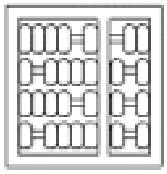

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Merging Technical Guidelines for Accessible Web Content with Universal Design Principles

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Abstract. Despite the number of recommendations for authoring accessible web content there is a lack in providing clear orientation for non specialist developers, as some recommendations are too extensive, too abstract or exclusively technical. These deficiencies contribute to the low adherence to recommendations since designers are not necessarily experts in accessibility. In this work we synthesize recommendations for the design of "accessible for all" products aiming at providing clear orientation to designers. The work resulted in a mapping of the W3C Web Content Accessibility Guidelines 2.0 and ISO 9241 recommendations into Universal Design Guidelines. The mapping provides an understanding of the relation between accessibility needs and the technical apparatus that can be used to fulfill them, so that experts in accessibility and web designers are both benefited by the mapping. Additionally we pointed out some aspects that are still not covered, or need improvement and, potentially, can help the design of accessible web content.

Keywords: Universal Design, Web Accessibility Guidelines, ISO 9241.

1. Introduction

The development of accessible web content is currently the focus of a number of conferences and it is an increasing concern in the public and private markets which are starting to become aware of the relevant slice of the population direct or indirectly affected by problems in the content their websites are offering. Currently there is an international effort to establish standards for accessibility for web-based systems. Examples include the Web Accessibility Initiative (WAI), kept by the World Wide Web Consortium [35] and other governmental initiatives such as the Section 508 [31], the Stanca Act [19], and the Act 5.296/2004 [5].

Even with the variety of sources of recommendations for web content development, designers frequently fail in authoring accessible products. Many are the factors that contribute to this scenario, among them we want to highlight those related to precision and coverage of the recommendations in relation to the whole context of websites usage such as: a) the lack of information between the recommendations and the needs that leverage them [26]; b) the target public diversity when considering geographical, political, economical, social and cultural aspects [24]; c) other factors such as physical restrictions (*e.g.* illumination, assistive peripherals); and d) recommendations are usually extensive and not in context; thus designers tend to use only semi-automatic validation tools without considering the impacts of their decisions.

In an attempt to help designers in authoring “accessible for all” web content we articulated recommendations coming from: the Universal Design – UD [8] principles and guidelines – for universal access (initially focused in the physical world), the Web Content Accessibility Guidelines 2.0 [34] - for web content, and ISO 9241 parts 1, 3, 4, 5, 6 and 9 [12, 13, 14, 15, 16, 17, 18] – for environmental considerations. Our approach aimed at gathering the best aspects from UD and the Web Content Accessibility Guidelines 2.0 (WCAG), from WAI, to produce a guide that is intended to be simple to understand the principles and objectives addressed by the guidelines while offering specific criteria for web content authoring.

Additionally we adopted ISO 9241 environmental aspects to cover the UD principles related to the physical aspects of designing.

This text is organized as follows: Section 2 presents the methodological references adopted in this work; Section 3 presents the results of our approach and discusses the main topics, and Section 4 presents our final considerations.

2. Methodological References

Universal Design (or Design for All) as defined by Connell *et al.* [8] consists in designing products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. The objective of the Universal Design is challenging and, despite of the difficulty – or even the impossibility due to the current technological and scientific lacks - faced in developing products for all, its practice instigates designers to potentially produce better solutions.

Aiming at helping designers to adopt the Universal Design, Connell *et al.* [8] compiled a set of 7 principles and 30 guidelines. Story *et al.* [28] present examples for each guideline, considering various scenarios and knowledge areas, including computer systems. Other researchers in computer science have sought for universal solutions (*e.g.* [1, 25, 32]) in software applications and their user interfaces. While Universal Design offers a concise orientation for the design of accessible physical products the principles and guidelines are still far from those that are needed for designers of web content and other non-tangible products.

