Toolkit for Designing Intercultural Automotive HMI

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Mars Climate Orbiter Havary (1998)

**Intention**

![Mars Climate Orbiter](image1)

**Fact**

![Mars Climate Orbiter](image2)

**Reason:**

Software used imperial units (pounds of force) rather than metric units (Newtons)

http://en.wikipedia.org/wiki/Mars_Climate_Orbiter
Culture and HMI

CHALLENGES

CULTURAL INFLUENCES ON DESIGN

GLOBALIZATION-LOCALIZATION
Challenges and Examples

- Successful IC Design requires more than adopted language and visual presentation (like e.g. colors and symbols):
  - different mentalities
  - thought patterns
  - problem solving strategies
  - Culture specific UI <> World UI

A world user interface is a compromise to adopt the same UI to different cultures with main market in focus.

A culture specific user interface is adopted to one specific region in the world deeply anchored in culture.

欢迎 / ברוך הבא / добро пожаловать / 환영 / مرحبًا

Parts from: Helmut Windl, Panasonic AG, Frankfurt
Automotive HMI

- Driver Work Place – culturally affected parts:
  - Display
  - Interaction
  - Information presentation
  - India vs. Germany

- Picture from: Continental AG Website, last access 10.11.2019,
Example: Driver navigation systems
Intercultural User Interface Consulting (IUIC)

01 IUID Research (hypothesizing, studying, modeling)

02 IUID Training (lectures, workshops, tutorials)

03 IUID Consulting (supporting, coaching, advising)
Rise of publications in the new millennium
Continuously Summarizing the State of IUID Research
Intercultural User Interface Design (IUID) denotes the process of adequately designing HCI while considering the requirements of the end users for the cultural context.

It is not just the architecture and the parameterization of the software that must be adapted, but also the characteristics of the HMI for the designated cultural context.

For the adaptations in design and technology according to cultural context, the method mix for intercultural user interface design can be used.
IUID Method-Mix

- Method of Culture-Oriented Design
- User Interface Characteristics
- HCI Dimensions
- Cultural Dimensions
- Cultural Variables
- Model of Culture-Dependent HCI
# Method of Culture-Oriented Design

<table>
<thead>
<tr>
<th>Theoretical Analysis</th>
<th>Determine intercultural factors by analysing user culture via cultural dimensions</th>
<th>Derive intercultural variables from the cultural differences found</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empirical Analysis</td>
<td>Determine the values for the intercultural variables regarding the desired user culture by user studies</td>
<td></td>
</tr>
<tr>
<td>Integration</td>
<td>Connect the variables to the human machine system by system design</td>
<td>Intercultural MMS</td>
</tr>
</tbody>
</table>
User Interface Characteristics

Mental Model:
Reference to prioritized data, orientation, structure, articulation, choice, kind of logic

Presentation:
Speech, context, colors, orientation

Navigation:
Choice, path, navigation

Interaction:
Kind of error messages, help, search, profile, orientation, interaction

Metaphor:
Orientation, thinking, structure
HMI Dimensions

- Describe the human machine interaction characteristics of a user or a user group (average behavior of the user(s) with machine by trend)
- Measurable and comparable by index

### Examples of HCI Dimensions and their Variables and Metrics

<table>
<thead>
<tr>
<th>HCI-DIMENSION</th>
<th>HCI-VARIABLE (S) (EXPRESSION (S) OF THE HCI-DIMENSION)</th>
<th>HCI-METRIC (S) (INDICATOR (S) OF THE EXPRESSION (S) OF THE HCI-DIMENSION)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interaction Frequency</td>
<td>Number of interactions per unit of time</td>
<td>Mouse clicks and mouse movements per second or session</td>
</tr>
<tr>
<td>Information- Density</td>
<td>Number of units of information per room unit</td>
<td>Number of words per message or on the display</td>
</tr>
<tr>
<td>Information- / Interaction- parallelism / order</td>
<td>Order of appearance of information units</td>
<td>Number and Order of dialog steps (e.g. number of message windows for a system error)</td>
</tr>
</tbody>
</table>

Cultural Dimensions

• Describe the cultural characteristics of a nation (average behavior of the members by trend)
• Measurable and comparable by index
Values of Hofstede’s Cultural Dimensions for 4 Countries

https://www.hofstede-insights.com/, last access 07|17|2019
Intercultural Variables

