



Standards on Cockpit Design & Common User Profile

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<https://cambum.net/index.htm>



Sources

- ▶ NASA Space Flight Human-system Standard, Volume 2, rev A: Human Factors, Habitability, And Environmental Health
- ▶ NASA Human Research Facility (HRF) Human-Computer Interface (HCI) Design Guide
- ▶ MIL-STD-1472G, 11 January 2012, US Department Of Defense, Design Criteria Standard, Human Engineering
- ▶ US Department of Transportation, NHTSA, Human Factors Design Guidance for Level 2 And Level 3 Automated Driving Concepts
- ▶ Japan Automobile Manufacturers Association (JAMA) – Guidelines for in-Vehicle Display Systems v3.0
- ▶ HARDIE Design Guidelines Handbook: Human Factors Guidelines for Information Presentation by ATT Systems



Examples of Coverage

Mil Std 1472G

NASA-STD-3001, VOLUME 2, REVISION A

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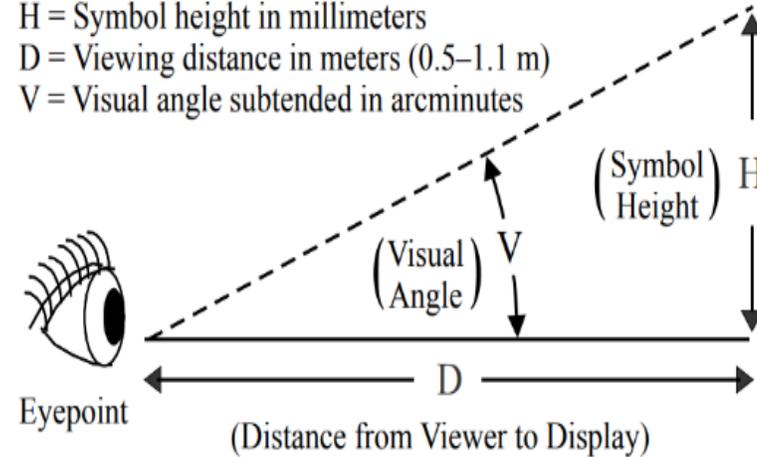
Visual Angle Calculation

Definitions of Variables Used in the Equations

H = Symbol height in millimeters

D = Viewing distance in meters (0.5–1.1 m)

V = Visual angle subtended in arcminutes



| Parameter | Icon | Text |
|--------------------------|---|---|
| Optimal visual angle (x) | 1.433 degrees | 0.333 degrees |
| Tan(x) | 0.025 | 0.0058 |
| Symbol Height (H) | $D \times \tan(x) = 120 \times 0.025$ $= 3 \text{ cm} = 1.18 \text{ in}$ | $D \times \tan(x) = 120 \times 0.0058$ $= 0.7 \text{ cm} = 0.275 \text{ in}$ |
| Symbol height (H) | 320.4 px | 72.09 px |



Character Display

- a. Black characters. Where the ambient illuminance will be above 10 lux (0.9 footcandle), black characters shall be provided on a light background.
- b. Dark adaptation. Where dark adaptation is required, the displayed letters or numerals shall be visible without impairing night vision (e.g., white on a dark background).
- c. Plain style. Letters and numerals shall be of **a plain style without serifs** (i.e., sans serif fonts) except as may be necessary to distinguish between characters which would otherwise be confused (e.g., “L”, “I”, “1”, “0”, “O”).
- d. Capital versus lower case. Capital letters shall be used for abbreviations. All capital letters shall be used for identification labels, headings and subheadings, signal words such as danger, caution, attention, notice, legends, and short message labels. Capital and lowercase letters shall be used for extended sentence messages, such as multi-sentence signs and instructional placards, or when it is necessary to use punctuation.
- e. Letter width. Alphanumeric characters shall have a width of 0.6 to 0.8 of the height except for single stroke characters (e.g., I, l) which shall be between 0.1 and 0.2 of the height.
- f. Numeral width. The width of numerals shall preferably be 0.6 of the height, except for “4”, which shall be 0.8 of the height, and “1” which shall be 0.2 of the height.
- g. Wide characters. Where wide characters are required, for items such as curved surfaces, or for
- h. column alignment of numbers, the basic height-to-width ratio may be increased to as much as 1:1.



Text rendering from NASA 1997 HCI Guideline

- a. Helvetica should be used as the primary font on all displays because it is a sans serif font that is highly legible at variable distances and will be used on PCS displays.
- b. For displays with 640 X 480 resolution, the minimum point size should be 10 point.
- c. For displays with 1024 X 768 resolution or higher, or when the resolution may vary, the minimum point size should be 14.
- d. For displays used primarily under normal illumination, all text should be black, except when indicating unavailable options, when it should be gray.
- e. In environments requiring dark adaptation, light characters on a dark background should be used.
- f. All text should be shown in mixed case, except for major titles, headings, labels and acronyms.
- g. Text should generally be left justified (ragged right edge), including the first word of a paragraph.
- h. Line lengths of extended text should be between 52 and 80 characters in length.
- i. A high brightness contrast ratio between text foreground and background should be used to ensure readability of the text.
- j. Whenever text is selected, the visual indication of the selection should be a reverse video of the text.



Character Display

- a. Stroke width. Stroke width shall meet the following:
 - Normal. For black characters on a white (or light) background, the stroke width shall be 0.1667 to 0.1429 of the height. The stroke width shall be the same for all letters and numerals of equal height.
 - Dark adaptation. Where dark adaptation is required or legibility at night is a critical factor, and white characters are specified on a dark background, the stroke width of the characters shall be from 0.1429 to 0.125 of the height. The stroke width shall be the same for all letters and numerals of equal height.
 - Transilluminated characters. For transilluminated characters, the stroke width shall be 0.1 of the height.
 - Maintain ratio. The stroke width ratios shall apply regardless of how high characters are made for distance viewing. However, for certain applications, characters with different stroke widths may be used on the same sign for emphasis. In this case, the thinnest character stroke shall be no less than 0.125 nor the thickest character stroke greater than 0.2 of the respective character heights.
 - Stroke continuity. Continuous stroke characters shall be used where applicable and practical for all equipment labels, legends, placards, and signs. Stencil characters may be used for shipping containers. Stencil characters shall not have stroke breaks greater than 0.5 the character stroke width.
- b. Character spacing. The minimum space between characters shall be one stroke width.
- c. Word spacing. The minimum space between words shall be not less than the width of one character (except for “I” or “1”).
- d. Line spacing. The minimum space between lines shall be one-half character height (e.g., line spacing in points equals $\frac{1}{2}$ font size in points).
- e. Character height versus luminance. The height of letters and numerals shall conform to [table I](#).



