In-vehicle UI standards

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Tutorial at:

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Automotive User Interfaces and Interactive Vehicular Applications
(Automotive UI 2012)

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October 17, 2012

There are 5 basic questions to be examined.

1. What kinds of documents guiding and requiring vehicle testing and design exist?
2. What is in a typical standard?
3. How does one find them?
4. How are they created and how does research have influence their content?
5. Which standards exist that affect driver interface and driver assistance systems?
   US DOT (FMVSS, visual manual guidelines, NCAP)
   ISO
   SAE
   ITU
The terms used to refer to standards and related documents have different meanings.

- Information Report
- Recommendation (Design, Technical, etc.)
- Recommended Practice
- Guideline
- Best Practice
- Consensus Practice
- Rule

- Standard
- Requirement
- Specification
- Code of Practice
- Regulation (executive branch)
- Law (legislative branch)

“Standards” differ on several dimensions.

- Who creates it and their process
government, SDO, any organization who has input
- National vs. International
- Availability (public vs. secret)
- Design, Performance, Process
  bumper example, outlet example
- Criteria
- Authority (should vs. shall/must)
- Enforcement (type approval)
What is in a typical standard?

Example: SAE Recommended Practice
Navigation and Route Guidance Function Accessibility While Driving (SAE J2364), 2004
(aka “15 second rule”)

Obtaining standards is not easy and is costly.

document is in the SAE Handbook
(often found in an engineering library)

purchase from SAE
13 pages ($65, SAE member $52 to $58.50)

There is usually a 1 paragraph introduction
that says why the standard is needed.

Introduction

Navigation and Route Guidance Systems have some functions that can take significantly more time to use than conventional controls and displays such as the headlights, windshield wipers, … (Kurokawa,…)

…Consequently, there are concerns that interacting with navigation and route guidance systems could unduly distract drivers …
The scope describes what the standard covers and, sometimes, what it does not cover.

This … applies to both Original Equipment Manufacturer and aftermarket route-guidance and navigation system functions for passenger vehicles. It establishes … which navigation functions should be accessible to the driver while the vehicle is in motion. These methods apply only to the presentation of visual information and the use of manual control inputs …

The … Practice does not apply to visual monitoring tasks … such as route following. Voice-activated controls or passenger operation of controls are also excluded.

You may also need copies of the normative references (referenced requirements), several of them.

Normative References for J2364

J287   Driver Hand Control Reach
J1050  Describing & Measuring the Driver’s Field of View
J2396  Driver Visual Behavior Using Video Based Techniques
J2365  Calculation of the Time to Complete In-Vehicle Navigation and Route Guidance Tasks

Example:
Accessible = within reach of the unconstrained driver as defined by SAE J287; and 2. the display is visible with head movement as defined by SAE J1050; and …

Also, numerous definitions (17 in J2364); definitions stds.
J2364 specifies 2 methods. Use 1.

Static Method - … a sample of subjects, after practice, completes each task of interest several times using a stationary vehicle … with a functioning or simulated driver interface. … The total time .. is … from the time the subject begins the task until the task is completed.

Interrupted Vision Method - …

Details are omitted here to save time.

Open 1.5 s, closed 1.5 s

The procedure is quite detailed.

Operational hardware in design location

Subjects (10) must be

* Licensed drivers not familiar with, or technically knowledgeable about, the specific driver interface under investigation
* Capable of operating the … interface … & completing the test
* 45 to 65 years of age

Prior to testing, each subject shall be trained in the use of the driver interface and the task ... Following training ... each subject will be given 5 practice trials for each task prior to testing.
This standard has criterion. Many do not.

Total task time
sum of log of times < log 15
 task < 5 s is excluded

Interrupted vision
sum of log of shutter open time < log of 20

Who develops standards and how
The U.S. (federal) government follows the Administrative Procedure Act.

