Standardized Testing with ArtemiS SUITE

In order to determine the acoustic characteristics of a product, it is often necessary to measure many operating states of the test object and to examine them in various ways. Standardized Testing with ArtemiS SUITE (ASM 22) is designed to perform test sequences and assists you with the entire process from data acquisition and data analysis to the finalized report. After designing the test procedure, you extract a task list for the HEAD Recorder (ASM 04). The list is displayed in a separate window of the HEAD Recorder and guides you through all required measurements, e.g., the various operating states of a test object. This facilitates the acquisition and organization of extensive measurement data. For analysis in ArtemiS SUITE, you can examine each individual operating state with its own dedicated analyses tailored to the measurement conditions. This allows you to perform the evaluation process in a standardized and efficient manner, thus significantly reducing the required amount of time.

Standardized Testing with ArtemiS SUITE is particularly useful
- if you have already developed and established standardized test procedures,[1]
- if you frequently repeat the same test procedure,
- if a test contains many measurements (e.g., for different operating states),
- if you need to apply different analyses to the individual measurements of a test,
- if the test report to be generated is very extensive.

Standardized Testing with ArtemiS SUITE assists you with
- structured data acquisition,
- keeping track of tests containing many measurements,
- automated data organization, e.g., channel-specific data routing suitable for the respective operating state, for tailored analysis of measurement data,
- automated report generation.

You don't need programming skills in order to use Standardized Testing in ArtemiS SUITE. However, you should be familiar with using ArtemiS SUITE and already have an established test procedure in place. Ideally, you have already worked out an Automation Project that has proven useful for your applications. Some elements of the processing chains of this Automation Project can be transferred directly into a Standardized Test Project, for example allowing you to make use of already-configured analyses.

By means of a practical example, this Application Note explains the various functions of Standardized Testing with ArtemiS SUITE.[2] A glossary of terms used in this document, such as *processing chain* or *test data set*, can be found in the last section.

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[1] Standardized Testing in ArtemiS SUITE was optimized for helping users with the performance of standardized measurement sequences. This module is not suitable for test procedures that are subject to frequent changes. If you have not yet established a proven test procedure, you should first examine your data interactively using a Pool Project and then create an Automation Project as the next step. This allows you to validate your measurement and testing procedure first. An Application Note covering Automation Projects can be found in the Download Center on our web site: http://head-acoustics.de/eng/download_center.php.

[2] The descriptions in this Application Note refer to version 8.2 of ArtemiS SUITE. The general proceeding applies to other versions as well. However, differences are possible in the scope of functions and in the user interface.

Creating a Standardized Test Project

Initially, the basic structure of the test procedure is modeled in a Standardized Test Project of ArtemiS SUITE. The Standardized Test Project is subdivided into two pools. The first pool contains a list of the **Test Conditions** (operating states) to be measured. In the second pool, the further processing for each Test Condition is specified by means of **Sequences**. Via **Start → New → Standardized Test Project**, you can create a new, empty project (see figure 1).
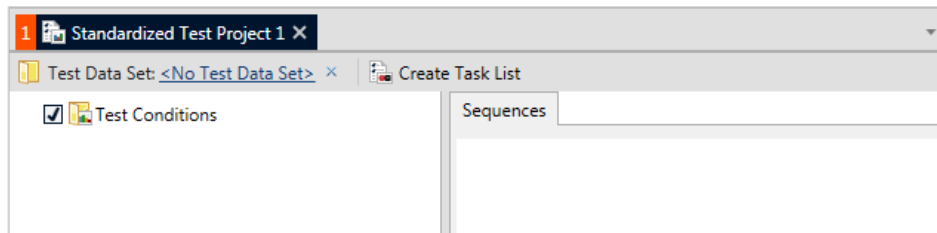

Figure 1: A new Standardized Test Project

This Application Note describes the creation and use of a Standardized Test Project by means of an example. For this example, let's assume a fictitious project involving a test series, where multiple operating states are measured for a number of vehicles (different gears and load states), i.e., the criterion *Gear* is measured in 6 variations (*Idle*, *1st Gear*, *2nd Gear* etc.) and the criterion *Load* in 3 variations (*Full Throttle*, *Part Load*, and *Coast Down*, or *High Load* and *Low Load* for the idle measurements with many or few electrical loads). Furthermore, each measurement is to be repeated once for validation purposes. Each test data set for this project thus consists of 34 measurements.

