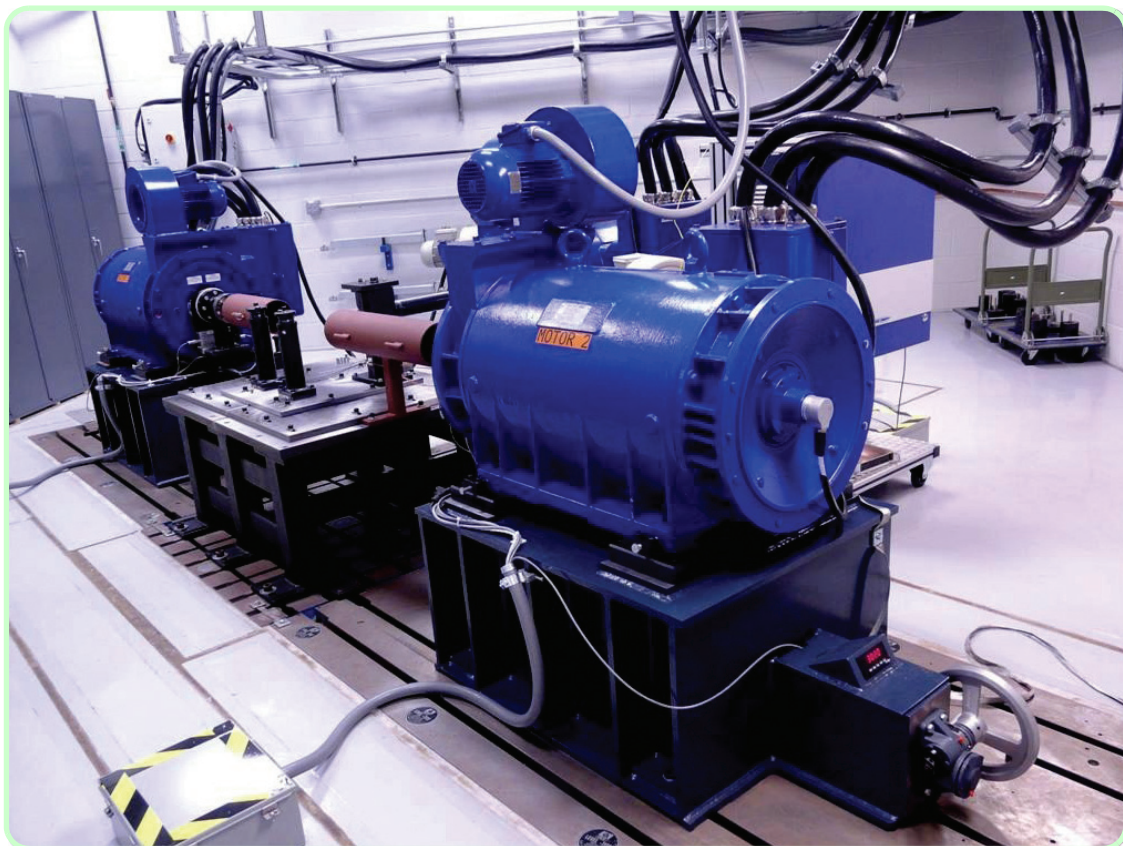
CASE STUDY

Linamar, McLaren Performance Technologies

Livonia, Michigan, USA
Automotive
NVH Design, Analysis and Testing

Linamar's more than 45 years of experience as a manufacturer of precision metallic components and systems for the automotive industry has served them well. As a manufacturer and supplier of highly engineered solutions for the automotive market their design and manufacturing base numbers 39 plants and some 17000 employees worldwide. Based in Guelph, Ontario, Linamar is one of Canada's largest automotive parts company. Linamar has partnered with Brüel & Kjær and works closely with us in the development of Linamar's products and automotive engineering solutions.

Photos courtesy of Linamar



Linamar – The Company

Linamar Corporation is a world-class designer and diversified manufacturer of precision metallic components and systems for the automotive, energy, consumer and mobile industries. From the entrepreneurial seeds planted by the dynamic founder and current Chairman, Mr. Frank Hasenfratz, Linamar has evolved into a \$2.2 Billion company with over 17000 employees and 39 manufacturing facilities located in Canada, USA, Mexico, Germany, Hungary, China and France. Linamar also has five product development centres and fourteen sales offices.



