HBBTV

USABILITY ANALYSIS

FINAL REPORT

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On behalf of the German TV Platform, the Chair of Business Information Systems and Media Management at the Mainz University of Applied Sciences conducted a multi-method research study comparing established HbbTV services on various television devices.

The objective of this explorative and qualitative study was to develop recommendations for TV broadcasters and hardware manufacturers alike on how to handle HbbTV. For this purpose, it was tested how the subjects accepted the broadcasters' existing HbbTV services and how the choice of device influenced application usage.

As it turned out, both the tests of specific hardware and the application-oriented tests yielded a positive impression overall. The subjects solved nearly all the tasks they were given in a short time and, for the most part, indicated satisfaction in the subsequent surveys. For this reason, the recommendations for action given here should be considered suggestions for improvements in a field of applications and devices that are already working well.

In this document, procedures, insights, and the recommendations that were derived will be presented in detail.

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Translation:
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ABSTRACT

1. Research Design:
   • The study was conducted in a multi-method design (eye tracking, post-test survey, retrospective think aloud, video observation).
   • The study consisted of a pre-test, an applications test (8 applications on 1 device) and a hardware test (1 application on 4 devices).
   • It was an explorative (hypotheses-generating) qualitative study, which consequently studied a small sample in depth.
   • The focus of the study was on select recipients with a defined prior knowledge, whose user behavior was studied in detail. The application test had n=12 participants, the hardware test n=14.

2. Applications Test:
   • Dynamic and static task bars were identified and compared.
   • There were five different types of user interfaces: tiles, lists, columns, axes, and segmented full frame.
   • For switching between applications, cross-linked or autonomous navigation logics were available.
   • Both internal pluralism (different key functions within one broadcaster) and external pluralism (different key functions between one broadcaster and another) were to be avoided.

3. Hardware Test:
   • All television sets tested and their remote control units proved extremely efficient in use.
   • Touchpad remotes showed a significant learning effect.
   • A dual use of color keys should be avoided.
   • A proposal for an ideal remote control was identified.
   • The device configuration proved difficult for a significant portion of users. This may be one reason why some of the HbbTV-enabled devices in private homes are not connected to the Internet.

4. Recommendations for Action:
   • Recommendations for broadcasters include access, user interface, navigation between applications, navigation within applications, and presentation of content (for specific recommendations, cf. p. 42ff).
   • Recommendations for hardware manufacturers include color keys, D-pad as well as clarity and manageability of the remote control (for specific recommendations, cf. p. 45f).
   • Overall recommendations focus on performance, feedback, and media keys (for specific recommendations, cf. p. 46).
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<td>2.18</td>
<td>Presentation of content on Das Erste</td>
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<td>Clear numeric pad I</td>
<td>40</td>
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<td>3.8</td>
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<td>40</td>
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<td>40</td>
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<tr>
<td>3.10</td>
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<td>41</td>
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RESEARCH DESIGN

In this chapter, the methodology and sequence of the study will be presented and explained in detail.

Contents
• Introduction
• Select Previous Studies

Applications Test
• Overview
• Subjects
• Methods

Hardware Test
• Overview
• Subjects
• Methods

1.1 INTRODUCTION

In contrast to the proprietary systems of the smart TV manufacturers, Hybrid Broadcast Broadband TV (HbbTV) is a pan-European standard, which is launched via the “Red Button” key on the remote control. Actual usage of HbbTV-enabled consumer devices by consumers is the key to their success for both device manufacturers and TV broadcasters. For this reason, user behavior in particular was studied in detail in the present explorative and qualitative study, which is based on previous studies (cf. Info Box 1.1).

The study included an applications test and a hardware test. By separating the two tests, it was possible to analyze user behavior with hardware and software independently of each other. Moreover, it also made it possible to attribute usability issues precisely to either group. Before these main tests, a pre-test was conducted focusing on ZDF’s Olympics app for the 2014 Winter Olympics.

Select Previous Studies

1.2 APPLICATIONS TEST OUTLINE

In the applications test, the focus was on the broadcasters’ HbbTV applications. These were divided into two fields: information and communication (full-range networks) and transaction (home-shopping networks). The task bars and core applications of eight networks were tested on the same TV set (cf. Info Box 1.2), 46” Samsung TV out of SmartTVLED-TV-Series7.

The test was conducted at the observation lab of the Mainz University of Applied Sciences.

Channels Selected

- full-range networks
  - Das Erste
  - ProSieben
  - RTL
  - ZDF
  - arte
  - RTL2

- home-shopping networks
  - QVC
  - Sonnenklar.TV

---

Figure 1.1: Test infrastructure of the applications test
1.3 SUBJECTS OF THE APPLICATIONS TEST

In total, twelve subjects were recruited by a recruiting agency (eResult – Research & Consulting GmbH, Göttingen) according to the selection criteria listed in the table below.

<table>
<thead>
<tr>
<th>SELECTION CRITERIA</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex and Age</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>n=4</td>
</tr>
<tr>
<td>under 30</td>
<td>1</td>
</tr>
<tr>
<td>30–49</td>
<td>2</td>
</tr>
<tr>
<td>over 49</td>
<td>1</td>
</tr>
<tr>
<td>Male</td>
<td>n=8</td>
</tr>
<tr>
<td>under 30</td>
<td>3</td>
</tr>
<tr>
<td>30–49</td>
<td>4</td>
</tr>
<tr>
<td>over 49</td>
<td>1</td>
</tr>
<tr>
<td>Education</td>
<td>all levels</td>
</tr>
<tr>
<td>Prior Knowledge</td>
<td></td>
</tr>
<tr>
<td>50% HbbTV novices</td>
<td></td>
</tr>
<tr>
<td>• No HbbTV experience</td>
<td></td>
</tr>
<tr>
<td>• Basic teletext knowledge required</td>
<td></td>
</tr>
<tr>
<td>50% HbbTV experts</td>
<td></td>
</tr>
<tr>
<td>• Basic teletext knowledge required</td>
<td></td>
</tr>
<tr>
<td>• Using HbbTV services at least once a week</td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td>all brackets</td>
</tr>
</tbody>
</table>