In the Standardized Test Project, you can add variations with the command **Insert Variation** in the context menu. Variations can be duplicated and restructured via copy & paste or with the mouse. That way, even extensive tests with many operating states can be modeled with little effort in your Standardized Test Project.

The resulting tree structure with all variations is shown in figure 2.

Using the **Create Task List** button, you can already generate the measurement task list for the HEAD Recorder from this information (see next section: "Configuring and using the HEAD Recorder Task List").

In the second pool, you can specify the further processing of the measurements via **Sequences**). A sequence can contain any number of processing operations, such as cutting a mark, filtering, analyses, etc. If you have worked with a Pool Project in ArtemiS SUITE, many of

Figure 2: Definition of test conditions (operating states)

the elements will be familiar to you. However, unlike a Pool Project, they are not arranged from left to right in Filter, Analysis, and Statistics Pools. Instead, in a Standardized Test Project the various elements are arranged vertically as a processing chain in the second (Sequences) pool, similar to an Automation Project.
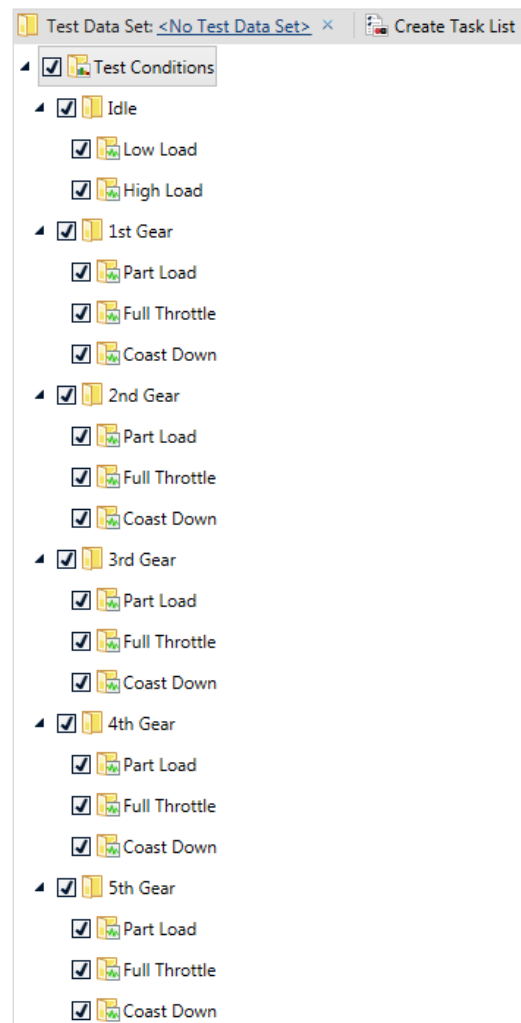
You can specify separate sequences for each individual measurement. That way, for example, idle measurements can be automatically processed in a different way than run-up measurements. Sequences applicable to multiple variations can be specified at the corresponding parent node. They are then inherited by the respective child test conditions, making it unnecessary to attach them to each variation via copy & paste. Regardless of that, it is still possible to assign additional sequences to individual child variations, which are then applied in addition to the inherited ones.

For the example project in this Application Note, measurements were made in the operating sets described above. Each measurement has 13 channels (see figure 3).
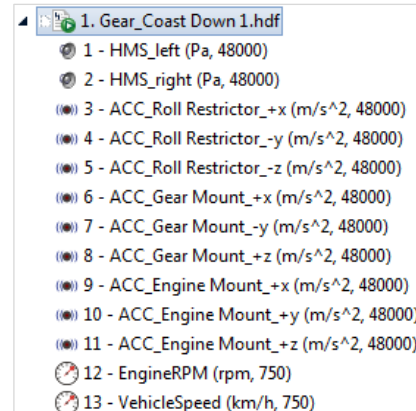You can configure different analyses for each measurement and even for each channel.