Lighting Condition

TABLE XXI. Character height versus luminance and viewing distance.

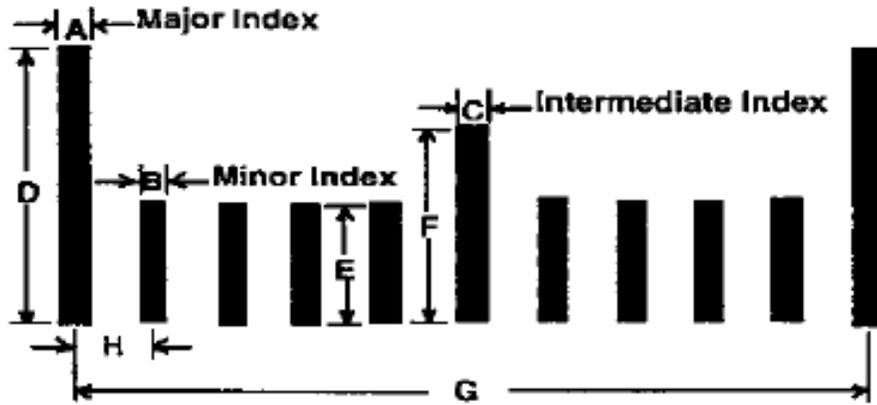
| Markings | Height ^{1/} | |
|---|---|---|
| | Low lighting, 3.5 cd/m ² (1 fL) or below | Normal lighting, above 3.5 cd/m ² (1 fL) |
| Critical markings with position variable (e.g., numerals on counters) | 5.0 – 8.0 mm (0.20 – 0.31 in) | 3.0 – 5.0 mm (0.12 – 0.20 in) |
| Critical markings with position fixed (e.g., numerals on fixed scales, controls and switch markings, or emergency instructions) | 4.0 – 8.0 mm (0.16 – 0.31 in) | 2.5 – 5.0 mm (0.10 – 0.20 in) |
| Noncritical markings (e.g., identification labels, routine instructions, or markings required only for familiarization) | 2.5 – 5.0 mm (0.10 – 0.20 in) | 2.5 – 5.0 mm (0.10 – 0.20 in) |

NOTE:

^{1/} Values assume a 710 mm (28 in) viewing distance (D). For other distances, multiply the above values by D/710 mm (D/28 in).



Graph Display



| Dimensions of dark markers on light background, visual angle ^{1/} | |
|--|---------------------------------|
| A Width of major scale index | 1.16 mrad (4 min) ^{2/} |
| B Width of minor scale index | 0.87 mrad (3 min) ^{2/} |
| C Width of intermediate scale index | 1.16 mrad (4 min) ^{2/} |
| D Length of major scale index | 7.86 mrad (27 min) |
| E Length of minor scale index | 3.49 mrad (12 min) |
| F Length of intermediate scale index | 5.82 mrad (20 min) |
| G Width of gap between major scale index | 25.02 mrad (86 min) |
| H Width of gap between minor scale index | 2.62 mrad (9 min) |

NOTES:

^{1/} For most applications with a dark graduation mark on a light background, the width of the minor graduation mark can be used for major and intermediate graduation marks as well. Use of this strategy allows the width of the pointer tip to be the same as all of the graduation marks. Visual angles are for longest anticipated viewing distance.

^{2/} 4.36 mrad (15 min) for light markers on dark background.

- A graph should be used when users need to monitor changing data, quickly scan and/or compare sets of data.
- A graph should be used when showing categorical or trend data.
- A graph should be used when showing continuous data that can be categorized without a loss in information content.
- In general, a graphical display should use the fewest lines or objects possible to accurately represent the data.
- In graphs, the user should be able to identify off-nominal values (e.g., color change) in tasks where there is a need to discriminate between such values.
- A scatterplot should be used to show how two variables are correlated or distributed.
- A bar graph should be used to show a comparative measure for discrete variables, for discrete levels within a variable, or for a variable at different times.
- If there is some sequence implied in the variables show in a bar graph, that sequence should be reflected in the order of the bars on the X axis. For example “LOW, MEDIUM, HIGH” should appear in that order, left to right, “1, 5, 10” in that order, left to right, etc.
- A line graph should be used to portray changes through time for one or more sets of data, such as trends over a period of hours, days, weeks, months or years.
- Whenever it is not feasible to label each object that is coded, a legend that can be hidden on user request should be provided.



Icon Size – Critical vs Non-Critical (NHTSA)

Icon Size:

- Optimal visual angle of primary graphical elements: 86 arcminutes
- Minimum visual angle of primary graphical elements:
 - 41 arcminutes for time-critical applications
 - 34 arcminutes for non-time-critical applications

Text Size (both within the icon and free-standing text):

- Optimal height: 20 arcminutes
- Minimum height: 16 arcminutes for time-critical applications; 12 arcminutes for non-time-critical applications

Equations for calculating symbol height, visual angle, and viewing distance.

| If Known... | Use These Equations for Calculating These Unknowns | | |
|--|---|--|--|
| | Visual Angle (V) in arcminutes | Symbol Height (H) in millimeters | Viewing Distance (D) in meters |
| Viewing Distance (D) and Symbol Height (H) | $V = 60 \cdot \text{Arctan}\left(\frac{H}{1000 \cdot D}\right)$ | — | — |
| Viewing Distance (D) and Visual Angle (V) | — | $H = 1000 \cdot D \cdot \tan\left(\frac{V}{60}\right)$ | — |
| Visual Angle (V) and Symbol Height (H) | — | — | $D = \frac{H}{1000 \cdot \tan\left(\frac{V}{60}\right)}$ |

Definitions of Variables Used in the Equations

H = Symbol height in millimeters
 D = Viewing distance in meters (0.5–1.1 m)
 V = Visual angle subtended in arcminutes

(Distance from Viewer to Symbol)

Examples of Symbol Elements in an Icon

- Primary graphical elements provide the primary information needed to encode or detect the icon.
- Secondary graphical elements provide additional context or clarifying information.
- Optimum visual angle refers to the angle at which the primary graphical elements are both conspicuous and legible.
- Minimum visual angle refers to the smallest angle at which the primary graphical elements are legible but not necessarily conspicuous.



