

# CASE STUDY

Linamar  
Canada

Canada  
Automotive

NVH Design, Analysis and Testing

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## Linamar – A Company on the Move

*“At the end of the day our job is to ensure that we have a high quality and quiet product.”*

A bright spot in an otherwise dark automotive market is Linamar. Linamar’s 40 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 37 plants and some 11000 employees worldwide. Based in Guelph, Ontario, Linamar is Canada’s second largest automotive parts company.

Linamar is a company on the move with plans to expand still going forward to complete an investment started in 2006 of \$1.1B in Ontario. The company’s product development group, McLaren Performance Technologies, is also expanding facilities in Livonia, MI to accommodate corporate expansion of engineering development services. This group is comprised of a product development group in Guelph, the original team brought on board through the acquisition of McLaren Engine and a recently acquired Ford\ACH Driveline group. The engineering offices in Southfield Michigan, the group’s current technical centre in Livonia, Michigan and a brand new Technology and Training Centre nearing completion in Guelph, have been tasked to provide a added value to their parts through enhanced NVH (Noise, Vibration, Harshness) design, analysis, and testing. With the industry tending to outsource more and more component level work, it is only a matter of time until the whole power train will be outsourced. The Linamar team is in a good strategic position to take on those opportunities. To maintain this position, Linamar, through McLaren Performance, is focusing on NVH design and testing at the top of its list.

**Fig. 1**  
A Linamar PTU



The NVH group at McLaren is currently focusing on gearboxes, drivelines, power transfer units (PTU), and rear drive units (RDU). A PTU is a little different from a transfer case. It is primarily for a front two-wheel drive vehicle, attaches to the transmission and sends torque through the RDU to the rear wheels. With fuel economy all the rage and new hybrid models presenting a new host of NVH related issues, anything that is considered to be potentially adding noise to the vehicle must pass some very serious scrutiny from the OEMs. This is where NVH comes in.

Considered to be a major differentiator between suppliers in the component market, NVH needs to be part of the total design process. Working together, both NVH designers and engineers from Linamar and McLaren Performance can achieve high-quality design and optimum noise and vibration performance. Dr. Mike Browne is one of the NVH engineers. When asked his opinion of the Linamar team concept he said, “Working on the NVH-related issues of our components, we see our role as cooperating with our designers in the early concept analysis. We continue to provide input and guidance throughout the development process and on through production. We want to make sure our parts are tuned for optimum performance and NVH”.

From the early design phase, engineers perform up-front analysis using CAE and other virtual tools to spec out the desired sound and vibration attributes for the component. Then, in the next phase, these attributes are tested and correlated to the model using Brüel & Kjær hardware and software.

Component and assembly testing includes both FRF/modal analysis, and operating level excitations. McLaren currently quantifies the operating gear mesh excitation using their Mini Transmitted Error (TE) test stand. Testing facilities will be greatly expanded this year with the addition of two state-of-the-art assembly test stands. This includes expanded capabilities for measurement of gear mesh excitations and TE in addition to radiated noise and other critical NVH characteristics. These test stands also provide flexible controlled operating conditions to determine the assembly level excitations during various operating conditions.

Vehicle level testing and analysis allows for quantification of the vehicle system and subsequent operating response of specific assemblies in the vehicle system. Modal, FRF, and transmissibility testing are all key tools for proper identification of the vehicle and driveline response characteristics. McLaren has a proven track record working with OEMs to correlate both prototype and manufacturing tests to vehicle NVH performance levels. In addition to correlation, McLaren has provided services to identify the targets and limits for proper acceptance, completing this burden for the OEM. McLaren helps OEMs with identifying the system characteristics related to noise issues so that an efficient, effective, and optimized vehicle and system level solution to the problem can be developed.

Manufacturing methods are another important aspect to minimizing noise. Linamar has the largest installation of gear grinding equipment in NA in its Guelph gear facility. Gear grinding provides for a much better fit and therefore improved noise performance.

Manufacturing of all driveline assemblies in Linamar plants are scrutinized through an NVH test prior to acceptance and shipment of the part. This test not only screens the parts for acceptable NVH levels prior to being assembled in a vehicle, but also provides data relative to the ongoing quality that is fed back into the manufacturing process.

Up-front cooperation between the teams and NVH integration into the design process allows Linamar to have a strong position in all aspects of product testing from component evaluation, to assembly, to the vehicle, and lastly, at manufacturer acceptance level testing.

### Setting New Standards!

**Fig. 2**  
*Mr. Steve Balistreri and Dr. Mike Browne in front of the expanding Livonia Technical Center*



Mr. Steve Balistreri and Dr. Mike Browne are the key players for NVH at Linamar. Dr. Browne has worked with Brüel & Kjær for many years. He is building the NVH lab and skill sets of tomorrow today! This was an opportunity for him to search the market place and consider the best analysis software and hardware available today. When all was done, he chose Brüel & Kjær. In a previous job Dr. Browne had successfully worked with Brüel & Kjær on the implementation of end of line product test systems using Production Test Advisor (PTA). In much the same way that NVH and design engineers work together at Linamar,

Brüel & Kjær worked with Dr. Browne and his team to meet his goal of building the capabilities from the ground up with an eye to the future. Drawing on his experience and wish list of capabilities, Brüel & Kjær designed a system that would make sure McLaren could meet the desired capabilities today but also tomorrow.

“It was big benefit for us to work with Brüel & Kjær. We were able to specify a complete list of equipment required based on our current and forecasted needs,” Dr. Browne said. To build an NVH department from the ground up is a daunting task. When asked what he thought the major challenge was, Dr. Browne commented, “We had to focus and make sure we covered every little detail from how many accelerometer cables to the analysis capability of the software”. As a full NVH product supplier, Brüel & Kjær was able to offload much of the concern

about the details, and allow Dr. Browne and the Linamar team to direct their attention to what was important, developing high-quality parts and increasing the business. By having the full product line, Brüel & Kjær could also provide a single stop for everything needed, from the right microphones for in-vehicle test to highly sophisticated software analysis.

### **Future Perspective**

In discussing Linamar's direction for the future, they are aggressively looking to expand and possibly look to take over responsibility for the whole driveline. From a product and NVH perspective, providing all the equipment and competencies could be a big plus for an OEM. Brüel & Kjær is no small part of that. From the transducers to the analysis and data storage, Brüel & Kjær helps to improve Linamar's product quality and gives an advantage over the competition. Dr. Browne closed by saying, "At the end of the day it is really our job to ensure that we have a high-quality and quiet product, Brüel & Kjær is a big part of that!"

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