

CALIFORNIA STATE UNIVERSITY, NORTHRIDGE

PREDICTING USABILITY PROBLEMS WITH USER GUIDES WITH EXPERT
HEURISTIC EVALUATION

A graduate project submitted in partial fulfillment of the requirements
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Table of Contents

Signature Page.....	ii
Acknowledgments.....	iii
List of Figures	v
List of Tables.	vi
Abstract.....	vii
1 Introduction	1
1.1 Background	1
1.2 Previous research.....	1
1.3 Current Study	3
2 Methods	4
2.1 Participants	4
2.2 Scenario Selection	5
2.3 Heuristic Evaluation (HE)	5
2.4 User Test 1 (UT1).....	6
2.5 Re-Design of User Guide	7
2.6 User Test 2 (UT2).....	8
3 Results	9
3.1 Overall Results	9
3.2 Heuristic Evaluation (HE).....	9
3.3 User Test 1 (UT1) Results.....	14
3.4 Re-Design User Guide.....	20
3.5 User Test 1 and User Test 2 (UT1 and UT2) Comparison Results	28
4 Discussion.....	33
4.1 Conclusions	33
4.2 Applied Approach	33
4.3 Limitations and Future Research.....	34
References.....	36
Appendix A: Original User Guide Excerpts	37
Appendix B: Re-Designed User Guide Pages	45
Appendix C: Complete List of Observations for HE, UT1, and UT2	51

List of Figures

Figure 1: Day in the Life Analysis.....	5
Figure 2: HE Usability Problems Pages 12-13	10
Figure 3: HE Usability Problems Page 13	11
Figure 4: HE Usability Problems Pages 18-19	12
Figure 5: HE Usability Problems Pages 19, 20, 22, and 23	13
Figure 6: HE Usability Problems Page 23	14
Figure 7: UT1 Only Usability Problem Page 23.....	19
Figure 8: Original and Re-Designed Page 12	21
Figure 9: Original and Re-Designed Page 14	23
Figure 10: Original Page 18-19 and Re-Designed Page 19	24
Figure 11: Original and Re-Designed Page 19	25
Figure 12: Original and Re-Designed Page 22	26
Figure 13: Original and Re-Designed Page 23a.	25
Figure 14: Original and Re-Designed Page 23b.	28
Figure 15: UT2 Usability Problem Page 12.....	30
Figure 16: UT2 Usability Problem Page 19.....	30

List of Tables

Table 1: UT1 Usability Problems	15
Table 2: UT1 Mean Time and Ratings	19
Table 3: UT2 Usability Problems	29
Table 4: UT1 and UT2 Comparison Mean Time and Ratings.....	32
Table 5: Individual Evaluator HE Performance.....	51
Table 6: UT1 Usability Problems (All)	55
Table 7: UT2 Usability Problems (All)	56

ABSTRACT

PREDICTING USABILITY PROBLEMS WITH USER GUIDES WITH EXPERT HEURISTIC EVALUATION

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This graduate project compares methods in human factors for improving the effectiveness of a consumer user guide in performing common automobile functions. The major methods used during this process included: (1) Heuristic Evaluation (HE); (2) User Testing (UT); and (3) Re-design of a user guide. Three scenarios were selected and were the focus of the HE, UT1, and UT2. During the HE, human factors experts were asked to identify any usability problems in the user guide involving the selected scenarios. In UT1, representative users were asked to complete the scenarios while following the user guide, with performance measured by failures, reported frustration, and time to complete. The user guide was re-designed based on all problems uncovered during HE and UT1 (using human factors principles), and re-tested in UT2 with five different users in order to validate the design changes and compare the performance to UT1. The first hypothesis was HE could identify at least 80% of the usability problems observed in UT1. The second hypothesis was (2) if all usability problems (both HE and UT1) were addressed in a re-design of the user guide, a re-test (UT2) should not introduce new usability problems and would take less time to complete the scenarios. The first hypothesis was supported, showing 93% (10 of 11) of usability problems observed during UT1 were discovered using HE (with the one problem not predicted in UT1 due to experienced frustration). The second hypothesis was not supported, as one new usability problem was introduced during UT2 (two failures for the step) and one previously uncovered problem was not mitigated by the design change (three participants experienced frustration). However, UT2 did show improved performance overall compared to UT1. Also, addressing the HE only problems in the re-design (four total), did not lead to new usability problems for those steps in UT2. This shows that HE can be a trusted method in finding the majority of usability problems with this system (one that does not require training to use), but re-designs should be verified using a second UT.

1 Introduction

1.1 Background

A variety of usability evaluation methods are applied in industrial settings to assess the effectiveness of products and their associated user guides. One method is User Testing (UT), also referred to as usability testing, which is a technique where representative end users interact with a product in order to (1) improve the usability of an end product and (2) validate that the product is safe to use. During testing, both objective performance and qualitative feedback are measured to guide any re-design of the product and/or user guide needed to improve usability and/or safety. Another method, Heuristic Evaluation (HE), is an evaluation of a product/interface by one or more human factors experts who examine the product and judge its relative compliance with recognized usability principles, often termed 'heuristics'. This is sometimes referred to as 'discount usability testing' in the field of Human Factors, as it can offer an inexpensive and quick way of evaluating a product, without the need for testing representative users. Only two to four experts may be used to perform a HE, as many usability problems can be uncovered based on evaluation of their design and usability knowledge (Nielsen, 1994). These HEs are typically performed either as a stand-alone technique, or are utilized in conjunction with user testing. Research on HE can be tricky since the variance in the expertise of the evaluator can significantly impact the outcome of the evaluation, and there are different methods for performing a HE evaluation used in applied research.

1.2 Previous research

Havvenber, Law, and Lárusdóttir, (2007) compared known HE methods to determine how effectively each method could predict usability problems in a UT for a common web portal system. The HE methods studied were Nielsen's usability heuristics and Gerhardt-Powals' cognitive engineering principles (both methods provide a framework for evaluators to identify usability problems using heuristics to support a standardized method among evaluators). Also measured was the way in which HE evaluators documented usability problems (i.e., software tool vs. hard copy) to assess if inter-evaluator reliability might vary as a function of documentation strategy.

The study found no significant differences between the HE methods used (Nielsen vs. Gerhardt-Powals'), or between the way in which the usability problems were documented (i.e., tool vs. paper), in regards to effectiveness, efficacy, and inter-evaluator reliability for predicting usability problems in a user test. Based on this particular study, it may be deduced that not one particular method for identifying usability problems in a HE is preferred when predicting usability problems in a UT.

Fu, Salvendy, and Turley (2002) suggest that HE should only be used as a complement to UT, as HE uncovers different *types* of usability problems than in a UT, and vice versa. Their analysis concluded that HE was the most effective in predicting usability problems related to skill-based and rule-based levels of performance; while UT was more effective for knowledge-based levels of performance, and therefore both should be used when evaluating a product. However, the products being evaluated were software products with a focus on human-computer interaction, where end users needed specific training to

interact with the system. This may have contributed to the lack of *knowledge-based* usability problems uncovered during the HE, since evaluators were Human Factors experts and had little experience with the system being evaluated (evaluators were only given a brief training on how to use the system prior to the HE).

Based on the results of the aforementioned study, the system evaluated required formal training in order to interact with properly, it may be deduced that the HE didn't uncover knowledge-based usability problems since the evaluators weren't as familiar with the system as the users in the UT. If a different product, not requiring specific domain knowledge to properly use was evaluated, would HE then be able to uncover *all* three types of usability problems seen in a subsequent UT, beyond just skill and rule-based usability problems?

Ssemugabi and Ruth de Villiers (2010) concluded that HE can be an effective, stand alone method for uncovering usability problems, when compared to user testing alone for a web-learning system. Based on literature studies performed by the researchers, a custom framework of 20 main criteria involving ideal interface and usability principles for evaluating web-based learning environments were created (including sub-criteria related to specific examples for e-learning websites). Some examples of these main criteria (with an example of a sub-criteria) include; Match between the system and the real world (-language usage similar to users in day-to-day environments); Learner control and freedom (-there are facilities for undo/redo); and Simplicity of site navigation (-users should know where they are). These criteria were later used by the HE evaluators and UT students to identify any violations in the system compared to the criteria while completing a set of pre-defined tasks.

The HE was performed by using four Human Factors specialists, who were asked to note problems related to the tasks (along with rating categorizing problems based on defined severity), and the criteria/sub-criteria the problem violated (if any). The UT was conducted by asking 61 students to complete the same tasks as the evaluators and to complete a questionnaire after each task in the form of closed and open-ended questions related to the list of criteria, so they could describe any issues in context with which criteria wasn't being met. Students also rated the severity of the problems in the same way as the evaluators. For both the HE and UT, researchers combined usability problems that were similar (addressing the same usability problem, but written differently by the evaluators and students) to consolidate the list of problems.

The results showed that the HE discovered 58 unique problems, compared to the user test, which uncovered 55 unique usability problems (with HE predicting 63% of the UT problems). The usability problems were compared to the 20 established design criteria, and it was concluded that all usability problems (both HE and UT) violated one of the pre-defined generated criteria for e-learning websites. More importantly, the HE predicted 83% of the major usability problems identified in the UT. These findings suggest that HE found more usability problems with the system when compared to the UT and predicted over 80% of the major problems in the UT.

If a more traditional UT was conducted (observation of users behavior while performing tasks) instead of a having users identify their own problems, would HE be able to predict more or less usability problems seen in the UT?

What if a company/manufacture seeking to improve a product/system does not have the resources to perform both HE and a UT, which might be their most optimal approach? What if using the UT method alone is still too expensive and time consuming? Can HE be a trusted usability evaluation method to uncover usability problems and actually re-design a product/or user guide based on the results? Also, if all HE uncovered usability problems are considered confirmed problems with a product, could “fixing them” lead to more usability problems for the end user? Conducting a HE and UT, re-designing a product, and performing a UT to validate product design changes, could provide insight to these questions.

1.3 Current Study

The purpose of this study is to (1) compare these two usability methods (HE and UT) to determine if HE can uncover usability problems as effectively as UT in the verification phase of a user guide for a system that does not require training; and (2) to validate changes made to the user guide based on the HE and UT, and to determine if HE only found problems would lead to any additional usability problems if re-designed. An initial example is included as part of the graduate project (see [Section 3](#)). The product tested was the user guide (Owner’s Manual: Jetta, U.S. Edition, Model Year 2014, 12.2013) for a 2014 Volkswagen Jetta, involving scenarios related to the dashboard. This product was chosen as representative of a system that neither end users nor Human Factors experts would need formal training in order to operate the functions of interest.

1.3.1 Hypotheses

- (1) HE will be able to predict at least 80% of usability problems found in a traditional UT when evaluating a user guide for the vehicle.
- (2) If all usability problems (both HE and UT) associated with the user guide are subsequently improved by modifying those steps, a re-test (second UT) should show no new usability problems and fewer observed usability problems when tested with a new set of representative users. If re-designs associated with HE uncovered problems not observed in the first UT do not lead to any usability problems in the second UT, it will show it is acceptable to fix all HE problems independent of a UT.

If the hypotheses are supported, it has wide spread implications as HE alone could serve as an effective alternative usability method for many projects with limited resources, providing a more accessible option for a wider range of product development. This is because HE requires significantly less time, money, and overall planning (e.g., recruiting representative users, facility costs, etc.), than typical UT programs. In addition, many systems could have aspects of their usability assessed by usability experts who are not necessarily subject matter experts on the technical aspects of the systems. This is especially relevant for products that do not require training. This process might also positively impact the experience of many end users of products that do not typically go through a UT process for the reasons mentioned above.

2 Methods

2.1 Participants

2.1.1 Heuristic Evaluation (HE) Participants

The HE was conducted using eight Human Factors experts, who were recruited based on their expertise in the field of Human Factors.

All eight HF experts included in this HE had at least a Master's degree in Human Factors and Applied Cognition (received from California State University, Northridge), along with a minimum of three years working in the field of Human Factors. The average experience amongst the eight evaluators was 7.6 years, with the range being 4 - 42 years. There were advantages and disadvantages for using evaluators coming from the same graduate program. One advantage being that since the usability problems were identified based on general human factors principles (and not using pre-defined heuristics), the problems were easy for the researcher to interpret and eventually combine when there were repeat responses (in order to identify unique problems). This also made design changes for those problems straightforward, as the researcher received the same academic training, as the evaluators. However, one disadvantage in using only evaluators coming the same HF program, could be a lack of variance in the type of usability problems found (which potentially could have uncovered fewer predicted usability problems). It should be noted that the eight evaluators included in this study were not chosen on the basis of their similar graduate training background, but based on their work experience and close proximity to the researcher.

Past literature suggests that with three to five evaluators, 65-75% of the usability problems in a product/system can be identified during HE (Nielson, 1994). However, this also depends on the type of product being tested and the expertise of the evaluators, so this number is not concrete, and has not been the topic of much empirical evaluation. Therefore for the purpose of this study, eight evaluators were used as a more conservative assumption given that this is an area still requiring more definitive research.

2.1.2 User Testing (UT) Participants

The two UTs included a total of 22 representative users who were recruited based on their driving experience (must have had a valid drivers license). Fourteen participants were used for the first UT and eight participants were used for re-test UT. To include a representative sample of users who may drive this vehicle, individuals aged 16 to 70 were used. The average age of the participants was 39.7 years, with a range of 16 - 70.

Nielson (1994) suggests using only five participants for a user test, as diminishing returns are seen when more participants are used. Nielson also suggests using five participants during a UT, claiming more than five will lead to diminishing returns for uncovering usability problems in a system. Since this is an ongoing debate in the field of human factors, more than five participants will be included in both UTs. Also, since the results of the first UT influenced the re-design of the user guide, more participants were included ($N=14$) than in the second re-test UT ($N=8$).

2.2 Scenario Selection

A day in the life analysis provides a description of how an intended product/system is to be used. The description includes turning the product on, using its various modes, setting up modes, environment/circumstances for system usage, etc. This analysis was conducted prior to the HE and UTs to determine which dashboard features are the most commonly used or the most important. This was the basis for determining the scenarios of most interest for the HE and UTs. See the figure below for the flow of the day in the life analysis for the vehicle being evaluated.

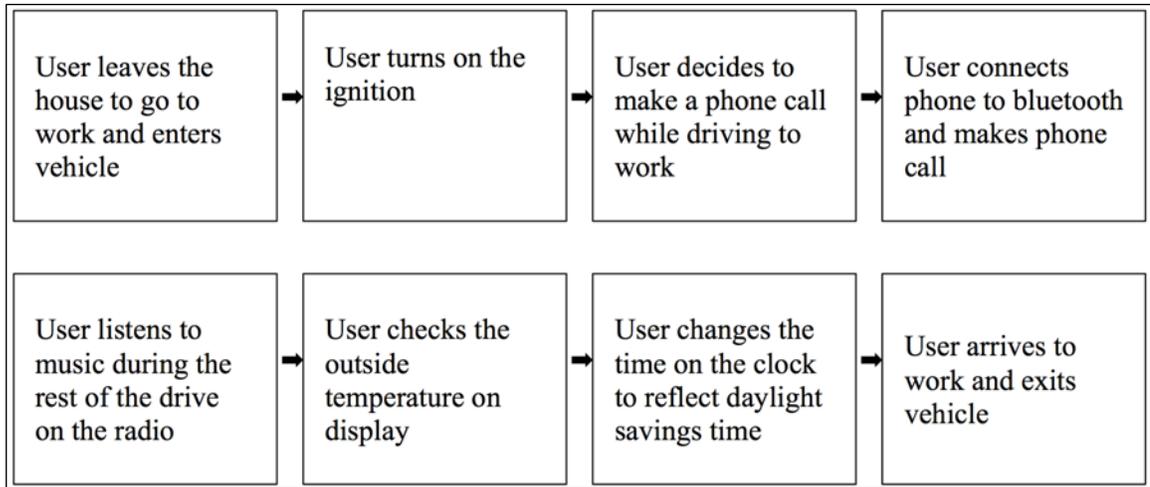


Figure 1: Day in the Life Analysis

Based on the day in the life analysis, it was concluded that the user guide scenarios to be evaluated were the following:

- 1.) Connect a mobile phone via Bluetooth
- 2.) Change the time on the clock
- 3.) Display outside temperature.

The user guide pages associated with these three scenarios are located in [Appendix A](#).

2.3 Heuristic Evaluation (HE)

Based on the three scenarios selected, the user guide and system of the vehicle were shown to the eight Human Factors experts. One hour was allocated for each evaluator to assess the usability of the user guide for all steps related to the relevant scenarios, while interacting with the actual system. This allowed sufficient time for the evaluators to uncover any potential usability problems, as the researcher conducted a dry-run of the UT to determine the length of time a user may take to complete the three scenarios, and wanted the evaluators to have the same length of time to conduct the HE.

For this study, the evaluators did not use a pre-defined set of heuristics to match the usability problem to, but instead used their human factors expertise involving design principles. Based on the study by Havvenber, Law, and Lárusdóttir (2007) mentioned earlier (see [Section 1.2](#)), no specific HE method was shown to predict usability problems for a UT better than the other, and, additionally, the study suggested that more emphasis

should be put on the opinion of the evaluator, if they are trained in the field of Human Factors.

If an evaluator identified a usability problem for a step in the user guide relevant to accomplishing one of the scenarios, they wrote down the usability problem on a piece of paper. The usability problem needed to include the specific problematic step (including exact location in user guide), and the anticipated problem users may experience while completing the step. Evaluators were reminded by the researcher that the actual vehicle was not being tested, only the user guide and to assume users will follow the user guide step-by-step. If the same usability problem was reported by at least two evaluators, it was considered a predictable usability problem.

In an attempt to standardize the results of the HE, the researcher debriefed with the evaluators to confirm that the listed usability problems were clearly understood by the researcher. After all evaluators completed the HE, a list of reported usability problems were compiled by the researcher, where similar usability problems for a particular step were combined to uncover how many *unique* usability problems had actually been listed. Again, if two or more evaluators reported the same usability problem; it was considered a predicted usability problem (i.e., that the same problem will be observed during the first UT).

The number of unique usability problems identified in the HE will be considered *actual* usability problems, regardless of the usability problems observed in the UT, and will be addressed in the re-design of the user guide. This is to help answer the research question related to ‘fixing’ all usability problems uncovered in a HE possibly leading to new potential problems if not confirmed by UT.