Colour Coding

MIL-STD-1472G

TABLE XIV. Wavelength values for color discrimination.

| Color name | Nanometers (nm) | CIE value (x, y, Y) |
|--------------|-----------------|-----------------------|
| Red | 700 | 0.6078, 0.3441, 31.05 |
| Orange | 600 | |
| Yellow | 570 | 0.4209, 0.5040, 111.4 |
| Yellow-green | 535 | |
| Green | 500 | |
| Blue-green | 493 | |
| Blue | 470 | 0.1566, 0.0808, 13.33 |

h. Color differentiation. When using color to group elements of a display together (i.e., to show parts are related or different) and the color has no meaning beyond a grouping function, up to 30 colors may be used.

i. Saturation coding. Hue saturation shall be used to indicate relative intensity (e.g., best, hottest, wettest, safest, deepest). Saturation coding is best done in grayscale, except when showcasing the following:

(1) Hotter to cooler where saturation changes from red to blue.

(2) More dangerous to less dangerous where intensity of red is used for dangerous areas while the background is in grayscale.

j. Color meanings. Colors shall be associated with the common color meanings presented in table XV.

(1) Cool colors. Cool colors (those with shorter wavelengths such as blue or green) shall be used to display information used infrequently and to convey status of background information.

(2) Warm colors. Warm colors (those with longer wavelengths, such as red or orange) shall be used to convey action or the requirement for a response.

k. Dark adaptation. When color-coding is used, luminance shall be more than 10 cd/m².

a. Use. Color-coding may be employed to differentiate between classes of information in complex, dense, or critical displays.

b. Foveal view only. Color shall not be used for gaining attention outside the optimum visual field (see figure 25).

c. Consistency. Color-coding shall be used consistently within a display and across displays of other systems used by the same users.

d. Preventing color mismatch. To avoid mismatch of color and color association that can slow recognition time and increase errors, each color shall represent only one category of displayed data.

e. Color customization. Color customization shall be allowed only for information that is not tactically significant.

f. Color recognition. When the user must recognize categories of information (e.g., represent different variables on a graph, different types of information on a map) no more than seven colors shall be used to represent and distinguish between categorically different information.

g. Color selection for color recognition. To maximize discriminability, colors having the dominant wavelengths listed in table XIV shall be used for color recognition.



Colour Coding - Meaning

TABLE XV. Common color association meanings.

| Color | Maps and tactical meaning | Classification meaning | Alarm, alert, threat meaning | Equipment meaning | Other common meaning |
|--------|---|------------------------|---|--|--|
| Red | Red alert Forces or situation at critical condition Hostile target identification | Secret | Critical consequences Danger or unsafe Severe threat Emergency Alarm | Closed/stopped Oxygen Malfunction Ordnance handling | Stop Heat or fire Failure OFF (as opposed to ON) |
| Orange | | Top Secret | Alarm, alert, or hazard High threat | | Value between red and yellow |
| Yellow | Forces or situation at marginal condition Unknown target affiliation CBRNE areas | | Warning, caution, or hazard Elevated threat Approaching critical Extreme Caution Impending danger | Oil | Abnormal state Delay Check/recheck |
| Green | Non-alert Neutral target affiliation Obstacles Forces or situation at acceptable condition | Unclassified | Normal Safe Low threat | Open/flowing | Maintenance personnel ON (as opposed to OFF) Intolerance/ acceptable Ready, proceed, satisfactory |

TABLE XV. Common color association meanings – Continued.

| Color | Maps and tactical meaning | Classification meaning | Alarm, alert, warning, threat meaning | Equipment meaning | Other common meaning |
|------------------------------|--|------------------------|---------------------------------------|--|---|
| Blue | Friendly target affiliation Deep water | | Safe Guarded threat | Noncritical items Water or flooding Nitrogen | Cool or cold |
| Cyan (turquoise, light blue) | Friendly target affiliation | | Advisory | Aerated water | Cool |
| Dark blue (navy blue) | | | Advisory | Untreated water | |
| Magenta (pink, light purple) | | | Alarm state Radiation hazard | | |
| Purple (violet) | | | | Aviation fuels | |
| White | | | Advisory | Steam | Medical personnel Empty Functional or physical position Action in progress |
| Black | Political boundary Image or figure edge | | | | Outline or border |
| Gray | | | | Smoke | Inactive/unavailable options or actions |



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Audio Guidelines



Use of Audio

Audio displays shall be provided under the following conditions:

- a. When information to be processed is short, simple, and transitory, requiring an immediate or time-based response.
- b. When the common mode of visual display is restricted by over-burdening, ambient light variability or limitation, user mobility, degradation of vision by vibration, high G-forces, hypoxia, or other environmental considerations, or anticipated user inattention.
- c. When the criticality of the event makes supplementary or redundant notification desirable.
- d. When it is desirable to warn, alert, or cue the user to subsequent additional response.
- e. When custom or usage has created anticipation of an audio display.
- f. When voice communication is necessary or desirable (e.g., hands-busy situations).



Preference over Visual

- (1) For signals of acoustic origin.
- (2) For warning signals to call attention to imminent or potential danger.
- (3) For situations when many displays are visually presented (e.g., piloting an airplane).
- (4) For presenting information independently of head orientation.
- (5) For situations when environmental conditions limit vision or makes seeing impossible.
- (6) For conditions of anoxia or high positive G-forces.
- (7) When signals must be distinguished from noise, especially periodic signals in noise.



