

CASE STUDY

Denmark

Danish Sound Technology – Peerless Production Line Testing

Audio

SoundCheck™, Microphones, Calibrators, Analyzer



For nearly eighty years, Denmark has been known as the home of many of the world's leading manufacturers of loudspeakers for high-quality audio reproduction. Peerless, now part of Danish Sound Technology, is a global market leader and the largest loudspeaker manufacturing facility in Denmark.

Peerless manufactures about half-a-million loudspeakers a year at facilities in Karlslunde, just outside Copenhagen, and at Panyu in China. Brüel & Kjær analyzers, microphones and calibrators are extensively used in the design and development of Peerless' range of high-quality loudspeakers. Six SoundCheck™ Electroacoustic Test Systems are used in final quality control and every loudspeaker is tested as it leaves the production line.

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The History of Peerless

The origins of Peerless go back to 1926 when Einar Skjold Petersen and his cousin, T.M. Larsen, formed the sales company Skjold Petersen & Co. Among others, the company represented an American loudspeaker brand called "Peerless". The world crisis, following the great depression in 1929, stopped these imports and the Danish company turned to repairing loudspeakers. It soon began to produce its own speakers and, as Peerless in the USA had closed down, Skjold Petersen & Co. took over the Peerless name.

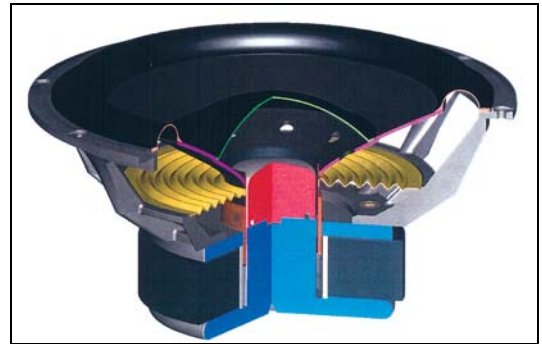
Quickly establishing a reputation for high quality, the company has continued to develop during the last 77 years. Throughout the years, Peerless' major global competitor for high-quality loudspeakers was the Danish brand Vifa, already amalgamated with Scan-Speak, another famous Danish brand. Why not all cooperate? In 2001 the three companies merged under the name "Danish Sound Technology" (DST). Employing about 200 people, DST's headquarters, sales and administration are located in Videbæk, Jutland.

The DST brands each manufacture the range of products that built its name. Each focuses on its strong points – Vifa for its tweeters, Scan-Speak for its famous range of "high-end" loudspeakers, and Peerless for big woofers with very low distortion.

Peerless Loudspeakers

Fig. 1
Cross-sectional view of a Peerless loudspeaker showing its construction and component parts

Peerless has always been famous for the reliability and quality of its products. The company started on the island, Amager. In 1956 it moved to Søborg and finally in 1983 to Karlslunde, the present location on the outskirts of Copenhagen. The production, quality control, administration and R&D departments together have a staff of about 70. The Karlslunde plant can make up to 4000 units a day, including woofers and tweeters.



In 1995 Vifa commissioned a manufacturing facility in Panju, China. The Panju plant now produces loudspeakers for all DST brand-names and is headed by a Danish production manager. The facility has modern, state-of-the-art production facilities. All assembly is in-house and, owing to lower tooling costs and labour rates, the plant is highly efficient with lower unit costs.

Peerless also sources most of its material from China, including iron parts, magnets, spiders, cones, voice coils and baskets (injection die-cast aluminium or stamped from sheet steel). Of course, all out-sourced material is designed and controlled by Peerless. Peerless is also licensed from NXT in England to produce NXT exciters and NXT panels – flat loudspeakers with very special qualities.

Wide Product Range

Peerless manufactures some 200 different loudspeaker models in the range from 2 to 15 inch diameter including tweeters. This includes standard products and types made specially for its OEM customers. These include many of the world's leading producers of audio reproduction equipment in Europe, US and Japan who demand Danish quality. Large woofers for surround-sound systems are a speciality. The customised products for this important market are built to conform to specifications jointly agreed between Peerless and the OEM customer. Production batches range from 200 to over 1000 units.