Figure 3: Measurement with 13 channels

The following describes some of these sequences and how they were implemented in the Standardized Test Project:

Idle, airborne sound channels	For these channels, the recordings are first trimmed to a certain time section (3 - 8 s) in order to eliminate possible interference at the beginning and at the end. These signal sections are then subjected to an A-weighted third-octave level analysis. Afterwards, the results from the first measurement and the repeated measurement are averaged.	
2nd gear, full-load run-up, airborne sound channels	For these channels, the recordings are first trimmed to a certain rpm range (1500 - 4500 rpm) in order to achieve comparable recordings. These signal sections are then subjected to an A-weighted third-octave level analysis versus revolution speed. Afterwards, the results from the two measurements are averaged.	
4th gear, full-load run-up, acceleration channels on gearbox mounting	For these channels, the recordings are first trimmed to a certain rpm range (1500 - 4500 rpm) in order to achieve comparable recordings. These signal sections are then subjected to an FFT analysis versus revolution speed. Afterwards, the results from the two measurements are averaged.	
3rd gear, coast down, acceleration channels on engine mounting	For these channels, the recordings are first trimmed to a certain rpm range (4500 - 1500 rpm) in order to achieve comparable recordings. These signal sections are then subjected to an order analysis of the 4th engine order, and the results are averaged.	

Configuring and using the HEAD Recorder Task List

In the task list for the HEAD Recorder, you can further specify the measurement conditions for all test conditions (operating states) to be recorded for a Standardized Test Project. All list items can be configured individually. This allows you, for example, to specify certain trigger conditions for each operating state, which are then applied automatically in the HEAD Recorder.
The task list extracted from a Standardized Test Project can then be displayed in a dedicated window of the HEAD Recorder and can be executed in a progression specified by the user. Since the measurements are clearly marked as done or not done yet, the complete data acquisition is a quick and straightforward process. Furthermore, all recordings are named automatically by the HEAD Recorder according to a consistent scheme, which is a necessary precondition for automated further processing. When all measurements on the list are done, the test data set is complete and all recordings required for the test procedure have been acquired.

To extract the task list for the HEAD Recorder in a Standardized Test Project, use the ***Create Task List*** button. A click on this button opens a new document in ArtemiS SUITE, which contains the task list (see figure 4).
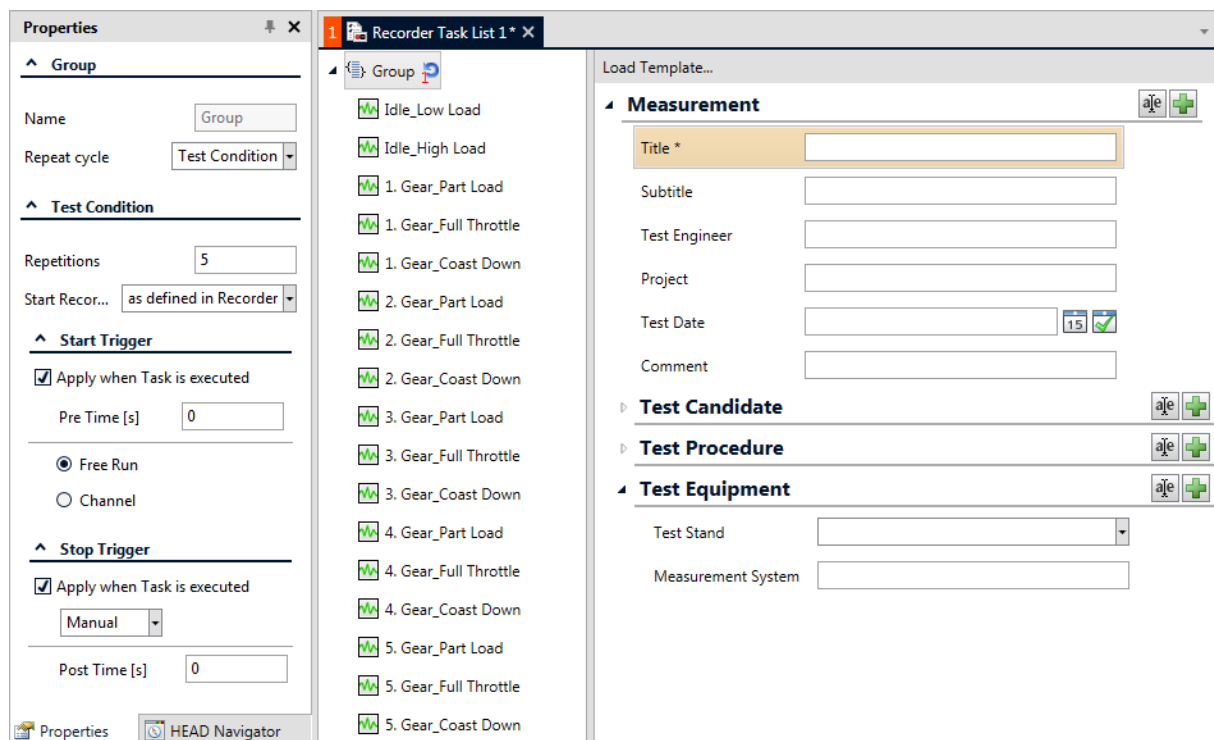