Functional Evaluation

| Function | Type of signal | | |
|-------------------------|--|--|--|
| | Tones (periodic) | Complex sounds (non-periodic) | Speech |
| Quantitative indication | Poor, maximum of 5 to 6 tones absolutely recognizable. | Poor, interpolation between signals inaccurate. | Good, minimum time and error in obtaining exact value in terms compatible with response. |
| Qualitative indication | Poor-to-fair, difficult to judge approximate value and direction of deviation from null setting unless presented in close temporal sequence. | Poor, difficult to judge approximate deviation from desired value. | Good, information concerning displacement, direction, and rate presented in form compatible with required response. |
| Status indication | Good, start and stop timing. Continuous information where rate of change of input is low. | Good, especially suitable for irregularly occurring signals (e.g., alarm signals). | Poor, inefficient; more easily masked; problem of repeatability. |
| Tracking | Fair, null position easily monitored; problem of signal-response compatibility. | Poor, required qualitative indications difficult to provide. | Good, meaning intrinsic in signal. |
| General | Good for automatic communication of limited information. Meaning must be learned. Easily generated. | Some sounds available with common meaning (e.g., fire bell). Easily generated. | Most effective for rapid (but not automatic) communication of complex, multi-dimensional information. Meaning intrinsic in signal and context when standardized. Minimum of new learning required. |



18

Alerts



Alerts - Visual

- Flash. Flash coding shall be employed to call the user's attention to mission critical events only. No more than 2 flash rates shall be used. Where one rate is used, the rate shall be 3 – 5 flashes per second. Where two rates are used, the second rate shall be not greater than 2 per second.
- The flashing light is typically a **2 Hz, equal on / off time (equal mark : space ratio) red light**. A second amber light can also be used, usually on larger aircraft, for the caution category alerts (i.e. “impending dangerous condition requiring attention but not necessarily immediate action”).
- Brightness. Brightness intensity coding shall be employed only to differentiate between an item of information and adjacent information. No more than two levels of brightness shall be used. Each level shall be separated from the nearest other level by not less than a 2:1 ratio.
- Pattern and location. Pattern and location coding may be used to reduce user search time by restricting the area to be searched to prescribed segments.
- Underlining. Underlining may be employed to indicate unusual values, errors in entry, changed items, or items to be changed.
- Symbol and size. Symbol coding may be used to enhance information assimilation from data displays. Symbols shall be analogs of the event or system element they represent or be in general use and well known to the expected users. Where size difference between symbols is employed, the major dimensions of the larger shall be not less than 150% of the major dimension of the smaller. Not more than three size levels shall be used.



Alerts - Visual

- Special symbols. When special symbols are used to signal critical conditions, they shall be used for only that purpose. Markers close to words marked. When a special symbol is used to mark a word, the symbol shall be separated from the beginning of the word by one space.
- Color. Color coding may be employed to differentiate between classes of information in complex, dense, or critical displays. The colors selected shall not conflict with the color associations specified in Table II. Information shall not be coded solely by color if the data must be accessed from monochromatic as well as color terminals or printed in hard copy versions. To enhance detectability and discriminability, color-filled symbols should be used instead of color outlined symbols.
- Shape. Shape coding may be used for search and identification tasks. When shape coding is used, the codes selected shall be based on established standards or conventional meanings.
- Brightness inversion. When a capability for brightness inversion is available (so-called "reverse video", where dark characters on a bright background can be changed under computer control to bright on dark, or vice versa), it may be used for highlighting critical items that require user attention. When used for alerting purposes, brightness inversion shall be reserved for that purpose, and not be used for general highlighting.



Alerts / Warning - Auditory

Warning signals may be either manually or automatically initiated, whichever is more appropriate to the circumstances. Manually initiated signals shall also be manually terminated. Automatically initiated signals shall be in accordance with the following:

- a. Persistence. Automatically initiated signals shall persist until either automatically or manually terminated.
- b. Automatic termination. Automatic termination shall not be on a time basis but rather on either initiation of action to restore normal conditions or upon restoration of normal conditions.
- c. Manual termination. Provision for manual termination shall be provided.
- d. Automatic reset. Automatic reset for the next initiating condition shall be provided for all signals which can be automatically initiated.
- e. Volume control. Local area volume control (with volume reduction limited to ensure signal audibility) may be incorporated provided full volume is automatically restored upon initiation of the next warning signal



Auditory Warning - Frequency

- a. Frequency range. The frequency range shall be between 250 and 8000 Hertz and, if possible, between 500 and 2000 Hertz.
 - (1) Difference from background. The selected frequency band shall differ from the most intense background frequencies and shall be in accordance with other criteria in this section.
 - (2) Signals traveling long distances. When signals must travel over 300 meters (985 feet), sounds with frequencies below 1000 Hertz shall be used.
 - (3) Signals traveling through obstacles. Frequencies below 500 Hertz shall be used when signals must bend around obstacles or pass through partitions.
- b. Electric power frequency avoidance. The frequency of a warning tone shall be different from that of the electric power employed in the system