Because the system being tested was the dashboard of a vehicle (owned by the researcher), the vehicle was driven to each evaluator, in order for them to interact with the system while referencing the user guide.

The user guide pages associated with these three scenarios are located in [Appendix A](#).

2.4 User Test 1 (UT1)

Based on the same three scenarios evaluated during the HE, 14 representative users participated in a UT in order to evaluate the relevant steps in the user guide. Participants were asked to read a step and perform the step listed in the user guide until the scenario was completed. The researcher explained that the vehicle dashboard was not being evaluated, only the user guide and to give feedback on the user guide only. Because the system being tested was the dashboard of a vehicle (owned by the researcher), the vehicle was driven to each participant, in order for him or her to interact with the system while referencing the user guide.

Usability problems were identified based on the criteria of failures and low ratings related to feeling frustration for a step. If one or more participants failed a step (i.e., couldn’t move on from a step to complete the scenario) or if two or more participants provided a subjective rating of ‘3’ or lower on a 7 point Likert scale related to feeling frustration, a usability problem was considered a usability problem. The subjective question related to frustration was, “I did NOT feel frustrated while completing this scenario” with ‘1’ representing ‘Strongly disagree’ and ‘7’ representing ‘Strongly agree. The question was

presented in this negative format so the feeling of being frustrated was associated with ratings 1, 2, and 3 on the 7 point scale, which are generally associated with negative responses on the scale, while positive ratings are usually 5, 6, and 7.

Only unique usability problems were reported in order to permit direct comparison with the HE usability problems, as opposed to a frequency count of observed failures and low ratings. For example, if 6 participants found a specific step confusing, and two participants failed to complete the same step, one unique usability problem associated with that step was reported using the criterion of two failures. For a complete list of failures and low ratings, see [Appendix C](#).

Time to complete each scenario was recorded as a means of comparing performance from UT1 to UT2 with the re-designed user guide.

After the completion of UT1, the researcher matched predicted usability problems identified in the HE to the usability problems observed in UT1 to determine the percent that HE predicted usability problems observed in UT1. If an observed usability problem from UT1 did not match up to a predicted usability problem from the HE, this shows that the HE did NOT predict that usability problem for UT1. Also, if a predicted usability problem from the HE did not match up to an observed usability problem from UT1, it was still considered a usability problem and addressed in the user guide re-design. For example, if a HE usability problem was reported, “Not clear there are two options for pairing the Bluetooth to the vehicle” and an observed usability problem in the UT was, “Incorrect option for pairing was chosen as participants automatically chose the first option not knowing there was another option for pairing”, they were ‘matched’ as the same usability problem.

2.5 Re-Design of User Guide

Based on the usability problems uncovered in the HE and UT1, the user guide was modified by the researcher, in an attempt to mitigate future usability problems for those steps where either (1) the participants failed to perform a step correctly, or (2) where two or more participants rated their level of frustration with a rating of ‘3’ or below. The researcher re-designed the user guide *only* for steps associated with the already established usability problems from the HE and UT1. All HE uncovered usability problems were re-designed in the user guide to determine if ‘fixing’ problems not seen in a UT would lead to new problems in a second UT.

The design changes were decided based on the human factors knowledge of the researcher, and recommendations suggested by evaluators during the HE, if any were provided. These design changes were accomplished by either adding wording or images or re-arranging existing content. If there were contradictory recommendations made by the evaluators, the researcher chose the option with the fewest amount of modifications/edits. This is because some of the existing information in the user guide most likely was included to address safety issues with the vehicle, and the researcher did not have access to any type of ‘risk’ document stating which statements those were and didn’t want to unintentionally edit those statements. Also, the researcher took into consideration that the design changes shouldn’t alter the ease of use for a different scenario not included in the test.

2.6 User Test 2 (UT2)

Based on the same three scenarios evaluated during the HE and UT1, eight representative users participated in a second UT in order to evaluate the relevant steps in the re-designed user guide. Different participants were tested using the same methods and performance measurements as UT1, but were provided the re-designed user guide. This was an opportunity to assess the validity of the usability problems uncovered from the HE and UT1, and to test if any of the HE ‘only’ usability problems would cause any added confusion based on the re-design. If no *new* usability problems arose during UT2 associated with the HE only usability problems, it will be show that re-designing a user guide based on the results of a HE alone is a valid approach.

The re-designed full-page user guide pages associated with these three scenarios are located in [Appendix B](#).

3 Results

3.1 Overall Results

HE uncovered 14 unique usability problems (10 out the 14 were observed in UT1, with the other four identified as HE *only* problems and recognized as actual problems in the re-design), a total of 11 unique usability problems were observed during UT1 (10 out of the 11 were predicted by HE), and two usability problems were observed during UT2. See the following Sections [3.2](#), [3.3](#), [3.4](#), and [3.5](#) for detailed results for the HE, UT1, the user guide re-design, and a comparison of UT1 and UT2, respectively.

3.2 Heuristic Evaluation (HE)

A total of 14 unique predicted usability problems were uncovered during the HE. Initially, 76 usability problems were listed in total by the eight evaluators, but after the researcher combined similar problems, there were then a total of 23 unique usability problems. Out of the now 23 unique usability problems, where 14 were identified by at least two evaluators, and the other 9 were identified by only a single evaluator. This means those 9 usability problems uncovered by only one evaluator were not considered *actual* problems and therefore were not compared to the results of UT1 (described in [Section 3.3](#)) and also not considered in the re-design of the user guide. [Table 1](#) shows the overall performance of each evaluator, including how many problems were uncovered and how many of the problems were also identified by another evaluator (and then ultimately considered an *actual* problem with the user guide). See [Appendix C](#) for a complete list of all 75 usability problems reported by the evaluators.

Table 1: Overall Evaluator Performance

Evaluator	Number of Problems Identified	Percent Identified by Another Evaluator
1	7 problems	100% (7 out of 7) identified by another evaluator.
2	13 problems	77% (10 out of 13) identified by another evaluator.
3	11 problems	81% (9 out of 11) identified by another evaluator.
4	10 problems	90% (9 out of 10) identified by another evaluator.
5	5 problems	100% (5 out of 5) identified by another evaluator.
6	10 problems	80% (9 out of 10) identified by another evaluator.
7	9 problems	89% (8 out of 9) identified by another evaluator.
8	10 problems	100% (10 out of 10) identified by another evaluator.

[Section 3.2](#) below shows the 14 unique predicted usability problems, the evaluators that listed the usability problem (at least two evaluators to be included in this list of predicted problems), if the same problem was observed in UT1, the location in the user guide covering the associated steps, followed by an image of the section in the user guide

related to the problem. Out of the 14 usability problems included in the list below, four were not observed in UT1, but still considered actual problems with the user guide (problems 2, 4, 11, and 12). See [Appendix A](#) for full-page images of the relevant original user guide excerpts.

3.2.1 HE Usability Problems

Scenario 1: Connect mobile phone to Bluetooth

1. Not clear there are two different options for pairing since hierarchy for decision is embedded in first option (see [Figure 2](#), left column of page 12). Identified by 50% of the evaluators (4 out of 8: evaluators 2, 4, 6, 7, and 8) and problem observed in UT1.

2. Definitions not clear as to what vehicle functions are contained in the instrument cluster, or the instrument cluster in general (see [Figure 2](#), left column of page 12). Identified by 25% of the evaluators (2 out of 8: evaluators 3 and 8) and problem *not observed* in UT1.

3. Not clear if vehicle has an instrument cluster *with* a menu or *without* a menu, which needs to be answered to decide which connection option to choose (see [Figure 2](#), left column of page 12). Identified by 100 % of evaluators (8 out of 8) and problem observed in UT1.

4. Not clear how to determine if a mobile phone is already paired to the vehicle, as only one phone can be paired at one time (see [Figure 2](#), right column, bottom of page 13). Identified by 38% of the evaluators (3 out of 8: evaluators 1, 2, and 5) and problem *not observed* in UT1.

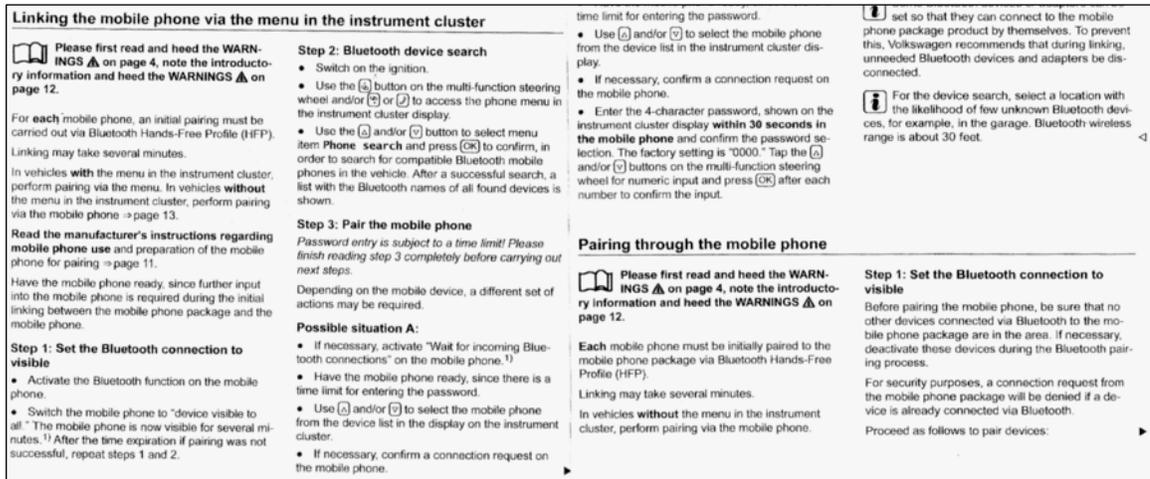


Figure 2: HE Usability Problems Pages 12-13

5. Lack of problem solving instructions if 'mobile package' times out while connecting mobile phone to Bluetooth. States it times out, but not how to turn it back on (see [Figure 3](#), top of page 14). Identified by 50% of the evaluators (4 out of 8: evaluators 1, 2, 3, and 6) and problem observed in UT1.

6. Listing four possible situations for ‘pairing using the mobile phone’ will lead to confusion, as users will automatically follow first situation (see [Figure 3](#), possible situations A-D page 13). Identified by 63% of the evaluators (5 out of 8: evaluators 1, 2, 3, 4, and 8) and problem observed in UT1.

7. Missing information on how to confirm a successful Bluetooth connection with a mobile phone (see [Figure 3](#), possible situations A-D page 13). Identified by 50% of the evaluators (4 out of 8: evaluators 4, 6, 7, and 8) and problem observed in UT1.

<ul style="list-style-type: none"> • Switch the ignition on. • The mobile phone package automatically becomes <i>visible</i> for 3 minutes after it is switched on, as long as no other device has already been connected. • Mobile telephones must be linked to the mobile phone package within 3 minutes. The Bluetooth visibility function of the mobile phone package ends automatically after about 3 minutes. <p>Step 2: Pair the Mobile phone</p> <p>Depending on the mobile device, a different set of actions may be required.</p> <p>Possible situation A:</p> <ul style="list-style-type: none"> • Activate Bluetooth function on the mobile phone. • Initiate the search for Bluetooth devices in the mobile phone. A list of found devices appears. • Select VW Phone. • The 6-character PIN in the display of the instrument cluster should agree with the 6-character PIN in the display of the mobile phone. If the PIN agrees, it must be confirmed using the [OK] button in the multi-function steering wheel and the mobile phone. • Confirm possible phone request with Yes if this Bluetooth connection should be made without re-entering a password. Whenever the ignition is switched on, the Bluetooth connection will be automatically established → page 15. • The data stored in the phone's contacts list is transferred into the vehicle.¹⁾ • Now the mobile telephone is successfully connected to the mobile phone package. <p>Possible situation B:</p> <ul style="list-style-type: none"> • Activate Bluetooth function on the mobile phone. • Initiate the search for Bluetooth devices in the mobile phone. A list of found devices appears. • Select VW Phone. • Confirm the Bluetooth connection on the mobile phone. • Confirm possible phone request with Yes if this Bluetooth connection should be made without re-entering a password. Whenever the ignition is switched on, the Bluetooth connection will be automatically established → page 15. 	<ul style="list-style-type: none"> • The data stored in the phone's contacts list is transferred into the vehicle.¹⁾ • Now the mobile telephone is successfully connected to the mobile phone package. <p>Possible situation C:</p> <ul style="list-style-type: none"> • Activate Bluetooth function on the mobile phone. • Initiate the search for Bluetooth devices in the mobile phone. A list of found devices appears. • Select VW Phone. • A message appears on the phone that a password must be entered for authorization. • Enter the four-digit password. The factory setting is "0000." If an incorrect password is entered, the linking process ends. In this case, repeat the pairing process. • Confirm possible phone request with Yes if this Bluetooth connection should be made without re-entering a password. Whenever the ignition is switched on, the Bluetooth connection will be automatically established → page 15. • The data stored in the phone's contacts list is transferred into the vehicle.¹⁾ • Now the mobile telephone is successfully connected to the mobile phone package. <p>Possible situation D:</p> <ul style="list-style-type: none"> • Activate Bluetooth function on the mobile phone. • Initiate the search for Bluetooth devices in the mobile phone. A list of found devices appears. • Select VW Phone. • Enter the 4-character password, shown on the display of the instrument cluster within 30 seconds in the mobile phone and confirm the password selection. The factory setting is "0000." Tap the [A] and/or [V] buttons on the multi-function steering wheel for numeric input and press [OK] after each number to confirm the input. • Confirm possible phone request with Yes if this Bluetooth connection should be made without re-entering a password. Whenever the ignition is switched on, the Bluetooth connection will be automatically established → page 15. • The data stored in the phone's contacts list is transferred into the vehicle.¹⁾ • Now the mobile telephone is successfully connected to the mobile phone package.
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Figure 3: HE Usability Problems Page 13

Scenario 2: Change time on clock

8. Unclear that descriptions of button locations are related to the figure on previous page (see [Figure 4](#)). Identified by 100% of the evaluators (8 out of 8) and problem observed in UT1.

9. Lack of information as to where the actual time changes in the vehicle as the time is displayed in two locations, instrument cluster or media center (see [Figure 4](#), button 5 description). Identified by 50% of the evaluators (4 out of 8: evaluators 2, 4, 6, and 7) and problem observed in UT1.

instrument cluster

Introduction

In this section you'll find information about:

- Instrument overview 18
- Displays 19
- Service reminder display 21

More information:

- Warning and indicator lights → page 15
- Volkswagen Information System → page 22
- Shifting → page 205
- Service reminder information → booklet Warranty and Maintenance

WARNING

Driving on today's roads demands the full attention of the driver at all times. Driver distraction causes accidents, collisions and serious personal injury!

- Never use the buttons in the instrument cluster while driving.

Instrument overview

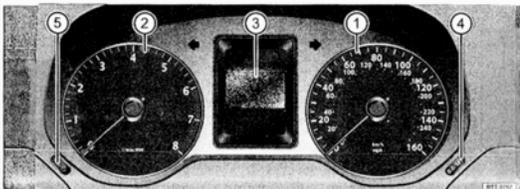


Fig. 9 Instrument cluster in the instrument panel.

Please first read and note the introductory information and heed the **WARNINGS** on page 18.

Instrument explanations → fig. 9:

- ① **Speedometer.**
- ② **Tachometer** (thousands of revolutions per minute when the engine is running).
The red zone at the end of the scale indicates maximum permissible engine rpm (revolutions per minute) for all gears after the break-in period. Before reaching the red zone, select the next higher gear or selector level position D, or ease your foot off the accelerator → ①.
- ③ **Displays** → page 19.

- ④ **Reset button** for the trip odometer display (trip).
 - Push the **(TRIP)** button briefly to toggle between the odometer and trip odometer displays.
 - Push the **(TRIP)** button for about 1 second to reset to zero.
 - Push and hold the **(TRIP)** button for about 15 seconds to display the vehicle's engine identification code. You must do this when the ignition is on, but the engine is not running.
- ⑤ **Button for setting the instrument cluster clock.**
 - With the ignition on, push the **(HOUR)** button to highlight the hour or the minutes in the clock display.
 - To advance the clock, push the **(MIN)** button **(C)**. Press and hold the button to fast forward.
 - Push the **(TRIP)** button again or wait about 10 seconds to finish setting the clock.

NOTICE

- To help prevent engine damage, always avoid high engine speeds, full throttle acceleration and heavy engine loads when the engine is cold.

NOTICE (continued)

- To help prevent engine damage, the tachometer needle should only enter the red zone (warning zone) briefly.

 Upshifting early into the next higher gear saves fuel and reduces engine noise.

Displays

Please first read and note the introductory information and heed the **WARNINGS** on page 18.

Depending on the vehicle model, different information may be shown in the instrument cluster display → page 18, *Instrument overview*.

- Warning and information texts
- Odometer displays
- Time
- Fuel gauge → page 244, *Indicator lights and fuel gauge*
- Outside temperature
- Selector lever position → page 205, *Shifting*

- Multi-Function Indicator (MFI) and menus for different settings → page 22, *Volkswagen Information System*
- Service reminder display → page 21, *Service reminder display*

Warning and information texts

The status of various vehicle functions and components is monitored when the ignition is switched on and while driving. Malfunctions are indicated by red and yellow warning symbols with text messages in the instrument cluster display (→ page 15, *Warning and indicator lights*). In some cases, they may also be signaled acoustically. The display can vary depending on the instrument cluster model. ▶

Figure 4: HE Usability Problems Pages 18-19

Scenario 3: Display outside temperature

10. Redundant information for outside temperature shown (four different pages) before instructions are provided as to how to display information (see [Figure 5](#), for the four mentions of the outside temperature, with the action item located in the paragraph underneath the figure on page 23). Identified by 100% of the evaluators (8 out of 8) and problem observed in UT1.

11. ‘Menu structure - overview’ header describing displays within the instrument cluster (including outside temperature) is confusing after learning the instrument cluster has no menu (see [Figure 5](#), page 22). Identified by 38% of the evaluators (3 out of 8: evaluators 3, 5, and 8) and problem *not observed* in UT1.