On the other hand, the Web Accessibility Initiative (WAI) contributes with recommendations and techniques specifically for accessibility on the Web. WAI has three foci: User Agent Accessibility Guidelines (UAAG) – for browsers, multimedia players, and assistive technologies; Authoring Tool Accessibility Guidelines (ATAG) – for web content authoring tools; and Web Content Accessibility Guidelines (WCAG) – for web content. This work focuses on WCAG principles, guidelines and success criteria.

WCAG offers specific recommendations and techniques (currently there are 12 guidelines and 61 success criteria) for the development of web content. Some of the major problems

when adopting WCAG guidelines rely on factors such as: they are not totally "machine testable" guidelines [22]; difficulty experienced by designers in understanding the consequences in accessibility aimed at the guidelines [7, 26]. Consequently, semi-automatic evaluation tools *e.g.* AChecker [4], Cynthia Says [9] frequently fail in helping designers to understand which possible issues are actually problems from those that are not, when considering the website context. For example, when validating the URL http://vilanarede.org.br, AChecker returned, in the report of possible errors, the message "*<title>Vila na Rede - Uma Rede Social Inclusiva</title>, Check Line 4, Column 1: title might not describe the document*" and other information regarding the guideline used with success and fail examples. Otherwise it lacks information regarding the criteria employed in the evaluation. In this example the most probable reason for this alert the language employed in the title (*i.e.* the AChecker parser has not international language support) and not because of its semantics. Inexperienced designers it would take some of time trying to understand why the title is considered as inadequate.

We argue that some guidelines are not necessarily "machine testable" because of their contextual, social and cultural dependency. Otherwise guidelines must provide enough information for aiding designers' interpretation in the technological and social contexts of the web applications. For this intent, joining Universal Design to WCAG principles and guidelines can be a relevant approach in providing the concise and broad orientation about user's needs and about environmental characteristics from Universal Design, transported to web content specific guidelines from WCAG.

3. Merging WCAG with UD

Next we present the methodology employed to conduct our analyses, the resulting mapping and the argumentation regarding the coverage and applicability of such approach for authoring web content. The approach we took in this work consisted of a three-step process:

- Analyze each information unit of WCAG and UD starting from the more abstract levels (*i.e.* principles) to the concrete levels (*i.e.* success criteria), considering both

discursive and codified content aiming at finding the correct alignment among the hierarchy of both WCAG 2.0 and UD. The objective was to find the best matching units so that designers could understand the mapping without the need of further information as, for example, to consider only a part of a unit or to join a number of parts for making sense of the content;

- Build a mapping of WCAG elected units into UD elected units;
- Analyze the results and identify lacks in the mapping. For each lack, to point out possible solutions.

The mapping tried to keep the characteristics of minimum number of mapping units; best precision (units addressing the same specific theme) and accuracy (do not involve other themes or need external information to fully understand the content); and applicability and covering evaluation of the mapped units related to the authoring of web content.

In the first step of our method we analyzed the information units. For Universal Design, the Story *et al.* [28] book and the website "The Center for Universal Design" [8] were the main references; for WCAG we considered the online content of the guidelines in its version 2.0 [34]. WCAG hierarchical organization of the units is composed of 4 levels (*i.e.* principles, guidelines, success criteria and techniques); UD has 2 levels (*i.e.* principles and guidelines). Following the objective of concision for the mapping we started trying to match the principles of WCAG into UD Principles. Despite apparently being possible to do that, the result of this mapping does not fit our objective of accuracy. Next we repeated the same procedure for the lower levels of each hierarchy until find a satisfactory result. The best matching we obtained employing UD Guidelines (30 units) and WCAG Success Criteria (61 units).

Each mapping unit is composed of one UD Guideline and its correspondent mapping that can be:

- Zero, one or more WCAG Success Criteria;
- An additional external reference (in this work we considered only ISO 9241);

- A suggestion or comment.

