Taming the Engineering of Information Services Websites with Standards

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Since its inception, the Internet has been a complex landscape for developers as well as users to negotiate. The new ISO/IEC/IEEE 23026 standard seeks to improve websites' usability and information content and simplify Web service management and maintenance activities.

Software and systems engineering are technical and complex processes. Without guidelines, software projects can be overwhelming to novice and experienced professional engineers alike. Standards are crucial as they describe essential proficiencies, including requirements-gathering methods, interface design for human cognitive abilities, and efficient and concise quality assurance tests for software and systems.

The IEEE Computer Society's Software and Systems Engineering Standards Committee publishes many technical standards that address software and systems development cycles. I had the opportunity to participate in the IEEE P23026 standards working group on revising IEEE Standard 23026 Systems and Software Engineering—Engineering and Management of Websites for Systems, Software, and Services Information.[1] This revision includes best practices for planning, designing, and engineering service websites for the Internet and Web development industry, which is evolving at an extremely rapid pace. Here, I offer a glimpse into the process of revising the outdated standard.

CONTRIBUTING KNOWLEDGE AND EXPERIENCE

The technology industry depends on the dedication and competence of engineering teams that build advanced and complex software and systems. Industries with mission-critical objectives that provide a range of software-dependent services, from the medical to the

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aerospace fields, are obligated to comply with IEEE standards because of regulatory or legal requirements. Participants in IEEE standards working groups bring their own diverse experiences and expertise to this collaborative effort.

I was attracted to the IEEE P23026 project because I wanted to contribute my particular skill set so that others might benefit from my real-world experience as a senior user interface and user experience engineer in the Web industry, and so that I could give back to my community.

I work with Web technologies and regularly apply Web, usability, and accessibility standards in products and projects, so I was able to assess the standard and apply what I'd learned. Upon finding outdated practices and norms, I realized why the standard was being revised.

THE NEED FOR STANDARDS ON THE WEB

Benefits of following standards when developing for the Web include ease of processing by different applications, accessibility of information, and efficient rendering in a multitude of devices and browsers. According to one study with a sample size of more than 3.5 million webpages, only 4.13 percent of the webpages on the Internet passed the W3C validator, one of many tools of the World Wide Web Consortium (W3C), an organization that develops and promotes the use of Web standards.[2]

This study implies that the great majority of existing webpages today are "invalid" because they do not adhere to W3C recommendations, which were established in 1995. The improper use of scripting markup contained in these webpages leads to issues such as inconsistent rendering across platforms and browsers. In addition, individuals with certain types of impairments might not be able to access some of the content; for instance, a blind person might encounter problems because screen reader technology cannot interpret the markup. Because Web products are becoming more application based, invalid pages might cause problems for standard APIs, resulting in undesirable behavior and functionality.

Thus, reasons for Web standards compliance include

› accessibility and flexibility in different devices and browsers;
› usability for those with physical or mental impairments; and
› maintainability, so that many engineers can develop large Web applications and have a common understanding of what to implement and how to do so.

Web designers and developers are encouraged to employ standards when constructing websites and Web applications to mitigate resources wasted by "reinventing the wheel" and to ensure the reliability of Internet products, methods, and services. The financial cost, time, and complexity associated with development would also be reduced substantially, freeing up time for more creative work while increasing the accessibility and longevity of Web content. The development of webpages and applications with valid HTML markup code and visual presentation that is separate from content are two general principles driving the basic Web standards.

Content, presentation, and behavior are the three components that comprise a basic interactive webpage. According to current Web development practice, each of these components
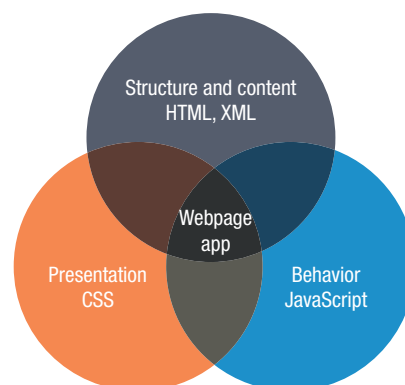

Figure 1. Triad of Web technologies. HTML establishes the content and its structure, Cascading Style Sheets (CSS) gives styling attributes for presentation, and JavaScript adds functional behavior to these Web elements.

should be separate, with the content and structure written in valid HTML or XML code and valid Cascading Style Sheets (CSS) code specified for the content's presentation layer, which includes color, typeface, and visual layout. CSS is a stylesheet language that determines the presentation of a document written in HTML or XML (including various XML languages such as SVG and XHTML). CSS describes how the structured elements must be rendered on screen, on paper, in speech, or in other media.