12. List of display options seems irrelevant, as the same list is expanded on next page (see [Figure 5](#), page 22 and page 23). Identified by 38% of the evaluators (3 out of 8: evaluators 3, 4, and 8) and problem *not observed* in UT1.

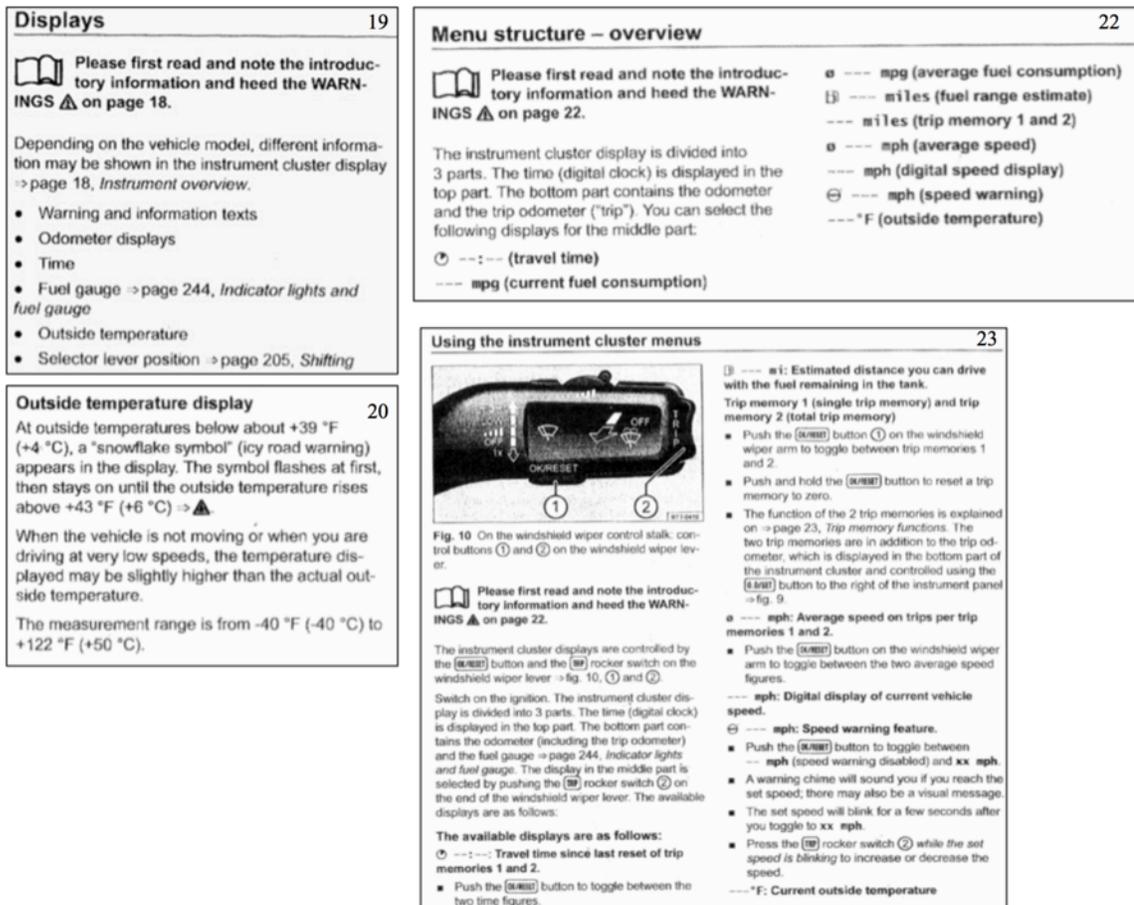


Figure 5: HE Usability Problems Pages 19, 20, 22, and 23

13. Disconnect between action item for toggling different displays and the referenced figure: action item embedded in paragraph beneath figure of windshield wiper lever, which is also used for toggling display (see [Figure 6](#), Fig. 10 and paragraph starting with text, “Switch on the...” on page 23). Identified by 50% of the evaluators (4 out of 8: evaluators 2, 6, 7, and 8) and problem observed in UT1.

14. Lack of information explaining how to display outside temperature in list of different displays that can be shown in the middle part of the instrument cluster display, when all others have information (see [Figure 6](#), last bullet on the bottom right column, page 23). Identified by 75% of evaluators (6 out of 8: evaluators 1, 2, 3, 4, 7, and 8) and problem observed in UT1.

23

Using the instrument cluster menus

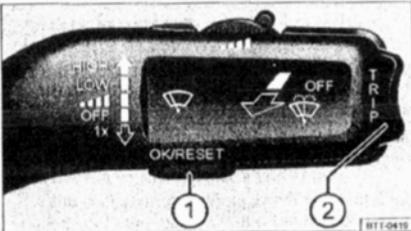


Fig. 10 On the windshield wiper control stalk: control buttons ① and ② on the windshield wiper lever.

Please first read and note the introductory information and heed the WARNINGS on page 22.

The instrument cluster displays are controlled by the **OK/RESET** button and the **TRIP** rocker switch on the windshield wiper lever → fig. 10, ① and ②.

Switch on the ignition. The instrument cluster display is divided into 3 parts. The time (digital clock) is displayed in the top part. The bottom part contains the odometer (including the trip odometer) and the fuel gauge → page 244, *Indicator lights and fuel gauge*. The display in the middle part is selected by pushing the **TRIP** rocker switch ② on the end of the windshield wiper lever. The available displays are as follows:

The available displays are as follows:

- ⌚ ---: ---: Travel time since last reset of trip memories 1 and 2.
 - Push the **OK/RESET** button to toggle between the two time figures.
- mpg: Current fuel consumption.
- ⊖ --- mpg: Average fuel consumption of trips per trip memories 1 and 2.
 - Push the **OK/RESET** button to toggle between the two figures.
- ⊞ --- mi: Estimated distance you can drive with the fuel remaining in the tank.

Trip memory 1 (single trip memory) and trip memory 2 (total trip memory)

- Push the **OK/RESET** button ① on the windshield wiper arm to toggle between trip memories 1 and 2.
- Push and hold the **OK/RESET** button to reset a trip memory to zero.
- The function of the 2 trip memories is explained on → page 23, *Trip memory functions*. The two trip memories are in addition to the trip odometer, which is displayed in the bottom part of the instrument cluster and controlled using the **OK/RESET** button to the right of the instrument panel → fig. 9.

- ⊖ --- mph: Average speed on trips per trip memories 1 and 2.
 - Push the **OK/RESET** button on the windshield wiper arm to toggle between the two average speed figures.
- mph: Digital display of current vehicle speed.
- ⊖ --- mph: Speed warning feature.
 - Push the **OK/RESET** button to toggle between --- mph (speed warning disabled) and **xx mph**.
 - A warning chime will sound you if you reach the set speed; there may also be a visual message.
 - The set speed will blink for a few seconds after you toggle to **xx mph**.
 - Press the **TRIP** rocker switch ② while the set speed is blinking to increase or decrease the speed.
- °F: Current outside temperature

Figure 6: HE Usability Problems Page 23

3.3 User Test 1 (UT1) Results

3.3.1 UT1 Usability Problems

A total of 11 unique usability problems were identified during UT1. See [Table 2](#) for a description of these usability problems, including the criteria for including as an observed

usability problem (i.e., the number of participants who failed to perform a task correctly (at least one) or provided ratings less than ‘3’ (at least two)). Also included in the table is text stating the predicted usability problem uncovered during the HE that matches (if uncovered), including the number of evaluators who predicted the usability problem. If an observed usability problem was not predicted by the HE, “Not predicted” is indicated in the table. The table also directs attention to the location of the usability problem related to sections of the user guide as shown in figures 2, 3, 4, 5, and 6 in Section 3.2 (as to not repeat the images) and Figure 7 in this sections (observed usability problem not predicted by HE). See Appendix C for a full list usability problems associated with failures and low ratings during UT1, including problems not included in the analysis (only one participant experienced frustration for a step). See Appendix A for full-pages of the relevant user guide excerpts that were evaluated.

Table 2: UT1 Usability Problems

Usability Problems	Criteria for including	Location in User Guide
Scenario 1: Connect mobile phone to Bluetooth		
<p>1. Incorrect Bluetooth connection option chosen. Participants followed instructions for the first option (Linking the mobile phone via the menu in the instrument cluster), instead of the correct second option (Pairing through the mobile phone).</p> <p>Reason for failure: Decision tree paragraph was not noticed, and therefore skipped, as it is included within the instructions for the first connection option. This led participants to automatically follow steps for the first option only, never realizing there was a second option. It is not possible to connect the mobile phone to Bluetooth by following the first option, as the vehicle model used in this study does not have the particular buttons on the steering wheel referenced. After failing this step, the facilitator asked participants to read the paragraph to recover.</p> <p>HE: Not clear there are two different options for pairing since hierarchy for decision is embedded in first option. (4 evaluators)</p>	Failures: 14	Page 12: Top left column (See Figure 2)
<p>2. Could not determine if the vehicle had an instrument cluster ‘with a menu’ or ‘without a menu’ in order to choose the correct option for connecting the mobile phone to Bluetooth.</p> <p>Reason for failure: After all participants failed to follow the correct pairing option, the facilitator asked participants to read the decision tree paragraph, “In vehicles with the menu in the instrument cluster, perform pairing via the menu. In vehicles without the menu in the instrument cluster, perform pairing via the mobile phone –page 13”. Participants could not determine if the vehicle had a menu (first option) or without a menu (second option-correct) in the instrument cluster and failed this step. There is no information in the user guide to help determine which option is the correct one.</p> <p>HE: Not clear if vehicle has an instrument cluster <i>with</i> a menu or <i>without</i> a menu, which needs to be answered to decide which</p>	Failure: 14	Page 14: Top left column (See Figure 2)

Usability Problems	Criteria for including	Location in User Guide
connection option to choose. (8 evaluators)		
<p>3. Bluetooth did not become visible on the mobile phone because the ‘mobile package’ timed out since more than three minutes after turning on the ignition had passed.</p> <p>Reason for failure: The ignition was turned on while attempting to follow the steps for the first option ‘Step 2: Bluetooth device search’, and by the time the participant found the correct second option for pairing, the ignition had been on for more than 3 minutes causing the ‘mobile phone package’ to time out, and then not possible to connect mobile phone to Bluetooth. This information is stated in the user guide, but it is not clear what steps should be taken if more than 3 minutes pass after turning on the ignition, leading the participant to fail this step.</p> <p>HE: Lack of problem solving instructions if ‘mobile package’ times out while connecting mobile phone to Bluetooth. States it times out, but not how to turn it back on. (4 evaluators)</p>	Failure: 1	<p>Page 14: Top left 2nd and 3rd bullet</p> <p>(See Figure 3)</p>
<p>4. Not clear there were different possible situations for pairing the mobile phone, within the correct second option.</p> <p>Reason for frustration: Two participants experienced frustration in pairing the phone to Bluetooth as it was not clear that there were multiple possible situations (A-D) for pairing the mobile phone, and the option they followed didn’t match up to what they were ‘supposed’ to be seeing according to the user guide. Both participants followed steps for ‘Possible situation A’, when ‘Possible situation B’ was the correct option. They both recovered after trial and error.</p> <p>HE: Listing four possible situations for ‘pairing using the mobile phone’ will lead to confusion, as users will automatically follow first situation. (5 evaluators)</p>	Number of ratings ‘3’ or below: 4	<p>Page 14: Both columns</p> <p>(See Figure 3)</p>
<p>5. Process for confirming a successful Bluetooth connection with a mobile phone was unclear.</p> <p>Reason for frustration: 12 participants experienced frustration trying to confirm a successful Bluetooth connection, because the user guide does not provide clear instructions on how to confirm if the mobile phone is connected to Bluetooth.</p> <p>HE: Missing information on how to confirm a successful Bluetooth connection with a mobile phone. (4 evaluators)</p>	Number of ratings ‘3’ or below: 12	<p>Page 14: Last steps for all possible situations</p> <p>(See Figure 3)</p>
Scenario 2: Change time on clock		
<p>6. Could not find buttons for changing the clock.</p> <p>Reason for failure: These 7 participants did not correlate numbers 4 and 5 shown in the step for changing the time to the numbers 4 and 5 in the figure shown on the previous page (describing the two buttons</p>	Failure: 7	<p>Page 18 & 19: Image on left page 18 and description for button 5 on the</p>

Usability Problems	Criteria for including	Location in User Guide
<p>used to change the time). This was due to the instructional step referring to the buttons by using the numbers 4 and 5 and by showing an icon of the actual button, leading participants to immediately attempt to match the icon of the button to a button on the vehicle dashboard, and not use the figure as a reference.</p> <p>HE: Unclear that descriptions of button locations are related to figure on page 18. (8 evaluators)</p>		<p>right page 19. (See Figure 4)</p>
<p>7. Not clear where the time change takes place on the dashboard of the vehicle, as there are two areas where the time is displayed.</p> <p>Reason for frustration: The time is displayed in two areas on the dashboard: on the instrument cluster display and the media center, leading these participants to try to change the time via the media center, which you cannot do. Eventually they figured it out it was the time is changed in the instrument cluster display by trial and error.</p> <p>HE: Lack of information as to where the actual time changes in the vehicle as the time is displayed in two locations (instrument cluster or media center). (4 evaluators)</p>	<p>Number of ratings '3' or below: 2</p>	<p>Page 18 & 19: Image on left page 18 and description for button 5 on the right page 19. (See Figure 4)</p>
<p>Scenario 3: Display outside temperature</p>		
<p>8. Could not find page including the action steps for toggling the different displays on the instrument cluster in order to display the outside temperature.</p> <p>Reason for failure: The outside temperature is mentioned 4 times in one chapter (with no referencing to the other pages), with the action step to display outside temperature only described on the last page. This led to failures as these participants didn't make it to the last page, assuming there was no other mention of outside temperature beyond what they just read.</p> <p>HE: Redundant information for outside temperature shown (four different pages) before instructions are provided as to how to display information. (8 evaluators)</p>	<p>Failure: 12</p>	<p>Page 19, Page 20, Page 22, & Page 23: All mentions of outside temperature. (See Figure 5)</p>
<p>9. Could not find action step for displaying the outside temperature because it wasn't noticeable as a step.</p> <p>Reason for failure: Action item embedded in paragraph beneath figure of windshield wiper lever, which is also used for toggling displays, because participants didn't think the wiper lever was related to displays and skipped the paragraph. (For those participants who failed to read up to page 23 where this information is located, the facilitator assisted and asked them to read page 23, but still failed to find it).</p> <p>HE: Disconnect between action item for toggling different displays and the referenced figure (action item embedded in paragraph beneath figure of windshield wiper lever, which is also used for toggling displays). (4 evaluators)</p>	<p>Failure: 7</p>	<p>Page 23: Underneath image and starting with text, "Switch on the ignition..." paragraph (See Figure 6)</p>

Usability Problems	Criteria for including	Location in User Guide
<p>10. Pushed trip rocker switch only one time to toggle displays, and failed to display outside temperature.</p> <p>Reason for failure: It was not clear to the participant that the TRIP rocker switch on the windshield wiper lever needed to be pushed <i>multiple</i> times to toggle through all available displays. This was due to missing information in the instructions, as it states to ‘push the trip rocker switch’.</p> <p>HE: Not predicted.</p>	<p>Failure: 1</p>	<p>Page 23: Underneath image and starting with text, “The display in the middle part...” (See Figure 7)</p>
<p>11. Outside temperature in list of available displays does not include any action steps.</p> <p>Reason for frustration: For the 3 participants who found outside temperature in the list of available displays under the windshield wiper lever figure 10, felt frustration due to the lack of information underneath this bullet. All other display options here have additional action step information, while the outside temperature bullet has no information, so it took longer for these participants to complete the step.</p> <p>HE: Lack of information explaining how to display outside temperature in list of different displays that can be shown in the middle part of the instrument cluster display, when all others have information. (6 evaluators)</p>	<p>Number of ratings ‘3’ or below: 3</p>	<p>Page 23: Bottom of right column (See Figure 6)</p>

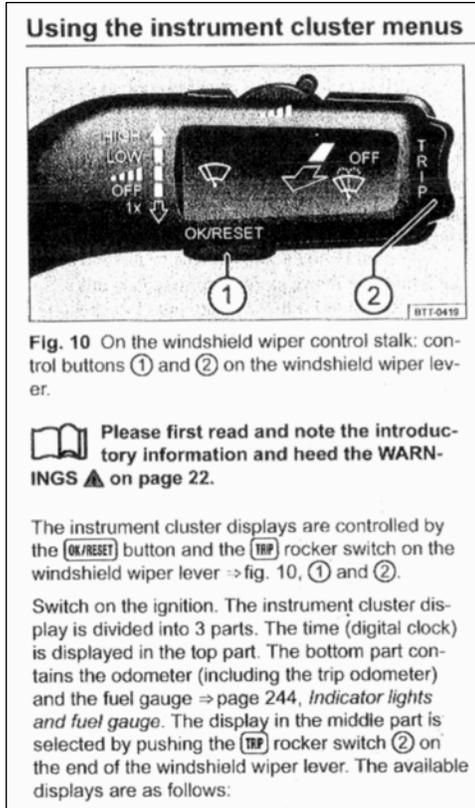


Figure 7: UT1 Only Usability Problem Page 23

3.3.2 UT1 Scenario Completion Times and Subjective Ratings

The average time to complete the scenarios were recorded for each participant, along with a rating to the question, “I did NOT feel frustrated while completing this scenario” with ‘1’ representing ‘Strongly disagree’ and ‘7’ representing ‘Strongly agree’. These measurements will be used to compare performance to UT2. The mean time to complete each scenario (in minutes) and the mean ratings related to feeling frustration after each scenario are shown in [Table 3](#) below.

Table 3: UT1 Mean Time and Ratings

Scenario	Mean Time to Complete Scenario	Mean Rating related to Frustration
Scenario 1: Connect mobile phone to Bluetooth	12:16 (Std dev: 0.15)	2.4 (Std dev: 0.94)
Scenario 2: Change time on clock	3:42 (Std dev: 0.04)	5.7 (Std dev: 1.07)
Scenario 3: Display outside temperature	6:45 (Std dev: 0.07)	2.3 (Std dev: 1.32)

3.3.3 Hypothesis 1

It was hypothesized (H1) that the experts performing the HE could predict at least 80% of the usability problems observed in UT1.

