

# CASE STUDY

Sweden

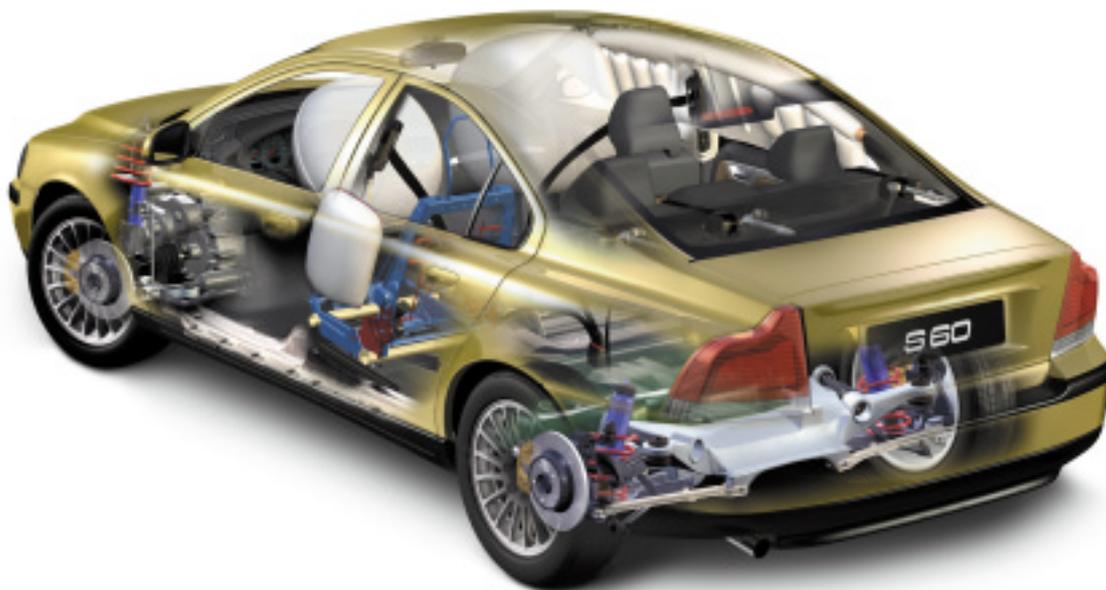
Automotive

## Volvo Car Corporation Noise Vibration Harshness Testing

PULSE, WorkFlow Manager, Transducers

*In the world of cars, the name Volvo is synonymous with safety, quality and reliability. Sound and vibration analysis is a vitally important aspect of automobile engineering. New model development time has been substantially reduced while the amount of available NVH data has greatly increased, thus ensuring constant product quality. Brüel & Kjær is proud to have worked with Volvo Car Corporation for many years. It is testimony to this relationship that a Volvo S60 is one of the central features in Brüel & Kjær's exhibition area.*

*The Volvo Car Corporation is 100% owned by the Ford Motor Company and is one of the companies in Ford's Premier Automotive Group, together with such marques as Jaguar, Aston Martin, Lincoln, etc. Volvo is Scandinavia's largest automotive manufacturer producing about 400000 cars a year. The name is shared with the Volvo Group which manufactures trucks, buses, articulated haulers, marine and industrial power pants, and aero engines.*



---

## Shorter Development Time

---

In the past, it could take many years from the conception of a new model until it was released for delivery. New design and development technology has had a major impact in this area and, as an example, within the first 9 months of 2000, Volvo introduced no less than four new models. But, although the time needed for development has been reduced, the amount of test and analysis data has increased. The result is that Volvo ensures constant increases in the overall quality of its cars.

---

## PULSE – Noise Vibration Harshness Testing

---

In 1997, shortly after the multi-analysis solution was first introduced, Volvo decided to upgrade one of its chassis-dyno equipped NVH test cells and ordered its first PULSE™ system from Brüel&Kjær. Volvo chose PULSE for several reasons. They needed an "open" system that could be easily customised. Another requirement was fast measurement cycle times to reduce the overall test time. PULSE provided real-time processing with up to 32 channels. With multi-analysis capability, Volvo could run several different types of analysis such as Order, 1/3-octave, FFT and Zwicker Loudness, simultaneously, on a single run-up.

Today, Volvo has many PULSE systems with a large channel count. PULSE is used for a wide variety of NVH analysis tasks including engine, wind tunnel, transmission and in-car testing. Of course, the engine produces a high proportion of noise in any vehicle. Therefore, it is not surprising that Volvo uses PULSE systems extensively for engine sound and vibration analysis. Hans Håkansson, NVH Test Manager, has overall responsibility for sound and vibration analysis. He says, "We currently have two engine sound test rooms and each uses a 24-channel PULSE system". He continues, "We also use PULSE in our two chassis-dyno (rolling road) test areas".