JavaScript—which is maintained by the standards organization ECMA International through its current standard ECMA-262 Edition 5.1, the ECMAScript Language Specification—is used to handle the behavior of HTML elements through the Document Object Model (DOM) interface. The DOM is an API that enables access to and modification of the current document. It allows manipulation of a document's nodes and elements. HTML, XML, and SVG have extended the DOM to manipulate their specific elements as well.

Figure 1 is an abstract representation of the "triad" of Web
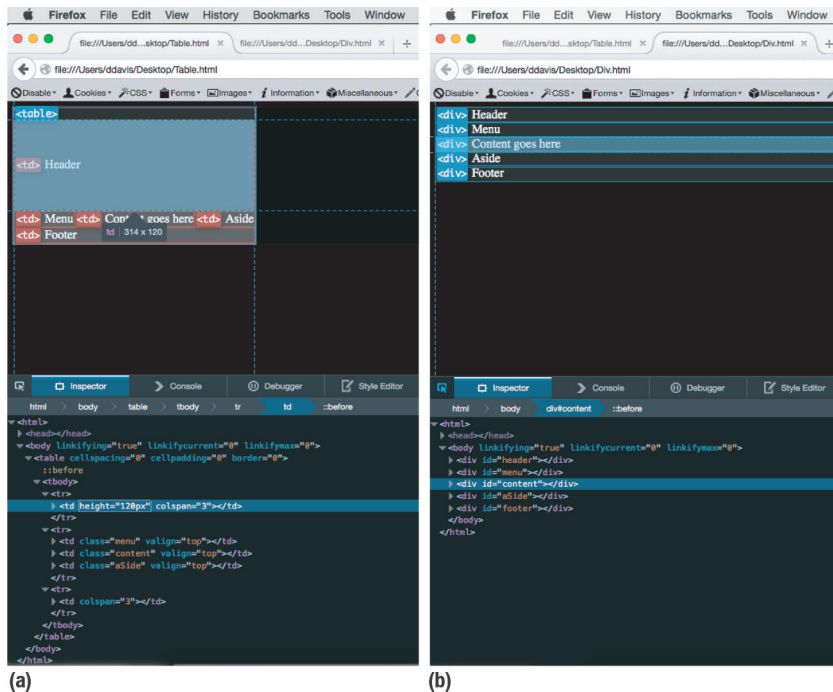
Figure 2. Comparison of the (a) `<table>` and (b) `<div>` elements. Much less HTML code is used with the `<div>` element than the `<table>` element because the presentation elements have been separated into CSS.

technologies—HTML, CSS, and Java-Script. However, most webpages do not comply even with these fundamental standards. One such example is the usage of the `<table>` element for web-page layout and to contain images. In HTML, the `<table>` element is used to mark up tabular data in two or more dimensions. Prior to the creation of CSS, many Web designers used the `<table>` element as a tactical layout tool due in part to its flexibility. Content developers with a high propensity of operating outside accepted industry norms and without constraint or care for semantic standards frequently used the `<table>` element to lay out pages because it was relatively easy to implement. Using the `<table>` element as a layout tool has been discouraged since HTML 4. Web standards recommend using the `<div>` element to divide a page into the desired layout, then using CSS to style those `<div>` elements accordingly for the intended visual presentation effect. Figure 2 shows a comparison of the `<table>` and `<div>` elements.

THE REVISION PROCESS

IEEE 2001-2002 was originally an IEEE standard developed by the IEEE Computer Society Systems and Software Engineering Standards Committee and would be later adopted by ISO/IEC JTC 1/SC7, Systems and software engineering. In addition, the IEEE Computer Society and ISO/IEC JTC 1/SC7 have a partner standards development agreement to harmonize standards and avoid duplication of effort.