For the mapping we decided to associate WCAG Success Criteria to the UD Guidelines and not the opposite, due to an expectative for reducing the number of mappings, and the UD Guidelines coverage of environmental aspects. For the majority of units the expectative for reduction became true (see Table 1 for an example), there were some cases that occurred the opposite to the expectative (see Table 2 for an example) when a WCAG Success Criterion was mapped into more than one UD Guideline.

Regarding UD Principle 1 we understand that the guidelines 1.1 “Provide the same means of use for all users: identical whenever possible; equivalent when not”, 1.2 “Avoid segregating or stigmatizing any users”, 1.4 “Make the design appealing to all users” represent the UD general objectives so that they are transversal to web content creation and, consequently, to all WCAG Guidelines.

Table 1. Example of mapping more than one WCAG Success Criteria into one UD Guideline.

UD Guideline	WCAG Success Criteria
2.4. Provide adaptability to the user's pace.	1.4.2. Audio Control
	2.2.1. Timing Adjustable
	2.2.2. Pause, Stop, Hide
	2.2.3. No Timing
	2.2.4. Interruptions
	2.2.5. Re-authenticating

Table 2. Example of mapping more than one UD Guidelines into one WCAG Success Criterion.

UD Guideline	WCAG Success Criteria
3.4 Arrange information consistent with its importance	2.4.10 Section headings
4.4 Differentiate elements in ways that can be described	

Table 3 presents examples of parts of the mapping regarding UD Principles 4 and 6. UD Guidelines 4.1 and 4.2 are good examples of how technical recommendations for web content from WCAG can be grouped into an UD Guideline and, consequently, easing the

comprehension of the context in which they are necessary. UD Guideline 6.2 is a case where ISO 9241 parts were employed. For the complete mapping consult Appendix.

Table 3. Examples of mappings for the principles 4 and 6 of UD.

UD Guideline	Mapping
4. Perceptible Information	
4.1. Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.	1.1.1. Non-text Content; 1.2.1. Audio-only and Video-only (Prerecorded); 1.2.2. Captions (Prerecorded); 1.2.3. Audio Description or Media Alternative (Prerecorded); 1.2.4. Captions (Live); 1.2.5. Audio Description (Prerecorded); 1.2.6. Sign Language (Prerecorded); 1.2.7. Extended Audio Description (Prerecorded); 1.2.8. Media Alternative (Prerecorded); 1.2.9. Audio-only (Live); 1.3.1. Info and Relationships; 1.3.3. Sensory Characteristics; 1.4.5. Images of Text; 1.4.9. Images of Text (No Exception)
4.2. Provide adequate contrast between essential information and its surroundings.	1.4.3. Contrast (Minimum); 1.4.6. Contrast (Enhanced); 1.4.7. Low or No Background Audio
6. Low Physical Effort	
6.2. Use reasonable operating forces.	ISO 9241-4 [14] Sections: 6.2.3 Key displacement and force; 6.2.7 Key repeat function; ISO 9241-9 [18] Section 4.4.2 Biomechanical Load/Effort

To understand the relative coverage of WCAG Success Criteria to UD guidelines we summarized them on the principles level in Table 4. For each relationship we present the absolute number of matched WCAG Success Criteria and its relative value to the total Success Criteria in the respective WCAG Principle. WCAG Success Criteria that appeared in more than one UD Guideline of the same UD Principle were computed only once.

The covering analysis table (Table 4) reveals a considerable compatibility level between UD and WCAG principles. We evidence this by observing that: WCAG Principle “Perceivable” is 86.36% matched to UD Principle “Perceptible Information”; WCAG Principle “Understandable” is 70.59% matched to UD Principle “Simple and Intuitive”.