- Classify culturally affected HMI variables

<table>
<thead>
<tr>
<th>Intercultural Variable</th>
<th>Localization-Level</th>
<th>Relationship to HCI-Design</th>
<th>Visibility of Variable Contents</th>
<th>Estimated detection / research difficulty [0 (easy) – 10 (heavy)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dialog design</td>
<td>Interaction</td>
<td>Direct</td>
<td>Hidden/over long time and deep analysis</td>
<td>10</td>
</tr>
<tr>
<td>Interaction design</td>
<td>Interaction</td>
<td>Direct</td>
<td>Hidden/over long time and deep analysis</td>
<td>9</td>
</tr>
<tr>
<td>System functionality</td>
<td>Function</td>
<td>Indirect</td>
<td>Visible/immediately recognizable</td>
<td>8</td>
</tr>
<tr>
<td>Service (Maintenance)</td>
<td>Function</td>
<td>Indirect</td>
<td>Visible/immediately recognizable</td>
<td>7</td>
</tr>
<tr>
<td>Technical documentation</td>
<td>Function</td>
<td>Indirect</td>
<td>Visible/immediately recognizable</td>
<td>6</td>
</tr>
<tr>
<td>Information presentation</td>
<td>Surface</td>
<td>Direct</td>
<td>Visible/immediately recognizable</td>
<td>4</td>
</tr>
<tr>
<td>Language</td>
<td>Surface</td>
<td>Direct</td>
<td>Visible/immediately recognizable</td>
<td>2</td>
</tr>
<tr>
<td>General system design</td>
<td>Surface</td>
<td>Indirect</td>
<td>Visible/immediately recognizable</td>
<td>0</td>
</tr>
</tbody>
</table>
Examples of Cultural Variables and their Values for China and Germany

<table>
<thead>
<tr>
<th>Variable/parameter</th>
<th>Germany</th>
<th>China</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Visible Intercultural Variable (VIV)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Color of alerts</td>
<td>Red</td>
<td>Red/Orange</td>
</tr>
<tr>
<td>Color of normal operating condition</td>
<td>Green</td>
<td>Yellow</td>
</tr>
<tr>
<td>Extent of color use</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Use touch devices</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td><strong>Non-visible intercultural variable (NVIV)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of units of information</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Number of system messages</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Number of mouse movements</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Number of words in messages</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Number of explanation dialogs</td>
<td>Very important</td>
<td>Less important</td>
</tr>
<tr>
<td>Argument structure</td>
<td>X because Y</td>
<td>Because Y, X</td>
</tr>
</tbody>
</table>
Measurable intercultural variables: “Cultural HMI Indicators”

<table>
<thead>
<tr>
<th>HCI-DIMENSION RELATED TO CULTURE</th>
<th>HCI-VARIABLE (S) (EXPRESSION (S) OF THE HCI-DIMENSION) RELATED TO CULTURE</th>
<th>HCI-METRIC (S) (INDICATOR (S) OF THE EXPRESSION (S) OF THE HCI-DIMENSION) RELATED TO CULTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interaction frequency in culture X</td>
<td>Number of interactions per unit of time in culture X</td>
<td>Mouse clicks and mouse movements per second or session in culture X</td>
</tr>
<tr>
<td>Information density in culture X</td>
<td>Number of units of information per room unit in culture X</td>
<td>Number of words per message or on the display in culture X</td>
</tr>
<tr>
<td>Information- / Interaction- parallelism / order in culture X</td>
<td>Order of appearance of information units in culture X</td>
<td>Number and Order of dialog steps (e.g. number of message windows for a system error) in culture X</td>
</tr>
</tbody>
</table>

HCI Dimensions and their Values for China and Germany

Model of Culture-Dependent HCI

- Action Chains (-)
- Individualism (-)
- Uncertainty Avoidance (-)
- Femininity (+)
- Network Density (+)
- Long Time Orientation (+)

- Information Density (+)
- Information Frequency (+)
- Info./Interaction Parallellity (+)
- Interaction Frequency (+)
- Interaction Speed (+)
- Interaction Exactness (-)
Distances Across Cultures According to Cultural Dimensions from Hofstede

### HCI Styles

<table>
<thead>
<tr>
<th>HCI Style</th>
<th>Cultural characterization using Hofstede's Indices</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asian</td>
<td>PDI high, IDV low, MAS middle, UAI low, LTO high</td>
<td>90</td>
</tr>
<tr>
<td>Indian</td>
<td>PDI high, IDV middle, MAS middle, UAI middle, LTO middle</td>
<td>70</td>
</tr>
<tr>
<td>African</td>
<td>PDI high, IDV low, MAS middle, UAI middle, LTO low</td>
<td>60</td>
</tr>
<tr>
<td>Scandinavian</td>
<td>PDI low, IDV high, MAS low, UAI middle, LTO low</td>
<td>40</td>
</tr>
<tr>
<td>Slavic</td>
<td>PDI high, IDV middle, MAS middle, UAI high, LTO low</td>
<td>30</td>
</tr>
<tr>
<td>Angle-Saxon</td>
<td>PDI low, IDV high, MAS middle, UAI low, LTO low</td>
<td>20</td>
</tr>
<tr>
<td>German</td>
<td>PDI low, IDV middle, MAS high, UAI middle, LTO low</td>
<td>10</td>
</tr>
</tbody>
</table>