The revision was developed jointly by both groups and prepared in ISO format, which mainly differs from the IEEE format in the opening clauses. Approval of the standard involved both ISO balloting by the National Body and IEEE balloting by a group of individuals that was separate from this working group. We in the P23026 working group had the option to join the balloting group and take part in the voting. After final approval of the new 23026 standard, IEEE 2001-2002 was archived.
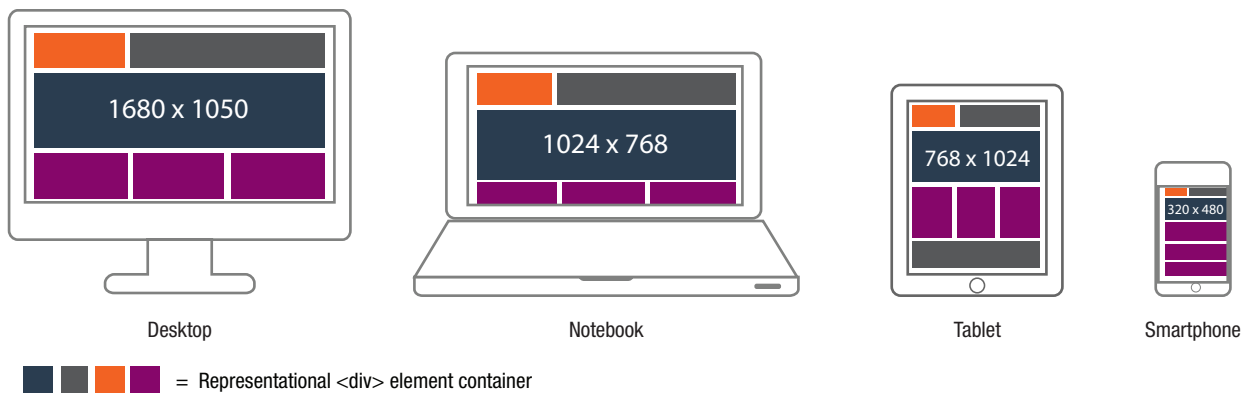
WHAT THE STANDARD COVERS

ISO/IEC/IEEE 23026:2015 Systems and Software Engineering—Engineering and Management of Websites for Systems, Software, and Services Information applies to websites with information about systems containing software (for example, design, test, and user documentation) and IT services (for example, service catalogs, service-level agreements, operating procedures, and policies). The goal of this standard is to improve the usability of informational websites and ease the maintenance of managed Web operations with respect to

› locating relevant and timely information,
› applying information security management,
› facilitating ease of use, and
› providing consistent and efficient development and maintenance practices.

The construction of a large, information-dense website is very complex, so having a plan is paramount to a successful design and engineering initiative. The importance of this plan is outlined in Clause 6.2: Establishing the Informational Website Design Strategy, which details the need for users to be considered as well as the target device and delivery format.

To ensure website content is accessible to wide audiences and a range of devices, one of my contributions now included in IEEE Standard 23026 Systems and Software Engineering recommends responsive Web design (RWD; see Figure 3):[1]

Responsive Web Design (RWD) is a method for web page construction to detect the user's screen size and orientation and dynamically change the layout accordingly, so the site produces output which is viewable and navigable with the devices and

Figure 3. Responsive Web design for multiple devices. Each of these devices has unique display dimensions that Web elements will adapt to, maintaining a consistent user experience.

web software of the intended site users. It employs the use of flexible layouts (columns), scalable images, and CSS media queries.

Clause 6.3: Developing a Strategy for Website Lifecycle Management includes implementation (strategy, design, development, testing, and configuration) and maintenance (release management, updates, and retirement) strategies that should be included in a website's project plan or requirements specifications. Requirements specifications cover performance, availability, and information security requirements. Functional and nonfunctional requirements should be linked to the website's strategic plan or charter from the website owner.

A website's information architecture should be established during the design process; designers should focus on organizing, structuring, and labeling content effectively and sustainably. The goal is to help users find information and complete tasks. To do this, designers and engineers need to understand how the pieces fit together to create the larger system as well as how items relate to each other within that system. The structure of such architecture can be narrow and deep or wide and shallow (see Figure 4), and the ideal structure depends on the information type and intended purpose.

Information architecture elements include

› classification/taxonomy schemes—categorization and structure of information,
› labeling systems—representation of information,
› navigation systems—browsing or moving through information, and
› search systems—query for information.