A range of Peerless loudspeakers is also sold in the audio aftermarket through distributors. Stocks are held at strategic locations throughout the world. Peerless also manufactures loudspeakers for the automotive industry. It supplies high-end products to both automotive manufacturers such as Mercedes, and quality automotive audio equipment companies.

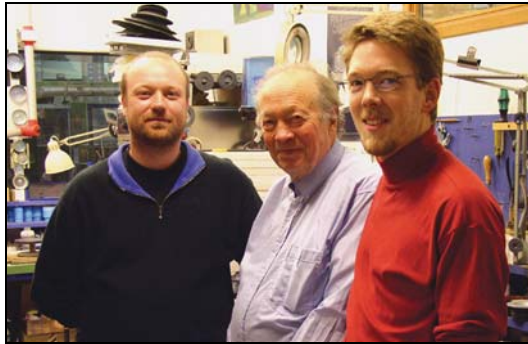
Accreditation

All DST manufacturing facilities in Denmark and China are certified by Lloyds Register Quality Assurance. In addition, all DST facilities are accredited to ISO 9000:2000.

Expertise

Fig. 2

From left to right: Gert Christensen – Senior Application Engineer, Knud Thorborg – Senior Acoustic Engineer, and Carsten Tinggaard – Product Manager



Knud Thorborg began working for Peerless in 1956. He has a Master's Degree in electrical engineering, specialising in acoustics, from Danish Technological University and worked in DTU's sound laboratory for three years before joining Peerless. Now the Senior Engineer and a Consultant, Knud is respected in the loudspeaker industry, not only in Denmark, but also throughout the world.

Knud says, "My personal interest is in loudspeaker theory. But I also make computer programs for calculations of voice coils and simulating data for speakers adapted to customers special demands. I have seen huge changes in the industry since I joined Peerless 47 years ago, but it is curious that the loudspeaker today in principle has changed little since Werner von Siemens original patent from the 1870s".

Carsten Tinggaard is an acoustic engineer and product manager. He has a Bachelor's degree in sound and acoustics from Odense and thereafter followed Master's degree courses at the Danish Technological University. Carsten has worked at Peerless for three years and has mainly focused on the development of flat loudspeakers using new NXT technology.

Flat Speakers

Fig. 3

A special test chamber has been developed for testing Peerless' range of flat loudspeakers using SoundCheck™ Electroacoustic Test Systems for quality control



Carsten explains, "The exceptional benefit of flat speakers using NXT technology is the very clear reproduction of speech. They don't move air like a piston but each point moves. They are not directive. Of course they can also be used for music, but speech is their real forté. Because the speakers are flat, they can be easily hidden – perhaps combined with a lamp – and therefore appeal to architects".

"We have also developed speakers using NXT technology for outdoor sporting events. The loudspeaker industry is notoriously conservative but these new flat speakers have so many advantages that we predict they will be widely used."

Flexible Production

Carsten says, "There will always be a small market for enthusiasts that demand specialist hand-made loudspeakers. Our goal is to make the very highest quality loudspeakers using volume production, not mass production methods. We aim at the high end of the commercial market. Our production plants in Denmark and China are very flexible and can easily be adapted to different models".

“New models can be designed and then made by hand in just a few days. And volume production can follow just as quickly once the required components are in-house. Our quick response to the demands of our customers is a key selling point.”

Research & Development

Fig. 4
Peerless' lab uses Brüel & Kjær Audio Analyzer Type 2012. The unit on the right is Laser Velocity Transducer Type 8323, used to measure the velocity of a loudspeaker's diaphragm



Knud says, “Our relationship with Brüel & Kjær goes back around 50 years. We already had some of their products when I joined Peerless in 1956. We use an Audio Analyzer Type 2012 in our R&D laboratory. We have had this since 1991 – in fact I believe we were one of the first customers. It is completely reliable, accurate and does everything we need. We feel very safe with it. All the instrumentation microphones used in the lab and in production are from Brüel & Kjær”.

He continues, “Rub and buzz are important parameters that must be measured when developing a new model and our test programs are all based on Brüel & Kjær software. The equipment must measure exactly the same every time. All algorithms for distortion calculations are repeatable and reliable.”