Towards a IUID Toolbox
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Synergy between IUID Method-Mix and Systematic Approach

Systematic Approach

- HCI Dimensions
- Cultural Variables
- Cultural Dimensions
- User Interface Characteristics
- Model of Culture-Dependent HCI
- Method of Culture-Oriented Design
Procedure for Systematically Applying the IUID Method-Mix

- Select the application, the main application cases and the desired target cultures
- Determine the respective interface elements (e.g. layout, buttons, text fields) and map them to the category of cultural variables (direct, indirect, visible, hidden) as well as to the characteristics of the user interface (presentation, interaction, navigation, mental model and metaphor).
- Determine the affected time and space-related HCI dimensions (e.g. information density or interaction frequency).
- Use the cultural-dependent HCI model to relate the HCI dimensions to the cultural dimensions in order to derive cultural interaction indicators (e.g. the ratio of the frequency of mouse clicks between users of culture X and culture Y) and finally implicate the design recommendations for IUID.
IUID Toolbox Application
IUID Toolbox UI
IUID Toolbox Architecture
IUID Toolbox Architecture

Graphical UI → IUID Database

Graphical UI → IUID Database

Artificial Intelligence Module

Findings from empirical studies
<table>
<thead>
<tr>
<th>Application / Use Case</th>
<th>Cultural aspect / Cultural dimension</th>
<th>UI Characteristics</th>
<th>Cultural variable</th>
<th>HMI dimension</th>
<th>Cultural interaction indicator</th>
<th>IUID implication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word processing / Filling in a form</td>
<td>Language / Communication network density</td>
<td>Presentation, Interaction</td>
<td>Direct (word length), layout</td>
<td>Information density, Interaction frequency</td>
<td>Average number of chars per word, page</td>
<td>Resizing, calculate size of display according to language</td>
</tr>
<tr>
<td>E-learning system / Learning content</td>
<td>Communication speed, power distance, uncertainty avoidance</td>
<td>Presentation, Navigation</td>
<td>Visible (character set, buttons)</td>
<td>Information presentation speed</td>
<td>Dialogues per minute, Number of breaks in interaction</td>
<td>Adapt speed of guided dialogues ( wizards ) and button size</td>
</tr>
<tr>
<td>Phone / Looking up, dialing via name or number</td>
<td>Communication speed, density of the information network</td>
<td>Interaction, Mental model</td>
<td>Indirect (online operating manual)</td>
<td>Interaction speed and interaction style</td>
<td>Number of pressing buttons per task</td>
<td>Choose appropriate input method editor (IME) and sorting algorithms</td>
</tr>
<tr>
<td>Word processor on a mobile phone / Sending a short text message via SMS</td>
<td>Power distance, individualism, uncertainty avoidance</td>
<td>Presentation : text, character, character set, layout, skin, edit field, send button, receiver list box</td>
<td>Direct, visible, surface (color, skin, language)</td>
<td>Information density, interaction frequency and speed, Information and interaction parallelism, interaction exactness</td>
<td>Number of pieces of information per space, Number of SMS per day, Number of saved contacts</td>
<td>Adapt system memory / Choose appropriate input method editor (IME) and sorting algorithms / allow customization of the number of entries in lists</td>
</tr>
</tbody>
</table>
Design Recommendations Germany-China

Germany

- Widget positions (position of status bar)
- Information density: low
- Information frequency: low
- $3 \times 650 \text{ m}$

China

- Information density: high
- Information frequency: high
- $4 \times$
Features of the IUID Toolbox

- Identifying the values of all required variables for IUID
- Deriving recommendations for intercultural user interface design
- Estimating the development expense for new IUID projects
- From manual paper version to automatically computation of all results by an expert system
Problems and Challenges

• Different Approaches
• Missing Empirical Confirmation
• Usage of Cultural Dimensions
• High Research Effort
• Cultural Complexity
Consider that there are different HMI styles around the world

Take the cultural context into account in designing automotive user interfaces

Use the IUID toolbox for intercultural automotive user interface design

Take advantage of the experience of intercultural user interface consulting
Thank you very much for your attention!

Please, contact me for further information, training or cooperation!

Dr. phil. Rüdiger Heimgärtner
Founder and CEO of IUIC

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Questions & Answers
Backup
Intercultural User Interface Design

• Adaptations in design and technology according to cultural context using a systematic method mix for intercultural user interface design
Integrating Cultural Aspects

01 Common Aspects for Intercultural UI Design

02 System Specific Cultural Aspects

03 Cultural model
HCl and HCl Design Process Affected by Culture

- Influence of Culture on Usability/UX and Usability Engineering
- Intercultural User Interface Design
- Cultural Influences on the Standardized User-Centered Design Process
- Influence of Culture on User’s Interaction with the UI
Task description
You want to drive on the teal road to the restaurant. Please adjust the sliders to get the pieces of information you like to see.