All executive departments and independent agencies covered

HF related regulations/rule making examples

<table>
<thead>
<tr>
<th>Agency</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPSC</td>
<td>toys, jet skis, off-road vehicles</td>
</tr>
<tr>
<td>DOL - OSHA</td>
<td>machine guarding, ergonomics</td>
</tr>
<tr>
<td>DOT FAA</td>
<td>hours of service</td>
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<tr>
<td>DOT FMCSA</td>
<td>control tower ops, aircraft spacing, passenger evac.</td>
</tr>
<tr>
<td>DOT NHTSA</td>
<td>driver distraction</td>
</tr>
<tr>
<td>FDA</td>
<td>medical devices, drug labels</td>
</tr>
<tr>
<td>NRC</td>
<td>plant design (control room, work standards, etc.)</td>
</tr>
</tbody>
</table>
How I think the Admin. Procedure Act works.

1. Internal agency discussion (gather data, authority (Congress can request & fund), no organizational conflict, …)
2. Notice of Proposed Rulemaking (NPRM, Federal Register)
3. Responses from anyone (companies, individuals, trade assn.)
4. Comment summary published (Federal Register)
5. Notice of public hearing (Federal Register, anyone can present, usually DC)
6. Modify rules & feedback
7. Publish of final rule (Federal Register)
8. Often legal action

years to get input & reach agreement
other governments may be different

Recognized standards development organizations have an open process, utilize recognized technical experts, avoid conflicts of interest, and work to build a consensus.

Professional organizations
HFES, SAE, ASME, IEEE, etc.

National standards organizations
ANSI, BSI, DIN, etc.

International standards organizations
ISO, ITU, IEC, etc.

standards
$, £, ¥, €
The International Standards Organization (ISO) is the largest standards development organization. (iso.org)

264 Technical Committees
Examples:
JTC1 - Information technology
TC8 - Ships and marine technology
TC17 – Steel
TC20 – Aircraft & space vehicles
TC22 – Road vehicles
TC34 – Food products
TC45 – Rubber and rubber products
TC61 – Plastics
TC159 - Ergonomics

Every technical committee has a secretariat (country/org that manages it), a convener (technical leader = chair) and many subcommittees.

ISO TC22 Road Vehicles (AFNOR)
19 subcommittees, 7 working groups,
~20 liaisons (TC204 – ITS)

Examples
SC1 – ignition equipment
SC2 – braking systems and equipment
SC3 – electrical and electronic equipment
SC9 – vehicle dynamics and road handling ability
SC11 – safety glazing materials
SC12 – passive safety crash protection systems
SC13 – Ergonomics applicable to road vehicles
SC17 - visibility
ISO Technical Committee 22/Subcommittee 13 (ISO TC22/SC13) Working Groups

WG 3 – Localization of controls and tell-tales
WG 5 – Symbols
WG 7 – Hand reach & R & H point determination
WG 8 – TICS on-board – MMI (telematics)

Working groups & subcommittee meetings ~ 1 week, twice / yr
Location varies (Paris, London, Munich, Stockholm, Turin, …)

Convener = John Shutko
SAE has secretariat, reports to

Members & membership fees

Standards of Interest to the Automotive User Interface Community (ISO TC 22/SC 13/WG 8)

<table>
<thead>
<tr>
<th>Document</th>
<th>Abbreviated Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Std 15005:2002</td>
<td>Dialogue management principles and compliance</td>
</tr>
<tr>
<td>Std 15006:2011</td>
<td>Auditory information specifications and compliance</td>
</tr>
<tr>
<td>Std 15007 (2 parts)</td>
<td>Visual behavior measurement</td>
</tr>
<tr>
<td>Std 15008:2009</td>
<td>Legibility</td>
</tr>
<tr>
<td>Std 16673:2007</td>
<td>Occlusion method to assess distraction</td>
</tr>
<tr>
<td>Trial Std 16951:2004</td>
<td>Message priority</td>
</tr>
<tr>
<td>Std 17287:2003</td>
<td>Suitability of interfaces while driving</td>
</tr>
<tr>
<td>Std 26022:2010</td>
<td>Lane change test to assess distraction</td>
</tr>
</tbody>
</table>
The ISO Process (Road vehicle ergonomics)  TF>WG>SC>TC