H1: The HE predicted 91% of the usability problems observed during UT1 (10 out of 11 observed usability problems), showing that HE was able to predict at least 80% of usability problems found through user testing. H1 was supported on the basis of predicting usability problems in UT1, regardless of how many problems were uncovered in HE.

3.4 Re-Design User Guide

A total of 15 unique usability problems were addressed in this re-design of the user guide (10 uncovered in both the HE and UT1, four only uncovered in the HE, and one only uncovered in UT1). The HE only usability problems were addressed in the re-design, to measure how users would perform for those steps in a re-test, to see if the re-design introduced any new problems. This is important when asking the question: Can you re-design a user guide on the basis of an HE alone without introducing new problems? If UT2 does not show usability problems for these specific steps and HE predicts at least 80% of UT1 usability problems, it would show using HE alone being a trustworthy approach. The four HE only usability problems were:

- Definitions not clear as to what vehicle functions are contained in the instrument cluster, or the instrument cluster in general.
- Not clear how to determine if a mobile phone is already paired to the vehicle, as only one phone can be paired at one time.
- ‘Menu Overview’ header describing displays within the instrument cluster (including outside temperature) is confusing after learning the instrument cluster has no menu.
- List of display options seems irrelevant, as the same list is expanded on next page.

The one usability problem only observed in UT1 (not in the HE) that was also addressed in the re-design was:

- Pushed trip rocker switch only one time to toggle displays, and failed to display outside temperature.

A total of 16 design changes were made to the user guide in an attempt to address these usability problems. One usability problem required two design changes in the user guide in order to address the issue, as content was moved and content was added (design changes 13 and 14). All other usability problems were addressed by using only one design change callout.

The following sections [3.4.1](#), [3.4.2](#), and [3.4.3](#) describe the usability problems, the design changes made to the user guide related to the problems, followed by a figure of the original user guide image and the re-designed user guide image, for scenarios 1, 2, and 3, respectively. The list of usability problems are numbered and correlate to the yellow highlighted number located on the relevant re-designed user guide page to show the location of the design change.

3.4.1 Scenario 1: Connect Mobile Phone to Bluetooth Design Changes

Usability problem: Not clear there are two different options for pairing since hierarchy for decision is embedded in first option.

- **Design change 1:** Move decision tree paragraph above the two Bluetooth options and add title, “Connecting your mobile phone:” above, for context. See the original image and callout 1 for the design change in [Figure 8](#).

Usability problem: Definitions not clear as to what vehicle functions are contained in the instrument cluster, or the instrument cluster in general.

- **Design change 2:** Added a statement after the decision tree paragraph, “To determine if your car has a menu in the instrument cluster, see which figure below best matches your vehicle.” See the original image and callout 2 for the design change in [Figure 8](#).

Usability problem: Not clear if vehicle has an instrument cluster *with* a menu or *without* a menu, which needs to be answered to decide which connection option to choose.

- **Design change 3:** Added images of both examples of two different instrument clusters to explain what the instrument cluster looks like. See the original image and callout 3 for the design change in [Figure 8](#).

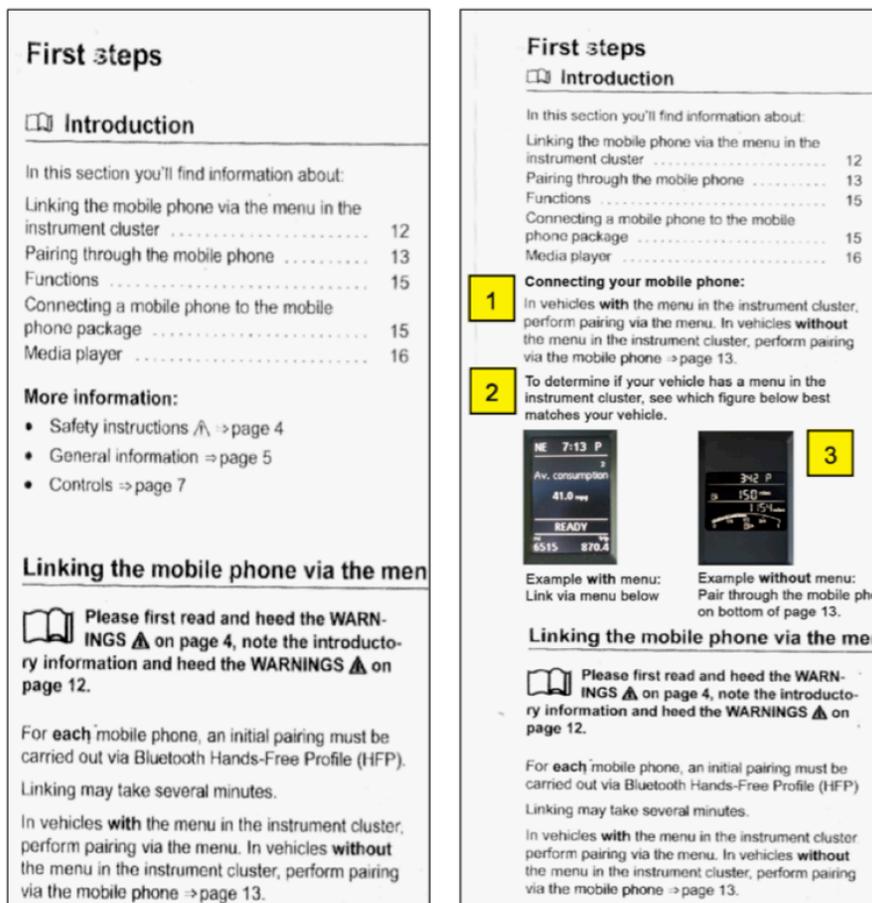


Figure 8: Original and Re-Designed Page 12

Usability problem: Not clear how to determine if a mobile phone is already paired to the vehicle, as only one phone can be paired at one time.

- **Design change 4:** Added a bullet step "If there is a Bluetooth symbol visible in the instrument cluster, a device needs to be removed." See original image and callout 4 for the design change in [Figure 9](#).

Usability problem: Lack of problem solving instructions if 'mobile package' times out while connecting mobile phone to Bluetooth. States it times out, but not how to turn it back on.

- **Design change 5:** Deleted the third bullet on page 14 as it provides redundant information to the second bullet, and replaced it with new text, "If the mobile phone package times out (more than 3 minutes have passed since turning on the ignition) simply switch the ignition off and then back on again." See original image and callout 5 for the design change in [Figure 9](#).

Usability problem: Listing four possible situations for 'pairing using the mobile phone' will lead to confusion, as users will automatically follow first situation.

- **Design change 6:** Copied bullet steps 1-3 from one of the possible situations (they are all the same) and pasted the steps before the possible situations. See original image and callout 6 for the design change in [Figure 9](#).

Usability problem: Missing information on how to confirm a successful Bluetooth connection with a mobile phone.

- **Design change 7:** Added a statement, "Check phone to confirm successful connection and/or look for Bluetooth symbol in instrument cluster". See original image and callout 7 for the design change in [Figure 9](#).

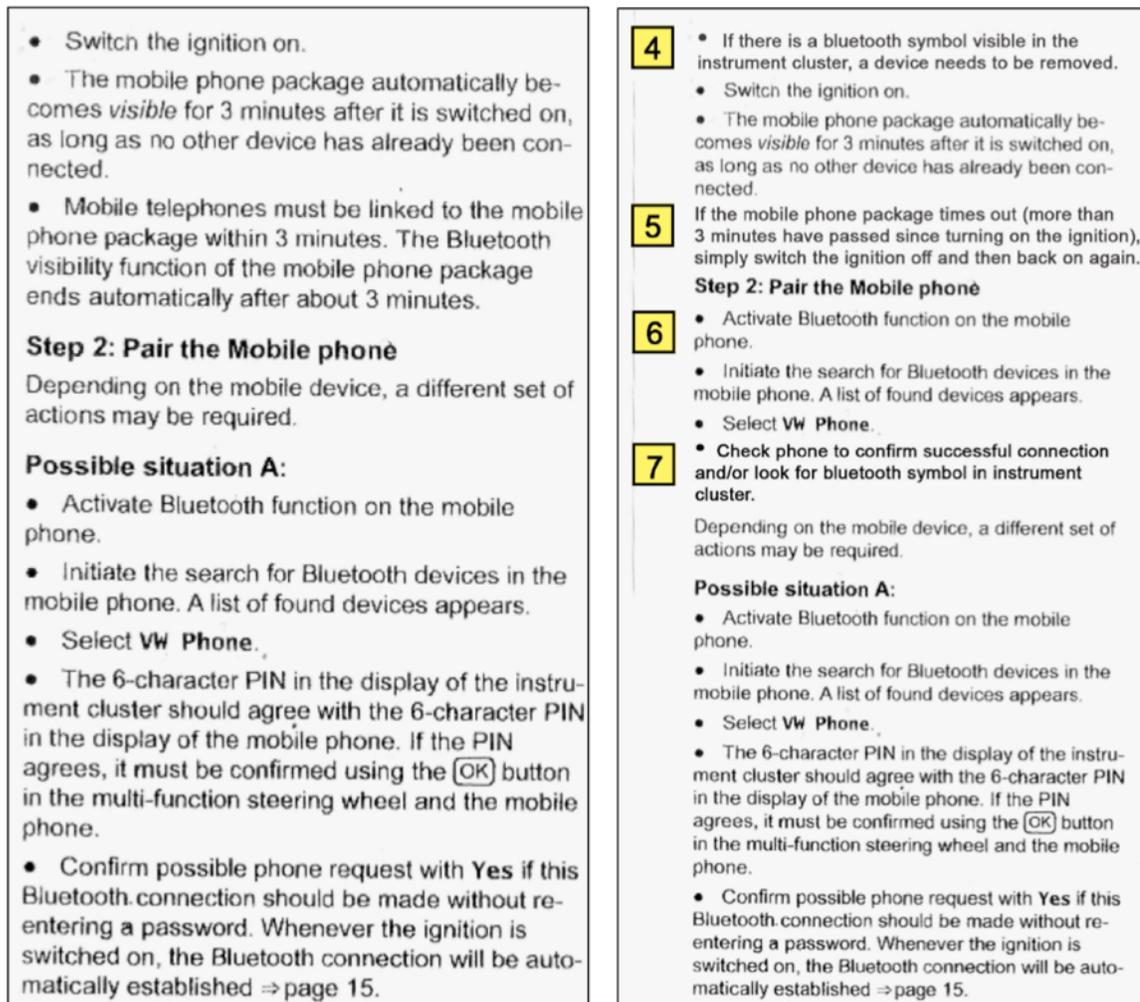


Figure 9: Original and Re-Designed Page 14

3.4.2 Scenario 2: Change the Time on the Clock Design Changes

Usability problem: Unclear that descriptions of button locations are related to figure on page 18.

- **Design change 8:** Listed all descriptions directly underneath image to create more of a connection to the figure and the descriptions; put descriptions in order as shown in figure; and replaced icons of buttons with circled correlating numbers. See original image and callout 8 for design change in [Figure 10](#).

Usability problem: Lack of information as to where the actual time changes in the vehicle as the time is displayed in two locations (instrument cluster or media center).

- **Design change 9:** Added, "The time changes through the displays '3'" next to time change button. See original image and callout 9 for design change in [Figure 10](#).

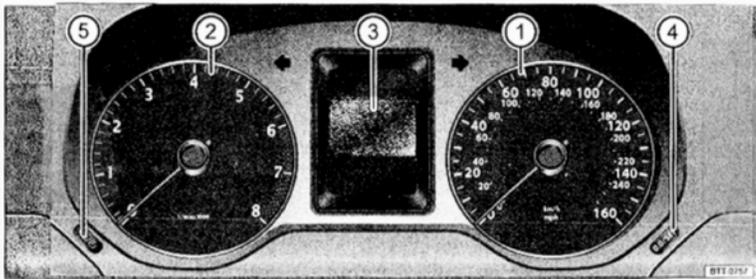


Fig. 9 Instrument cluster in the instrument panel.

Please first read and note the introductory information and heed the WARNINGS on page 18.

Instrument explanations -> fig. 9:

- ① **Speedometer.**
- ② **Tachometer** (thousands of revolutions per minute when the engine is running).
The red zone at the end of the scale indicates maximum permissible engine rpm (revolutions per minute) for all gears after the break-in period. Before reaching the red zone, select the next higher gear or selector level position D, or ease your foot off the accelerator -> ①.
- ③ **Displays** -> page 19.

- ④ **Reset button** for the trip odometer display (**trip**). 19
 - Push the button briefly to toggle between the odometer and trip odometer displays.
 - Push the button for about 1 second to reset to zero.
 - Push and hold the button for about 15 seconds to display the vehicle's engine identification code. You must do this when the ignition is on, but the engine is not running.
- ⑤ **Button for setting the instrument cluster clock.**
 - With the ignition on, push the button to highlight the hour or the minutes in the clock display.
 - To advance the clock, push the button ④. Press and hold the button to fast forward.
 - Push the button again or wait about 10 seconds to finish setting the clock.

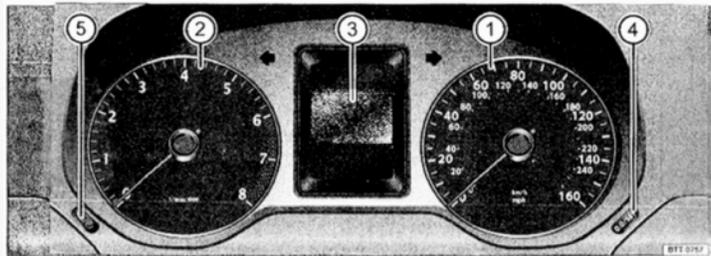


Fig. 9 Instrument cluster in the instrument panel.

Please first read and note the introductory information and heed the WARNINGS on page 18.

Instrument explanations -> fig. 9:

- 8** ⑤ **Button for setting the instrument cluster clock.** (Clock located in Displays ③) **9**
 - With the ignition on, push the ⑤ button to highlight the hour or the minutes in the clock display.
 - To advance the clock, push the ④ button. Press and hold the button to fast forward.
 - Push the ⑤ button again or wait about 10 seconds to finish setting the clock.
- ② **Tachometer** (thousands of revolutions per minute when the engine is running).
The red zone at the end of the scale indicates maximum permissible engine rpm (revolutions per minute) for all gears after the break-in period. Before reaching the red zone, select the next higher gear or selector level position D, or ease your foot off the accelerator -> ①.
- ③ **Displays** -> page 19.
- ① **Speedometer.**
- ④ **Reset button** for the trip odometer display (**trip**).
 - Push the ④ button briefly to toggle between the odometer and trip odometer displays.
 - Push the ④ button for about 1 second to reset to zero.
 - Push and hold the ④ button for about 15 seconds to display the vehicle's engine identification code. You must do this when the ignition is on, but the engine is not running.

Figure 10: Original Page 18-19 and Re-Designed Page 19

3.4.3 Scenario 3: Display Outside Temperature Design Changes

Usability problem: Redundant information for outside temperature shown (four different pages) before instructions are provided as to how to display information.

- **Design change 10:** First mention of outside temperature given reference to action item pages. Bullet point list combined onto one page and statement added at end of bulleted list "Not all information can be seen at one time in the instrument display. To switch the information that is shown, go to page 22 and 23 for more details". See original image and callout 10 for design change in [Figure 11](#).

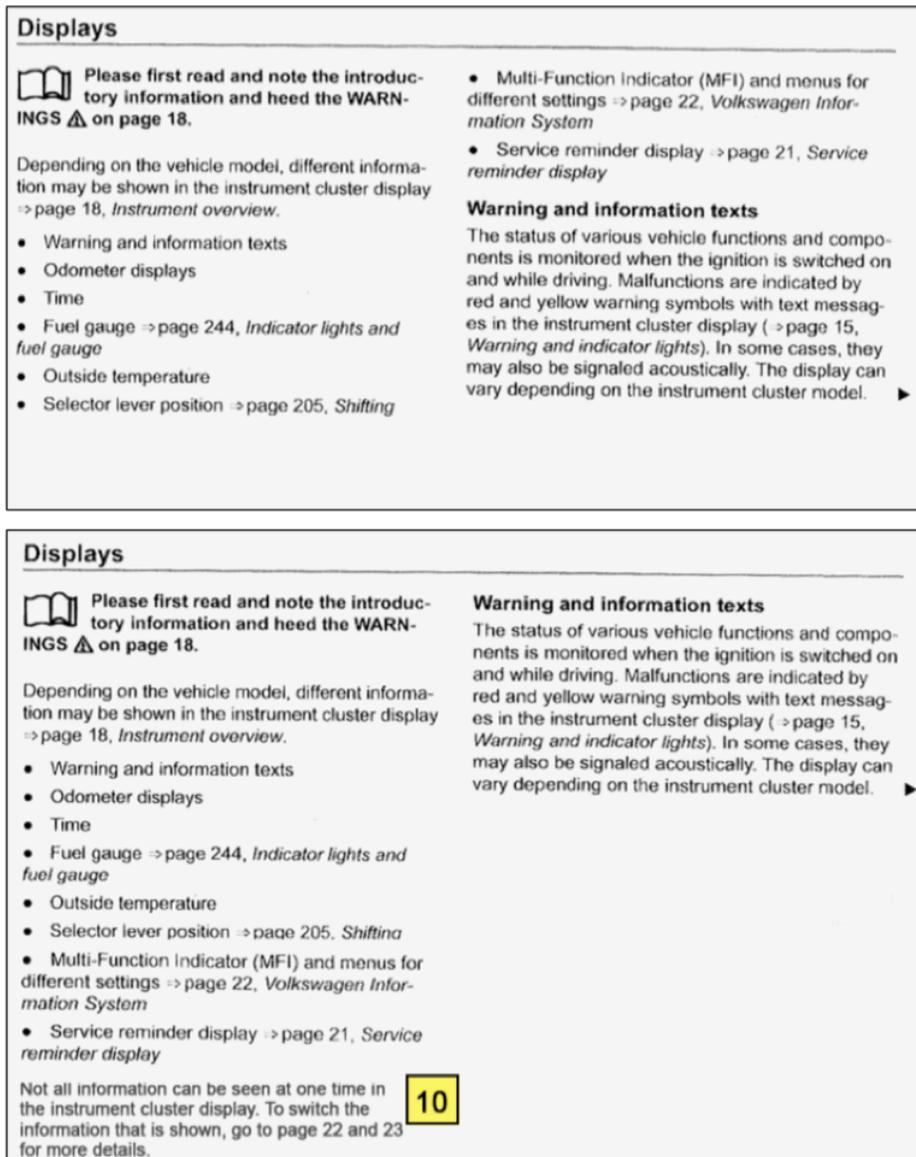


Figure 11: Original and Re-Designed Page 19

Usability problem: ‘Menu Overview’ header describing displays within the instrument cluster (including outside temperature) is confusing after learning the instrument cluster has no menu.