Figure 4: Task list for the HEAD Recorder extracted from a Standardized Test Project

On the left side, such a document shows a list of all test conditions under a parent element (Group). You can freely re-group and sort the elements according to your needs to optimize the order of recording. For example, for an optimal utilization of your time at the test stand, you can make your coast-down recordings immediately after a run-up recording rather than recording all run-ups first and then all coast-downs. Furthermore, you can add new items or remove existing ones, e.g., in order to subdivide a Standardized Test Project into several task lists.
On the right side of the task list, you will find an example of User Documentation.[3] With a click on ***Load Template*** in the toolbar, you can also open a file browser and load a different HATX file.

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[3] Instructions on how to work with User Documentation can be found in the Application Note with the same name. You can download this Application Note from our Download Center:
http://head-acoustics.de/eng/nvh_application_notes_documentation_data_base.htm

In the Properties window (shown on the left side in figure 4), you can configure various settings for the test condition that is currently active in the task list. Changes made in the Properties window of the parent element are applied to all elements under this parent element. Of course, you can also select multiple test conditions at once and apply changes jointly to all of these test conditions.

Some of the possible settings are described in the following as examples. A complete description can be found in the Help System of ArtemiS SUITE.

In the **Group** section, you can specify the order of repeated measurements (**Repeat cycle**):

- **Group**: With this setting, each of the specified test conditions is recorded once in the given order. For any repeated measurements, the entire group is processed again.
- **Test Condition**: With this setting, any repetitions of an individual test condition are performed first. This means that in this case, the same test condition is recorded several times in succession. Afterwards, the next test condition is recorded several times, etc.

In the **Test Condition** section, you can specify the number of repetitions. To do so, enter the desired number in the **Repetitions** field.

In the sections **Start Trigger** and **Stop Trigger**, you can specify the desired trigger conditions for the respective measurement. That way, you can ensure that all measurements are comparable and the conditions required for the standardized evaluation are met (e.g., the desired rpm range or the desired signal duration).
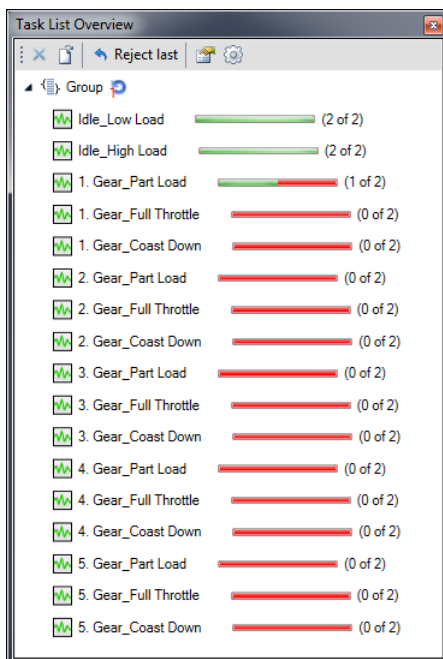

Figure 5: Task list overview

Once you have configured all required settings in the task list, you can save the list (as an HRTX file) and open it in the HEAD Recorder. To do so, first open a task list window in the HEAD Recorder via **Tools → Task List: Overview**). Click on the icon to open a new list. The overview then shows all test conditions to be measured as well as the status of the measurements (see figure 5). With a click on the icon, you can also display the properties of the individual test conditions.

Via **Tools → Task List: Current Condition**, you can open another window, which displays the current test condition to be measured, along with the buttons required for acquisition (Start, Stop, etc.) in a straightforward layout.