Table 1.1: Selection criteria applications test
1.4 TASKS OF THE APPLICATIONS TEST

Each subject tested the services of four different TV broadcasters. For this, the test supervisor gave the subjects **two tasks per channel**, which the subject had to perform within the channel's HbbTV services. In order to assuage potentially nervous subjects, they were given two general and simple HbbTV tasks to begin with. In addition, subjects were reminded that the hardware and software were being tested, not the subjects’ individual skills.

<table>
<thead>
<tr>
<th>Tasks by Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Entry-Level Tasks</strong></td>
</tr>
<tr>
<td>• Please familiarize yourself with the remote control unit and the control of the TV set. Switch through the channels, adjust the volume, and briefly access teletext.</td>
</tr>
<tr>
<td>• If you wait for a moment after changing channels, a cue for the HbbTV function will appear in the lower right corner of the screen. By pressing the red key (“Red Button”), you will be able to access the channel’s HbbTV services. Please note that you will have to wait for the cue to appear again after switching channels.</td>
</tr>
</tbody>
</table>

**Info Box 1.3**

Das Erste

• You missed the program Elefant, Tiger & Co. yesterday at 16:10 hrs (subject is given an index card as a reminder). Please try to watch the program now.
• Please access the same video now via EPG/video library (the method not used in task #1).

ZDF

• Please launch the „heute journal plus“ app. Jump to the weather forecast at the end of the program. Switch to yesterday’s heute journal newscast.
• Have all the programs on health and medicine displayed in the video library.

ProSieben

• Sie haben gestern um 17:00 Uhr die Sendung „Taff“ verpasst (Proband erhält eine Karteikarte als Gedächtnisstütze). Bitte versuchen Sie die Sendung jetzt anzuschauen.
• Bitte wechseln Sie nun in den Comedy Channel und starten Sie einen Clip im Vollbild.

RTL

• You missed the program Taff yesterday at 17:00 hrs (subject is given an index card as a reminder). Please try to watch the program now.
• Please switch to the Comedy Channel and run a clip in full-frame mode.
ARTE
• Please find out at what times the X:ENIUS magazine will be broadcast tomorrow.
• Please run the video on the Michael Reis Quartet concert at the “Like a Jazz Machine” festival on 2014-05-14 (subject is given an index card as a reminder).

RTL2
• Run a clip from the Die Kochprofis series.
• Launch the “TV Solitaire” game.

QVC
• What is the price of today’s “Offer of the Day”?
• Run the video pertaining to the printer recommended by customers.

Sonnenklar.TV
• Run a travel video about any Black Forest hotel.
• From the current offers and from the top sellers, please tag one trip each as a favorite (subject is given an index card as a reminder). Call up the two favored trips in the “Favorites” menu.

**Task Rotation**
In order to avoid bias, e.g., through learning effects, the sequence of the tasks was changed with each subject.
Table 1.2 shows the rotation scheme applied in this test. Sonnenklar.TV and QVC were always tested last in the sequence because they are transaction-oriented channels whose content is different from the information- and communication-oriented services of the other channels.

<table>
<thead>
<tr>
<th>Subject #</th>
<th>1st Application</th>
<th>2nd Application</th>
<th>3rd Application</th>
<th>4th Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Das Erste</td>
<td>RTL2</td>
<td>arte</td>
<td>QVC</td>
</tr>
<tr>
<td>2</td>
<td>ZDF</td>
<td>Das Erste</td>
<td>RTL2</td>
<td>Sonnenklar.TV</td>
</tr>
<tr>
<td>3</td>
<td>ProSieben</td>
<td>ZDF</td>
<td>Das Erste</td>
<td>QVC</td>
</tr>
<tr>
<td>4</td>
<td>Das Erste</td>
<td>ProSieben</td>
<td>ZDF</td>
<td>Sonnenklar.TV</td>
</tr>
<tr>
<td>5</td>
<td>ZDF</td>
<td>Das Erste</td>
<td>ProSieben</td>
<td>QVC</td>
</tr>
<tr>
<td>6</td>
<td>ProSieben</td>
<td>ZDF</td>
<td>Das Erste</td>
<td>Sonnenklar.TV</td>
</tr>
<tr>
<td>7</td>
<td>RTL</td>
<td>ProSieben</td>
<td>ZDF</td>
<td>QVC</td>
</tr>
<tr>
<td>8</td>
<td>arte</td>
<td>RTL</td>
<td>ProSieben</td>
<td>Sonnenklar.TV</td>
</tr>
<tr>
<td>9</td>
<td>RTL2</td>
<td>arte</td>
<td>RTL</td>
<td>QVC</td>
</tr>
<tr>
<td>10</td>
<td>RTL</td>
<td>RTL2</td>
<td>arte</td>
<td>Sonnenklar.TV</td>
</tr>
<tr>
<td>11</td>
<td>arte</td>
<td>RTL</td>
<td>RTL2</td>
<td>QVC</td>
</tr>
<tr>
<td>12</td>
<td>RTL2</td>
<td>arte</td>
<td>RTL</td>
<td>Sonnenklar.TV</td>
</tr>
</tbody>
</table>

Table 1.2: Task matrix applications test
1.5 METHODS OF THE APPLICATIONS TEST

Eye Tracking
The tracking and recording of eye movements allows the identification of usability issues. Usability is usually measured in effectiveness, efficiency, and subjective satisfaction. The logic of navigation, information and interaction were given special attention. For this test, the Tobii X120 eye-tracking device was used as hardware and the Tobii Studio application as software.