- **Design change 11:** Changed title of section to, "Instrument Cluster Display Overview" to remain consistent and give meaning to section to show that it relates to the content on the next page. See original image and callout 11 for design change in [Figure 12](#).

Usability problem: List of display options seems irrelevant, as the same list is expanded on next page.

- **Design change 12:** Added an action item statement, “In order to switch the information being shown in the middle part of the instrument cluster display (all displays in the previous list) do the following: Press the Trip rocker switch (2) located on the windshield wiper lever (see Fig. 10) until the intended display appears. For more details about the instrument cluster menu displays, go to page 23.” See original image and callout 12 for design change in [Figure 12](#).

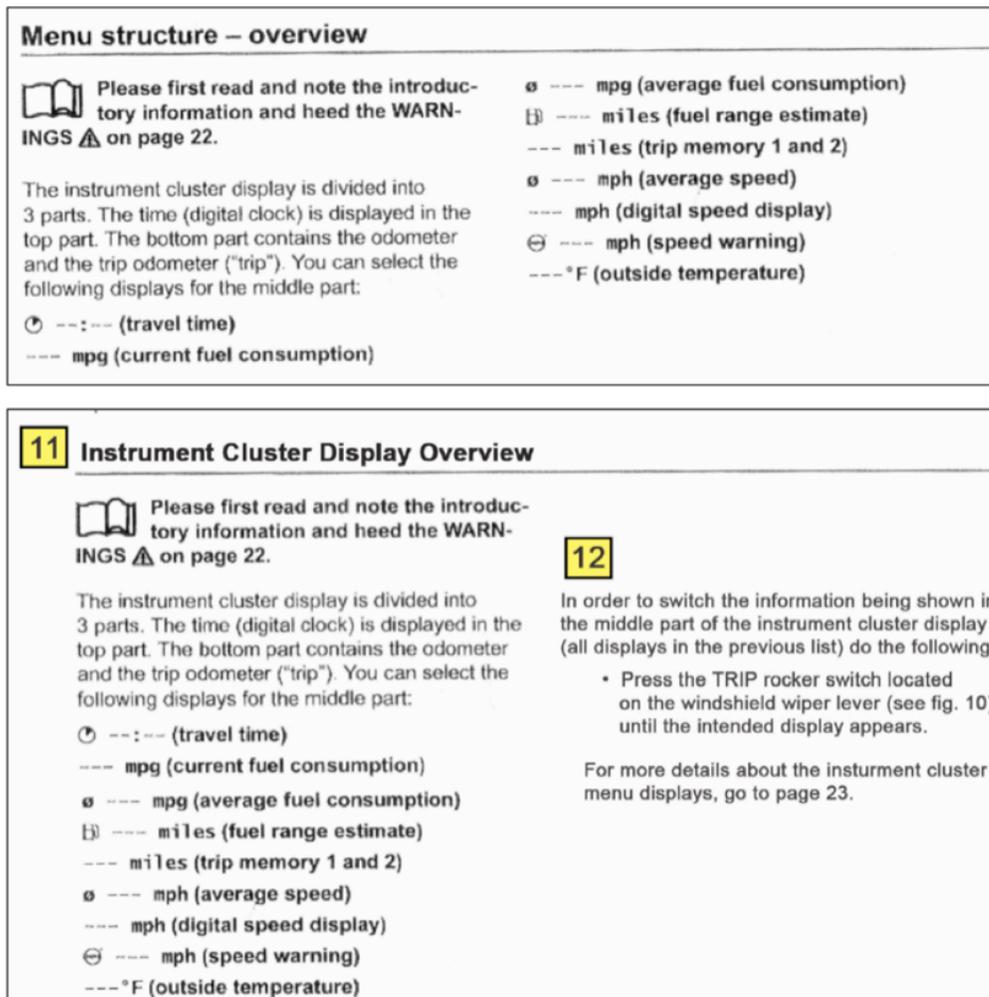


Figure 12: Original and Re-Designed Page 22

Usability problem: Disconnect between action item for toggling different displays and the referenced figure (action item embedded in paragraph beneath figure of windshield wiper lever, which is also used for toggling displays).

- **Design change 13:** Moved figure directly above paragraph referencing it (moving warnings above figure). See original image and callout 13 for design change in [Figure 13](#).
- **Design change 14:** Added statement, “Press rocker switch (2) to change middle display.” See original image and callout 14 for design change in [Figure 13](#).

Usability problem: Lack of instructions for how many times the trip rocker switch needs to be pushed to toggle displays.

- **Design change 15:** Added sentence to action item paragraph, "Keep pushing (2) until your intended display appears"; and deleted sentence immediately after, “The available displays are as follows:” as it is a typo and repeated twice. See original image and callout 15 for design change in [Figure 13](#).

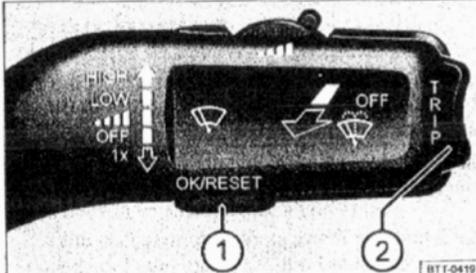
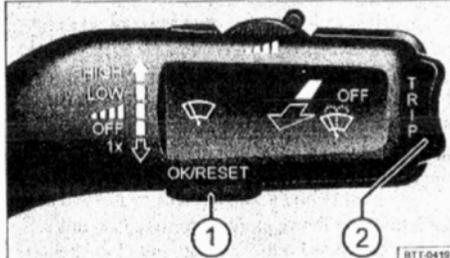
Using the instrument cluster menus	Using the instrument cluster menus
	<p data-bbox="878 856 1317 932">Please first read and note the introductory information and heed the WARNINGS ⚠ on page 22.</p> <p data-bbox="862 961 911 1003">13</p> 
<p data-bbox="305 1150 781 1220">Fig. 10 On the windshield wiper control stalk: control buttons ① and ② on the windshield wiper lever.</p>	<p data-bbox="862 1283 1317 1360">Fig. 10 On the windshield wiper control stalk: control buttons ① and ② on the windshield wiper lever. Press rocker switch ② to change middle display.</p>
<p data-bbox="305 1249 781 1318">Please first read and note the introductory information and heed the WARNINGS ⚠ on page 22.</p>	<p data-bbox="818 1310 862 1352">14</p>
<p data-bbox="305 1354 781 1423">The instrument cluster displays are controlled by the OK/RESET button and the TRIP rocker switch on the windshield wiper lever → fig. 10, ① and ②.</p> <p data-bbox="305 1430 781 1661">Switch on the ignition. The instrument cluster display is divided into 3 parts. The time (digital clock) is displayed in the top part. The bottom part contains the odometer (including the trip odometer) and the fuel gauge ⇒ page 244, <i>Indicator lights and fuel gauge</i>. The display in the middle part is selected by pushing the TRIP rocker switch ② on the end of the windshield wiper lever. The available displays are as follows:</p>	<p data-bbox="862 1375 1317 1444">The instrument cluster displays are controlled by the OK/RESET button and the TRIP rocker switch on the windshield wiper lever → fig. 10, ① and ②.</p> <p data-bbox="862 1451 1317 1661">Switch on the ignition. The instrument cluster display is divided into 3 parts. The time (digital clock) is displayed in the top part. The bottom part contains the odometer (including the trip odometer) and the fuel gauge ⇒ page 244, <i>Indicator lights and fuel gauge</i>. The display in the middle part is selected by pushing the TRIP rocker switch ② on the end of the windshield wiper lever. Keep pushing ② until your intended display appears. 15</p>
<p data-bbox="305 1675 781 1703">The available displays are as follows:</p>	<p data-bbox="862 1675 1317 1703">The available displays are as follows:</p>

Figure 13: Original and Re-Designed Page 23a.

Usability problem: Lack of information explaining how to display outside temperature in list of different displays that can be shown in the middle part of the instrument cluster display, when all others have information.

- **Design change 16:** Added, "Push rocker switch (2) on the windshield wiper lever (fig.10) until the outside temperature is displayed in the middle part". See original image and callout 16 for design change in [Figure 14](#).

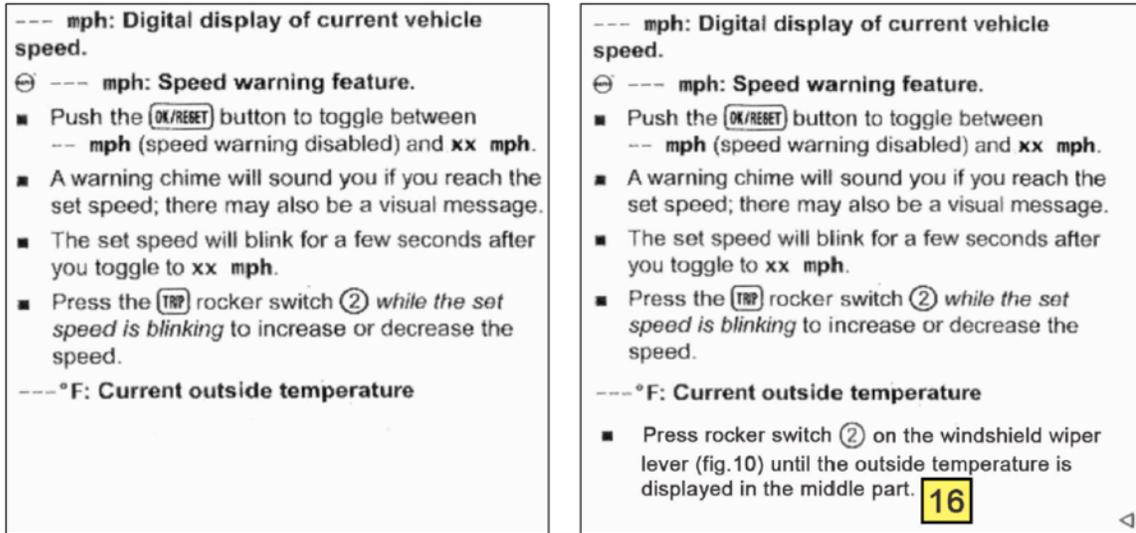


Figure 14: Original and Re-Designed Page 23b.

3.5 User Test 1 and User Test 2 (UT1 and UT2) Comparison Results

The following sections include information for detailed descriptions of the usability problems, followed by a comparison of UT1 and UT2 completion times and ratings, and a discussion about H2.

3.5.1 UT2 Usability Problems

A total of two residual usability problems were identified during UT2, by 3 of the 8 participants, while following the re-designed user guide. One out of the two usability problems observed in UT2 was already uncovered during both the HE and UT1 (see [Table 4](#), number 2), showing the re-design effort was not successful in mitigating the already identified usability problem. The other usability problem observed was a *new* usability problem, introduced by the re-design choice of the researcher, as it was related to added content in the user guide (see [Table 4](#), number 1). This usability problem was related to a design change added to mitigate a usability problem uncovered in both HE and UT1.

Table 4: UT2 Usability Problems

Usability Problems	Criteria for including	Location in Re-Designed User Guide
Scenario 1: Connect mobile phone to Bluetooth		
<p>1. Unable to match new figure examples of a vehicle with and without a menu in the instrument cluster, to the vehicle being tested.</p> <p>Reason for failure: Both participants could not match the new figure examples of the instrument cluster display to the one in the vehicle being tested, as the ignition needs to be turned on to see the current display, which was missing from the text in the user guide. An additional step stating, “Turn on ignition” should have been stated first.</p> <p>This added content was in response to the usability problem uncovered during the HE and UT1: “Not clear how to determine if instrument cluster is with or without a menu”.</p>	Failures: 2	<p>Page 12: Top left column; two images, along with descriptor paragraph above images</p> <p>(See Figure 15)</p>
Scenario 3: Display outside temperature		
<p>2. Could not find page including the action steps for toggling the different displays on the instrument cluster in order to display the outside temperature.</p> <p>Reason for frustration: 3 participants experienced frustration looking for the action item for how to toggle the display in the instrument cluster because it took too long to find the information. The new addition of the reference paragraph on page 19 wasn't noticed by 2 of these 3 participants because they were fixated on the bullet 'Outside temperature' (above the new reference paragraph) which had no other information written directly next to it, like some of the other bullets in the same list. The one participant who did notice the new reference paragraph, went to page 22 and 23 for more information as instructed, but got lost in the front matter at the top of page 22, became fatigued and began partially reading the remaining information. This was due to the fact that the new reference paragraph didn't say exactly <i>where</i> on page 22 and page 23 the information could be found. There should have been reference page number directly to the bullet 'outside temperature' and exactly where to go once directed to page 22 and 23, to be more specific.</p>	Number of ratings '3' or below: 3	<p>Page 19: Right of page, paragraph underneath bulleted list)</p> <p>(See Figure 16)</p>

First steps

Introduction

In this section you'll find information about:

Linking the mobile phone via the menu in the instrument cluster	12
Pairing through the mobile phone	13
Functions	15
Connecting a mobile phone to the mobile phone package	15
Media player	16

Connecting your mobile phone:

In vehicles **with** the menu in the instrument cluster, perform pairing via the menu. In vehicles **without** the menu in the instrument cluster, perform pairing via the mobile phone => page 13.

To determine if your car has a menu in the instrument cluster, see which figure below best matches your vehicle.



Example **with** menu:
Link via menu below



Example **without** menu:
Pair through the mobile phone on bottom of page 13.

WARNING

Accidents and injuries can occur if the driver is distracted.

- Linking the mobile phone and setting up a user profile are to be done only when the vehicle is not moving.

 Some networks may not support all language-dependent characters and services.

More information:

- Safety instructions \wedge => page 4
- General information => page 5
- Controls => page 7
- Calling => page 18
- Phone menu => page 22

Linking the mobile phone via the menu in the instrument cluster

Figure 15: UT2 Usability Problem Page 12

Displays

 Please first read and note the introductory information and heed the **WARNINGS** \triangle on page 18.

Depending on the vehicle model, different information may be shown in the instrument cluster display => page 18, *Instrument overview*.

- Warning and information texts
- Odometer displays
- Time
- Fuel gauge => page 244, *Indicator lights and fuel gauge*
- Outside temperature
- Selector lever position => page 205, *Shifting*

Not all information can be seen at one time in the instrument cluster display. To switch the information that is shown, go to page 22 and 23 for more details.

- Multi-Function Indicator (MFI) and menus for different settings => page 22, *Volkswagen Information System*
- Service reminder display => page 21, *Service reminder display*

Warning and information texts

The status of various vehicle functions and components is monitored when the ignition is switched on and while driving. Malfunctions are indicated by red and yellow warning symbols with text messages in the instrument cluster display (=> page 15, *Warning and indicator lights*). In some cases, they may also be signaled acoustically. The display can vary depending on the instrument cluster model.

Figure 16: UT2 Usability Problem Page 19

The design changes made to the user guide based on the results of both the HE and UT1 introduced one new usability problem (two participant failures) and did not mitigate one of the already identified usability problems (three participants experienced frustrated) . The researcher inadvertently left out important steps needed to optimize the design changes in two areas:

1. **Design change 3** (see Section [3.4.1](#)): Two images showing examples of instrument cluster displays were added to page 18 to provide the user with additional information to determine if the instrument cluster in the vehicle had a menu or did not have a menu to make the correct Bluetooth connection option. However, the instrument cluster display in the vehicle will only match the added examples in the re-designed user guide if the ‘ignition is turned on’ first. This step is included later on in the action steps, but was unintentionally not added upfront with the images. This led to two failures for this step in UT2.
2. **Design change 10** (see Section [3.4.2](#)): A paragraph referencing pages 22 and 23 was added to page 19 in an attempt to guide the users to the correct page where the action items for toggling the display information (to display the outside temperature) was located. However, the paragraph unintentionally omitted details as to *where* exactly on page 22 and 23 the information could be found. This led three participants to experience frustration for finding this step once they were at pages 22 and 23, as there was a lot of information included these pages.

3.5.2 UT1 and UT2 Scenario Completion Times and Subjective Ratings Comparison

The average time to complete all three scenarios for UT2 was 4 minutes and 54 seconds, while the average time to complete the three scenarios for UT1 was 7 minutes and 34 seconds for UT1, showing it took 2 minutes and 40 seconds *longer* to complete the scenarios in UT1 using the original user guide. This demonstrates that the re-design of the user guide aided a different set of participants to complete the same scenarios in less time. Also, the average mean rating for UT2 across all three scenarios was ‘5’, compared to ‘3.5’ in UT1, showing that participants experienced *less* frustration while completing scenarios using the re-designed user guide. The mean time to complete each scenario (in minutes) and the mean ratings related to feeling frustration after each scenario are shown in [Table 5](#) below for both UT1 and UT2.

Table 5: UT1 and UT2 Comparison Mean Time and Ratings

Scenario	UT1 Mean Time in Minutes	UT2 Mean Time in Minutes	UT1 Mean Rating (1=Frustrated 7=Not Frustrated)	UT2 Mean Rating (1=Frustrated 7=Not Frustrated)
Scenario 1: Connect mobile phone to Bluetooth	12:16 (Std dev: 0.15)	5:51 (Std dev: 0.06)	2.4 (Std dev: 0.94)	4.3 (Std dev: 1.45)
Scenario 2: Change time on clock	3:42 (Std dev: 0.04)	2:45 (Std dev: 0.03)	5.7 (Std dev: 1.07)	6.25 (Std dev: 0.89)
Scenario 3: Display outside temperature	6:45 (Std dev: 0.07)	6:06 (Std dev: 0.06)	2.3 (Std dev: 1.32)	4.5 (Std dev: 1.6)
Averages across scenarios	7:34 (Std dev: 0.18)	4:54 (Std dev: 0.08)	3.5 (Std dev: 1.94)	5 (Std dev: 1.6)

3.5.3 Hypothesis 2

It was hypothesized (H2) that fewer usability problems and no *new* usability problems would be introduced by addressing all usability problems from the HE and UT1 to re-design the user guide, when tested with a different set of participants.