national delegation requests a standard on some topic
NWI (New Work Item) discussed at several WG meetings
If >1/2 SC/TC P approve & 5 commit then NP (New Project)
    NWI (New Work Item), TF (task force), 3 yr clock starts
TF meets every 6 months & drafts standard (report up)

Who are the delegates (#, expertise, employers, long-term)
What happens in meetings (language, UN, technical/politics),
Who votes & comments on what
See: http://www.iso.org/iso/home/standards_development.htm

How does research influence the content of standards?
Availability & amount matter (0, 4-5, >10 publications).

Initial consideration by authors in working group
  do they know about the research prior starting standard
    send key people copies
    send the committee copies -> assigned a document #
  can they find it when search the internet
    include the standard name and # in keywords in research
    include the standard in the article/report reference list

Review process
  does a reviewer or committee member say to include
    an article or report as a reference
How to find human factors/ergonomic standards

1. Use the ppt from this presentation!

2. Look at standards development organization (ISO, ITU, SAE, etc.) web sites

3. Use Google only as a last resort. unlikely to be found by Google you may not know the terms to use

1. Go to ISO.org

2. Click on Standards Development
3. Click on Technical Committees

4. Scroll down the list to find the relevant committees. They are TC 22, TC 159, and TC 204.
5. Click on TC 22.

735 standards published

6. Click on work programme.
7. Click on published standards.

8. Click on SC 13 (Ergonomics).

9. Scroll through the list to find relevant standards.
10. When you find a standard you think is of interest, click on it.

The lack of details and cost are problems. (CHF 80 = $86)
So, usually you need some guidance from a standards expert about what is in each standard, and a friendly librarian who will buy the standards.

<table>
<thead>
<tr>
<th>Document</th>
<th>Abbreviated Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Std 15622:2010</td>
<td>Adaptive cruise control (ACC) performance requirements and tests</td>
</tr>
<tr>
<td>Std 15623:2002</td>
<td>Forward vehicle collision (FCW) warning performance requirements and tests</td>
</tr>
<tr>
<td>Std 17361:2007</td>
<td>Lane departure warning (LDW) systems performance requirements and tests</td>
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<tr>
<td>Draft Std 17387:2008</td>
<td>Lane change decision aid systems (LCDAS) performance requirements and tests</td>
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<tr>
<td>Std 22178:2009</td>
<td>Low speed following (LSF) systems performance requirements and tests</td>
</tr>
<tr>
<td>Std 22179:2009</td>
<td>Full speed range adaptive cruise control (FSRA) systems performance requirements and tests</td>
</tr>
<tr>
<td>Draft Std 22839</td>
<td>Forward vehicle collision systems—Operation and performance, requirements</td>
</tr>
<tr>
<td>Std 22840:2010</td>
<td>Extended-range backing aid systems (ERBA)</td>
</tr>
<tr>
<td>CD 26684</td>
<td>Cooperative intersection signal information and violation warning systems (CISIVWS)</td>
</tr>
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</table>
US Department of Transportation (US DOT), National Highway Traffic Safety Administration (NHTSA), Federal Motor Vehicle Safety Standards (FMVSS)

Most relevant examples for automotive UI


<table>
<thead>
<tr>
<th>101</th>
<th>Controls and displays</th>
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</thead>
<tbody>
<tr>
<td>111</td>
<td>Rear view mirrors</td>
</tr>
<tr>
<td>125</td>
<td>Motorcycle controls and displays</td>
</tr>
</tbody>
</table>

Others concern windshield wiping, brake hoses, tires and rims, roof crush, side impact protection, child restraints, etc. (~54 total)