During the website engineering process, designers and engineers should consider the portability of legacy code as well as the use of cloud Web services and apps for the core metadata. Changes happen rapidly with the development of new browser versions and technology updates. Other engineering considerations include

› bandwidth efficiencies—the "first bytes (including <head> bytes) have the most impact on network overhead";[1]
› server technology independence—whenever possible, produce pages that don't depend on server settings; and
› database management system considerations—enable the site's data persistence or dynamic update and integrity.

EVALUATING AND TESTING WEBSITES

Throughout the design and engineering process, the Web product should be tested according to industry procedures. Standard ISO/IEC/IEEE 23026:2015 has several updated guidelines that coincide with the current Web industry; it is here that I made significant contributions regarding usability testing.
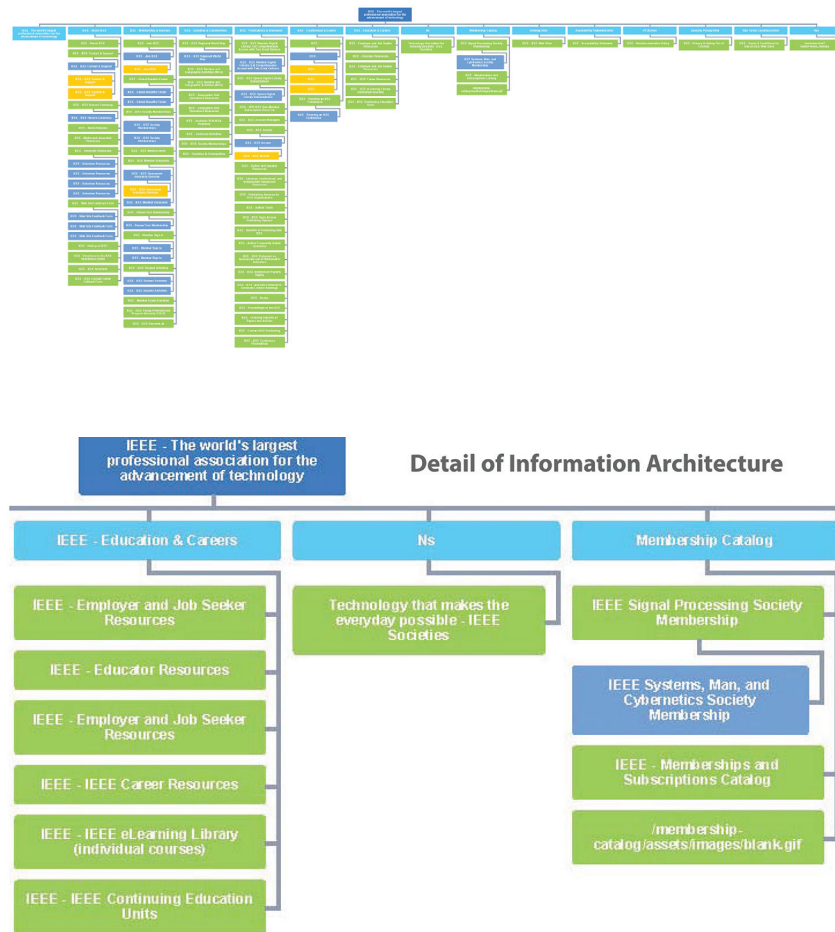
Website developers should create criteria for evaluating website usability by analyzing the target user community and information to be retrieved. They should also prepare test cases to evaluate users' interactions with the website.

Common user interface characteristics can be tested by heuristic evaluation methods, such as checking the visibility of system status, and other heuristic methods can be used in the interface development cycle—for example, helping users recognize, diagnose, and recover from errors.

Quality assurance should be part of website planning and development. The project plan should indicate specific tools and processes to be used during implementation to ensure that quality objectives are met.

In addition, website developers should test markup language for validation and accessibility conformance. Webpages should be submitted for

Figure 4. Information architecture of IEEE's ieee.org website with a detail section. The top diagram shows the overall system, and the bottom detail gives a closer look at how the information is classified.

either internal or external validation of HTML or XML for document type definition (DTD) conformance and Web Content Accessibility Guidelines 2.0 compliance using tools such as the W3C Markup Validation Service.

Other recommendations include website life-cycle management and maintenance procedures and methods. Website management should include the potential technical, regulatory, and policy changes; security; business continuity; financial issues; and organizational aspects that might require changes in information content, protection, designation, or access. Maintenance procedures include eliminating or clearly labeling obsolete information content and discontinued services, updating the status of information or services, and validating and updating links to related information.