H2: There were a total of two usability problems observed during UT2 compared to 11 in UT1. One out of the two usability problems observed in UT2 was already uncovered during UT1. This means that one *new* usability problem was introduced related to the re-design of the user guide. This shows that H2 was not supported on the basis of a *new* usability problem being introduced after re-designing the user guide.

Overall, the re-design of the user guide had a positive effect as it lead to fewer usability problems, the times to complete the scenarios were reduced, and the subjective feedback regarding frustration improved, as validated in UT2. However, a new usability problem was introduced related to two participant failures for a step, showing that changes made to the user guide would have benefited from either a second HE or a second UT, as shown here, to confirm all design changes.

4 Discussion

4.1 Conclusions

Since user testing on its own is already a trusted approach for evaluating the usability of a product or system, this study set out to answer how well a HE could predict usability problems in a UT for the same product. Also, the research question was asked was, “If all uncovered usability problems from the HE were considered problems (based on two or more evaluators stating the same problem), would “fixing” those problems lead to more usability problems for the end user? Lastly, the study validated all design changes (associated with the HE and UT1).

In this study, a user guide for a 2014 Volkswagen SI vehicle was evaluated using two methods, HE and UT, and the user guide was re-designed based on usability problems uncovered by the two methods. Then a second UT was performed to validate the changes made to the user guide. It was hypothesized that (1) if a HE could predict at least 80% of usability problems in a UT, the HE would be considered a valuable method on its own for predicting usability problems, if a UT can’t also be performed. Also hypothesized was (2) if all usability problems (both HE and UT) associated with the user guide were addressed in a re-design, no new usability problems would be introduced and fewer usability problems would be observed in a second UT. This would also show if HE found problems *not* observed in the first UT, but were addressed in the re-design of the user guide, would lead to any new observed problems in the second UT for those steps. This is relevant in order to have a discussion about re-designing a product based on HE alone.

H1 was supported with HE predicting 91% of the observed usability problems in UT1, while H2 was not supported due to a new usability problem being introduced based on the re-design. The new usability problem was due to a design change which attempted to mitigate a usability problem initially found in the both the HE and UT1. It should be noted that the design changes associated with the four HE only usability problems (not observed in UT1), did not lead to new usability problems when addressed in the re-design.

4.2 Applied Approach

This study was conducted using applied Human Factors Psychology principles learned throughout the researchers’ course work during graduate school. Since a traditional academic thesis approach was not taken, the study was able to focus on more applied research questions more closely related to traditional HF work environments, instead of an academic one. However, a con for choosing this approach, is that replicating this study may prove to be difficult since a more casual form of a HE was conducted, where the evaluators predicted usability problems not based on pre-defined heuristics, but on their experience with user behavior instead. Also, the design changes were the opinion of the researcher, based on design principles learned during graduate coursework, where another researcher could potentially re-design the user guide differently, yielding different results.

4.3 Limitations and Future Research

The following are a list of limitations for this study and the possible implications for future research:

1. The product tested had a limited number of ‘steps’ needed in order to accomplish the particular scenarios. For this reason, it may have been easier for the HE evaluators to predict the UT1 usability problems, since there were only a small amount of problems. If a different product was tested that had more steps needed to complete the scenarios, the results may show different findings in regards to HE predicting usability problems in a UT. Also, because the user guide was re-designed based on all HE usability problems (and UT usability problems), it would be interesting to know if there would be more usability problems only uncovered in the HE (with a product with more steps), that potentially could introduce more usability problems in a second UT if re-designed.
2. Hypothesis 2 involved comparing UT1 and UT2 based on new usability problems introduced and the frequency of already uncovered usability problems, when a different set of participants followed the re-designed user guide. The user guide was re-designed based on *all* usability problems uncovered in both the HE and UT1. More importantly than validating *all* design changes, would have been *ONLY* validating design changes based on the HE, as it pertains more to the research questions asked. For example H1 answered the research question, “Could HE predict enough usability problems in an UT to trust the method on its own, as to not need to conduct a UT?” While H2 should have been more focused on the other question, “If you *do* trust HE alone, based on the support of H1, would re-designing all uncovered HE problems lead to better or worse results in a UT with the modified user guide (assuming a UT was not available to base re-designs on). Re-designing the user guide based on the usability problems observed in UT1 seems to not support the overall research question, but more to validate the design changes made by the researcher overall. Even though only one usability problem was observed in UT1 that wasn’t uncovered in the HE, if the study was conducted again with a product including more steps, re-designing the user guide based on HE problems alone would be more interesting to compare to a second UT.
3. The researcher criteria not previously established in any publication, that if two or more evaluators uncovered the usability problem, it was considered an *actual* usability problem in the user guide, and therefore addressed in the re-design. Other HEs consider each usability problem listed by an evaluator a predicted problem with a system, not only if two or more evaluators listed the same problem. If this approach was used, then each listed usability problem (23 unique out of 75 total problems) would have been considered an actual problem with the user guide and addressed in the re-design, which possibly could have led to new usability problems in UT2. The approach used in this study was an attempt to create a stricter procedure for accepting HE usability problems as more evaluators were included compared to the typical 3-4 evaluators. If a future study were conducted using 3-4 evaluators where each unique problem was considered an actual problem, would new usability problems be observed in a re-test of the user guide?

4. The HE evaluators all received their Masters' degree in Human Factors and Applied Psychology from California, State University, Northridge. The results of the HE would have been more varied if evaluators with more varied backgrounds in HF were also included in this study.

References

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Appendix A: Original User Guide Excerpts

First steps

Introduction

In this section you'll find information about:

Linking the mobile phone via the menu in the instrument cluster	12
Pairing through the mobile phone	13
Functions	15
Connecting a mobile phone to the mobile phone package	15
Media player	16

More information:

- Safety instructions ↗ ⇒ page 4
- General information ⇒ page 5
- Controls ⇒ page 7

- Calling ⇒ page 18
- Phone menu ⇒ page 22

⚠ WARNING

Accidents and injuries can occur if the driver is distracted.

- **Linking the mobile phone and setting up a user profile are to be done only when the vehicle is not moving.**

 Some networks may not support all language-dependent characters and services.

Linking the mobile phone via the menu in the instrument cluster

 Please first read and heed the **WARNINGS** ⚠ on page 4, note the introductory information and heed the **WARNINGS** ⚠ on page 12.

For **each** mobile phone, an initial pairing must be carried out via Bluetooth Hands-Free Profile (HFP).

Linking may take several minutes.

In vehicles **with** the menu in the instrument cluster, perform pairing via the menu. In vehicles **without** the menu in the instrument cluster, perform pairing via the mobile phone ⇒ page 13.

Read the manufacturer's instructions regarding mobile phone use and preparation of the mobile phone for pairing ⇒ page 11.

Have the mobile phone ready, since further input into the mobile phone is required during the initial linking between the mobile phone package and the mobile phone.

Step 1: Set the Bluetooth connection to visible

- Activate the Bluetooth function on the mobile phone.
- Switch the mobile phone to "device visible to all." The mobile phone is now visible for several minutes.¹⁾ After the time expiration if pairing was not successful, repeat steps 1 and 2.

Step 2: Bluetooth device search

- Switch on the ignition.
- Use the  button on the multi-function steering wheel and/or  or  to access the phone menu in the instrument cluster display.
- Use the  and/or  button to select menu item **Phone search** and press **OK** to confirm, in order to search for compatible Bluetooth mobile phones in the vehicle. After a successful search, a list with the Bluetooth names of all found devices is shown.

Step 3: Pair the mobile phone

Password entry is subject to a time limit! Please finish reading step 3 completely before carrying out next steps.

Depending on the mobile device, a different set of actions may be required.

Possible situation A:

- If necessary, activate "Wait for incoming Bluetooth connections" on the mobile phone.¹⁾
- Have the mobile phone ready, since there is a time limit for entering the password.
- Use  and/or  to select the mobile phone from the device list in the display on the instrument cluster.
- If necessary, confirm a connection request on the mobile phone. ▶

¹⁾ Depending on the mobile phone.

- The 6-character PIN in the instrument cluster display should agree with the 6-character PIN in the display of the mobile phone. If the PIN agrees, it must be confirmed using the **OK** button in the multi-function steering wheel and the mobile phone.
- Confirm any further requests on the mobile phone.
- Press **OK** to confirm the message in the instrument cluster that a user profile should be created. If 4 user profiles have already been created, delete one of them.
- The data stored in the phone's contacts list is transferred into the vehicle.¹⁾
- Now the mobile telephone is successfully connected to the mobile phone package.

Possible situation B:

- If necessary, activate "Wait for incoming Bluetooth connections" on the mobile phone.¹⁾
- Have the mobile phone ready, since there is a time limit for entering the password.
- Use **▲** and/or **▼** to select the mobile phone from the device list in the instrument cluster display.
- If necessary, confirm a connection request on the mobile phone.
- Enter the 4-character password, shown on the instrument cluster display **within 30 seconds in the mobile phone** and confirm the password selection. The factory setting is "0000." Tap the **▲** and/or **▼** buttons on the multi-function steering wheel for numeric input and press **OK** after each number to confirm the input.

- Confirm password input with **OK**.
- Confirm any further requests on the mobile phone.
- Press **OK** to confirm the message in the instrument cluster that a user profile should be created. If 4 user profiles have already been created, delete one of them.
- The data stored in the phone's contacts list is transferred into the vehicle.¹⁾
- Now the mobile telephone is successfully connected to the mobile phone package.

i Up to 4 devices can be stored as *known* in the mobile phone package. Depending on the radio or navigation system, "shortcut buttons" can be stored for 3 or 4 devices. If necessary, delete a device that is no longer used from the user profile → page 25. Up to 2500 contacts, each with up to 5 telephone numbers, can be stored in memory of the mobile phone package.

i Some Bluetooth devices or adapters can be set so that they can connect to the mobile phone package product by themselves. To prevent this, Volkswagen recommends that during linking, unneeded Bluetooth devices and adapters be disconnected.

i For the device search, select a location with the likelihood of few unknown Bluetooth devices, for example, in the garage. Bluetooth wireless range is about 30 feet.

Pairing through the mobile phone

 Please first read and heed the **WARNINGS**  on page 4, note the introductory information and heed the **WARNINGS**  on page 12.

Each mobile phone must be initially paired to the mobile phone package via Bluetooth Hands-Free Profile (HFP).

Linking may take several minutes.

In vehicles **without** the menu in the instrument cluster, perform pairing via the mobile phone.

Step 1: Set the Bluetooth connection to visible

Before pairing the mobile phone, be sure that no other devices connected via Bluetooth to the mobile phone package are in the area. If necessary, deactivate these devices during the Bluetooth pairing process.

For security purposes, a connection request from the mobile phone package will be denied if a device is already connected via Bluetooth.

Proceed as follows to pair devices:

¹⁾ Depending on the mobile phone.

- Switch the ignition on.
- The mobile phone package automatically becomes *visible* for 3 minutes after it is switched on, as long as no other device has already been connected.
- Mobile telephones must be linked to the mobile phone package within 3 minutes. The Bluetooth visibility function of the mobile phone package ends automatically after about 3 minutes.

Step 2: Pair the Mobile phone

Depending on the mobile device, a different set of actions may be required.

Possible situation A:

- Activate Bluetooth function on the mobile phone.
- Initiate the search for Bluetooth devices in the mobile phone. A list of found devices appears.
- Select **VW Phone**.
- The 6-character PIN in the display of the instrument cluster should agree with the 6-character PIN in the display of the mobile phone. If the PIN agrees, it must be confirmed using the **OK** button in the multi-function steering wheel and the mobile phone.
- Confirm possible phone request with **Yes** if this Bluetooth connection should be made without re-entering a password. Whenever the ignition is switched on, the Bluetooth connection will be automatically established → page 15.
- The data stored in the phone's contacts list is transferred into the vehicle.¹⁾
- Now the mobile telephone is successfully connected to the mobile phone package.

Possible situation B:

- Activate Bluetooth function on the mobile phone.
- Initiate the search for Bluetooth devices in the mobile phone. A list of found devices appears.
- Select **VW Phone**.
- Confirm the Bluetooth connection on the mobile phone.
- Confirm possible phone request with **Yes** if this Bluetooth connection should be made without re-entering a password. Whenever the ignition is switched on, the Bluetooth connection will be automatically established → page 15.

- The data stored in the phone's contacts list is transferred into the vehicle.¹⁾
- Now the mobile telephone is successfully connected to the mobile phone package.

Possible situation C:

- Activate Bluetooth function on the mobile phone.
- Initiate the search for Bluetooth devices in the mobile phone. A list of found devices appears.
- Select **VW Phone**.
- A message appears on the phone that a password must be entered for authorization.
- Enter the four-digit password. The factory setting is "0000." If an incorrect password is entered, the linking process ends. In this case, repeat the pairing process.
- Confirm possible phone request with **Yes** if this Bluetooth connection should be made without re-entering a password. Whenever the ignition is switched on, the Bluetooth connection will be automatically established → page 15.
- The data stored in the phone's contacts list is transferred into the vehicle.¹⁾
- Now the mobile telephone is successfully connected to the mobile phone package.

Possible situation D:

- Activate Bluetooth function on the mobile phone.
- Initiate the search for Bluetooth devices in the mobile phone. A list of found devices appears.
- Select **VW Phone**.
- Enter the 4-character password, shown on the display of the instrument cluster **within 30 seconds in the mobile phone** and confirm the password selection. The factory setting is "0000." Tap the **▲** and/or **▼** buttons on the multi-function steering wheel for numeric input and press **OK** after each number to confirm the input.
- Confirm possible phone request with **Yes** if this Bluetooth connection should be made without re-entering a password. Whenever the ignition is switched on, the Bluetooth connection will be automatically established → page 15.
- The data stored in the phone's contacts list is transferred into the vehicle.¹⁾
- Now the mobile telephone is successfully connected to the mobile phone package. ▶

¹⁾ Depending on the mobile phone.

Instrument cluster

Introduction

In this section you'll find information about:

Instrument overview	18
Displays	19
Service reminder display	21

More information:

- Warning and indicator lights → page 15
- Volkswagen Information System → page 22
- Shifting → page 205
- Service reminder information → booklet *Warranty and Maintenance*

WARNING

Driving on today's roads demands the full attention of the driver at all times. Driver distraction causes accidents, collisions and serious personal injury!

- Never use the buttons in the instrument cluster while driving.

Instrument overview

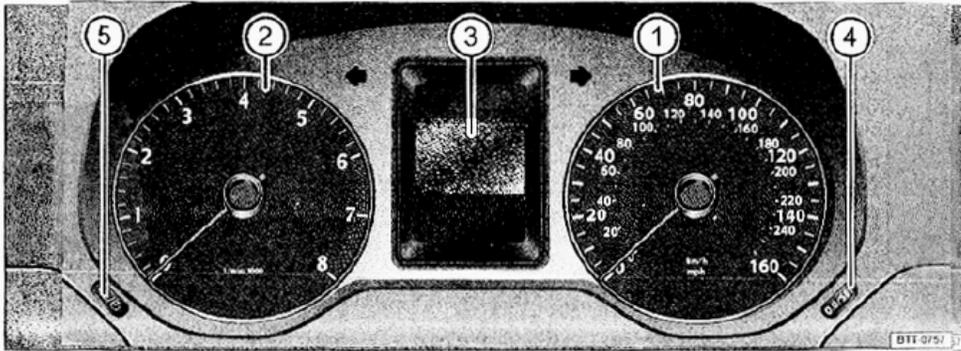


Fig. 9 Instrument cluster in the instrument panel.

 Please first read and note the introductory information and heed the WARNINGS  on page 18.

Instrument explanations → fig. 9:

- ① **Speedometer.**
- ② **Tachometer** (thousands of revolutions per minute when the engine is running).
The red zone at the end of the scale indicates maximum permissible engine rpm (revolutions per minute) for all gears after the break-in period. Before reaching the red zone, select the next higher gear or selector level position **D**, or ease your foot off the accelerator → ①.
- ③ **Displays** → page 19.

- ④ **Reset button** for the trip odometer display (**trip**).
- Push the **[0.0/SET]** button briefly to toggle between the odometer and trip odometer displays.
 - Push the **[0.0/SET]** button for about 1 second to reset to zero.
 - Push and hold the **[0.0/SET]** button for about 15 seconds to display the vehicle's engine identification code. You must do this when the ignition is on, but the engine is not running.
- ⑤ **Button for setting the instrument cluster clock.**
- With the ignition on, push the **[r./0]** button to highlight the hour or the minutes in the clock display.
 - To advance the clock, push the **[0.0/SET]** button ④. Press and hold the button to fast forward.
 - Push the **[r./0]** button again or wait about 10 seconds to finish setting the clock.

ⓘ NOTICE

- To help prevent engine damage, always avoid high engine speeds, full throttle acceleration and heavy engine loads when the engine is cold.

ⓘ NOTICE (continued)

- To help prevent engine damage, the tachometer needle should only enter the red zone (warning zone) briefly.



- Upshifting early into the next higher gear saves fuel and reduces engine noise.

Displays



Please first read and note the introductory information and heed the **WARNINGS** ⚠ on page 18.

Depending on the vehicle model, different information may be shown in the instrument cluster display → page 18, *Instrument overview*.

- Warning and information texts
- Odometer displays
- Time
- Fuel gauge → page 244, *Indicator lights and fuel gauge*
- Outside temperature
- Selector lever position → page 205, *Shifting*

- Multi-Function Indicator (MFI) and menus for different settings → page 22, *Volkswagen Information System*
- Service reminder display → page 21, *Service reminder display*

Warning and information texts

The status of various vehicle functions and components is monitored when the ignition is switched on and while driving. Malfunctions are indicated by red and yellow warning symbols with text messages in the instrument cluster display (→ page 15, *Warning and indicator lights*). In some cases, they may also be signaled acoustically. The display can vary depending on the instrument cluster model. ▶

Type of notification	Symbol color	Explanation
Priority 1 warning message	Red	Symbol flashing or lit – sometimes with acoustic warnings.  Stop! →  . Check malfunction and take corrective action. Contact an authorized Volkswagen dealer or an authorized Volkswagen Service Facility for assistance if necessary. Menus cannot be accessed when a priority 1 warning message is displayed. The warning message will turn off automatically after a few seconds. You can confirm and turn off some warning messages using the (OK/RESET) button.
Priority 2 warning message	Yellow	Symbol flashing or continuously lit – sometimes with acoustic warnings. Malfunctions or low operating fluid levels may cause vehicle damage and vehicle breakdown →  . Check malfunction as soon as possible. Contact an authorized Volkswagen dealer or an authorized Volkswagen Service Facility for assistance if necessary.
Information text	–	Information about various vehicle situations.