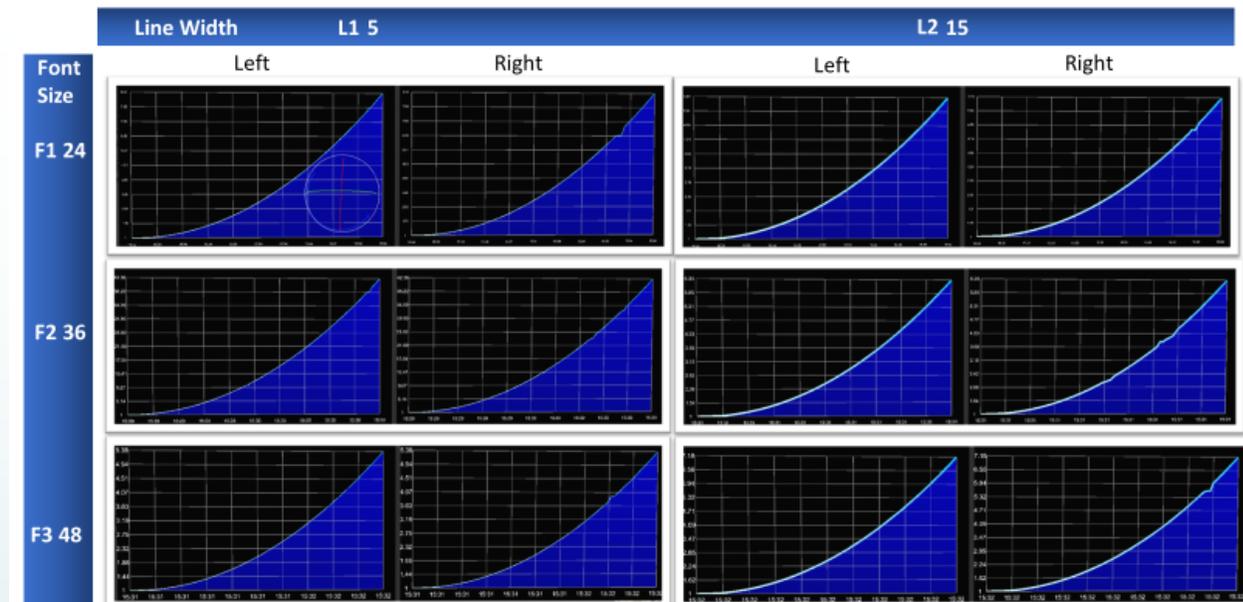


Auditory Warning - Intensity

- a. Compatibility with acoustical environment. The intensity, duration, and source location of audio alarms and signals shall be compatible with the acoustical environment of the intended receiver as well as the requirements of other personnel in the signal areas.
- b. Compatibility with existing signal codes. Warning signal characteristics and meanings selected for a system or facility shall be compatible with signals already established for the particular warning situation.
- c. Compatibility with other critical signals. No warning signal shall be of such a character as to preclude hearing any other warning signal or reception of vital voice communication.
- d. Compatibility with clothing and equipment. Audio signals shall be loud enough to be heard through equipment or garments (e.g., parka hood, CBRNE protective hood, single or double hearing protective devices) covering the ears of the listener. Audio signals shall be loud enough to be understood through equipment or garments (e.g., parka hood, CBRNE protective hood, hearing protective devices) covering the ears of the listener.
- e. Damage risk control. Audio warning signals shall not be of such intensity as to cause d

Interface Personalization

- Within the design space defined by standards, there is still ample scope of personalizing user interface
 - Font size, font type, colour contrast and many other interface properties can be adjusted in real time
- Different persons may have different preference for non-critical information
- Interface can be personalized based on situation
 - Font size may automatically increase for higher g-load as readability decreases with g-load
 - Screen brightness may be adjusted based on ambient illuminance
 - User interface can be decluttered if operator is under high cognitive load





ITUPublications

International Telecommunication Union
Standardization Sector

ITU-T Technical Report

(11/2023)

TR.CUP

**Concept of a common user profile format used
to personalize audiovisual media**

What is Common User Profile

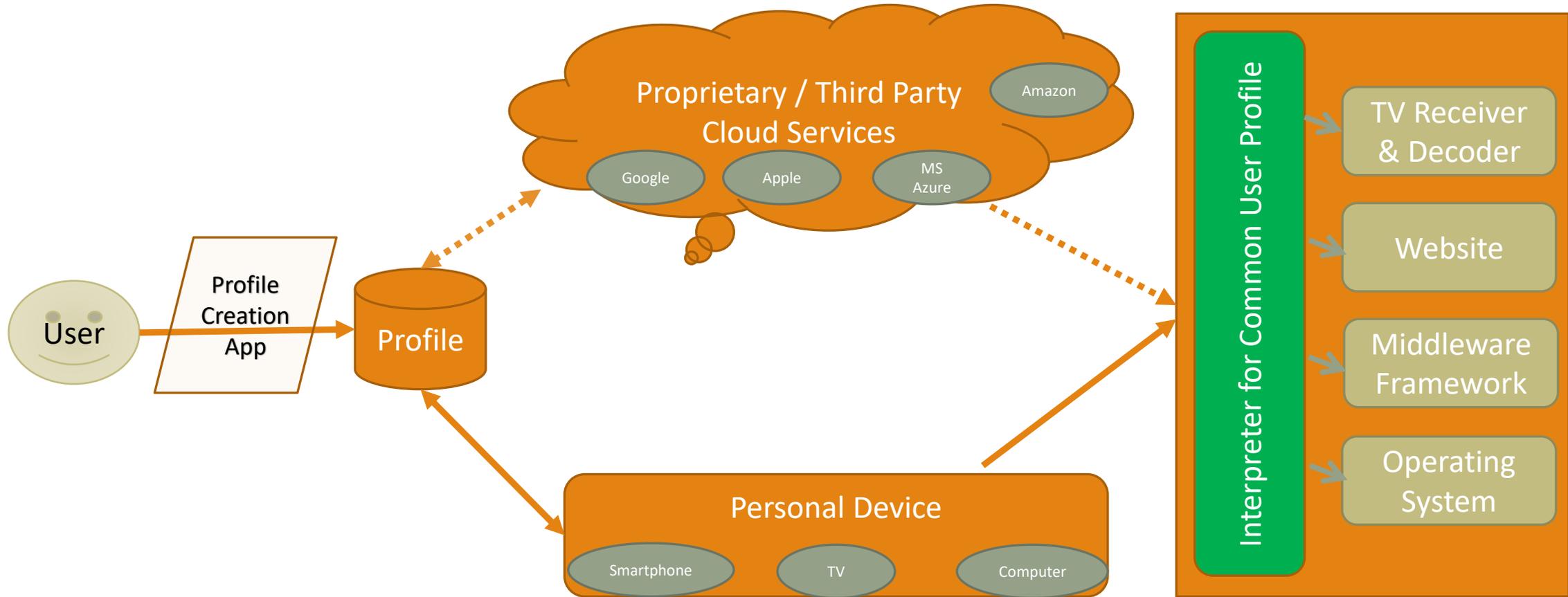
- Creating a common user profile format to offer personalized service to people with different range of abilities
- Deploying in a device and application independent format
- Adapting user interface parameters like font size, colour contrast, audio volume, arrangement of screen elements and so on
- Following up earlier similar work at EU standardization committee on user modelling, ITU FG AVA and presently Q11/9 of ITU SG9 and Q26 of ITU SG 16 and ITU SG6.

Proposed Approach

- A common minimal profile that will be acceptable by many
- Any service provider can add more variables specific to application or new scientific invention.
- Details should not reveal any personal information or details on specific cause of impairment
- A **user profile creation application** will be run locally to populate these fields

- User Preference
 - Background colour (bg)
 - Foreground colour (fg)
 - Audio volume (vol)
- Screen Text
 - Minimum Character Height (ch_text)
 - Contrast Ratio(cr_text)
- Alternative text language (altText_lang)
- Subtitle
 - Minimum font size (fs_caption)
 - Speed (speed_Caption)
 - Language (lang_Caption)
 - Maximum latency (latency_Caption)
 - Length and width of Caption Box (window_Caption)
- Cursor
 - Minimum size (cursorSize)
 - Foreground colour (fg_Cursor)
 - Speed (speed_Cursor)
- Screen Element
 - Minimum icon size (iconSize)
 - Inter element spacing (icon_Spacing)
- Preferred I/O Modality
 - Primary Input Modality (inputModality)
 - Primary Output Modality (output_Modality)
- Audio Output Language
 - Primary (lang_Primary)
 - Secondary (lang_Secondary)

Plan of Implementation



Sequence of Actions

- User will create the profile using Profile Creation Application.
- The implementation details of the Profile Creation Application will not be part of the recommendation
- User may upload the profile to proprietary or third-party cloud application, although it is not mandatory and indicated by dashed line in the following diagram
- The profile will be stored in the personal device used to run the Profile Creation Application.
- The user can create multiple profiles for different devices.
- There will be an interpretation application for user profile. This interpretation application will adapt user interface based on profile
- The interpretation mechanism should understand the variables defined in the Common user profile to personalize audio-visual content and **this understanding of variable will constitute the mandatory part of the resolution.**
- The TV Receiver and Decoder, Website developer, any middleware developer or operating system developer will use the recommendation for implementing the interpretation mechanism.