Post-Test Survey
In the subsequent survey, the motives and subjective assessments of the subjects were determined. All elements and models evaluated by the subjects were pictured on the questionnaire, in order to safeguard a uniform understanding.

Retrospective Think Aloud
Together with the subjects, the test supervisor identified and analyzed usability issues in a replay analysis.

Video Observation
Further insights were gained from the video material of both subject and monitor, recorded by observation cameras.

Figure 1.2: Tobii X120 (Source: www.tobii.com)

<table>
<thead>
<tr>
<th>Bitte beurteilen Sie folgende Aussagen</th>
<th>trifft voll und ganz zu</th>
<th>trifft zu</th>
<th>neutral</th>
<th>trifft nicht zu</th>
<th>trifft überhaupt nicht zu</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3.1. Die Startleiste ist übersichtlich. (Informationslogik)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3.2. Die Startleiste ist</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1.3: Sample excerpt from the questionnaire
1.6 HARDWARE TEST OUTLINE

In the hardware test, the focus was on the TV sets and the control of HbbTV. Four devices with a total of five remote control units were tested with one HbbTV application (cf. Info Box 1.6). For the test, the Das Erste app was chosen because it allows a navigation via color and number keys as well as video control via the media keys on the remote. Furthermore, this app covers the areas of program guide (EPG), video on demand (VoD), and digital text. The test was conducted at the observation lab of the Mainz University of Applied Sciences.

### Devices Tested
- Philips (47PFL7008K/12)
- Samsung (UE46F7090SL)
- Sony (KDL-50W805B)
- Toshiba (50L7363D)

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**Figure 1.4: Test infrastructure of the hardware test**
1.7 TASKS OF THE HARDWARE TEST

The test supervisor gave the subjects four tasks, one after another, which they had to solve on three different devices. The last of the four tasks had to be solved on only one device. In addition, the subjects were given a brief introduction into HbbTV before the first task. Since the tasks were identical for all three devices, the subjects were already familiar with the application’s navigational logic when they operated the second and third devices. The evaluation of software and hardware was thus separated. Since the software’s logic was now familiar to the subjects, their subsequent actions allowed the testers to draw conclusions on the usability of the hardware, namely the TV sets and their corresponding remote control units.

Task Rotation
In order to prevent a distortion of the results due to the sequence of the devices, the sequence of the devices was altered for each of the subjects according to the rotation scheme in Table 1.3.

Tasks

Introduction
• The main subject of this test is HbbTV. HbbTV offers you the option to retrieve extra content from the Internet – such as video clips, information on the current programming, or an enhanced teletext – in addition to the TV program you are watching.

Task 1a – Access HbbTV
• Please try to access such an HbbTV service (pointing out Red Button after 1:30 min.).

Task 1b – Free HbbTV Browsing
• Please try, during the next three minutes, to find as many options to interact with the HbbTV services of the TV channels stored under positions one through eight by using your remote control.

Task 2 – Accessing VoD and Operating Controls within a Video
• Please switch to Das Erste now, which is stored in position 1, and launch the HbbTV application.
• Please run the program Elefant, Tiger & Co., broadcast yesterday at 16:10 hrs., in full-frame mode (subject is given an index card as a reminder).
• Please fast-forward the video to a position approximately 20 minutes into the program.
• Please pause the video. Please resume playback.
• Please stop the video and restart it from the beginning.

Task 3 – Switching Applications
• Please start the video via the video library/EPG (depending on how the subject found the video).
• Please return to the task bar.

Task 4 – Connecting Devices to the Internet (with only one device)
• Please change the type of connection on this device from LAN to WLAN (wireless LAN).
<table>
<thead>
<tr>
<th>Subject #</th>
<th>1st device</th>
<th>2nd device</th>
<th>3rd device</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Toshiba</td>
<td>Sony</td>
<td>Philips</td>
</tr>
<tr>
<td>2</td>
<td>Philips</td>
<td>Samsung (keypad)</td>
<td>Sony</td>
</tr>
<tr>
<td>3</td>
<td>Sony</td>
<td>Toshiba</td>
<td>Samsung (keypad)</td>
</tr>
<tr>
<td>4</td>
<td>Toshiba</td>
<td>Sony</td>
<td>Philips</td>
</tr>
<tr>
<td>5</td>
<td>Philips</td>
<td>Samsung (keypad)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Sony</td>
<td>Philips</td>
<td>Samsung (keypad)</td>
</tr>
<tr>
<td>7</td>
<td>Samsung (touchpad)</td>
<td>Sony</td>
<td>Philips</td>
</tr>
<tr>
<td>8</td>
<td>Philips</td>
<td>Samsung (touchpad)</td>
<td>Sony</td>
</tr>
<tr>
<td>9</td>
<td>Sony</td>
<td>Toshiba</td>
<td>Samsung (touchpad)</td>
</tr>
<tr>
<td>10</td>
<td>Samsung (touchpad)</td>
<td>Philips</td>
<td>Toshiba</td>
</tr>
<tr>
<td>11</td>
<td>Toshiba</td>
<td>Samsung (touchpad)</td>
<td>Sony</td>
</tr>
<tr>
<td>12</td>
<td>Philips</td>
<td>Toshiba</td>
<td>Samsung (touchpad)</td>
</tr>
<tr>
<td>13</td>
<td>Philips</td>
<td>Samsung (keypad)</td>
<td>Toshiba</td>
</tr>
<tr>
<td>14</td>
<td>Sony</td>
<td>Toshiba</td>
<td>Samsung (keypad)</td>
</tr>
</tbody>
</table>

*Table 1.3: Rotation scheme hardware test*
1.8 SUBJECTS OF THE HARDWARE TEST

In total, four[teen]e subjects were recruited by a recruiting agency (eResult – Research & Consulting GmbH, Göttingen) according to the selection criteria listed in the table below.