---

## The Right Kind of Sound

---

**Fig. 1**  
*Joachim Barbugian, one of Volvo's development engineers uses a PULSE system*

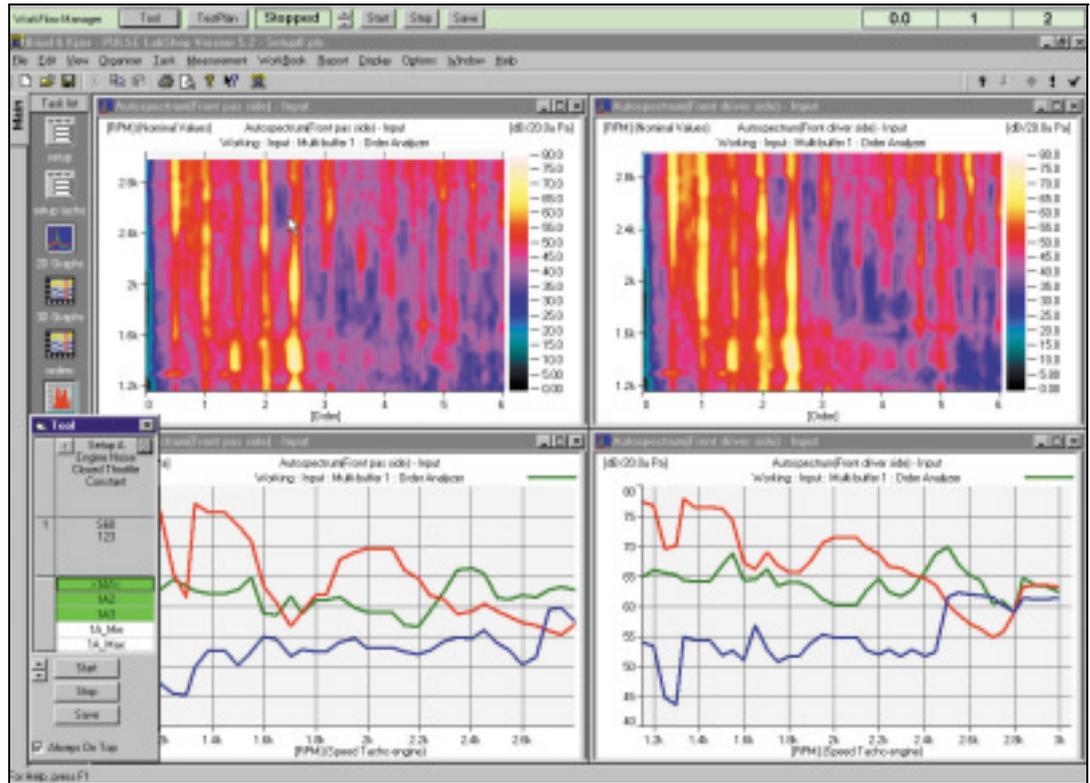


Joachim Barbugian has worked at Volvo for 25 years and, for the last 10 years, has been a development engineer. Joachim comments, "We exclusively use Brüel & Kjær microphones and accelerometers for all our sound and vibration analysis. This gives several benefits, such as reduced setup time and only one source of supply. In our engine test cells, we not only measure and control all the engine parameters, but we can also adjust and monitor the fuel, air and water intake temperatures and therefore carry out tests under a wide variety of simulated climatic conditions. All this data is

fed into PULSE. We also have a programmable robot which measures sound intensity". He continues, "Sound and vibration analysis is important for many reasons. Of course we want to make our cars generally quieter, but we also want them to have the right kind of sound that pleases our customers".

The chassis-dyno areas are used for complete car tests. Volvo has developed an overhead rack system that carries the microphones, cables and switch boxes for the PULSE front-ends. "We can raise and lower the rack remotely", says Joachim.

**Fig. 2**  
Contour plots are made using PULSE LabShop and PULSE Workflow Manager



## Staying Ahead

Volvo is constantly developing new engines and components and sound and vibration analysis plays a vital part in this work. Not surprisingly, Volvo also tests and evaluates complete cars and engines manufactured by its competitors.

"We always try to stay ahead", comments Joachim. He continues, "Before PULSE we had to use many different PC programs and set up different analyzers. What used to take a week now takes a day. This has greatly shortened our development period and reduced the time it takes to bring a new model to the market. PULSE is very flexible and user-friendly. We can produce reports quickly and this helps to save time and reduce costs".