Finding the NHTSA Visual-Manual Guidelines
(“voluntary” NHTSA Distraction Guidelines)

Search regulations.gov for docket NHTSA-2010-0053
Gives document, comments, notices, of hearings, etc. (125 documents)

Document = NHTSA-2010-0053-0009
www.regulations.gov/#!documentDetail;D=NHTSA-2010-0053-0009
Outline of NHTSA Visual-Manual Guidelines

Executive summary
Background and why
NHTSA research on measurement methods
Current distraction guidelines
Justification for sections in NHTSA guidelines
  Examples: Vehicle types, devices, tasks, lock outs, steering wheel controls, downward viewing angle, tests to consider, eye glance criteria, subject selection, occlusion protocol, errors
The guidelines

Methods Preferred by NHTSA

<table>
<thead>
<tr>
<th>Method Name</th>
<th>Acceptance Criteria</th>
</tr>
</thead>
</table>
| EGDS = Eye Glance Driving Simulator | 85% of glances < 2.0 s  
Mean glance < 2.0 s  
Total glance time < 12.0 s |
| OCC = Occlusion              | Total shutter open time < 9 s                  |
Other Methods Mentioned by NHTSA

<table>
<thead>
<tr>
<th>Step</th>
<th># task steps&lt;6</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS-BM=Driving Simulator with Benchmark</td>
<td>SD gap, 3 lane departures&lt;=benchmark</td>
</tr>
<tr>
<td>DS-FC=Driving Simulator w/Fixed Acceptance Criteria</td>
<td>Performance measures&lt;=acceptance values</td>
</tr>
<tr>
<td>DFD-BM=Dynamic Following in Driving Simulator with Benchmark</td>
<td>EGDS glance criteria + performance&lt;benchmarks (perform. incl SDLP, car following delay, % targets detected, visual response time)</td>
</tr>
<tr>
<td>DFD-FC=Dynamic Following in Driving Simulator with Fixed Criteria</td>
<td>Same as DFD-BM with fixed acceptance criteria</td>
</tr>
</tbody>
</table>

NHTSA Requirements for Subjects

<table>
<thead>
<tr>
<th>Women</th>
<th>Men</th>
<th>Age Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3</td>
<td>18-24</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>25-39</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>40-54</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>&gt;55</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

“The lower limit, 18 years of age, is due to concerns about testing with minors.”

“organizations may set an upper age limit (such as 65 years old) … if they can easily find … participants and they have health concerns about testing with elderly test participants.”
NHTSA Occlusion Test Protocol

Device in realistic location (fitted in buck or mockup)
Subjects are trained
Test per ISO 16673 (shutter open for 1.5 s, closed for 1.5 s)
  Start: Experiment triggers start when subject is ready
  End: when subject says done
Min of 1 practice and 1 test trial / subject
Computer records # open intervals
21/24 subjects must complete task
  in <= 6 open intervals (= 9.0 s open time)

NHTSA Eye Glance-Driving Simulator Protocol

| Simulator | Screen min 6.8 ft w x 4.5 ft h at >=15.4 ft  
            | (25 deg FOV, seems small)  
            | Record at >=30 Hz, Lag <=0.1 s  
            | inputs (steering wheel, brake pedal, throttle), vehicle  
            | (orientation and position, lane position, speed,  
            | lateral and longitudinal acceleration), gap  
            | Max 0.1 sec lag  
| Scenario  | Undivided 4 lane road, flat, posted at 55  
            | Lead vehicle at 50 mi/hr  
            | Drive >= 2 times, 1 with device, 1 without  
            | >=1 practice + 1 test trial  
| Criteria  | <=15% of device glances <=2.0 s  
            | 21/24 mean glance time <=2.0 s  
            | 21/24 total glance time <= 12.0 s  