<table>
<thead>
<tr>
<th>SELECTION CRITERIA</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex and Age</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>n=(5)</td>
</tr>
<tr>
<td>under 30</td>
<td>2</td>
</tr>
<tr>
<td>30–49</td>
<td>2</td>
</tr>
<tr>
<td>over 49</td>
<td>1</td>
</tr>
<tr>
<td>Male</td>
<td>n=(9)</td>
</tr>
<tr>
<td>under 30</td>
<td>2</td>
</tr>
<tr>
<td>30–49</td>
<td>5</td>
</tr>
<tr>
<td>over 49</td>
<td>2</td>
</tr>
<tr>
<td>Education</td>
<td>all levels</td>
</tr>
<tr>
<td>Prior Knowledge</td>
<td></td>
</tr>
<tr>
<td>50% HbbTV novices</td>
<td></td>
</tr>
<tr>
<td>• No HbbTV experience</td>
<td></td>
</tr>
<tr>
<td>• Basic teletext knowledge required</td>
<td></td>
</tr>
<tr>
<td>50% HbbTV experts</td>
<td></td>
</tr>
<tr>
<td>• Basic teletext knowledge required</td>
<td></td>
</tr>
<tr>
<td>• Using HbbTV services at least once a week</td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td>all brackets</td>
</tr>
</tbody>
</table>

*Table 1.4: Selection criteria hardware test*
1.9 METHODS OF THE HARDWARE TEST

Video Observation
The subjects as well as their answers to the test supervisor’s specific questions were recorded from two different camera angles and subsequently evaluated, documenting and analyzing the subjects’ processing as well as statements relevant to the study.

RC Puzzle
After the subjects had completed all their tasks, they were asked to assemble their ideal remote control from the control elements in Figure 1.5 and to explain their choices of individual components. In doing so, the subjects were also observed via video cameras, and their statements were documented.

Post-Test Questionnaire
In the final interview, the subjects’ motives and subjective assessments were inquired. For this purpose, photos of all remote control units used had been pictured on the questionnaires. Furthermore, the subjects were given the opportunity to test the remotes and the devices while filling out the questionnaire.

camera angle #1: subject
camera angle #2: monitor

Figure 1.5: Control elements of the remote controls
2.4. Sony

Bitte beurteilen Sie folgende Aussagen:

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Aussage</th>
<th>trifft voll und ganz zu</th>
<th>trifft zu</th>
<th>neutral</th>
<th>trifft nicht zu</th>
<th>trifft überhaupt nicht zu</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1.1</td>
<td>Die Fernbedienung ist handlich.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>2.4.2</td>
<td>Der Druckpunkt der Tasten reagiert optimal.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>2.4.3</td>
<td>Das Steuerkreuz dieser Fernbedienung ist gut positioniert.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>2.4.4</td>
<td>Die Farbbasten sind gut positioniert.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>2.4.5</td>
<td>Die Mediatasten (Play, Pause, Stopp) sind gut ausgerichtet.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>2.4.6</td>
<td>Die Programm- und Lautstärkenwippe ist gut ausgerichtet.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>2.4.7</td>
<td>Der Rückknopf ist gut positioniert.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>2.4.8</td>
<td>Eine generelle Übersichtlichkeit auf der Fernbedienung ist gegeben.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>2.4.9</td>
<td>Die Lesbarkeit der Tastenüberschriften ist gut gewählt.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>2.4.10</td>
<td>Die verwendeten Symbole bzw. die Tastenbeschriftung sind leicht zu verstehen.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

2.4.11. Welche Beschriftungen bzw. Symbole finden Sie nicht selbsterklärend? ________

________________________________________________________________________________
________________________________________________________________________________
________________________________________________________________________________

Figure 1.6: Sample excerpt from the questionnaire
Eight applications were tested on one device. In this chapter, we will present the results and the recommendations for action derived.

### Contents
- Services Available
- Access
- User Interfaces
- Navigation between Applications
- Navigation within Applications
- Presentation of Content

### 2.1 AVAILABLE SERVICES
The TV broadcasters’ HbbTV services can be categorized by strategy as follows:
- Selection Strategy: focus on one application (e.g. ZDF)
- Option Strategy: several equal applications (e.g. ProSieben)
- Focus Strategy: several applications, one of which is highlighted (e.g. RTL)

Some subjects criticized the scope of options with broadcasters arte, ZDF, and RTL2. In general, no preferences for either of the strategies could be established.

“Too little information, too compact, I would have liked more information.” *subjects 1, 7, 11*

### 2.2 ACCESS
In the examination of the task bars, **two distinct viewing patterns** were identified by means of the eye-tracking analysis.

#### Wide Focus
Figure 2.1 shows the task bars used by ProSieben, RTL, and ZDF, plus a “heat map” that visualizes an accumulation of all points of gaze of the subjects who saw this task bar.

It shows that the points of gaze are spread across the entire width of the task bar, which means that the subjects visually scanned the entire task bar while looking at it.