Linamar Development Center

In 2003, Linamar acquired McLaren Performance Technologies under which Linamar's product development group is organised at three locations:

- Livonia, Michigan, USA
- Guelph, Ontario, Canada
- Crimmitschau, Germany

McLaren is well known for its advanced engineering capability, especially with respect to the complete engine and transmission/driveline. Its design capability is augmented by an exhaustive knowledge base of all the component parts that go into these complex powertrain systems.



McLaren Performance Technologies' test capabilities include:

- Rapid Prototyping
- NVH/Acoustic Evaluation
- Performance/Development/Durability
- Mechanical Testing
- Metallurgical Inspection
- Cold fluid testing

The modern engine testing facility in Livonia, Michigan can operate around the clock and houses 16 dynamometer test cells capable of doing endurance and reliability testing, steady state emissions testing, engine build tear down evaluation, powertrain engineering and design, noise and vibration studies.

Expanded NVH/Durability Testing Facility

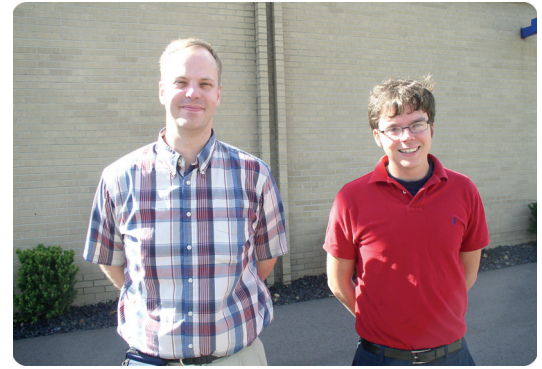
A Linamar PTU

The NVH (Noise, Vibration, Harshness) group at McLaren focuses on gearboxes, drivelines, power transfer units (PTU) and rear drive units (RDU). With increased attention on fuel energy and the new hybrid models presenting a new host of NVH challenges, any component that potentially adds noise to the vehicle must pass serious scrutiny from vehicle manufacturers. As a result, NVH has become a major differentiator between component suppliers and, therefore, needs to be part of the total design process.



Engineering Specialist
Dr. Mike Browne Ph.D.
(left) and NVH
Engineer Steve
Balistreri

In 2010, Linamar commissioned a brand new NVH/Durability testing facility at the Livonia site. Dr. Mike Browne, an Engineering Specialist with McLaren Performance Technologies (NVH, Driveline Systems/Powertrain Engineering department) was heavily involved in building this facility from the ground up. Dr. Browne has a B.Sc. in Mechanical Engineering from Seattle, moved to Detroit to work for Ford in the gearbox/transmission department, and later graduated as M.Sc. and Ph.D. while working for Ford, Visteon and Linamar. In fact, it was Dr. Browne who introduced Brüel & Kjær and PULSE into Linamar. In a previous job, he had successfully worked with Brüel & Kjær on the implementation of end-of-line product test systems using Production Test Advisor (PTA). As he himself puts it, "PULSE has proved to be of great benefit".



Dr. Mike Browne and his team work closely with the OEMs and are involved in all aspects of the NVH development process – from benchmarking competitors' products through target setting, component evaluation and durability testing, to assembly, to the vehicle and, finally, to manufacturer acceptance level testing. And the main objective for all this testing and analysis? According to Dr. Mike Browne, "It has to be quiet in the vehicle. That's what it comes down to at the end of the day".

NVH/Acoustic Evaluation

TE Test Cell

Transmitted Error

The new facility now boasts expanded capabilities for measurement of gear mesh excitation and Transmitted Error (TE). In addition to its existing Mini-TE test stand, the facility now has two new, state-of-the-art assembly test stands. As well as TE, radiated noise and other critical NVH characteristics, these test stands provide flexible, efficient and controlled operating conditions to determine the assembly level excitations during various operating conditions.