Odometer displays

The *odometer* indicates the total distance driven by the vehicle.

The *trip odometer (trip)* shows the distance driven since the last time the trip odometer was reset. The last digit indicates 1/10 mile (100 meters).

Outside temperature display

At outside temperatures below about +39 °F (+4 °C), a "snowflake symbol" (icy road warning) appears in the display. The symbol flashes at first, then stays on until the outside temperature rises above +43 °F (+6 °C) → .

When the vehicle is not moving or when you are driving at very low speeds, the temperature displayed may be slightly higher than the actual outside temperature.

The measurement range is from -40 °F (-40 °C) to +122 °F (+50 °C).

Selector lever positions

The selector lever position is shown both on the side of the selector lever and in the instrument cluster display. The respective gear may also be shown in the instrument cluster display in Drive D and Sport Drive S, as well as in Tiptronic® mode.

WARNING

Failure to heed warning lights and instrument cluster text messages can cause the vehicle to break down in traffic and result in a collision and serious personal injury.

- Never ignore warning lights or text WARNINGS.

WARNING (continued)

- Always stop the vehicle as soon as it is safe to do so.
- Park the vehicle at a safe distance from moving traffic and where no part of the hot catalytic converter and exhaust system can come into contact with flammable materials under the vehicle, such as dry grass, brush, spilled fuel, etc.
- A broken down vehicle presents a high accident risk for itself and others. Switch on emergency flashers and set up a warning triangle to warn oncoming traffic.

WARNING

Roads and bridges may be dangerously icy even if the outside air temperature is above freezing.

- If you use the outside temperature display to tell you about frost conditions, remember that roads can even ice over at temperatures above +39 °F (+4 °C). Always remember: even if the "snowflake symbol" (icy road warning) is not displayed, there could still be black ice on the road.
- Never rely exclusively on the outside temperature display.

NOTICE

Failure to heed warning lights or text WARNINGS can result in vehicle damage.

Volkswagen Information System

Introduction

In this section you'll find information about:

Menu structure – overview	22
Using the instrument cluster menus	23
Trip memory functions	23

When the ignition is switched on, you can display different types of information in the instrument cluster.

Buttons on the windshield wiper lever operate the menus for the instrument cluster.

The number of menus in the instrument cluster display depends on the electronics and equipment on the vehicle.

An authorized Volkswagen dealer or an authorized Volkswagen Service Facility may be able to add or modify functions depending on your vehicle's equipment.

Some menu items can only be accessed when the vehicle is not moving.

As long as a priority 1 warning message is displayed, no menus can be accessed. To display menus, press the **OK/RESET** button on the windshield wiper lever.

More information:

- Outside mirrors → page 130
- Driver assistance systems → page 229
- Radio or Navigation system ⇒ booklet *Radio* or ⇒ booklet *Navigation system*
- Mobile phone package ⇒ booklet *Mobile Phone Package*

WARNING

Driving on today's roads demands the full attention of the driver at all times. Driver distraction causes accidents, collisions and serious personal injury!

- **Never access menus when the vehicle is moving.**

 Emergency starting and starting the engine with a very weak vehicle battery or after the vehicle battery has been replaced may change or delete system settings (including time, date, and programming). Check the settings and correct as necessary once the vehicle battery has built up a sufficient charge.

Menu structure – overview

 Please first read and note the introductory information and heed the **WARNINGS**  on page 22.

The instrument cluster display is divided into 3 parts. The time (digital clock) is displayed in the top part. The bottom part contains the odometer and the trip odometer ("trip"). You can select the following displays for the middle part:

-  --- (travel time)
- mpg (current fuel consumption)

-  --- mpg (average fuel consumption)
-  --- miles (fuel range estimate)
- miles (trip memory 1 and 2)
-  --- mph (average speed)
- mph (digital speed display)
-  --- mph (speed warning)
- °F (outside temperature)

Using the instrument cluster menus

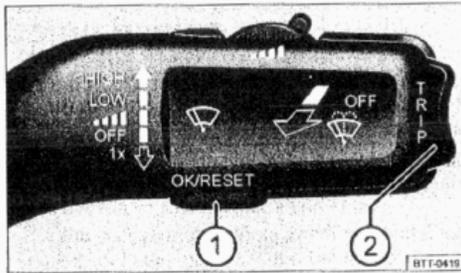


Fig. 10 On the windshield wiper control stalk: control buttons ① and ② on the windshield wiper lever.

Please first read and note the introductory information and heed the **WARNINGS** on page 22.

The instrument cluster displays are controlled by the **OK/RESET** button and the **TRIP** rocker switch on the windshield wiper lever \Rightarrow fig. 10, ① and ②.

Switch on the ignition. The instrument cluster display is divided into 3 parts. The time (digital clock) is displayed in the top part. The bottom part contains the odometer (including the trip odometer) and the fuel gauge \Rightarrow page 244, *Indicator lights and fuel gauge*. The display in the middle part is selected by pushing the **TRIP** rocker switch ② on the end of the windshield wiper lever. The available displays are as follows:

The available displays are as follows:

- ⌚ ---: ---: **Travel time since last reset of trip memories 1 and 2.**
 - Push the **OK/RESET** button to toggle between the two time figures.
- **mpg: Current fuel consumption.**
- ⊖ --- **mpg: Average fuel consumption of trips per trip memories 1 and 2.**
 - Push the **OK/RESET** button to toggle between the two figures.

Trip memory functions

Please first read and note the introductory information and heed the **WARNINGS** on page 22.

--- **mi: Estimated distance you can drive with the fuel remaining in the tank.**

Trip memory 1 (single trip memory) and trip memory 2 (total trip memory)

- Push the **OK/RESET** button ① on the windshield wiper arm to toggle between trip memories 1 and 2.
- Push and hold the **OK/RESET** button to reset a trip memory to zero.
- The function of the 2 trip memories is explained on \Rightarrow page 23, *Trip memory functions*. The two trip memories are in addition to the trip odometer, which is displayed in the bottom part of the instrument cluster and controlled using the **0.0/SET** button to the right of the instrument panel \Rightarrow fig. 9.

⊖ --- **mph: Average speed on trips per trip memories 1 and 2.**

- Push the **OK/RESET** button on the windshield wiper arm to toggle between the two average speed figures.

--- **mph: Digital display of current vehicle speed.**

⊖ --- **mph: Speed warning feature.**

- Push the **OK/RESET** button to toggle between --- **mph** (speed warning disabled) and **xx mph**.
- A warning chime will sound you if you reach the set speed; there may also be a visual message.
- The set speed will blink for a few seconds after you toggle to **xx mph**.
- Press the **TRIP** rocker switch ② while the set speed is blinking to increase or decrease the speed.

--- **°F: Current outside temperature** ◀

The instrument cluster display has 2 automatic memories: **1 – single trip memory** and **2 – total trip memory**. The number of the trip memory is shown at the upper right of the display. ▶

Appendix B: Re-Designed User Guide Pages

First steps

Introduction

In this section you'll find information about:

Linking the mobile phone via the menu in the instrument cluster	12
Pairing through the mobile phone	13
Functions	15
Connecting a mobile phone to the mobile phone package	15
Media player	16

1

Connecting your mobile phone:

In vehicles **with** the menu in the instrument cluster, perform pairing via the menu. In vehicles **without** the menu in the instrument cluster, perform pairing via the mobile phone → page 13.

2

To determine if your vehicle has a menu in the instrument cluster, see which figure below best matches your vehicle.



Example **with** menu:
Link via menu below



Example **without** menu:
Pair through the mobile phone on bottom of page 13.

3

WARNING

Accidents and injuries can occur if the driver is distracted.

- Linking the mobile phone and setting up a user profile are to be done only when the vehicle is not moving.

Some networks may not support all language-dependent characters and services.

More information:

- Safety instructions ↗ → page 4
- General information → page 5
- Controls → page 7
- Calling → page 18
- Phone menu → page 22

Linking the mobile phone via the menu in the instrument cluster



Please first read and heed the **WARNINGS** on page 4, note the introductory information and heed the **WARNINGS** on page 12.

For **each** mobile phone, an initial pairing must be carried out via Bluetooth Hands-Free Profile (HFP). Linking may take several minutes.

In vehicles **with** the menu in the instrument cluster, perform pairing via the menu. In vehicles **without** the menu in the instrument cluster, perform pairing via the mobile phone → page 13.

Read the manufacturer's instructions regarding mobile phone use and preparation of the mobile phone for pairing → page 11.

Have the mobile phone ready, since further input into the mobile phone is required during the initial linking between the mobile phone package and the mobile phone.

¹⁾ Depending on the mobile phone.

Step 1: Set the Bluetooth connection to visible

- Activate the Bluetooth function on the mobile phone.
- Switch the mobile phone to "device visible to all." The mobile phone is now visible for several minutes.¹⁾ After the time expiration if pairing was not successful, repeat steps 1 and 2.

Step 2: Bluetooth device search

- Switch on the ignition.
- Use the button on the multi-function steering wheel and/or or to access the phone menu in the instrument cluster display.
- Use the and/or button to select menu item **Phone search** and press **OK** to confirm, in order to search for compatible Bluetooth mobile phones in the vehicle. After a successful search, a list with the Bluetooth names of all found devices is shown.

Step 3: Pair the mobile phone

- 4**
- If there is a bluetooth symbol visible in the instrument cluster, a device needs to be removed.
 - Switch the ignition on.

- The mobile phone package automatically becomes *visible* for 3 minutes after it is switched on, as long as no other device has already been connected.

- 5**
- If the mobile phone package times out (more than 3 minutes have passed since turning on the ignition), simply switch the ignition off and then back on again.

Step 2: Pair the Mobile phone

- 6**
- Activate Bluetooth function on the mobile phone.
 - Initiate the search for Bluetooth devices in the mobile phone. A list of found devices appears.
 - Select **VW Phone**.
- 7**
- Check phone to confirm successful connection and/or look for bluetooth symbol in instrument cluster.

Depending on the mobile device, a different set of actions may be required.

Possible situation A:

- Activate Bluetooth function on the mobile phone.
- Initiate the search for Bluetooth devices in the mobile phone. A list of found devices appears.
- Select **VW Phone**.
- The 6-character PIN in the display of the instrument cluster should agree with the 6-character PIN in the display of the mobile phone. If the PIN agrees, it must be confirmed using the **OK** button in the multi-function steering wheel and the mobile phone.
- Confirm possible phone request with **Yes** if this Bluetooth connection should be made without re-entering a password. Whenever the ignition is switched on, the Bluetooth connection will be automatically established → page 15.
- The data stored in the phone's contacts list is transferred into the vehicle.¹⁾
- Now the mobile telephone is successfully connected to the mobile phone package.

Possible situation B:

- Activate Bluetooth function on the mobile phone.
- Initiate the search for Bluetooth devices in the mobile phone. A list of found devices appears.
- Select **VW Phone**.
- Confirm the Bluetooth connection on the mobile phone.

¹⁾ Depending on the mobile phone.

- Confirm possible phone request with **Yes** if this Bluetooth connection should be made without re-entering a password. Whenever the ignition is switched on, the Bluetooth connection will be automatically established → page 15.
- The data stored in the phone's contacts list is transferred into the vehicle.¹⁾
- Now the mobile telephone is successfully connected to the mobile phone package.

Possible situation C:

- Activate Bluetooth function on the mobile phone.
- Initiate the search for Bluetooth devices in the mobile phone. A list of found devices appears.
- Select **VW Phone**.
- A message appears on the phone that a password must be entered for authorization.
- Enter the four-digit password. The factory setting is "0000." If an incorrect password is entered, the linking process ends. In this case, repeat the pairing process.

- Confirm possible phone request with **Yes** if this Bluetooth connection should be made without re-entering a password. Whenever the ignition is switched on, the Bluetooth connection will be automatically established → page 15.
- The data stored in the phone's contacts list is transferred into the vehicle.¹⁾
- Now the mobile telephone is successfully connected to the mobile phone package.

Possible situation D:

- Activate Bluetooth function on the mobile phone.
- Initiate the search for Bluetooth devices in the mobile phone. A list of found devices appears.
- Select **VW Phone**.
- Enter the 4-character password, shown on the display of the instrument cluster **within 30 seconds in the mobile phone** and confirm the password selection. The factory setting is "0000." Tap the **A** and/or **V** buttons on the multi-function steering wheel for numeric input and press **OK** after each number to confirm the input.
- Confirm possible phone request with **Yes** if this Bluetooth connection should be made without re-entering a password. Whenever the ignition is switched on, the Bluetooth connection will be automatically established → page 15.
- The data stored in the phone's contacts list is transferred into the vehicle.¹⁾
- Now the mobile telephone is successfully connected to the mobile phone package. ▶

instrument cluster

Introduction

In this section you'll find information about:

Instrument overview	18
Displays	19
Service reminder display	21

More information:

- Warning and indicator lights → page 15
- Volkswagen Information System → page 22
- Shifting → page 205
- Service reminder information → booklet *Warranty and Maintenance*

WARNING

Driving on today's roads demands the full attention of the driver at all times. Driver distraction causes accidents, collisions and serious personal injury!

- Never use the buttons in the instrument cluster while driving.

Instrument overview

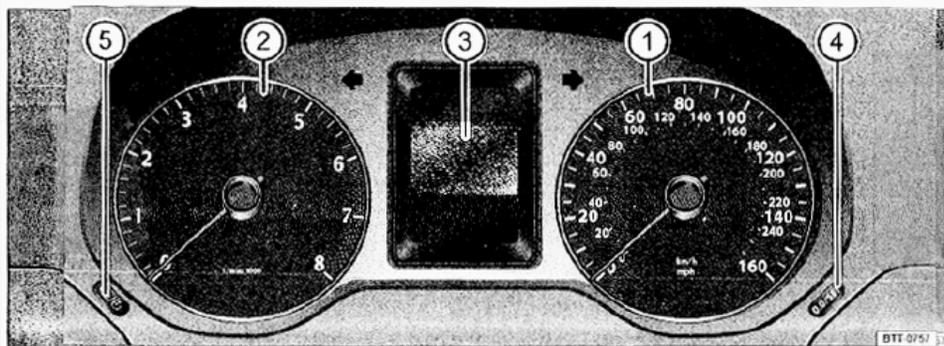


Fig. 9 Instrument cluster in the instrument panel.

Please first read and note the introductory information and heed the WARNINGS ⚠ on page 18.

Instrument explanations → fig. 9:

8

⑤ **Button for setting the instrument cluster clock.** (Clock located in Displays ③)

- With the ignition on, push the ⑤ button to highlight the hour or the minutes in the clock display.
- To advance the clock, push the ④ button. Press and hold the button to fast forward.
- Push the ⑤ button again or wait about 10 seconds to finish setting the clock.

9

② **Tachometer** (thousands of revolutions per minute when the engine is running).

The red zone at the end of the scale indicates maximum permissible engine rpm (revolutions per minute) for all gears after the break-in period. Before reaching the red zone, select the next higher gear or selector level position D, or ease your foot off the accelerator → ①.

③ **Displays** → page 19.

① **Speedometer.**

④ **Reset button** for the trip odometer display (trip).

- Push the ④ button briefly to toggle between the odometer and trip odometer displays.
- Push the ④ button for about 1 second to reset to zero.
- Push and hold the ④ button for about 15 seconds to display the vehicle's engine identification code. You must do this when the ignition is on, but the engine is not running.

NOTICE

- To help prevent engine damage, always avoid high engine speeds, full throttle acceleration and heavy engine loads when the engine is cold.

NOTICE (continued)

- To help prevent engine damage, the tachometer needle should only enter the red zone (warning zone) briefly.



- Upshifting early into the next higher gear saves fuel and reduces engine noise.

◀

Displays



Please first read and note the introductory information and heed the WARNINGS  on page 18.

Depending on the vehicle model, different information may be shown in the instrument cluster display → page 18, *Instrument overview*.

- Warning and information texts
- Odometer displays
- Time
- Fuel gauge → page 244, *Indicator lights and fuel gauge*
- Outside temperature
- Selector lever position → page 205, *Shifting*
- Multi-Function Indicator (MFI) and menus for different settings → page 22, *Volkswagen Information System*
- Service reminder display → page 21, *Service reminder display*

Not all information can be seen at one time in the instrument cluster display. To switch the information that is shown, go to page 22 and 23 for more details.

10

Warning and information texts

The status of various vehicle functions and components is monitored when the ignition is switched on and while driving. Malfunctions are indicated by red and yellow warning symbols with text messages in the instrument cluster display (→ page 15, *Warning and indicator lights*). In some cases, they may also be signaled acoustically. The display can vary depending on the instrument cluster model. ►

Volkswagen Information System

Introduction

In this section you'll find information about:

Instrument cluster display overview	22
Using the instrument cluster menus	23
Trip memory functions	23

When the ignition is switched on, you can display different types of information in the instrument cluster.

Buttons on the windshield wiper lever operate the menus for the instrument cluster.

The number of menus in the instrument cluster display depends on the electronics and equipment on the vehicle.

An authorized Volkswagen dealer or an authorized Volkswagen Service Facility may be able to add or modify functions depending on your vehicle's equipment.

Some menu items can only be accessed when the vehicle is not moving.

As long as a priority 1 warning message is displayed, no menus can be accessed. To display menus, press the **OK/RESET** button on the windshield wiper lever.

More information:

- Outside mirrors → page 130
- Driver assistance systems → page 229
- Radio or Navigation system → booklet *Radio* or → booklet *Navigation system*
- Mobile phone package → booklet *Mobile Phone Package*

WARNING

Driving on today's roads demands the full attention of the driver at all times. Driver distraction causes accidents, collisions and serious personal injury!