Analyzing measurements and displaying results

Once the acquisition of the data set is complete, the data can be passed to the Standardized Test Project. To do so, click on **No Test Data Set** in the toolbar of the project and select the folder containing your data set. The individual HDF files are then automatically assigned to the corresponding test conditions in the project and thus to the associated processing sequences. A successfully assigned HDF file is indicated by a green box ■. Due to limited space, a maximum of three boxes per test condition is displayed. A tooltip displays a complete list of all associated repeated measurements. Missing recordings are indicated by □□□ (see figure 6).
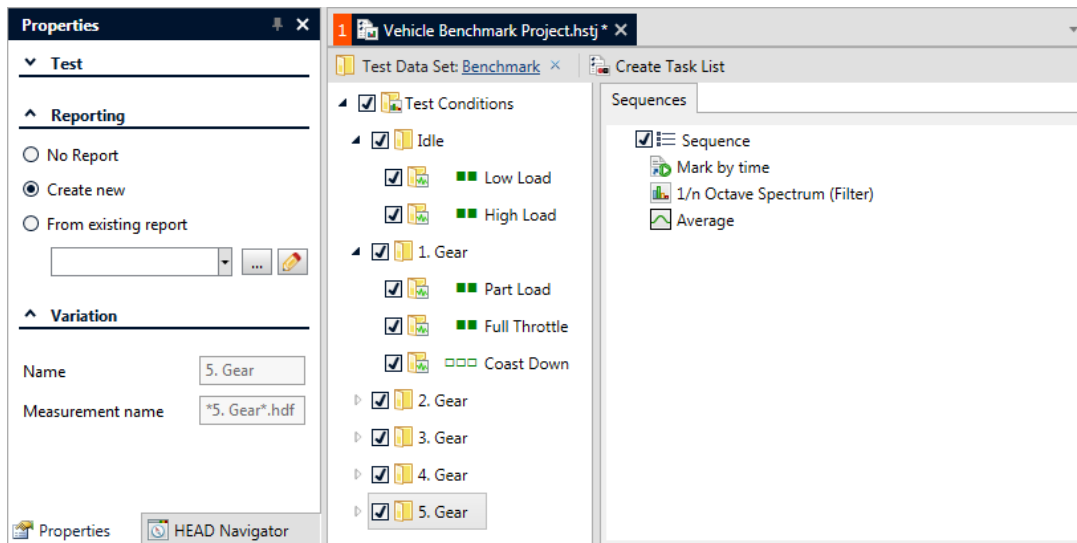

Figure 6: Standardized Test Project with test data set

With a click on the 🔳 icon, you can now apply the specified sequences to all correctly assigned recordings in your project. According to your selection in the Properties window, the results are either written to a temporary folder or to a subfolder of the measurement data folder. One folder contains all results of a test, i.e., all results created by the calculation of one test data set.

In order to visualize the results, you can use the folder containing the test data and all calculation results as a data source for report generation. If you don't have a report template, you can select the **Create new** option in the **Reporting** section of the Properties window of the test conditions and start the calculation. Afterwards, you can specify the layout and presentation of the data in the newly created report. Once you have created a suitable report template, you can use it for all subsequent calculations. To do so, select **From existing report** and select the desired template by clicking on the 🔲 button. Figure 7 shows an example with four report pages for the example project of this Application Note. If you have saved User Documentation with your recordings, you can add this information to your report. In this case, when making a new calculation, not only the analysis results in the report will be replaced with the new ones, but also the corresponding User Documentation. Detailed descriptions of the reporting functionality and how to work with User Documentation can be found in the help system of ArtemiS SUITE and in the Application Notes about these subjects.[4]