While the WCAG Principle "Operable" is fragmented across the majority of UD Principles except in "Size and Space for Approach and Use". Considering this result we can point out some considerations:

Physical aspects. UD Principles "Low Physical Effort" (see Table 3 for an example) and "Size and Space for Approach and Use" demand specific guidelines. Even considering that WCAG is focused on web content we believe that web designers must have concerns regarding the environmental aspects surround users when interacting with digital artifacts. For this intent we employed some ISO 9241 parts that address environmental aspects *i.e.* Part 3: Visual display requirements [12, 17]; Part 4: Keyboard requirements [14]; Part 5: Workstation layout and postural requirements [15]; Part 6: Guidance on the work environment [16]; Part 9: Requirements for non-keyboard input devices [18]. ISO 9241 concerns ergonomics of human-system interaction. ISO 9241 Part 1 [13] defines the scope of ergonomics as "*... matching the design of products or systems, including displays, input devices, software, workplace, working environment and tasks, to the characteristics, capabilities and limitations of potential users*".

Table 4. Covering analysis of WCAG (columns) in relation to the UD principles (rows). Each cell present the number of WCAG Success Criteria that address the UD Principle followed by the value relative to the total number of WCAG 2.0 Success Criteria in their respective WCAG Principle. WCAG Success Criteria are computed only once in each principles relation.

	Perceivable	**Operable**	**Understandable**	**Robust**
Equitable Use	0(0%)	2(10%)	0(0%)	0(0%)
Flexibility in Use	4(18.18%)	10(50%)	0(0%)	0(0%)
Simple and Intuitive	1(4.55%)	7(35%)	12(70.59%)	0(0%)
Perceptible Information	19(86.36%)	4(20%)	0(0%)	2(100%)
Tolerance for Error	0(0%)	3(15%)	5(29.41%)	1(50%)
Low Phys. Effort	0(0%)	1(5%)	0(0%)	0(0%)
Size/Space Approach/Use	0(0%)	0(0%)	0(0%)	0(0%)

Granularity. The choice to map more granular levels (*i.e.* UD Guidelines and WCAG Success Criteria) seems to be adequate. As each WCAG Success is mapped into a UD Guideline we can say that, considering the WCAG Success Criteria (*i.e.* 61 units), it was

possible to reduce the number at a half. For UD the number was not modified. . We can observe some other signals that reinforce its adequacy:

- Only 19 of the 61 WCAG Success Criteria repeat in different UD Guidelines;
- Only 2 of those 19 WCAG Success Criteria repeat more than twice (they repeat 3 times);
- And 9 of those 19 WCAG Success Criteria repeat in the same UD Guideline.

Considering the data above, we can conclude that in about 84% of the mapping units the matching is direct from WCAG to UD (69%) or it belongs to the same UD Principle (15%). About 16% of the WCAG Success Criteria are mapped in different UD Principles. This not implies a bad matching; otherwise it can require more attention to the designer to address the WCAG Success Criterion goals in different UD Principles contexts.

Examples of repeated WCAG Success Criteria in the same UD Principle are 1.4.5 “Images of Text” and 1.4.9 “Images of Text (No Exception)” that are mapped into the UD Principle 4 “Perceptible Information”, in the UD Guidelines 4.1 “Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information” and 4.4 “Differentiate elements in ways that can be described (*i.e.*, make it easy to give instructions or directions)”. Table 2 presents an example in which a WCAG Success Criteria is mapped into UD Guidelines from different UD Principles.

Hands and Reading direction. It was not possible to identify in WCAG 2.0, Success Criteria for the UD Guideline 2.2 “Accommodate right- or left-handed access and use” because of its effect is solved by hardware devices as keyboard and mouse or other assistive technology. Otherwise it could be considered in the sense of the reading direction (see [33]).

Ubiquitous (or Pervasive) Computing proposes the use of Information and Communication Technologies (ICT) spread in the whole environment people are immersed. Considering the tendency of computers become “unremarkable” [37, 23]; it raises a number of possibilities and challenges that affect the way web content is become available. Streitz, *et al.* [29] proposes the concept of Roomware, a environment where ICT are integrated in room

elements as, for example, doors, walls and furniture. These environments can potentially contribute to the "access for all" objective by providing more natural interfaces due they use real life elements. On the other hand, if ICT do not take into account the recommendations for universal access (*e.g.*, UD and ISO 9241) the will harass the exclusion scenario by bringing the current computing problems to the activities of the real life.