#### Narrow Focus
Figure 2.2 shows the task bars used by broadcasters Das Erste, arte, and RTL2, also visualizing the accumulated points of gaze in a “heat map.” In these three task bars, the points of gaze are clearly more concentrated and not spread across the entire width. On the one hand, for arte and RTL2, this may be due to the fact that the elements of the task bar are actually located closer to the center; on the other hand, it may be attributed — e.g. for Das Erste — to the drop-down menu at the center, which serves as a visual anchor point for the user and focuses his/her gaze.
Figure 2.1: Task bars with wide focus area

Figure 2.2: Task bars with narrow focus area
Rating by the Subjects
In the post-test questionnaire, the task bars were rated by the subjects according to the following criteria:
- clarity
- ease of use
- operating options

As seen in Table 2.1, there is a slight preference for dynamic task bars in comparison to static ones. The dynamic task bars of ARD and ZDF received particularly high ratings. Among the static task bars, RTL2 was rated significantly higher than arte.

In total, the rating was positive across the board for all broadcasters. Considering the two task bars with exceptionally high grades, it is apparent that they are graphically consistent throughout. This fact was perceived as pleasant by the subjects and had a positive effect on their ratings.

<table>
<thead>
<tr>
<th>Das Erste (dynamic)</th>
<th>ZDF (dynamic)</th>
<th>ProSieben (dynamic)</th>
<th>RTL (dynamic)</th>
<th>ARTE (static)</th>
<th>RTL2 (static)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.56</td>
<td>1.56</td>
<td>2.00</td>
<td>1.89</td>
<td>2.78</td>
<td>1.72</td>
</tr>
</tbody>
</table>

Table 2.1: Task bar rating
[rating on a five-point scale: 1 = very good, 5 = less good]
2.3 USER INTERFACES

In the post-test survey, the user interface types shown in Figures 2.4 and 2.5 were rated by the subjects according to the following criteria:

- clarity
- ease of use
- operating options
- suitability for search of video content
- suitability for browsing video content
- orientation

**Clarity**
Clarity should be enhanced by a uniform and consistent graphic design.

**Short Text**
Short, yet easy-to-read text enhances clarity.

**Reference Points**
Dynamic task bars should include reference points (e.g. drop-down menu for Das Erste, set anchor mark at the first item)

![Recommended actions](image)

**Figure 2.4: Overview of interface types**

![Interface types](image)
Figure 2.5: Interface types with examples
The results in Table 2.2 show that all navigation models tested worked very well. None of the models identified received a negative rating. The highest-rated models were columns (1.6) and tiles (1.7), the lowest-rated lists (2.3).

**Recommendation for Action**

The recipients felt particularly comfortable with tiles and columns. Columns are particularly suitable for applications with a great navigational depth (many hierarchy levels). The subjects in this test indicated that this model gave them the best indication of the navigational level they were on.

### 2.4 SWITCHING BETWEEN APPLICATIONS

As shown above, the broadcasters’ HbbTV services frequently comprise several applications. Two overall navigation logics were identified. Some of the broadcasters tested (Das Erste, RTL2, arte) offer switching between apps both via the task bar and directly from the apps. Since the apps are thus cross-linked to each other, the latter type is referred to as **cross-linked navigation** (cf. top part of Figure 2.6).

Other broadcasters tested do not allow a direct switch between apps. The apps are thus **autonomous** (cf. bottom part of Figure 2.6).

Here are the broadcasters which offer cross-linked navigation:

<table>
<thead>
<tr>
<th>TWO-AXES</th>
<th>LIST</th>
<th>TILES</th>
<th>SEGMENTED FULL FRAME</th>
<th>COLUMNS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>2.3</td>
<td>1.7</td>
<td>2.0</td>
<td>1.6</td>
</tr>
</tbody>
</table>

*Table 2.2: Interface model rating*

[rating on a five-point scale: 1 = very good, 5 = less good]
Das Erste

Figure 2.7 plots a typical gaze for one of the subjects, with the circles visualizing the points of gaze. The numbers inside the circles indicate the sequence, the size of the circles the duration of the gaze.

Figure 2.7: Gaze plot subject 3
Task: “Please switch to the Electronic Program Guide (EPG) of Das Erste.”
For RTL2, the analysis of the eye-tracking data also shows that switching between applications works well. The search processes for the correct menu took between 2 and 19 seconds and were thus also quite brief.

### Info Box 2.1

Das Erste:
Search process between 4 and 15 seconds

It is conspicuous that (nearly) all subjects first took a look into the main menu and only afterwards moved down to the color navigation, which contains the “EPG” menu item they are looking for (cf. Figures 2.8 and 2.9). The color navigation shows quite a large external plurality (between channels) and also an existing internal plurality (within the channel).
It is conspicuous that here most subjects first searched in the color navigation, before moving their gaze up to the main menu, which actually contains the menu item they are looking for (cf. Figures 2.10 and 2.12.). For interpretation, it is relevant that the starting point of the preceding task was very close to the menu item in ques-

Figure 2.10: Navigational options RTL2

RTL2: Search process between 2 and 19 seconds

Info Box 2.2

Figure 2.11: Gaze plot subject 1 “Please launch the game ‘TV Solitaire.’”

Figure 2.12: Heat map for subjects 1, 2, 10, 11, 12 Task: “Please launch the game ‘TV Solitaire.’”
tion. This explains, on the one hand, the very short search period of 2 seconds and, on the other hand, the elliptical area of gaze, which links the menu item in question to the starting point.

**arte**

For arte, the analysis of the eye-tracking data also shows that switching between apps works very well and that the corresponding links are being looked for by the subjects. The search processes for the correct menu only took between 1 and 6 seconds in this case.

The very brief search processes may be explained by the fact that for the application we tested, no navigational elements other than the color navigation were available. Figures 2.13 and 2.14 show very clearly how the gazes of the subjects focus on this menu.