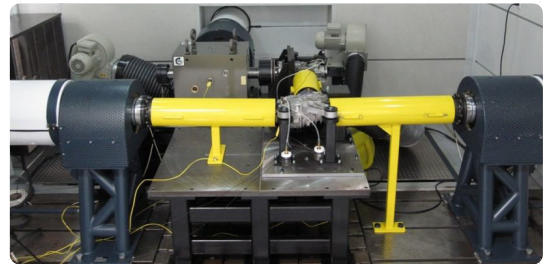


The TE and Mini-TE test stands both use a PULSE front-end as the primary data acquisition system (analysis frequency range of 0 – 25.6 kHz) and a Brüel & Kjær Optical Tachometer. The new test stands also include a PULSE Data Acquisition System – 30-channels with Analysis Frequency Range of 0 – 25.6 kHz and 12 Aux. Channel Tracking.

The NVH Test Cell

Performance/Development

The NVH/Durability dynos include a Hemi-anechoic Test Cell with a 160 Hz Planarchoic acoustic chamber where the shaft and dynos can slide in and out and up and down making it possible to test any type of gearbox. This test cell also includes a climatic chamber where the temperature can be dropped to –40°C at the component under test. It takes two hours to get down to such a low temperature.

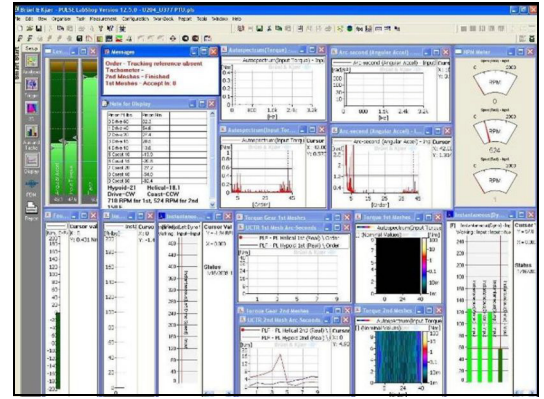


And common to all the test cells in the new facility is the low background noise. In addition to the PULSE systems at the new facility, there are a number of Brüel & Kjær accelerometers, microphones and cables. "We especially like the TEDS recognition on transducers," says Steve. He continues, "We also use torque transducers from Brüel & Kjær's sister company HBM. The outputs from these also go into the PULSE front-end".

Future

PULSE operating screenshot

Linamar would like to expand its partnership with Brüel & Kjær to influence strategic development, and has two PULSE PTA systems including PULSE Reflex Core for testing their powertrain components at their production facilities around the world. “We’re using Reflex more and more,” says Dr. Browne. “With our PTA systems we have real-time connection from the system back to Linamar for troubleshooting and data analysis. This is in line with our strategy of global manufacturing with centralised development and we have a PULSE Data Manager/PTA pilot setup in Detroit. This is used to set pass/fail limits for new components prior to launch in the factories”.



Dr. Mike Browne continues, “Production testing is a big growth area for us. A future concept could be for Linamar to build a complete production test system including NVH functionality and then the production line builder would attach the Linamar system to the production line”.

When asked which overall efficiency improvement he could see in his work, Mike responded that, “Today, customers are not interested in just reject rates, they want good products. Factories do not have skilled people to do trend analysis, and you cannot rely on them to manually forward production control data in a systematic way yet factories want to keep the reject rate low. So if it goes above acceptable limits they may do some limited troubleshooting before they ask for assistance. The ideal situation would include a global production quality monitoring system, so that customers can spot trends perhaps months before the reject rate goes up”.

A Linamar Rear Drive Unit (RDU)

Dr. Mike Browne is involved all through the product process from application support to sales (joint customer visits) during the early sales phase, through customised development of products, introduction of products into production including pass/fail criteria (US or overseas) and acting as support when reject rates exceeds acceptable levels. In his own words, “Tomorrow’s winners are those companies that can take the data, manage the data, and drill down to reach conclusions on production variability”.



One thing is certain for the future – the Linamar/Brüel & Kjær partnership goes from strength to strength. As John Jennings, Director of Engineering at Linamar says, “As the world leader in sound and vibration solutions in the automotive industry, we have exclusively partnered with Brüel & Kjær and it’s our intention to work closely with them in the development of our products and also to have an influence on the future development of Brüel & Kjær’s automotive engineering solutions”.