4. Discussion

WCAG mapped into UD and complemented with ISO 9241 environmental recommendations seams to be a comprehensive and concise set of information about web content accessibility. The organization of UD principles and guidelines in this way has the potential to bring to designers a deeper understanding of the technical recommendations promoted by WCAG and ISO 9241. Moreover, UD read by the lens of WCAG and ISO 9241 allowed adapting the principles and guidelines usually inspired by the physical world to the virtual world. In this section we highlight some characteristics that deserve further discussion about the mapping at its coverage.

Reading level. WCAG Success Criteria 3.1.5 "Reading Level" states that texts should not require reading ability more advanced than the lower secondary education level or must offer an alternative presentation for the information. The lower secondary education level is defined by UNESCO [30] as "*… the two or three year period of education that begins after completion of six years of school and ends nine years after the beginning of primary education*". Despite the international acceptance of this definition it may not be adequate when considering developing countries (*e.g.*, India and Brazil); for this intent we analyzed the Brazilian social and educational demographics.

First of all we consulted the 2007 Brazilian National Research by Household Sample [10] from the Brazilian Institute of Geography and Statistics – IBGE (from its Brazilian acronym). The schooling average of the Brazilian population between 15 and 59 years old is 7.83 years. This information reveals that, in terms of years at school, Brazil fits the

UNESCO classification. However, when considering the slice of the Brazilian population of 60 or more years old the average falls to only 3.8 years.

In addition we have to consider the quality of those years of school attendance; for this intent we consulted the Indicator of Functional Literacy - INAF (from its Brazilian acronym) [11]. INAF considers the ability to read and understand texts and graphic representations. In contrast with the data from IBGE, according to INAF, in 2009, 29.66% of Brazilian population between 15 and 59 years old were functionally illiterate (*i.e.*, they are not able to perform simple tasks involving reading words and phrases even if part of them is able to read numbers - *e.g.* telephone numbers, prices, etc. or are able to find explicit information in short and known texts - *e.g.* an advertisement or a short letter, read and write usual numbers and perform simple operations to handle money for the payment of small amounts or perform length measurements using a tape-measure [11]). We observed that the illiteracy indicator does not have a normal distribution and it increases significantly with the age of the population. Thus, we believe the choice of the literacy level of the website target audience should take into account the context it is inserted.

Operability of user interface elements. In our research the UD Guideline 7.3 "Accommodate variations in hand and grip size" is interpreted in the sense of pointing devices (*e.g.* mouse and touch screen). While WCAG does not address directly this subject, ISO 9241 treats the question and offers strait directions about the design of buttons. Additionally we want to address situations as, for example, users without or with low experience with computers, older people, people with low accuracy in their hands movements, and other conditions that limit the accuracy when using pointing devices.

More than pointing out lacks in standards for the design of interface elements, here we want to highlight the relevance of considering the target audience needs and context. A way of dealing with the problem of UI operability in the context considered in this paper was presented in Almeida *et al.* [3], who proposed to adopt techniques and methods from Participatory Design with the target audience (low literacy and low skills for using digital artifacts). Some interface elements, extracted from that reference, illustrates ways of helping those users to operate pointing devices. They are: a set of arrows that complement

the browser scroll bar and help users by moving a bigger portion of the web page and by associating more properly the direction of the movement with the graphical representation used (see Figure 1 item a); radio and check buttons labels that are click able with the click able area significantly increased (see Figure 1 item b).

Figure 1. Techniques for improving the operability of interface elements. Item (a) presents directional arrows that complement browsers scroll bars. Item (b) presents a list of checkboxes that can be selected by clicking in any place of the highlighted area. Images extracted from the *Vila na Rede* social network (http://www.vilanarede.org.br).