- **Never access menus when the vehicle is moving.**

 Emergency starting and starting the engine with a very weak vehicle battery or after the vehicle battery has been replaced may change or delete system settings (including time, date, and programming). Check the settings and correct as necessary once the vehicle battery has built up a sufficient charge.

11 Instrument Cluster Display Overview

 Please first read and note the introductory information and heed the **WARNINGS**  on page 22.

The instrument cluster display is divided into 3 parts. The time (digital clock) is displayed in the top part. The bottom part contains the odometer and the trip odometer ("trip"). You can select the following displays for the middle part:

-  ---:--- (travel time)
- mpg (current fuel consumption)
-  --- mpg (average fuel consumption)
-  --- miles (fuel range estimate)
- miles (trip memory 1 and 2)
-  --- mph (average speed)
- mph (digital speed display)
-  --- mph (speed warning)
- °F (outside temperature)

12

In order to switch the information being shown in the middle part of the instrument cluster display (all displays in the previous list) do the following:

- Press the TRIP rocker switch located on the windshield wiper lever (see fig. 10) until the intended display appears.

For more details about the instrument cluster menu displays, go to page 23.

Using the instrument cluster menus

 Please first read and note the introductory information and heed the **WARNINGS**  on page 22.

13

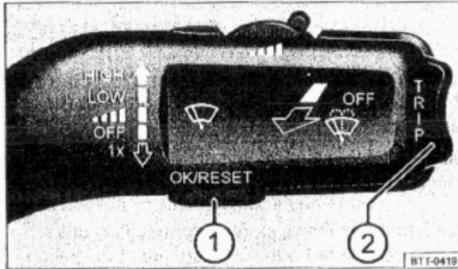


Fig. 10 On the windshield wiper control stalk: control buttons ① and ② on the windshield wiper lever. Press rocker switch ② to change middle display.

14

The instrument cluster displays are controlled by the **OK/RESET** button and the **TRIP** rocker switch on the windshield wiper lever → fig. 10, ① and ②.

Switch on the ignition. The instrument cluster display is divided into 3 parts. The time (digital clock) is displayed in the top part. The bottom part contains the odometer (including the trip odometer) and the fuel gauge → page 244, *Indicator lights and fuel gauge*. The display in the middle part is selected by pushing the **TRIP** rocker switch ② on the end of the windshield wiper lever. Keep pushing ② until your intended display appears. **15**

The available displays are as follows:

 ---:---: **Travel time since last reset of trip memories 1 and 2.**

- Push the **OK/RESET** button to toggle between the two time figures.

--- **mpg: Current fuel consumption.**

 --- **mpg: Average fuel consumption of trips per trip memories 1 and 2.**

- Push the **OK/RESET** button to toggle between the two figures.

Trip memory functions

 Please first read and note the introductory information and heed the **WARNINGS**  on page 22.

 --- **mi: Estimated distance you can drive with the fuel remaining in the tank.**

Trip memory 1 (single trip memory) and trip memory 2 (total trip memory)

- Push the **OK/RESET** button ① on the windshield wiper arm to toggle between trip memories 1 and 2.
- Push and hold the **OK/RESET** button to reset a trip memory to zero.
- The function of the 2 trip memories is explained on → page 23, *Trip memory functions*. The two trip memories are in addition to the trip odometer, which is displayed in the bottom part of the instrument cluster and controlled using the **0.0/SET** button to the right of the instrument panel → fig. 9.

 --- **mph: Average speed on trips per trip memories 1 and 2.**

- Push the **OK/RESET** button on the windshield wiper arm to toggle between the two average speed figures.

--- **mph: Digital display of current vehicle speed.**

 --- **mph: Speed warning feature.**

- Push the **OK/RESET** button to toggle between --- **mph** (speed warning disabled) and **xx mph**.
- A warning chime will sound you if you reach the set speed; there may also be a visual message.
- The set speed will blink for a few seconds after you toggle to **xx mph**.
- Press the **TRIP** rocker switch ② while the set speed is *blinking* to increase or decrease the speed.

--- **°F: Current outside temperature**

- Press rocker switch ② on the windshield wiper lever (fig.10) until the outside temperature is displayed in the middle part. **16**

The instrument cluster display has 2 automatic memories: 1 – **single trip memory** and 2 – **total trip memory**. The number of the trip memory is shown at the upper right of the display. 

Appendix C: Complete List of Observations for HE, UT1, and UT2

[Table 6](#) shows the individual performance of each of the eight evaluators for the HE. Beneath each listed usability problem shows either the HE predicated problem identifier (if two or more evaluators listed the same/similar problem), or shows, ‘Not predicted’ which means only that one evaluator listed that usability problem and was therefore not included in the re-design or used to predict UT1 problems.

Table 6: Individual Evaluator HE Performance

HE Evaluator	Scenario 1	Scenario 2	Scenario 3
<p>-Number of problems identified</p> <p>1</p> <p>-7 problems</p>	<p>-It is not clear how to determine if 'your model' has the menu in the instrument cluster. The unique term here is instrument cluster and I know you have an instrument cluster, so the assumption is it includes a menu. However, the actual unique term here is <i>menu</i>.</p> <p>(HE problem 3)</p> <p>-It is not clear how to determine if another device is already connected via Bluetooth to the car.</p> <p>(HE problem 4)</p> <p>- First bullet under Step 1 (page 14) says to 'Switch the ignition on.' However, it's most likely the user has had the car ignition on if they started to follow the steps of pairing on page 12 'Linking the mobile phone via menu in cluster' so by the time they get to this step, 3 minutes has passed since the ignition was on, so pairing will be unsuccessful. No problem-solving step included.</p> <p>(HE problem 5)</p> <p>- There are four possible solutions for pairing once you have decided to pair using the phone. There are commonalities between all four, which are not clear upfront. It is unreasonable to expect users to figure out which one is to be used by trial and error.</p> <p>(HE problem 6)</p>	<p>-Not clear if the circled 5 is STEP 5 or Picture 5.</p> <p>(HE problem 8)</p>	<p>-Page 19 and 20 show information regarding temperature, but doesn't say where to go for steps to see it.</p> <p>(HE problem 10)</p> <p>- Page 23 shows a list of displays you can toggle and steps to see each one, except for the outside temperature, its blank.</p> <p>(HE problem 14)</p>
<p>2</p> <p>-13 problems</p>	<p>- Lack of information to aid users in determining which instrument cluster they have in order to choose correct option.</p> <p>(HE problem 1)</p> <p>- The hierarchy is wrong in this section because menu w/ or without should come first in both sections, not in the middle of the first option.</p> <p>(HE problem 3)</p> <p>- Misleading headers in this section (page 12-13). Second pairing option through phone on page 13 is incorrect title because you DO use your phone for the first one on page 12 too. Seems like page 12 is first steps on car and page</p>	<p>- No information in the text as to where the time changes in the car.</p> <p>(HE problem 9)</p> <p>- Circled 5 seems to be associated with a step, not diagram, because they are listed in numerical order</p>	<p>- Page 19 and 20 that outside temperature is included in the displays, but doesn't say where to go for more info.</p> <p>(HE problem 10)</p> <p>- Paragraph not noticeable includes action step.</p> <p>(HE problem 13)</p> <p>- Drop down list shows outside temperature, but omits the action item and assumes you will read in paragraph.</p>

HE Evaluator -Number of problems identified	Scenario 1	Scenario 2	Scenario 3
	<p>13 is second steps on phone (not clear this is two different options). (Not included)</p> <p>- No instructions on how to know if another device is already connected (which I know is done by seeing Bluetooth symbol in instrument cluster). (HE problem 4)</p> <p>- To see if a Bluetooth connection is already present, the car must be on, which is missing from instructions on page 13) (Not included)</p> <p>- No step to remind user that you must turn ignition off and on again if the three minutes passes and mobile package times out. NO troubleshooting. (HE problem 5)</p> <p>- Mobile phone package is not a good term; it is vague and goes against population stereotypes. (Not included)</p> <p>- Unclear which possible situation (A-D) is the correct one. (HE problem 6)</p>	<p>and the figure is not. (HE problem 8)</p>	<p>(HE problem 14)</p>
<p>3 - 11 problems</p>	<p>-Not clear what an instrument cluster is (no diagram). (HE problem 2)</p> <p>- Determining if you have a menu in the instrument cluster or not, is not possible with the limited information. (HE problem 3)</p> <p>- "Each phone" saying is confusing because it leads users to think that more than one phone can be paired, when only one phone can be paired at a time. (Not identified)</p> <p>- Step states that there is a three minute time for Bluetooth visibility after turning on ignition, but doesn't explain how to use this information to problem solve. (HE problem 5)</p> <p>- Four possible situations should be presented using the easiest, most common one first, not all four. (HE problem 6)</p>	<p>-The number 5 is not clear that it relates to image, as it looks like a numbered step. (HE problem 8)</p> <p>- No information on how to increase and decrease in time. (Not included)</p>	<p>-Page 19 shows bullet regarding outside temperature and page 20 shows information on what the symbols for outside temperature mean, but not information how to display it. (HE problem 10)</p> <p>-Uses 'Menu' as a header on Page 22 when describing displays within the instrument cluster, when this model has no menu in the instrument cluster. Uses the term MENU two different ways. (HE problem 11)</p> <p>-Page 23: Shows bullet that you have temperature feature, but zero information on how to display it like the other bullets. (HE problem 14)</p> <p>-Page 22 and 23 seem to include similar information. (HE problem 12)</p>

HE Evaluator -Number of problems identified	Scenario 1	Scenario 2	Scenario 3
4 - 10 problems	<p>- No decision tree for which option to use for pairing (not clear there are two options). (HE problem 1)</p> <p>- Page 12 referencing page 13 is not clear enough, as users could go to the top and not the bottom of page 13 and follow incorrect steps. (Not included)</p> <p>- No way to determine if menu is in instrument cluster or not. (HE problem 3)</p> <p>- Because people do things step by, they will automatically do possible situation A/B first. (HE problem 6)</p> <p>- No confirmation for successful Bluetooth connection suggested. (HE problem 7)</p>	<p>- Didn't expect the clock to change on the instrument cluster, but on the radio, which is incorrect. (HE problem 9)</p> <p>- Not clear where the clock button in the car because it isn't clear the circled 5 relates to the image. (HE problem 8)</p>	<p>- Not clear the buttons on the windshield wiper are related to changing displays. (HE problem 12)</p> <p>- Page 19 and 20 lack reference page numbers to where action item can be found. (HE problem 10)</p> <p>-Page 23 is missing information for how to toggle outside temperature, when all others have some action information. (HE problem 14)</p>
5 - 5 problems	<p>-Unclear how a user would find out if the instrument cluster has menu or not, most would assume they have the menu, as all cars have a <i>menu</i>. (HE problem 3)</p> <p>-Users may not understand that all connected phones need to be disconnected as there is no step to confirm if there are. (HE problem 4)</p>	<p>- Not clear that the circled 5 is directing attention to figure, as it looks like a step since the list is in numerical order and figure is not. (HE problem 8)</p>	<p>-Page 19, 20, and 22 may throw people off because it describes symbols of temperature, but no action is included, and not clear there are more pages mentioning temperature. (HE problem 10)</p> <p>- Header on page 22 is misleading as it is using the term 'Menu' Structure when 'menu' is used differently. (HE problem 11)</p>
6 - 10 problems	<p>-Decision tree is located too far down in the first option, leading users to want to skip over it and keep reading (even though it's the wrong option). (HE problem 1)</p> <p>-Missing information on how to tell if your instrument cluster has a menu or is without a menu. (HE problem 3)</p> <p>-Terms not defined and not synonymous: Linking phone vs. Pairing phone? (Not included)</p> <p>-Lack of recovery steps included for if the Bluetooth visibility times out after the ignition has been turned on for more than three minutes (i.e., turn on off ignition or turn on off Bluetooth on phone) (HE problem 5)</p> <p>-No feedback in user guide to confirm successful Bluetooth connection (which can be</p>	<p>-Circled numbers look like steps in a sequence (as opposed to mapping, not clear it is referencing figure. (HE problem 8)</p> <p>-The time is shown in the car in two places, where does it actually change? (HE problem 9)</p>	<p>-Page 20 is misleading because it describes symbols of temperature, but no action. (HE problem 10)</p> <p>-Page 22-23 disconnect of information, not clear 23 maps to 22. (HE problem 12)</p> <p>-Using Tripp button on the windshield wiper is not intuitive and not clear enough that figure is related to toggling displays. (HE problem 13)</p> <p>- Page 22, not clear what the symbol "----" represent in the bulleted list. (Not included)</p>

HE Evaluator -Number of problems identified	Scenario 1	Scenario 2	Scenario 3
	done either on phone or symbol in IC) (HE problem 7)		
7 - 9 problems	<p>-Not clear there are two different ways to connect a phone to Bluetooth as it looks like there is only the first option. (HE problem 1)</p> <p>-Missing information on how to tell if your instrument cluster has a menu or is without a menu. (HE problem 3)</p> <p>-No way to tell if a new Bluetooth connection was successful. (HE problem 7)</p> <p>-Lack of action item steps on page 13 is confusing since the header is Step 1 (steps follow on next page). (Not included)</p>	<p>-Not clear the numbers are related to the buttons in the image. (HE problem 8)</p> <p>-Unclear where the time change happen. (HE problem 9)</p>	<p>-Shows outside temperature on 3 pages before listing how to display it, leading users to not keep looking. (HE problem 10)</p> <p>-Not easy to find action step related to display outside temperature, as it is listed in paragraph after a windshield image. (HE problem 13)</p> <p>-No information listed underneath Outside Temperature in list on page 23. (HE problem 14)</p>
8 - 10 problems	<p>-Instrument cluster not defined. (HE problem 2)</p> <p>-Paragraph to help decide which option to choose is listed in the first option, hard to see. (HE problem 1)</p> <p>-Not possible to know if the car has a menu in the instrument cluster, based on user guide alone. (HE problem 3)</p> <p>-Four possible situations that all seem similar to pair. (HE problem 6)</p> <p>-User guide has too many options for verifying Bluetooth connection and none apply. (HE problem 7)</p>	<p>-Wasn't obvious the circled buttons 4 and 5 were related to the location in the picture. (HE problem 8)</p>	<p>-Mentioned outside temperature multiple times before explaining how to do it on the last page it is mentioned. (HE problem 10)</p> <p>-Using the term MENU in header when not all cars have a menu in the instrument cluster is confusing. (HE problem 11)</p> <p>-May not be able to find steps to toggle display, as located beneath an image of a windshield wiper. (HE problem 13)</p> <p>-Outside temperature in list under action item paragraph, is blank. (HE problem 14)</p>
Frequency of count of all problems: 76			

[Table 7](#) shows *all* usability problems identified in UT1 based on failures and low ratings related to experiencing frustration. A usability problem was identified based on a failure or low rating by a participant, but only included in the analysis (compared to HE and re-designed) if it had at least one failure and two or more low ratings related to frustration.

Table 7: UT1 Usability Problems (All)

UT1 Usability Problems	Number of Failures and Low Rating '3' or below	Included in analysis?
Incorrect Bluetooth connection option chosen. Participants followed instructions for the first option (Linking the mobile phone via the menu in the instrument cluster), instead of the correct second option (Pairing through the mobile phone).	Failures: 14 Low ratings: 14	Yes
Could not determine if the vehicle had an instrument cluster 'with a menu' or 'without a menu' in order to choose the correct option for connecting the mobile phone to Bluetooth.	Failures: 14 Low ratings: 14	Yes
Bluetooth did not become visible on the mobile phone because the 'mobile package' timed out since more than three minutes after turning on the ignition had passed.	Failures: 1 Low ratings: 1	Yes
Not clear there were different possible situations for pairing the mobile phone, within the correct second option.	Failures: 0 Low ratings: 4	Yes
Process for confirming a successful Bluetooth connection with a mobile phone was unclear.	Failures: 0 Low ratings: 12	Yes
Could not find buttons for changing the clock. (Note: no low ratings because these 7 participants eventually matched the button icon to the dashboard intuitively, since they couldn't match it to the picture, and therefore were not frustrated).	Failures: 7 Low ratings: 0	Yes
Not clear where the time change takes place on the dashboard of the vehicle, as there are two areas where the time is displayed.	Failures: 0 Low ratings: 2	Yes
Could not find page including the action steps for toggling the different displays on the instrument cluster in order to display the outside temperature.	Failures: 12 Low ratings: 13	Yes
Could not find action step for displaying the outside temperature because it wasn't noticeable as a step.	Failures: 7 Low ratings: 7	Yes
Pushed trip rocker switch only one time to toggle displays, and failed to display outside temperature.	Failures: 1 Low ratings: 2	Yes
Outside temperature in list of available displays does not include any action steps.	Failures: 0 Low ratings: 3	Yes
Function buttons on steering wheel do not match buttons on steering wheel and it doesn't mention your car may not have buttons.	Failures: 0 Low ratings: 1	No

UT1 Usability Problems	Number of Failures and Low Rating '3' or below	Included in analysis?
'Turn on ignition' is not clear if I have to turn on the car engine.	Failures: 0 Low ratings: 1	No
Editing the time 'timed out' after a few seconds and it took me some time to realize why I couldn't advance the time anymore. Doesn't say that in user guide.	Failures: 0 Low ratings: 1	No
Term mobile phone package is confusing and they keep using it.	Failures: 0 Low ratings: 1	No

[Table 8](#) shows *all* usability problems identified in UT2 based on failures and low ratings related to experiencing frustration. A usability problem was identified based on a failure or low rating by a participant, but only included in the analysis (compared to HE and re-designed) if it had at least one failure and two or more low ratings related to frustration.

Table 8: UT2 Usability Problems (All)

UT2 Usability Problems	Number of Failures and Low Rating 3 or lower	Included in Analysis?
Unable to match new figure examples of a vehicle with and without a menu in the instrument cluster, to the vehicle being tested.	Failures: 2 Low ratings: 2	Yes
Could not find action step for displaying the outside temperature because it wasn't noticeable as a step.	Failures: 0 Low ratings: 3	Yes
Process for confirming a successful Bluetooth connection with a mobile phone was unclear.	Failures: 0 Low ratings: 1	No
Not sure how to make the time AM or PM, it doesn't mention that in the user guide.	Failures: 0 Low ratings: 1	No