### US DOT New Car Assessment (NCAP) Program

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<tbody>
<tr>
<td>US DOT FCW NCAP</td>
<td>Forward crash warning system test</td>
</tr>
<tr>
<td>US DOT LDW NCAP</td>
<td>Lane departure warning system confirmation test</td>
</tr>
<tr>
<td>US DOT ESC NCAP</td>
<td>Electronic stability control confirmation test</td>
</tr>
</tbody>
</table>

### SAE Standards and Recommended Practices from the SAE Safety and Human Factors Committee

In Google, type “SAE safety and human factors standards”

Click tab for documents

Click tab for work in progress
<table>
<thead>
<tr>
<th>Document</th>
<th>Shortened Name</th>
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<tr>
<td>J2364_200408</td>
<td>Navigation Function Accessibility While Driving</td>
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<tr>
<td>J2365_200205</td>
<td>Calculation of the Time to Complete In-Vehicle Navigation Tasks</td>
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<tr>
<td>J2395_200202</td>
<td>In-Vehicle Message Priority</td>
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<td>J2396_200007</td>
<td>Definitions and Measures Related Driver Visual Behavior Using Video Techniques</td>
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<tr>
<td>J2399_200312</td>
<td>Adaptive Cruise Control (Acc) Operating Characteristics and User Interface</td>
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<tr>
<td>J2400_200308</td>
<td>Forward Collision Warning Systems: Operating Characteristics and User Interface</td>
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<tr>
<td>J2678_200408</td>
<td>Navigation Function Accessibility While Driving Rationale</td>
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<tr>
<td>J2802_201001</td>
<td>Blind Spot Monitoring System (BSMS): Operating Characteristics and User Interface</td>
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<td>J2808_200708</td>
<td>Road/Lane Departure Warning Systems: Human Interface</td>
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<td>J2830_200807</td>
<td>Process for Comprehension Testing of In-Vehicle Icons</td>
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<td>J2831_201204</td>
<td>Design and Engineering for In-Vehicle Alphanumeric Messages</td>
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<tr>
<td>J2889/1_201205</td>
<td>Measurement of Minimum Noise Emitted by Road Vehicles</td>
</tr>
</tbody>
</table>

Only committee members have free access to documents. As an example, J2364 is $66.
TC159 (Ergonomics) develops standards that provide background for Automotive UI work. (Selected groups)

SC 1 - General ergonomics principles
  - WG 1 Principles of ergonomics & ergonomic design
  - WG 2 Ergonomic principles related to mental work
SC 3 - Anthropometry and biomechanics
SC 4 - Ergonomics of human-system interaction
  - WG 1 Fundamentals of controls and signalling methods
  - WG 2 Visual display requirements
  - WG 3 Controls, workplace and environmental requirements
  - WG 5 Software ergonomics of HCI
  - WG 6 Human-centred design for interactive systems
  - WG 9 Tactile and haptic interaction
  - WG 11 Ease of operation of everyday products
SC 5 – Ergonomics of the physical environment

ISO TC159 (Ergonomics) has produced many standards that are of general and specific interest to human factors/ergonomics professionals.

TC 159/SC 1 - General ergonomics principles

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>ISO 6385:2004</td>
<td>Ergonomic principles in the design of work systems</td>
</tr>
<tr>
<td>ISO 10075</td>
<td>Ergonomic principles related to mental workload (definitions, principles, requirements)</td>
</tr>
<tr>
<td>ISO/FDIS 26800</td>
<td>Ergonomics -- General approach, principles and concepts</td>
</tr>
</tbody>
</table>
TC 159/SC 4 - Ergonomics of human-system interaction