Parsing. WCAG Success Criterion 4.1.1 "Parsing" addresses the syntax of markup content aiming at contributing to the correct interpretation by user agents. Even considering that markup is the heart of web content the use of other technologies cannot be ignored. Statistics presented that in 95% of the web browsers JavaScript is enabled [36] and the flash player is installed in 99% of the web browsers [2]. Additionally, between 30% and 40% of the websites contain flash files and about 74.5% use some kind of scripting [38]. W3C already includes WCAG techniques using JavaScript codes. Otherwise there are other script languages being used currently in large scale (*e.g.*, PHP, .Net) that demand attention. Even for JavaScript it is difficult to try to cover all sort of script that can be added to markup content. One alternative for that could be to develop accessibility evaluation tools that do not rely only on static pages – as it is usually performed; the evaluation could simulate scenarios to identify when the execution of a script generates a not accessible output in complement to check coding.

Environment of use. ISO 9241-6 "Guidance on the work environment" is an example of how ISO 9241 can contribute to UD and WCAG. Considering UD Guideline 4.2 "Provide

adequate contrast between essential information and its surroundings" that is mapped to WCAG Success Criteria 1.4.3 "Contrast (minimum)", 1.4.6 "Contrast (enhanced)", and 1.4.7 "Low or no background audio"; Even in a successful scenario (*i.e.* all the WCAG Success Criteria are accomplished) the accessibility may still be limited due to environmental conditions, as described in ISO 9241-6 Section 6 Guidance on sound and noise. ISO 9241-6 covers 6 aspects that may influence the accessibility of environments: 1) natural and artificial lighting, 2) sound and noise, 3) mechanical vibrations, 4) electromagnetic fields and static electricity, 5) thermal environment, and 6) space organization and workplace layout. So that the mapping, by aggregating ISO 9241, provides designers with technical recommendations not restricted only to web content per se.

Social and emotional factors. WCAG Principles can partially capture the Model of Human Information Processor and its basic mechanisms as proposed by Card *et al.* [6]. The WCAG Principle "Perceivable" can be associated to the Perceptual Processor, the Principle "Operable" to the Motor Processor and the Principle "Understandable" to the Cognitive Processor. The Principle "Robust" treats computer coding issues. UD Principles and ISO 9241 focus on the physical word that enable or restrict users when interacting with computers.

Stamper [27] proposed the Semiotic Ladder, a representation of information systems that extends the semiotic classical 3 layers (or divisions) of signs (*i.e.* syntactics, semantics and pragmatics) to 6 layers (*i.e.* physical, empirics, syntactics, semantics, pragmatics and social). Ideally a good design should take into account all the 6 layers to model an information system. UD and ISO 9241 address primarily the physics and empirics layers, while WCAG focuses on syntactics and semantics. The pragmatics and social layers are not yet addressed by any set of recommendations. These layers are becoming the focus of new works on Human-Computer Interaction and mark the expansion of the area beyond considerations of human cognition, usability, and GUI to a holistic view of people as part of information systems, including affective aspects and considerations of the pragmatic and social issues involved when interacting with computers.

5. Conclusion

Developing web content aiming at being “accessible for all” is a complex activity especially due the difficulty in knowing the target public, not homogeneous anymore, and having access to them. Literature and international organizations have contributed with efforts towards proposing sets of recommendations (principles, guidelines, technical criteria) to aid designers in their tasks of creating accessible web content. Aiming at supporting designers in making sense of those different sets, this paper mapped WCAG Success Criteria into UD Guidelines. From this mapping we identified a need for additional recommendations to address physical aspects of the environment people are immersed when interacting with computers. For this intent we complemented the mapping with some ISO 9241 recommendations. The resulting mapping offers designers the accessibility information grounded in the real world from UD articulated with technical orientation for computing technology from WCAG and ISO 9241 (parts 1, 3, 4, 5, 6 and 9). We intended to help designers in understanding the reason they should consider accessibility issues by understanding the target public’s needs and by creating technical solutions in their products.