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[4] You can download the Application Notes at the following URL:
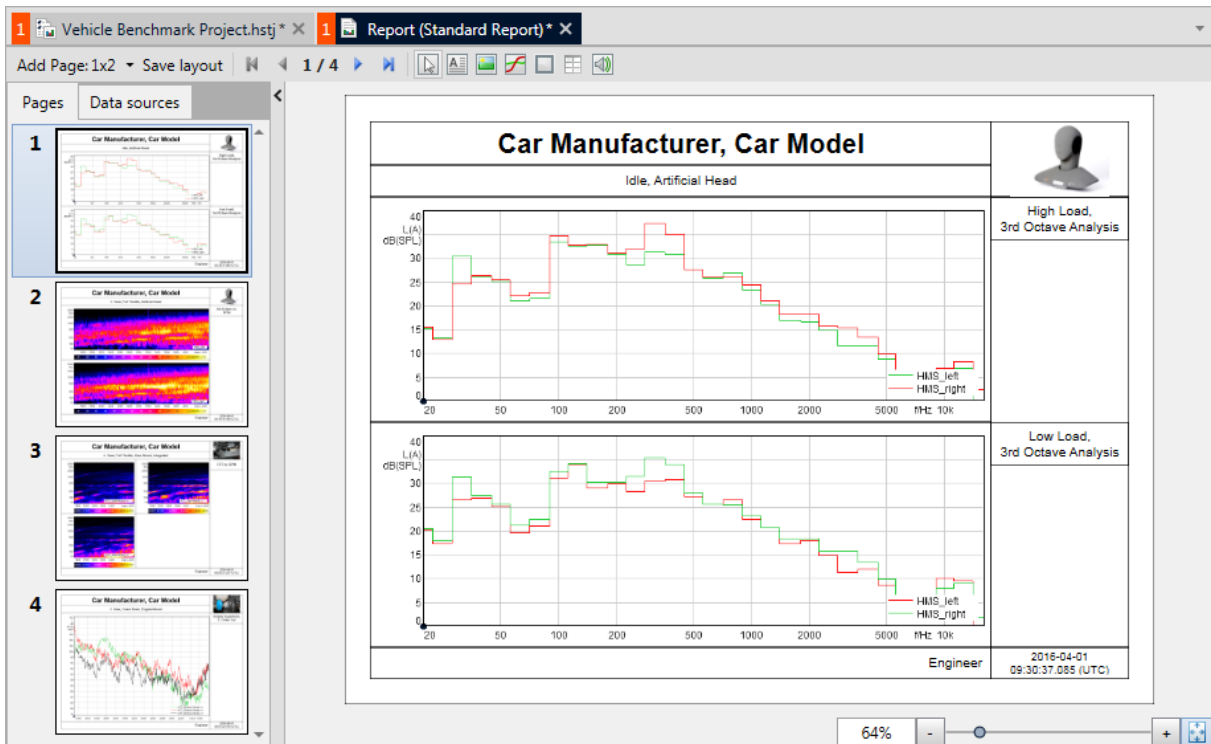http://www.head-acoustics.de/eng/nvh_application_notes_reporting.htm

Figure 7: Example of a report

By using a Standardized Test Project with processing sequences specified individually for each test condition, and by using the same report template for all tests of a series, each new calculation will give you a standardized and comparable report at the click of a button.
Once the calculation is complete, ArtemiS SUITE displays the finished report. After reviewing it, you can export it to PPTX or PDF format by clicking on the **Export to** button.

Standardized Testing with ArtemiS SUITE is a versatile tool with a broad range of functions. The task described in this Application Note is just one of many ways to use Standardized Testing in ArtemiS SUITE. Many other application possibilities are available. Your HEAD acoustics representative will gladly help you evaluate your needs and identify possible applications in your company or department.

Explanation of terms

This section explains terms used in this Application Note for the description of Standardized Testing.

- Standardized testing means performing a **test series** consisting of n **tests**.
- Each **test** is a test of exactly one **test object**. A **test series** can contain several **tests** of different **test objects** or one **test object** in different operating states.
- A **test** is performed according to a standardized **test procedure**.
- The **test procedure** is modeled in the **Standardized Test Project**. For this purpose, the **test conditions** (operating states) to be measured are specified in a tree structure.
- A **test condition** comprises **variations** of a **criterion** or multiple **criteria**. Examples:
  - For a test, a vehicle is to be measured in 1st, 2nd, and 3rd gear. This means that such a test measures three variations of the *Gear* criterion: *1st gear*, *2nd gear*, and *3rd gear*.
  - For a test of a seat adjustment motor, the criterion *Installation* is specified with two variations: *Not installed* and *Installed*.
- For each **test condition**, a single **measurement** or several repeated measurements (**repetitions**) can be performed.
- A **Standardized Test Project** consists of two **pools**. The first **pool** contains the **test conditions**. In the second **pool**, the processing **sequences** for the measurement of the respective **test condition** are specified.
- **Sequences** are inherited by child **test conditions** in the tree structure. That way, analyses to be applied to multiple measurements need only be specified once.
- A **Standardized Test Project** allows the **test conditions** to be converted into a **task list** for the HEAD Recorder. This **task list** also specifies the number of **repetitions**.
- The **task list** is opened in the HEAD Recorder and processed. The recorded data created by this are the **test data set**.
- A **test data set** consists of a folder that can be given any name by the user. This folder contains all **measurements** and **repetitions**. The names of the **measurements** are based on the **test conditions** and assigned automatically by the HEAD Recorder.
- After the measurements, the **test data set** can be loaded in the **Standardized Test Project** and analyzed by means of the **sequences** specified for the **test conditions**.
- If desired, the analysis results can also be presented in a **report**.