<table>
<thead>
<tr>
<th>ISO 1503:2008</th>
<th>Spatial orient. &amp; direx. of movement</th>
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<td>ISO 9355</td>
<td>Design of displays &amp; control actuators</td>
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<tr>
<td>ISO 11064 (7 pts)</td>
<td>Design of control centers</td>
</tr>
<tr>
<td>ISO 14915-1:2002</td>
<td>Multimedia user interfaces</td>
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<tr>
<td>ISO/TR 16982:2010</td>
<td>Usability methods</td>
</tr>
<tr>
<td>ISO/TS 18152</td>
<td>Spec. of human-system assessment</td>
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<tr>
<td>ISO/TR 18529:2000</td>
<td>Human-centered life cycle process</td>
</tr>
<tr>
<td>ISO 20282-1:2006</td>
<td>Everyday product context of use &amp; user characteristics</td>
</tr>
<tr>
<td>ISO/TS 20282-2:2006</td>
<td>Test method for walk up &amp; use products</td>
</tr>
<tr>
<td>ISO/NP TS 20282-3</td>
<td>Test method for consumer products</td>
</tr>
<tr>
<td>ISO 20281-4:2007</td>
<td>Consumer product installation tests</td>
</tr>
<tr>
<td>ISO 24503:2011</td>
<td>Tactile dots and bars on consumer products</td>
</tr>
</tbody>
</table>

ISO 9241 – Ergonomic requirements for office work with visual display terminals (VDTs) is a very important topic for the design computer hardware and software.

Examples:

4: keyboards
5: workstation layout
14: menus
15: commands
17: form filling
143: forms
151: web interfaces
300:- visual displays
400:- input devices
TC 159/SC 5 - Ergonomics of the physical environment

<table>
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<tr>
<th>Standard</th>
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<td>ISO 7243:1989</td>
<td>WBGT</td>
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<tr>
<td>ISO 7731</td>
<td>Auditory danger signals</td>
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<td>ISO 9921</td>
<td>Speech communication assessment</td>
</tr>
<tr>
<td>ISO 11428:1996</td>
<td>Visual danger signal general requirements &amp; tests</td>
</tr>
<tr>
<td>ISO 11428:1996</td>
<td>Auditory &amp; visual danger signals</td>
</tr>
<tr>
<td>ISO/TS 14505</td>
<td>Thermal environments in vehicles</td>
</tr>
<tr>
<td>ISO/NP 16077</td>
<td>Indoor air quality subj. assessment</td>
</tr>
<tr>
<td>ISO 24500:2010</td>
<td>Accessible design – sounds</td>
</tr>
<tr>
<td>ISO 24501:2010</td>
<td>Accessible design – luminance contrast</td>
</tr>
<tr>
<td>ISO/DIS 28803</td>
<td>Application of intl. physical standards to people with special requirements</td>
</tr>
</tbody>
</table>

International Telecommunications Union (ITU)
Focus Group on Distraction (FG-Distraction)

http://www.itu.int/en/ITU-T/focusgroups/distraction/Pages/default.aspx
Contact: Spennock@qnx.com

Reports to be produced
- factors to consider when developing UI
driver and passenger in-vehicle tasks
- optimal information flow and message formats
techniques to reduce distraction related crashes

Requirements input
- design guidance for mobile devices including phones
methods to assess workload
- performance requirements for automotive services
- coordination among components to reduce cognitive demand
- visual-manual guidelines
### International Telecommunications Union P Series
#### Terminals and subjective & objective assessment methods

**Examples**

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<th>#</th>
<th>Title</th>
</tr>
</thead>
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<td>P.800</td>
<td>Methods for subjective determination of transmission quality</td>
</tr>
<tr>
<td>P.805</td>
<td>Subjective evaluation of conversational quality</td>
</tr>
<tr>
<td>P.851</td>
<td>Subjective quality evaluation of telephone services based on spoken dialogue systems</td>
</tr>
<tr>
<td>P.862</td>
<td>Perceptual evaluation of speech quality (PESQ): An objective method for end-to-end speech quality assessment of narrow-band telephone networks and speech codecs</td>
</tr>
<tr>
<td>P.863</td>
<td>Perceptual objective listening quality assessment</td>
</tr>
</tbody>
</table>

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