Moreover, the social and emotional aspects are increasingly becoming subjects of interest of researches in HCI (*e.g.*, [20, 21]). The analysis conducted in this paper revealed that the knowledge about these aspects should be brought to the recommendations for web content authoring activity. Additionally, regional and cultural characteristics are important influencing factors in applying general recommendations as we argued in relation to the reading level recommendation.

This work leverages further research including, for example: the empiric evaluation of the approach by designers of web content; creation of web application to aid evaluations using the mapping (currently in development); the investigation of other recommendations as, for example, the software parts of the ISO 9241, aiming at improving the coverage of the UD guidelines; the suggestion of recommendations for web content based on social and affective aspects.

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Appendix

This section presents the full mapping table resulting from the analysis of WCAG 2.0 Success Criteria, UD Guidelines, and, complementarily some parts the ISO 9241 related to physical and contextual standards and recommendations. In Table 5 the first column presents the UD Guidelines, the second column contains the mapping related to the respective UD Guideline. The mapping can be: one or more WCAG Success Criteria, an ISO 9241 part or section or an author consideration.

Table 5. Full mapping of WCAG 2.0 and, partially, ISO 9241 into UD.

UD Guideline	Mapping
1. Equitable Use	
1.1. Provide the same means of use for all users: identical whenever possible; equivalent when not.	Valid for every Success Criteria
1.2. Avoid segregating or stigmatizing any users.	Valid for every Success Criteria
1.3. Provisions for privacy, security, and safety should be equally available to all users.	2.2.4. Interruptions; 2.2.5. Re-authenticating
1.4. Make the design appealing to all users.	Valid for every Success Criteria
2. Flexibility in Use	
2.1. Provide choice in methods of use.	2.1.1. Keyboard; 2.1.3. Keyboard (No Exception); 2.4.1. Bypass Blocks; 2.4.5. Multiple Ways; 2.4.8. Location
2.2. Accommodate right- or left-handed access and use.	This guideline is usually accomplished by hardware devices as keyboard and mouse or other assistive technology. Otherwise it could be considered in the sense of the reading direction (W3C, 2009) when thinking in web content.
2.3. Facilitate the user's accuracy and precision	1.4.3. Contrast (Minimum); 1.4.4. Resize text; 1.4.8. Visual Presentation
2.4. Provide adaptability to the user's pace.	1.4.2. Audio Control; 2.2.1. Timing Adjustable; 2.2.2. Pause, Stop, Hide; 2.2.3. No Timing; 2.2.4. Interruptions; 2.2.5. Re-authenticating
3. Simple and Intuitive Use	
3.1. Eliminate unnecessary complexity.	3.1.3. Unusual Words; 3.1.4. Abbreviations; 3.1.5. Reading Level