**Info Box 2.3**

The search process between 1 and 6 seconds

**Figure 2.13: Navigational options arte**

**Figure 2.14: Heat map for subjects 1, 8, 9, 10, 11**

Task: “Please run the video on the Michael Reis Quartet concert at the ‘Like a Jazz Machine’ festival on 2014-05-14.”
Figure 2.15: Gaze plot subject 9
Task: “Please run the video on the Michael Reis Quartet concert at the ‘Like a Jazz Machine’ festival on 2014-05-14.”

<table>
<thead>
<tr>
<th>Very important</th>
<th>Important</th>
<th>Not important</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>6</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 2.3: Rating of the importance of cross-linked navigation by the subjects (n=11)

Importance of Cross-Linked Navigation for the User

In the post-test interview, the subjects were asked how important direct links between two apps were to them personally. Only two of the subjects considered direct links between apps unimportant, six subjects considered them important, and three even very important (n=11). Ten out of eleven subject regarded saving time and navigating faster as the greatest benefit of this direct navigation.

“You can simply move ahead faster and don’t have to go back circuitously, in order to select another menu item.”

subject 3

Info Box 2.4

Direct navigation options were important to the subjects.

Benefits:
Saving time and navigating faster
Direct links between different applications should be offered whenever possible (e.g. as a shortcut).

For the use of the color keys, internal plurality (inconsistent use of the keys within one channel) should be avoided in the color allocation at any rate.

If two applications already offer contentual connections, direct links should be set (e.g. program preview and VoD offers).

The color keys should be used for switching between core applications. A consistent key allocation across all channels (low external plurality) would be desirable.

Alternatively, links in the form of menu items may also be used.

When applying numerical keys, it should be taken into consideration that these may not be available at all or only in inconvenient ways, e.g. on devices with a touchpad remote control.
2.5 NAVIGATION WITHIN APPLICATIONS

After the navigation between applications was addressed in the previous subchapter, the focus will now be on the navigation within the applications. Three of the problems concerned broadcasters, a fourth one the position of the cursor.

<table>
<thead>
<tr>
<th>Task</th>
<th>Das Erste</th>
<th>ZDF</th>
<th>ProSieben</th>
<th>RTL</th>
<th>ARTE</th>
<th>RTL2</th>
<th>QVC</th>
<th>Sonnenklar.tv</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>1+2</td>
<td>2</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 2.4: Number of tasks that could not be solved without assistance (n = 6 subjects × 2 tasks = 12 tasks per channel)

Altogether, the internal navigation was expedient with all broadcasters. However, some of the subjects had problems with the following three tasks:

**Sonnenklar.TV**

“From the current offers and from the top sellers, please tag one trip each as a favorite.”

**Problem:** The “mark as favorite” function was not found. The function was located on the green color key.

**ZDF**

“Have all the programs on health and medicine displayed in the video library.”

**Problem:** The “Themes” menu was not found.

**arte**

“Please run the video on the Michael Reis Quartet concert at the ‘Like a Jazz Machine’ festival on 2014-05-14.”

**Problem:** The video was searched in “arte+7,” not under “concert.”

**Cursor Position**

Problems also occurred when subjects “lost” their cursor and were unable to identify their current position or which elements they could select next.

Frequently, the subjects were only able to find the position of their cursor again by randomly operating the D-pad controls.

**Recommendation for Action**

It should be ensured that the user can identify the current position of the cursor at all times and know which elements they may select next.
Rating by the Subjects

In the post-test survey, the navigation within the applications was rated by the subjects according to the following criteria:
• simplicity
• clarity
• information content
• intuitive operation
• visual presentation
• comfort of use

The result of this ratings is presented in Table 2.5. The navigational structure of Sonnenklar.TV in particular was praised by the subjects for its simplicity and clarity.

“Very simple, and it is easy to find one’s way around.”

subject 10

“Very ‘simple’ design. Very good overview.”

subject 4

The navigational structure of Das Erste was also well received by the subjects due to its clarity and the successful graphic design.

### Return Key

Navigation in HbbTV was not always consistent. The return key on the remote control only led back to the uppermost level of the applications, but not back to the task bar, which the subjects could only access by pressing the “zero” numerical key on their remote. Even though this is indicated in the menu, as highlighted in Figure 2.16, subjects were confused by this digression from the navigation pattern and had to look for this function first.

<table>
<thead>
<tr>
<th>Das Erste</th>
<th>ZDF</th>
<th>Pro Sieben</th>
<th>RTL</th>
<th>ARTE</th>
<th>RTL2</th>
<th>QVC</th>
<th>Sonnenklar.tv</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.7</td>
<td>2.2</td>
<td>2.3</td>
<td>2.1</td>
<td>3.0</td>
<td>2.3</td>
<td>1.8</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Table 2.5: Rating of navigation within the applications  
[rating on a five-point scale: 1 = very good, 5 = less good]

Figure 2.16: Color and numeric navigation ARD EPG for Das Erste
In the post-test questionnaire, the presentation of content was rated according to the following criteria:

- information
- arrangement/sorting
- identification of multimedia content
- recognizability of content
- visual presentation

In this category, Sonnenklar.TV and Das Erste also received the highest ratings. With arte, the main point of criticism was that not all information was provided and that the arrangement of the content lacked a certain logic.

### Table 2.6: Rating of presentation of contents
[rating on a five-point scale: 1 = very good, 5 = less good]

<table>
<thead>
<tr>
<th></th>
<th>Das Erste</th>
<th>ZDF</th>
<th>Pro Sieben</th>
<th>RTL</th>
<th>ARTE</th>
<th>RTL2</th>
<th>QVC</th>
<th>Sonnenklar.tv</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.4</td>
<td>2.4</td>
<td>2.0</td>
<td>1.6</td>
<td><strong>2.6</strong></td>
<td>2.2</td>
<td>1.9</td>
<td><strong>1.4</strong></td>
</tr>
</tbody>
</table>

**2.6 PRESENTATION OF CONTENT**

The return key should be available to the user on all navigational levels of the application.