All the sound and vibration analysis data, together with the related reports, are available on Volvo's computer network and therefore instantly available to everyone involved in the development work, at various locations in different countries.

---

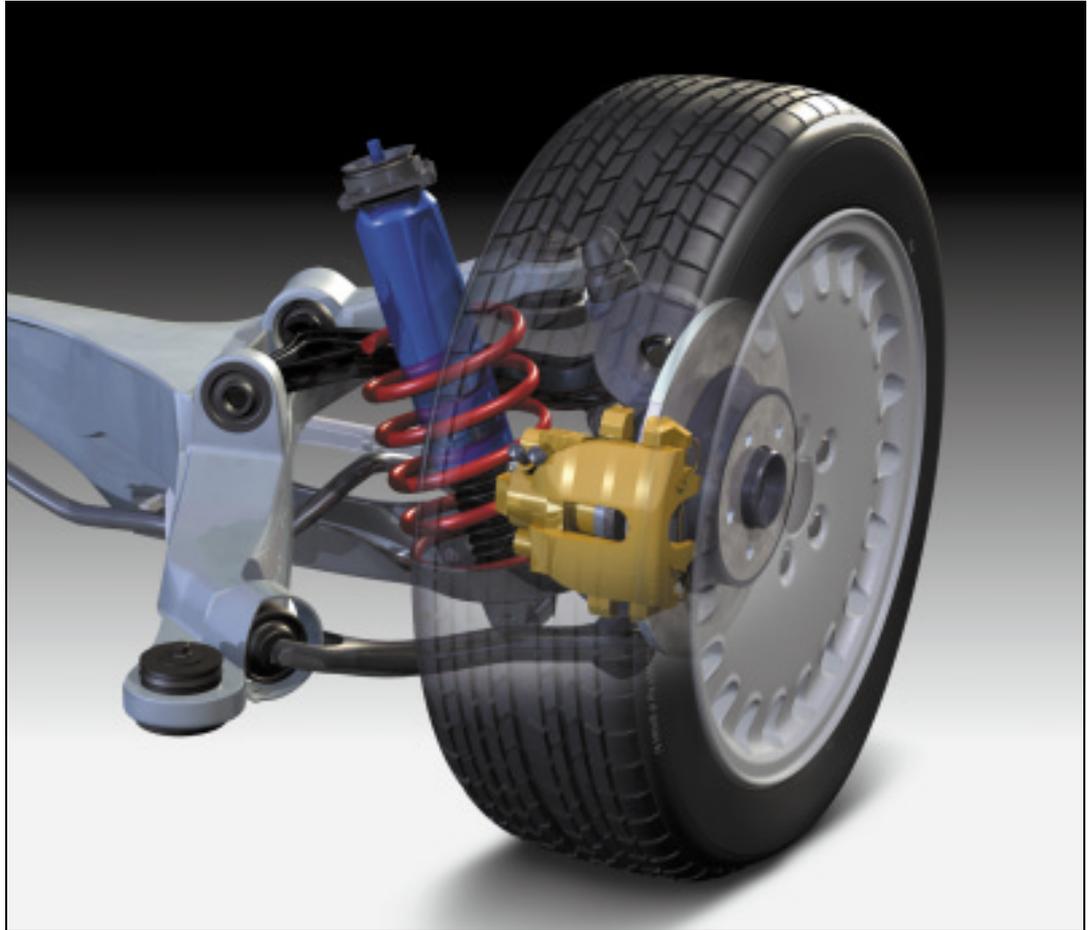
## Repetitive Testing – PULSE WorkFlow Manager

---

Volvo wanted a program to help their staff with repetitive testing. Working together with Brüel & Kjær, the PULSE WorkFlow Manager was developed.

This guides the engineer from the test planning stage right through to automatic generation and archiving of reports.

**Fig. 3**  
*The suspension and braking systems are subject to thorough NVH testing*



### **Setup**

The time taken to define and then communicate the test plan to the engineers was cut by 70% when compared to the previous system. The Test Plan in WorkFlow Manager only needs to be set up once and can then be used repetitively for each similar set of measurements.

### **Measurement**

The higher channel-count and the ability to perform multi-analysis with PULSE makes it possible to take all the necessary measurements for a test run simultaneously with all the required analyzers running in parallel.

### **Reporting**

Automated reporting using PULSE and the WorkFlow Manager means that printed reports are available as soon as the test has been performed.

Test Engineer Ulf Nilsson says, "I am very happy with the speed of the system, and since I have the Word report from the test on my personal PC, I can immediately forward it to my colleagues, for example in Holland, for their immediate evaluation."