Please give reasons, why you have chosen exactly this information.

I like to be informed about the most important things along my route.
## Cultural Interaction Indicators

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Ratio (C : G)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of error clicks</td>
<td>2 : 1</td>
</tr>
<tr>
<td>Number of simultaneous tasks</td>
<td>2 : 1</td>
</tr>
<tr>
<td>Speed of mouse moves</td>
<td>1,6 : 1</td>
</tr>
<tr>
<td>Number of mouse moves</td>
<td>1,3 : 1</td>
</tr>
<tr>
<td>Number of left mouse clicks</td>
<td>1,2 : 1</td>
</tr>
<tr>
<td>Interaction breaks with mouse &gt; 10s</td>
<td>1 : 1,22</td>
</tr>
</tbody>
</table>

(Heimgärtner 2007)
• Our globally connected world demands for global standards to some extend: HCI dimensions and HCI styles around the world
## Old IUID-Method-Mix Worksheet

<table>
<thead>
<tr>
<th>Application(s) / Use Case(s)</th>
<th>Culture</th>
<th>Cultural Dimension(s)</th>
<th>User Interface Characteristics</th>
<th>Intercultural Variable(s)</th>
<th>HCI Dimension and their relationship to cultural dimension(s) according to culture-dependent HCI Model</th>
<th>Cultural Interaction Indicator(s)</th>
<th>IUID implication(s) / recommendation(s)</th>
</tr>
</thead>
</table>
Outcome example
Findings by Applying the IUID Method-Mix

Groups had different approaches to solve the task

- Analytically think about a solution – after selecting a use case, easy to find and relate the items to the categories
- Identify examples for the categories and concepts in the internet by comparison
- Look at an application to identify examples for the categories and concepts
# New IUID-Method-Mix Worksheet

<table>
<thead>
<tr>
<th>Use Case</th>
<th>Culture</th>
<th>Cultural Dimension</th>
<th>Relationship from culture-dependent HCI Model</th>
<th>HCI Dimension</th>
<th>User Interface Characteristics</th>
<th>Intercultural Variable(s)</th>
<th>Recommendation(s) for IUID</th>
</tr>
</thead>
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</tbody>
</table>
Produkte müssen gebrauchstauglich und benutzungsfreundlich sein. 
Für jeden. Weltweit.

Wir zeigen Ihnen,
wie Sie Ihre Produkte benutzungsfreundlich machen.
wie Sie Produktentwicklungsprozesse prüfen und optimieren.
wie Sie weltweit Mensch-Maschine-Schnittstellen für alle entwickeln.

Forschung
Kontinuierliche Literatursuche und Mensch-Maschine-Interaktionsforschung
garantieren Ihnen ein exklusives, wissenschaftlich gesichertes Expertenwissen auf dem neuesten Stand.

Schulung
Seminare und Workshops vermitteln allen an der Produktentwicklung Beteiligten (Management, Marketing, Design, Produktion, Vertrieb) fundierte Kenntnisse in Sachen Gebrauchstauglichkeit.

Beratung
Die intensive Begleitung bei der Entwicklung gebrauchstauglicher Produkte und Prozesse auch im interkulturellen Kontakt befähigt Ihr Unternehmen weltweit zu maßgeschneiderten Lösungen.

Wir leben Usability.
Wir prüfen Prozesse.
Wir begreifen Kulturen.
IUIC in Science and Industry - Since 2003

- Acknowledged
- Working at current research status
- Tasks are clarified and tackled
- References
- Network
Research

• With IUIC you have access to the current state of research in the field of development of usable products and human-machine interaction, especially for the intercultural context.

• IUIC transforms the latest scientific findings from research cooperation's and committee work into action-relevant knowledge for practice.
Training

- IUIC conducts seminars according to the CPUX curriculum of the UXQB with accredited certification possibilities of the German Usability Professional Association (German UPA).
- IUIC also offers training for process testing based on the ISO 15504 international standard.
- The methods for optimizing the usability of products and processes are conveyed in seminars regarding other cultures (IUID).
- Project-accompanying coaching serves the correct application of the learned in practice.
Consulting

- IUIC accompanies you in the development of products and processes suitable for use from the idea to the market introduction also in the intercultural context.
- We review the relevant processes for product development in your company (based on the standard ISO 33000).
- We show you which aspects of the user interface design are important for other cultures and how development guidelines or customized solutions are generated for your company.
Contact

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