**Complexity**

The navigational structures should be kept as complex as necessary but as clear and simple as possible. The subjects preferred few menu items and simple graphics.

**Recommendations for Action**

**Handlungsempfehlung**

Playable media content should be clearly marked as such. Moreover, auto-run of content should be avoided, in order to leave the user in control.
Figure 2.17: Presentation of content on RTL

Figure 2.18: Presentation of content on Das Erste

Figure 2.19: Presentation of content on Sonnenklar.TV
3. H ARDWARE TEST

One application was tested on four devices. In this chapter, we will present the results and the recommendations for action derived.

Contents
- Outline
- D-Pad
- Media and Color Keys
- Volume and Channel Rockers
- Remote Control Special Keys
- Clarity and Manageability of the Remote Control
- Ideal Remote Control
- Performance and Feedback
- Device Configuration

3.1 OUTLINE

Out of the 240 subtasks given, only nine were aborted. The high percentage of completions proves the effectiveness of the remote controls in use. Furthermore, it shows that all subjects were able to familiarize themselves quickly with the various RC units and solve their tasks. The aggregated ratings for all remote controls resulted in a very condensed field, as shown in Table 3.1. The overall rating covers the following aspects:
- feel
- positioning of keys
- clarity
- legibility of labels
- imagery used

3.2 D-PAD

The D-pad in Figure 3.1 was the one most frequently used by the subjects for their ideal remote. This was explained by the good feel, the clear

Table 3.1: Rating of remote controls by the subjects
Average rating of all quantitative questions in the Post-Test Survey [rating on a five-point scale: 1 = very good, 5 = less good]
and easy-to-understand key arrangement and a generally uncluttered keypad. In nearly all the cases, the subjects placed the D-pad in a central position.

**Touch-D-Pad**

The touch panel, which replaced the key-D-pad on the remote, was viewed with skepticism and was thus an element that was rarely used. Three subjects integrated it into their ideal remote, one of them, however, only as an extra option in addition to the key-D-pad.

On closer view, the touchpad remote was the one most frequently criticized. Six of the 13 subjects stated that they missed certain keys: four of them missed the numeric pad, two the media keys (multiple choices were allowed).

**Learning Effects**

The longer the subjects used the remote controls, the more they felt at ease with their operation. A comparison of the average times used to complete tasks 2 and 3 – in Table 3.2 – shows the learning curve. This effect was particularly pronounced with regard to the touchpad remote: In the second operation, subjects were 2:20 minutes faster than during the first.

**Pronounced Learning Effect with the Touchpad Remote Control**

---

**Recommendations for Action**

**D-Pad Position**

The D-pad should be located in a central position on the remote control.

**D-Pad Feel**

Das D-pad should feel different than the surrounding keys.

---

**Table 3.2: Learning Effects**

<table>
<thead>
<tr>
<th></th>
<th>Average (all) Task 2</th>
<th>Average (all) Task 3</th>
<th>Average (touchpad) Task 2</th>
<th>Average (touchpad) Task 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run video</td>
<td>1:56 (n=39)</td>
<td>1:35 (n=35)</td>
<td>3:55 (n=5)</td>
<td>1:35 (n=4)</td>
</tr>
</tbody>
</table>

Task 2: Run video (either directly from the video library or via EPG). Mean value across 39 operations (in minutes)

Task 3: Run video via the alternative method (EPG or video library, depending on method chosen in Task 2). Mean value across 39 operations (in minutes)
D-PAD

3.3 MEDIA AND COLOR KEYS

Media Keys
Nearly all subjects used the remote controls’ media keys to navigate within the videos (Task 2.2: Fast-forward to 20:00; Task 2.3: Pause video playback; Task 2.4: Restart video playback). The on-screen control elements offered via HbbTV were often used for try-out only or after a hint from the test supervisor. This trend is supported by the RC puzzle: 13 of the 14 subjects integrated media keys into their ideal remote.

Color Keys
The color keys were presented in different ways on the various remote controls. They included solid and partial coloration, sometimes with additional labeling. Most of the subjects preferred the solid colors, because they were easier to identify. The subjects considered the labeling of the keys (A, B, C, D) rather confusing.

Dual Use
In some cases, the color keys had been assigned additional functions specific to the device. In many cases, they were activated before the HbbTV app had loaded completely. In these cases, pressing the keys opened certain TV menus, which the subjects had not expected. They found this dual use irritating.

D-Pad Surroundings
It is advisable not to place too many other keys in the immediate vicinity of the D-pad.

Second Remote
In order to address users who are happy to try out new things and in order to make use of learning effects, a second, innovative remote control may be added as an alternative.

Recommendations for Action

Dual Use
A dual assignment of the color keys should be avoided.

Color Design of Color Keys
The color keys should be in solid colors and unlabeled, if possible.
3.4 VOLUME AND CHANNEL ROCKERS

The subjects preferred vertical rockers positioned near the outer edge of the remote control. Additional keys, such as the mute key, were positioned between the volume and the channel rocker. In the questionnaire, rockers that were easy to feel without looking received better grades.

Figure 3.2: Easy-to-feel volume and channel rocker

Figure 3.3: Volume and channel rocker with extra keys

3.5 REMOTE CONTROL SPECIAL KEYS

As a standard, only a limited number of keys on a remote control are assigned to HbbTV apps: D-pad, return key, media and color keys, plus the numeric pad.