Describing Variables

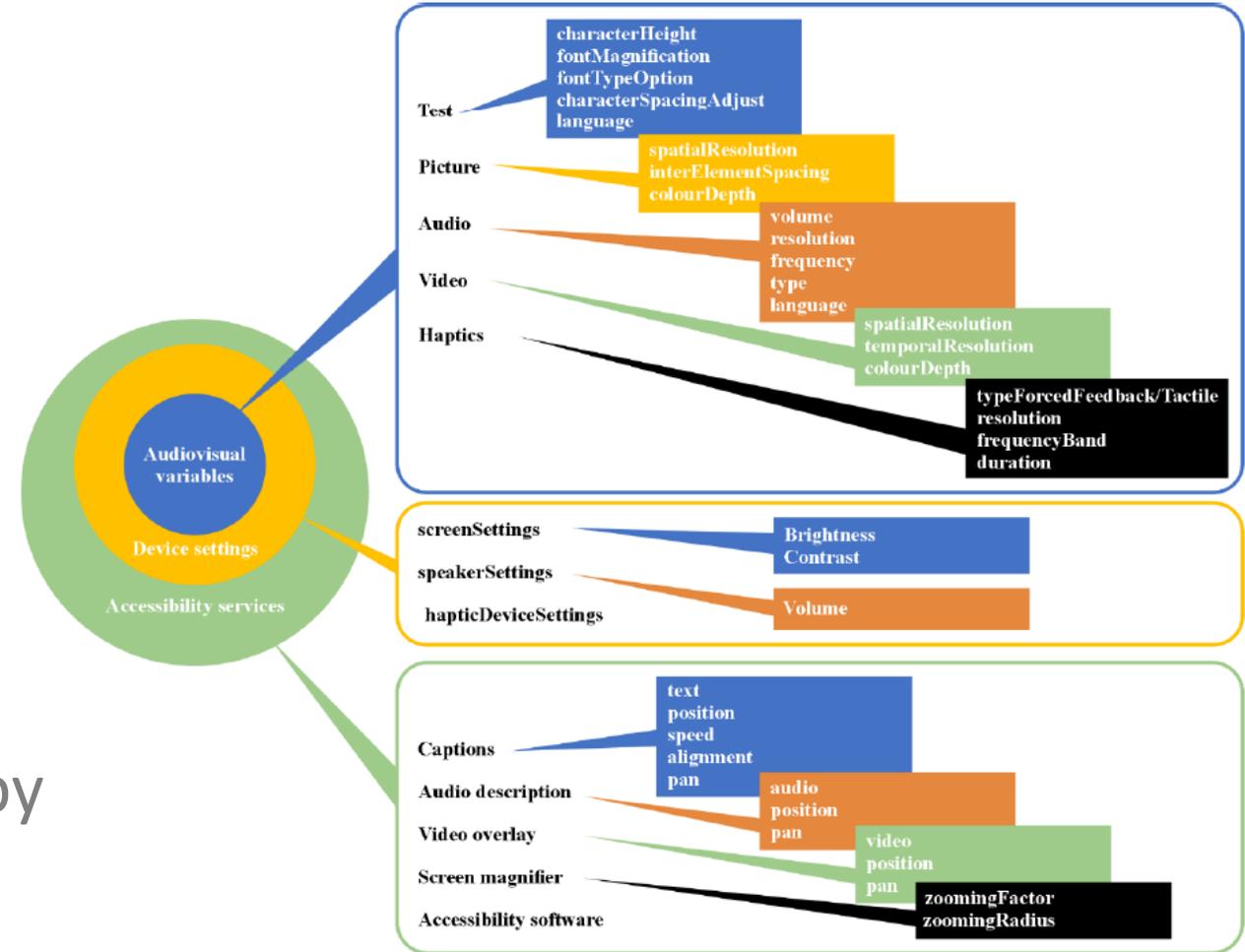
Name – Naming Convention

Data Type – string for XML,
interpreter will use it to convert

Value Range – Nominal, Ordinal

Unit – SI unit / no unit

Description – For interpretation by
humans



TR.CUP(23)

Figure 1 – Hierarchy for describing variables

Ways of Integration

Invoking a mapping application between users' range of abilities and interface parameters

- Executing at server side
- Executing at client machine

Modifying settings at

- Application level (e.g.: Android App)
- Browser level (e.g.: Browser Plug-in)
- Middleware level (e.g.: SetTop Box)
- Operating System level (e.g.: new Accessibility feature of Windows / iOS / Android)

- Will **not** be a part of the recommendation

| Profile Code | GS | Tremor | ROMW | Minimum Font Size | Colour Blindness | Adaptation | Predicted Best Modality | Colour Contrast | Button Spacing |
|--------------|---------|--------|-------------|-------------------|------------------|--------------|-------------------------|-----------------|----------------|
| | (in kg) | | (in degree) | (in point) | | | | | |
| A | 16 | YES | 71 | 14 | Protanopia | Gravity Well | Pointing/Screen | Blue White | 20* |
| B | 25 | NO | 52 | 14 | Protanopia | Damping | Pointing/Gesture/Screen | Blue White | 20 |
| C | 59 | NO | 66 | 12 | Deuteranopia | Damping | Pointing/Gesture/Screen | Blue White | 20 |
| D | 59 | NO | 66 | 0 | N/A | Damping | Speech/Audio | N/A | 20 |
| E | 25 | YES | 52 | 14 | None | Gravity Well | Pointing/Screen | Any | 20 |
| F | 59 | NO | 120 | 14 | Tritanopia | Damping | Pointing/Gesture/Screen | White Black | 5* |
| G | 9 | NO | 63 | 14 | None | Gravity Well | Pointing/Screen | Any | 20 |