Fig. 5
The anechoic test chamber is triangular. No two surfaces are parallel, thus ensuring a reduction in standing waves. A Brüel & Kjær 1/2" Microphone Type 4191 is used for measurement



A Laser Velocity Transducer Type 8323 is used to measure the velocity of a loudspeaker's diaphragm, to calculate the Thiele and Small parameters.

The laboratory has a special anechoic chamber to measure the performance of a loudspeaker using Audio Analyzer Type 2012 and Microphone Type 4191 (a high-performance free-field instrumentation microphone, with a frequency response of 3 Hz – 40 kHz).

It has a triangular shape and no two surfaces are parallel. This greatly reduces the standing waves and provides very accurate measurements to be made. The typical lower frequency response of a Peerless 12 inch woofer is down to 20 Hz.

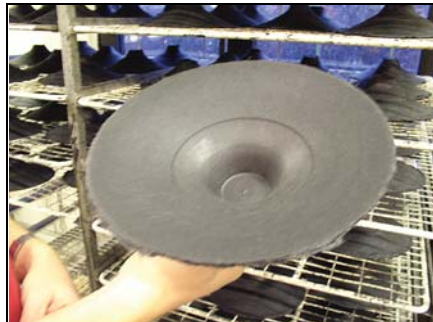
Loudspeaker Cone Manufacture

A Peerless speciality is making loudspeaker cones. Knud explains, “The cone is most important for loudspeaker quality and is a product differentiator. We make our own paper and vacuum formed polypropylene cones in our factory. In addition, we buy cones from specialist companies, in accordance with our designs, as some are less expensive than we could produce them. And some cone manufacturers use techniques that we do not have in-house”.

Fig. 6
Peerless' speciality is manufacturing its own cones. The in-house manufacturing facility is unique in Denmark



Fig. 7
A finished paper cone. The formulations of the paper-based material are a closely guarded secret



He continues, “Our paper cone production is unique in Denmark. We are the only company making cones from raw material directly imported from large Swedish paper manufacturers. All other Danish loudspeaker companies use recycled material”.

“Of course, the exact composition of our paper and our very special production is confidential. We mill the paper pulp in our paper mill, add special fibres such as NOMEX[®], and the pulp is “sucked” onto shaped perforated plates.”

“Then the cone is air dried in an oven, and impregnated to make it water proof and to obtain the right stiffness and damping. But we never press the material, thus avoiding spoiling the fibre structure of the paper. Practically all other paper cones in the world are pressed wet. Finally, the cones are punched to the right size, the surround is mounted, and now it’s ready for use in our production.”

One Hundred Percent Tested

Carsten explains, “Our reputation is built on quality and reliability. Therefore, every loudspeaker that Peerless manufactures, either here in Karlslunde, or in China, is 100% tested as it comes off the production line either using SoundCheck[™] Electroacoustic Test Software or the internally developed Peerless Acoustic Control System (PACS) test system. We have three SoundCheck[™] systems here, and I have installed three more at the Panyu plant in China. Each system uses a Brüel & Kjær Microphone Type 4191”.

He continues, “We have a separate test template for each model. These are created from reference sequences within SoundCheck[™]”.

“We have three reference programs – one for woofers, one for mid-range units and one for tweeters. We can then easily modify these to establish the test limits for each type of loudspeaker.”

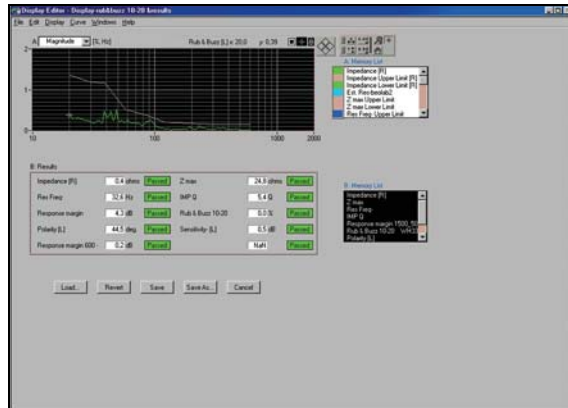
The measured parameters include:

- frequency response
- sensitivity
- impedance
- harmonic distortion
- rub and buzz (over the 10th harmonic and upwards)
- Q at resonance (QM)
- resonant frequency of the loudspeaker

The stepped sine waves that are used are dependent on the specification of the model being tested. Typically, three different sweeps are made to measure specific factors such as the impedance, Q factor or resonant frequency. If the loudspeaker passes the basic test, then a more detailed test is performed. This involves a sweep using high power using the stepped sine wave generator. The parts of the critical frequency range for a specific model can be optimised to speed up the test. The test can focus on the

critical frequency response ranges in order to reduce the sweep time. Sweeping from 20 Hz to 2 kHz, a typical test takes about 30 seconds. All SoundCheck™ test data is saved on a central network server and reports and statistics are produced. In addition, the test data is regularly placed on CD-ROMs as backup.

Fig. 8
PASS/FAIL criteria are easily set or changed and status is shown clearly after each test. The display also shows that individual test parameters are within the defined tolerances



Carsten adds, “The production line test staff are not acoustics experts. The SoundCheck™ user interface is very simple and shows a PASS/FAIL indication. A graph is also displayed. In the event of a loudspeaker failing the test, this indicates the probable cause of the problem and our production staff become experienced in fault diagnosis and classification. Analysis of the test data also shows where problems with rub and buzz occur. It’s a very useful tool for production line management”.

He continues, “We are very pleased with SoundCheck™ and have used all the system’s available facilities. It’s ‘plug & play’ and easy to use. As it is written in LabVIEW®, it is very easy to modify or upgrade. It is also a big advantage that some of our major OEM customers, such as Bang & Olufsen, also use SoundCheck™”.

Calibration

Carsten says, “Every morning, before production testing begins, we use SoundCheck™ to measure on a reference loudspeaker that is kept specially for this purpose. Heat and humidity have an effect on the frequency response and therefore we test the loudspeakers relative to a reference unit”.

Every two months, absolute calibration is carried out on all microphones used in SoundCheck™ using a Pistonphone Type 4220 (124 dB at 250 Hz). A Sound Level Calibrator Type 4231 is also used.

SoundCheck™ Electroacoustic Test System – BZ 52320

Fig. 9
One of the production lines at Peerless’ facility at Karlslunde



“SoundCheck™ was developed, exactly for this type of application, in the US by Listen Inc., formed by Steve Temme. Steve has been associated with Brüel & Kjær for many years, and has developed this versatile, software-based system for the production line testing of electroacoustic devices. SoundCheck™ runs under Windows® and comprises a series of ‘Virtual Instruments’. This means that no special hardware is required as the system operates using a standard professional sound card (supplied with the system) and a PC equipped with a Pentium® processor. SoundCheck™ performs very rapid frequency and phase response, impedance and distortion tests in one sweep, typically in less than five seconds.

Fig. 10
Loudspeakers
nearing completion
on a production
line at the
Karlslunde factory

Customisation

SoundCheck™ is easily programmed and is delivered with a range of options that automate testing. The operation sequences required by each customer, for example, user prompts, conditional branching, and non-keyboard commands, are easily accomplished using the Sequence Editor Module. All the accessories necessary for on-line production control, such as foot-switches, buzzers and barcode readers, are supported and can be easily installed.



Key Facts

- Peerless is part of Danish Sound Technology – it is a global market leader and the largest loudspeaker manufacturing facility in Denmark
- The origins of Peerless go back to 1926
- Peerless is known for the reliability and quality of its products
- Peerless focuses on the design and manufacturer of large woofers with low distortion
- In 1995 Vifa commissioned a manufacturing facility at Panyu, China. Today, this factory manufactures speakers for all DST brands
- Peerless markets its products to OEMs, the aftermarket and automotive manufacturers
- Peerless also makes flat speakers using NXT technology
- “Our relationship with Brüel & Kjær goes back around 50 years”
- Brüel & Kjær microphones are exclusively used in the lab and production
- Peerless’ speciality is making its own loudspeaker cones
- Peerless has six SoundCheck™ systems
- “The SoundCheck™ user interface is very simple and shows a PASS/FAIL indication”
- “We are very pleased with SoundCheck™”
- “It is a big advantage that some of our major OEM customers also use SoundCheck™”