Many remote controls have additional keys, e.g. a keypad on the back (Figure 3.4) or special “home” keys. The subjects were confused when those keys were not available in the HbbTV app, or when pressing the key led them into menus that were specific to the device at hand. Especially from the “home” key, subjects initially expected a return to the task bar of the HbbTV app or to regular broadcast programming.

Figure 3.4: Remote control with reverse-side keypad

Figure 3.5: Addressable keys

Keys addressable and usable by HbbTV

Keys recognized by HbbTV – however, input is processed by device
3.6 CLARITY AND MANAGEABILITY OF THE REMOTE CONTROL

The clarity of the remote controls was rated nearly equal. The size of the RC unit was one of the factors that affected clarity. The subjects also found it clearer if labels were printed onto the key itself, rather than above or below. They also found them clearer when the labels were offset and had a good color contrast with the key color, and when most of the keys had only a single function (Question 2.x.8: “A general clarity of the remote control exists”).

The size of the remote control also played a role for its manageability. Compared to clarity, however, size had the opposite effect in this respect: The smaller a remote control, the more manageable it was considered by the subjects (Question 2.x.1: “The remote control is manageable”).

3.7 IDEAL REMOTE CONTROL

From the five remote control units available, the subjects built their ideal remote controls. Figure 3.9 shows this ideal RC, as assembled from the individual preferred elements. The ideal remote shows – as did many of the subjects’ remote controls – a vertical segmentation into a TV segment with numeric pad, volume and channel rockers, and a media segment with D-pad, color and media keys.

Recommendation for Action

Size
The remote control should not be too large in overall size.
3.8 PERFORMANCE AND FEEDBACK

A good performance played a major role for the subjects. When device and HbbTV menus were available quickly and navigation was fluid, the subjects were able to perform their tasked quickly. When loading delays occurred, however, the subjects found it useful when they were visualized clearly. This visualization prevented impatient multiple inputs as well as insecurities in operation.

3.9 DEVICE CONFIGURATION

Switching the devices from a wired Internet connection (LAN) to a wireless connection (WLAN) was performed in 2:34 minutes on average. Out of 13 executions of the operation, however, only eight were completed successfully. Five attempts were aborted after approximately seven minutes or stopped by the test supervisor when it became apparent that the subjects were clearly unable to cope. Four of the five aborted attempts related to a single device, which means that on one device, none of the subjects was able to locate the relevant menu and change the settings.

Feedback
Loading and waiting times should always be indicated clearly.

Loading Times
Loading times should be kept as short as possible.

Recommendation for Action

Segmentation
The remote control should be clearly segmented and structured.
4 RECOMMENDATIONS FOR ACTION

This chapter summarizes the recommendations to TV broadcasters and device manufacturers as well as overall recommendations.

Contents
- Recommendations for TV Broadcasters
- Recommendations for Device Manufacturers
- Overall Recommendations

4.1 RECOMMENDATIONS FOR TV BROADCASTERS

Access

Clarity
Clarity should be enhanced by a uniform and consistent graphic design.

Short Text
Short, yet easy-to-read text enhances clarity.

Reference Points
Dynamic task bars should include reference points (e.g. drop-down menu for Das Erste, set anchor mark at the first item).
**User Interfaces**

**Preferred Models**
The recipients felt particularly comfortable with tiles and columns. Columns are particularly suitable for applications with a great navigational depth (many hierarchy levels). The subjects in this test indicated that this model gave them the best indication of the navigational level they were on.

**Navigation within Applications**

**Cursor Position**
It should be ensured that the user can identify the current position of the cursor at all times and know which elements they may select next.

**Return Key**
The return key should be available to the user on all navigational levels.

**Complexity**
The navigational structures should be kept as complex as necessary but as clear and simple as possible. The subjects preferred few menu items and simple graphics.

**Presentation of Content**

**Media Content**
Playable media content should be clearly marked as such. Moreover, auto-run of content should be avoided, in order to leave the user in control.
Switching between Applications

**Links**
Direct links between different applications should be offered whenever possible (e.g. as a shortcut).

**Uniformity within a Channel**
For the use of the color keys, internal plurality (inconsistent use of the keys within one channel) should be avoided in the color allocation at any rate.

**Contentual Connections**
If two applications already offer contentual connections, direct links should be set (e.g. program preview and VoD offers).

**Color Keys**
The color keys should be used for switching between core applications. A consistent key allocation across all channels (low external plurality) would be desirable.

**Alternative to Color Keys**
Alternatively, links in the form of menu items may also be used.

**Numerical Keys**
When applying numerical keys, it should be taken into consideration that these may not be available or at all or only in inconvenient ways, e.g. on devices with a touchpad remote control.
4.2 RECOMMENDATIONS FOR HARDWARE MANUFACTURERS

D-Pad

D-Pad Position
The D-pad should be located in a central position on the remote control.

D-Pad Feel
Das D-pad should feel different than the surrounding keys.

D-Pad Surroundings
It is advisable not to place too many other keys in the immediate vicinity of the D-pad.

Second Remote
In order to address users who are happy to try out new things and in order to make use of learning effects, a second, innovative remote control may be added as an alternative.

Color Keys

Dual Use
A dual assignment of the color keys should be avoided.

Color Design of Color Keys
The color keys should be in solid colors and unlabeled, if possible.
Clarity and Manageability of the Remote Control

Segmentation
The remote control should be clearly segmented and structured.

Size
The remote control should not be too large in overall size.

4.3 OVERALL RECOMMENDATIONS

Performance and Feedback

Feedback
Loading and waiting times should always be indicated clearly.

Loading Times
Loading times should be kept as short as possible.

Media Keys

Video Control
Media keys should continue to be available on the remote control unit. Nevertheless, on-screen control elements should be designed more attractively.
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