### **Time Saved**

The overall result was a 45% time saving using the PULSE system when compared to the previously installed eight-channel system.

Hans Håkansson says, "The Test Plan facility in the PULSE WorkFlow Manager really turns the PULSE system into an efficient testing tool. The Test Plan lets the test cell engineer plan the test in advance, thus saving him costly test cell time. Furthermore", continues Hans, "it guides him through the test, making sure the right information is saved with the data. The Test Plan can be added to the final report, providing an overview of the complete test".

---

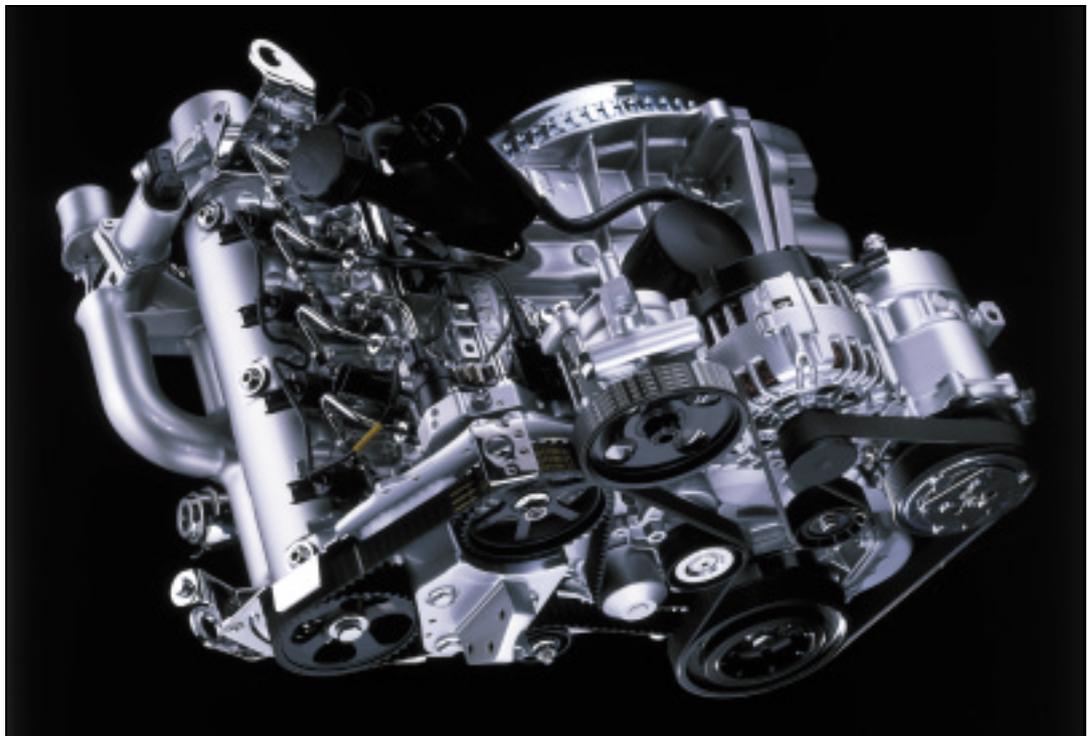
## **Mussel**

---

The latest example of the close cooperation between Volvo and Brüel&Kjær is the development of a special engine noise mapping program. Joachim says, "We want to plot the engine sound, in decibels, as a function of the RPM and the load on the engine. The plot produced looks like a mussel you find on the seashore, so that's what we call it – Mussel".

By combining the experience of its engineers, like Hans Håkansson and Joachim Barbugian, with Brüel & Kjær's sound and vibration solutions, Volvo will continue to be a market leader in the automotive industry, developing components, engines and cars for the 21st Century.

**Fig. 4**  
*Volvo engines are continuously developed. Extensive NVH testing is performed in the Motor Labs*



**Fig. 5**  
*Most of us can only dream*



---

## Key Facts

---

- Volvo has been a Brüel & Kjær customer for many years – the first PULSE system was ordered in 1997
- Volvo now has many PULSE systems and a high average channel count
- PULSE enables multianalysis in one test run
- "What used to take a week now takes a day"
- Volvo and Brüel & Kjær worked together to develop WorkFlow Manager
- WorkFlow Manager guides the engineer from the test planning stage through to report generation
- Test setup time has, in some cases, been reduced by 70%
- Printed reports are available as soon as the tests have been completed
- Using WorkFlow Manager has given an overall time-saving of 45%
- The Volvo/Brüel & Kjær partnership continues with the special "Mussel" engine noise mapping program