3.2. Be consistent with user expectations and intuition.	2.4.3. Focus Order; 3.2.1. On Focus; 3.2.2. On Input; 3.2.3. Consistent Navigation; 3.2.4. Consistent Identification; 3.2.5. Change on Request
3.3. Accommodate a wide range of literacy and language skills.	2.4.2. Page Titled; 2.4.6. Headings and Labels; 3.1.1. Language of Page; 3.1.2. Language of Parts; 3.1.3. Unusual Words; 3.1.4. Abbreviations; 3.1.5. Reading Level; 3.1.6. Pronunciation
3.4. Arrange information consistent with its importance.	1.3.2. Meaningful Sequence; 2.4.10. Section Headings
3.5. Provide effective prompting and feedback during and after task completion.	2.4.4. Link Purpose (In Context); 2.4.7. Focus Visible; 2.4.9. Link Purpose (Link Only); 3.3.5. Help
4. Perceptible Information	
4.1. Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.	1.1.1. Non-text Content; 1.2.1. Audio-only and Video-only (Prerecorded); 1.2.2. Captions (Prerecorded); 1.2.3. Audio Description or Media Alternative (Prerecorded); 1.2.4. Captions (Live); 1.2.5. Audio Description (Prerecorded); 1.2.6. Sign Language (Prerecorded); 1.2.7. Extended Audio Description (Prerecorded); 1.2.8. Media Alternative (Prerecorded); 1.2.9. Audio-only (Live); 1.3.1. Info and Relationships; 1.3.3. Sensory Characteristics; 1.4.5. Images of Text; 1.4.9. Images of Text (No Exception)
4.2. Provide adequate contrast between essential information and its surroundings.	1.4.3. Contrast (Minimum); 1.4.6. Contrast (Enhanced); 1.4.7. Low or No Background Audio
4.3. Maximize "legibility" of essential information.	1.4.8. Visual Presentation
4.4. Differentiate elements in ways that can be described (*i.e.*, make it easy to give instructions or directions).	1.3.3. Sensory Characteristics; 1.4.1. Use of Color; 1.4.5. Images of Text; 1.4.9. Images of Text (No Exception); 2.4.10. Section Headings
4.5. Provide compatibility with a variety of techniques or devices used by people with sensory limitations.	2.1.1. Keyboard; 2.1.2. No Keyboard Trap; 2.1.3. Keyboard (No Exception); 4.1.1. Parsing; 4.1.2. Name, Role, Value
5. Tolerance for Error	
5.1. Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded.	2.3.1. Three Flashes or Below Threshold; 2.3.2. Three Flashes; 3.3.1. Error Identification; 3.3.2. Labels or Instructions; 4.1.1. Parsing

5.2. Provide warnings of hazards and errors.	3.3.2. Labels or Instructions; 3.3.4. Error Prevention (Legal,Financial, Data); 3.3.6. Error Prevention (All)
5.3. Provide fail safe features.	2.1.2. No Keyboard Trap; 3.3.4. Error Prevention (Legal, Financial, Data); 3.3.6. Error Prevention (All)
5.4. Discourage unconscious action in tasks that require vigilance	3.3.3. Error Suggestion; 3.3.4. Error Prevention (Legal, Financial, Data); 3.3.6. Error Prevention (All)
6. Low Physical Effort	
6.1. Allow user to maintain a neutral body position.	ISO 9241-4 (1998) Section 6.1 Design requirements and recommendations/General design of the keyboard; ISO 9241-5 (1998); ISO 9241-6 (1999); ISO 9241-9 (2000) Section 4.4.1 Biomechanical load/Posture
6.2. Use reasonable operating forces.	ISO 9241-4 (1998) Sections: 6.2.3 Key displacement and force; 6.2.7 Key repeat function; ISO 9241-9 (2000) Section 4.4.2 Biomechanical Load/Effort
6.3. Minimize repetitive actions.	ISO 9241-9 (2000) Section 6.1.4.6 Button Design/Button lock
	2.4.1. Bypass Blocks
6.4. Minimize sustained physical effort.	ISO 9241-5 (1998) Sections: 5.6.1 Document holders; 6.1.4.3 Button Design/Button force.
7. Size and Space for Approach and Use	
7.1. Provide a clear line of sight to important elements for any seated or standing user.	ISO 9241-3 (1992; 2000) Sections: 5.1 Design Viewing distance; 5.2 Line-of-sight angle; 5.3 Angle of view
7.2. Make reach to all components comfortable for any seated or standing user.	ISO 9241-5 (1998) Section 5.2.3 Standing and sit/standing postures
7.3. Accommodate variations in hand and grip size.	ISO 9241-9 (2000) Sections: 4.3.3 Controllability/Grip Surface; 6.1.4.2 Button design/Button Shape; 6.1.4.7 Button design/Grasp stability; 6.1.4.13 Button design/Shape and size
7.4. Provide adequate space for the use of assistive devices or personal assistance.	This guideline can be translated in terms of code compatibility aiming at be correctly interpreted by assistive technologies *e.g.*, installation of a screen reader or magnifier; to provide enough space for the person use a head pointer.