Input and Output of CUP

```
<string xmlns="https://cambum.net">
  <IfaceParam> <horButtonSpacing>
192</horButtonSpacing>
<verButtonSpacing>
108</verButtonSpacing> <FontSize>
25</FontSize>
<ColourContrast>Black_White</Colour
Contrast> <Language>English
</Language> <BestIP>Stylus
</BestIP> <BestOP>Screen </BestOP>
</IfaceParam></string>
```

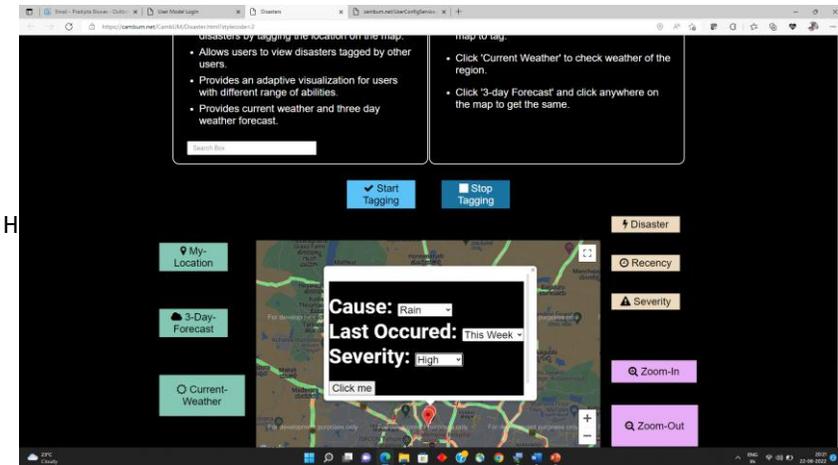
Input XML



Interpreter for Common User Profile

```
BODY
{
    BACKGROUND-COLOR: black;
    LETTER-SPACING: normal;
    FONT-FAMILY: Verdana;
    COLOR: white;
    FONT-SIZE: 24px
}
body,
input,
select,
BUTTON
{
    FONT-FAMILY: Arial,H
    FONT-SIZE: 24px
}
P
{
    COLOR: white;
    FONT-SIZE: 24px
}
H3
{
    COLOR: white;
    FONT-SIZE: 24px
}
```

Output Stylesheet



Example of Rendering

Interface Personalization

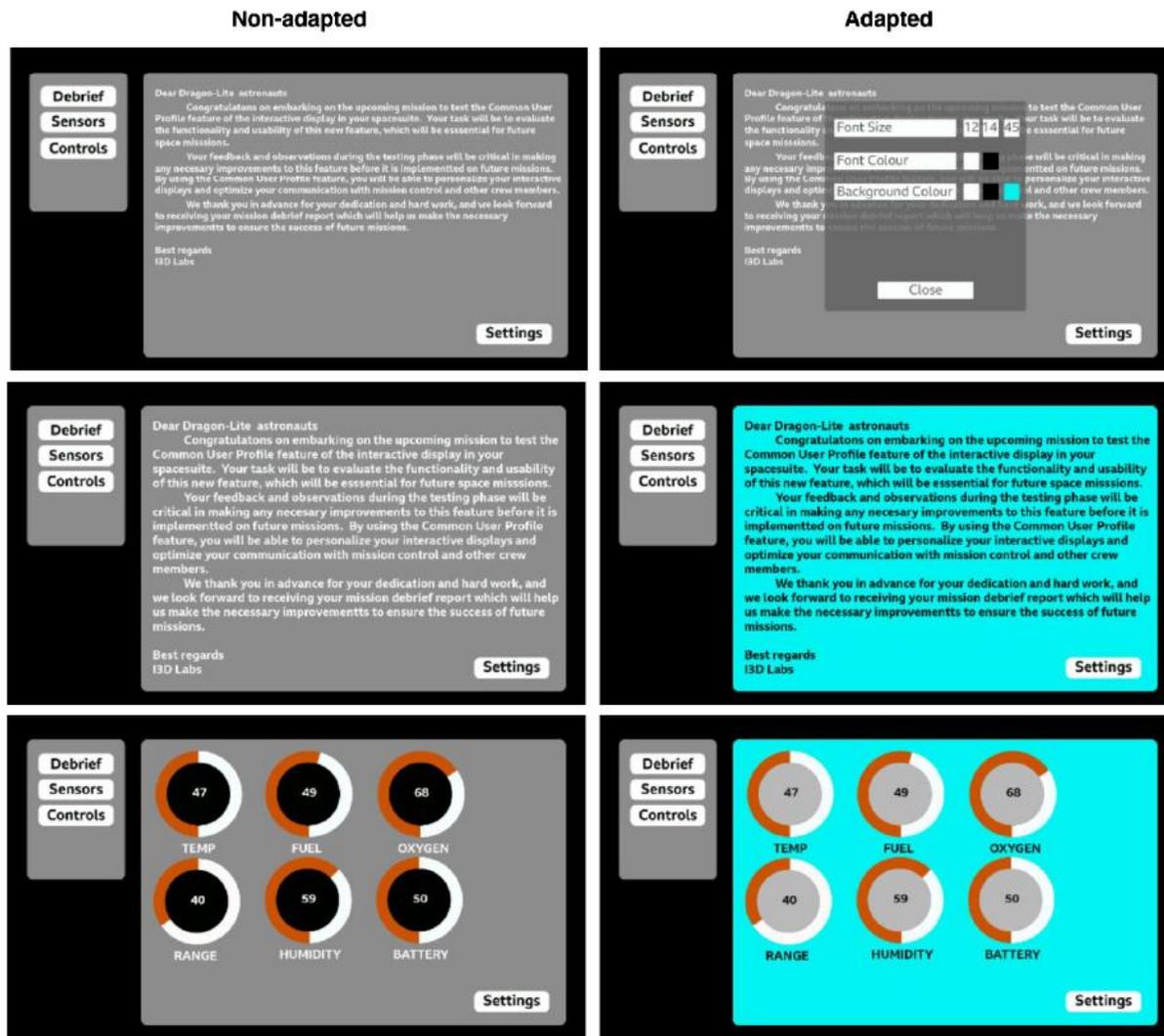


Figure 10 – Non-adapted and simulated CUP adapted screens

➤ Non Critical Information can be personalized based on individual preference in terms of font size, colour contrast and so on.