INCLUSIONS AND EXCLUSIONS

Unlike previous versions, the new standard no longer addresses everything on the Web, so the working group didn't cover marketing sites, social networking, online transactional applications, or training and tutorial websites. Instead, the scope was limited to websites that deal with information about systems, software, and IT services. The standard recognizes website owners', providers', and webmasters' varying roles as well as content provided by website owners and users.

Throughout the revision process, the working group researched and cross-referenced other standards that addressed specific competencies, such as accessibility and usability. These included references to W3C, ISO, IEC, and IEEE but didn't include tools, languages, and metadata. In the case of the W3C, the group worked with a liaison of the consortium to verify accurate and current references to W3C standards that cover HTML and other Web protocols in depth. The standard increases emphasis on usability and addresses security concerns but is not primarily an information security standard for protocols, languages, or tools. We refer readers to the ISO/IEC 27000 series for security standards.

The revised standard doesn't include requirements for unique products but rather states requirements for an acceptable level of engineering and management that applies to most technical information websites most of the time. The standard must be proven in practice, so it can't include cutting-edge technology or advanced research concepts. In addition, it's not a tutorial or how-to guide for constructing websites.

TEAMS AND DECISION PROCESS

In addition to revising the original Clause 9: Evaluation and Testing of Websites, my role in the working group was also as a team leader. As lead, I was responsible for delegating sections of clause 9 to my team members and compiling all the revisions into one document. I also contributed to the new clause 6.2 on RWD, explaining the importance of this practice owing to the proliferation of mobile devices.

The team used Microsoft Excel to capture ISO committee members' comments and started with the consolidated comments relating to each team's section.

Through email, video chats, and Web applications, we held meetings conducting initial walk-throughs, performed detailed evaluations and discussed the comments, and collectively decided what to accept and reject. This included assigning tasks and sections to different team members to handle the comments, and then compiling the different parts into one document containing all the updates.

Some of the comments, such as grammatical errors, were easy to address. An example of handling a rejected comment follows:

Comment type: Editorial

Comment: May want to use the terms "metrics" and "analytics" here

Disposition Status: Rejected

Disposition Detail: Related Standard ISO/IEC/IEEE 19039 on measurement uses the term "measure" rather than "metrics" in this context.

Some comments required drafting new paragraphs or a more extensive revision. The following is one such example:

Comment type: Technical

Comment: Possible content missing

Proposed change: Are we possibly missing a section on gathering user metrics, such as stale content that has not been updated in x number of months/years, content that is orphaned (no links in or out), content that has not been accessed or has low access rate, search terms used, search terms that had no hits, etc.?

Disposition Status: Revised

Disposition Detail: Regarding gathering user metrics, I have added a paragraph with a suggestion: "Using the analytics tool can support the measuring of statistics to evaluate how the website performs and how successful conversion rates are. Analysis of daily unique hits, monthly page views, and browser statistics can be useful data to support the validation of the following. ..."

REVIEW AND BALLOTING

ISO and IEEE balloting were conducted at approximately the same time. For IEEE, there was a 30-day invitation to join the balloting pool and a 30-day balloting period to review, comment, and vote. The ISO balloting period was three months in length. It's typical to have two recirculation ballots on later drafts.

Balloters provided comments, such as suggestions to add and objections to the draft, which were collected in a spreadsheet. Both IEEE and ISO members reviewed the draft standards. The working group reviewed each comment and decided to either implement a proposed change to the draft or reject the comment, adding descriptive text explaining the reason for the rejection. The ballot and revision process repeated until the document addressed each comment. It's common for a standard to go through several ballots before consensus is reached, which is an approval of 75 percent for IEEE and two-thirds affirmative for ISO.

After the balloting and voting, the standard was accepted and is now published. This collaborative effort spanned approximately two years. To have confirmation that our hard work had been recognized was truly rewarding. I look forward to continually contributing to other IEEE technical standards and the opportunity to work with other passionate professionals from around the world. ⊏

REFERENCES

1. *IEEE Std. 23026, Systems and Software Engineering—Engineering and Management of Websites for Systems, Software, and Services Information*, IEEE, 2015.
2. B. Wilson, MAMA: W3C Validator Research, Opera Software ASA, 2008.

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