➤ NASA studies found readability decreases even at 1.4G

➤ Text Size can be adapted based on G-Load for better readability

➤ Reverse Contrast can implement Dark Adaptation automatically

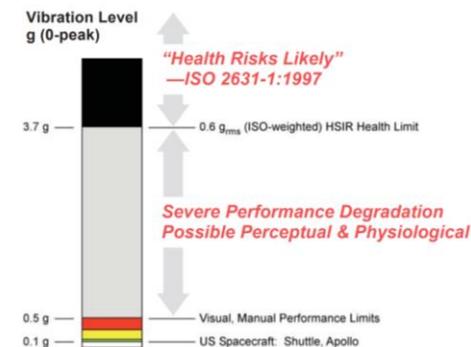


Figure 1. Vibration levels and human health and performance impacts.

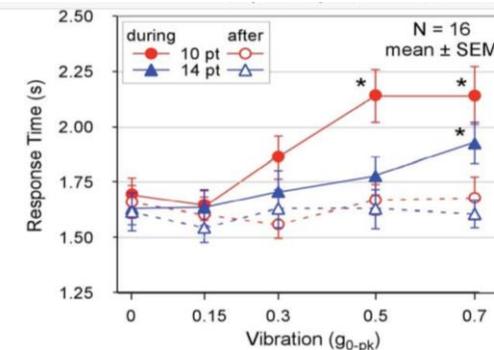


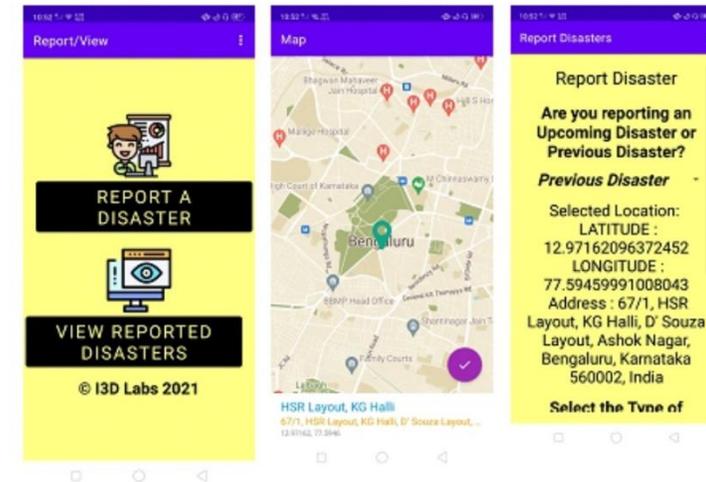
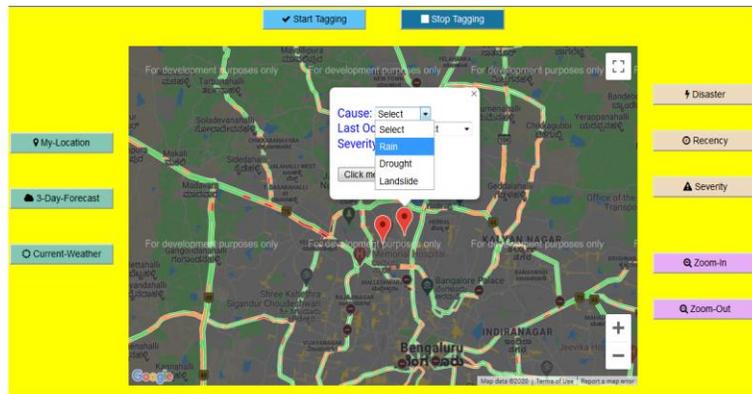
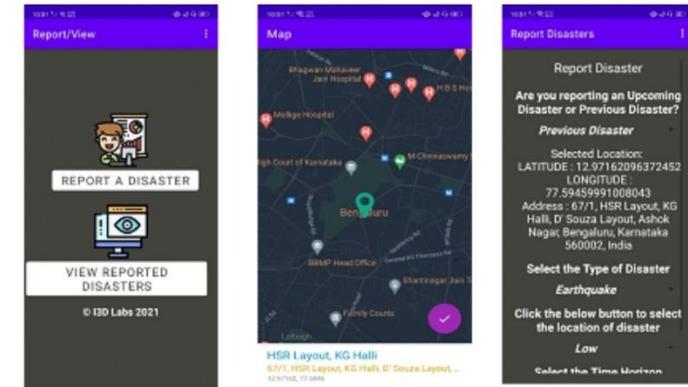
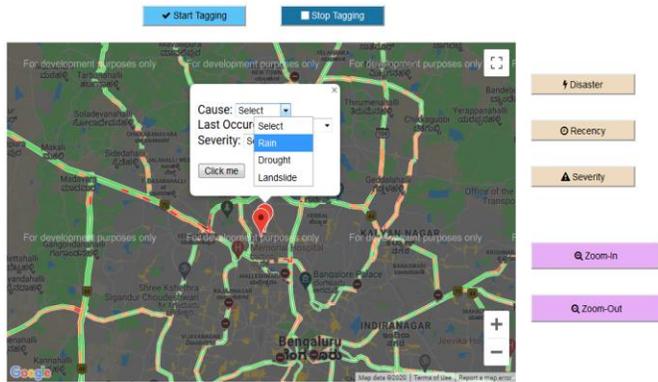
Figure 13. Mean response times (\pm SEM) of the general-population participants during (solid symbols and lines) and immediately after (open symbols and dashed lines) vibration at each of the 5 levels for 10-pt (red) and 14-pt (blue) font. Note the three points with significant ($p < 0.05$) increases over baseline. Note also the fact that performance after vibration (dashed lines) is

Interface Personalization



Figure 9 – Simulation of CUP adaptation on the actual SpaceX crew capsule screens

Interface Personalization



Conclusion

- Standards specify details of user interface and interaction design from specifying minimum stroke width to icon and graph elements
- This presentation gave an overview of existing HCI standards from NASA, US DoD, NHTSA, JAMA and so on. The presentation is not an exhaustive list.
- Standards are discussed for display design, auditory interface, alerts and warning.
- A new concept of Common User Profile can personalize user interfaces based on preference and situation within the design space defined by standards.