Classifying Web Metrics[1]

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Abstract. Quality is an essential characteristic for web success. Several authors have defined different methodologies, guidelines, techniques and tools in order to assure the quality of web sites. Recently, a wide ranging set of metrics have been proposed for quantifying web quality attributes. However, there is little consensus among them. These metrics are sometimes not well defined, neither empirically or theoretically validated. Moreover, these metrics focus on different aspects of web sites or different quality characteristics, confusing the practitioners interested in using these metrics rather than helping them. With the aim of classifying these metrics and make their use easier, we have elaborated the WQM model (Web Quality Model), which distinguishes three dimensions related to features, lifecycle processes and quality characteristics. In this paper we analyze the most relevant web metrics using this framework and present some preliminary conclusions.

1. Introduction

Nowadays web technology has attained an absolute importance within the Information Systems. The ever increasing presence of web technology and its criticality for organizations survival make essential to assure a minimum web quality, which it is not always the case [3, 11]. In the last years several experts have work out different proposals to improve web quality: methodologies [35], quality frameworks [13], estimation models [28], guides of styles and criteria [47], etc.

Since nineties, a wide ranging set of metrics have been proposed for quantifying web quality attributes [2,4,6-8,10,12-14,17-32,34-39,41-44]. However, these metrics are sometimes not well defined, neither empirically or theoretically validated. Moreover, these metrics focus on different aspects of web sites or different quality characteristics, confusing the practitioners interested in using these metrics rather than helping them. Recently, Dhyani et al. [12] proposed a web classification framework using different categories: web graph properties, web page significance, usage

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characterization, web page similarity, web page search and retrieval, and theoretical information. However they discard other important dimensions such as lifecycle and web features which are included in our model. Moreover, in this survey they do not consider some very interesting metrics such as [24, 28, 34].

With the aim of classifying these metrics and make their use easier, we have elaborated the WQM model (Web Quality Model), which distinguishes three dimensions related to web features, lifecycle processes and quality characteristics.

In the following section we present the WQM model explaining in depth each one of its dimensions. In the third section we will summarize the result of the classification of the most relevant web metrics. Conclusions and future work will appear in the last section.

2 The Web Quality Model

In [41] the authors define a cube structure in which they consider three basic aspects when making a test of a web site. Following this same idea, in [46] we proposed another "cube" in which the three dimensions represent those aspects that must be considered in the evaluation of the quality of a web site: features, life cycle processes and quality aspects, that can be considered orthogonal. This model can be used for classification purposes, so it will be possible to classify not only metrics but also methodologies, style guides, and other proposals related to web. In fact we have used this model for classifying different works on web engineering and we have refined our dimensions.

In this section we will summarize the last the current version of the WQM, which is represented in figure 1.

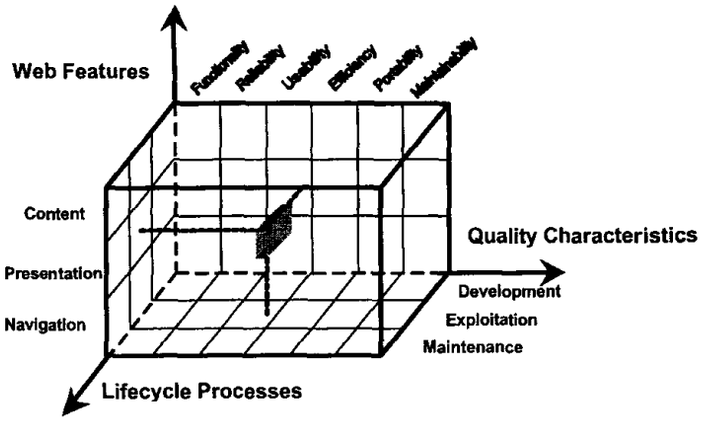

Figure 1. Graphic representation of the model.

2.1 Web Feature Dimension

In this dimension we include the three "classic" web aspects: *Content*, *Presentation* and *Navigation* [7,15,16].

In *Content* we have included not only data as text, figures, images, video clips, etc, but also programs and applications that provide functionalities as scripts, CGI programs, java programs, and others. Data is not only pure data, but also structuring and representation issues. Due to the closely intertwining of functions and data the border between them is not clearly drawn, and we consider together.

Navigation concerns the facilities for accessing information and for moving across the web.

Presentation is related to the way in which content and navigation are presented to the user.

2.2 Quality Characteristics Dimension

For the description of this dimension we use as basis the Quint2 model [33] based on the ISO 9126 standard [20]. We have decided to work with this model instead of the standard because Quint2 extends the ISO standard with new characteristics very appropriate for web products. Quint2 is a hierarchical model that fixes six basic characteristics, each has a set of subcharacteristics, to which there a set of attributes are associated. These are the basic elements. Table 1 shows the characteristic of Quint2, indicating, if necessary, those subcharacteristics added or removed respect to ISO 9126.

There is a *compliance* subcharacteristic for all characteristics (attributes of software that make the software adhere to application related standards, conventions in laws and similar prescriptions).

2.3 Life Cycle Processes Dimension

In this dimension we include the diverse processes of the web site life cycle which, following the ISO 12207-1 standard [19] can be differentiated in main processes. In the current version of the model we only included three main processes in this dimension: the development process, the exploitation process (that includes the operative support to the users) and the maintenance one (that includes the evolution that experiences the web site).

It is necessary to consider that the development process contains diverse activities:

- Analysis of system requirements: in which the functional and nonfunctional requirements of the system are specified, including the design restrictions
- Design of the system architecture: in which the main components of hardware and software, as well as the manual operations of the system will be identified.
- Analysis of the software requirements, including the specification of the functional and non-functional characteristics, exploitation and execution requirements and maintenance requirements.
- Design of the software architecture, that is, the high level structure that identifies the main components of the system.

Functionality. A set of attributes that bear on the existence of a set of functions and their specified properties. The functions are those that satisfy stated or implied needs. ▪ *Suitability*: Attribute of software that bears on the presence and appropriateness of a set of functions for specified tasks. ▪ *Accuracy*: Attributes of software that bear on the provision of right or agreed results or effects. ▪ *Interoperability*: Attributes of software that bear on its ability to interact with specified systems. ▪ *Security*: Attributes of software that bear on its ability to prevent unauthorized access, whether accidental or deliberate, to programs or data. ▪ *Traceability* (Quint2): Attributes of software that bear on the effort needed to verify correctness of data processing on required points.
Reliability. A set of attributes that bear on the capability of software to maintain its level of performance under stated conditions for a stated period of time. ▪ *Maturity*: Attributes of software that bear on the frequency of failure by faults in the software. ▪ *Fault tolerance*: Attributes of software that bear on its ability to maintain a specified level of performance in cases of software faults or of infringements of its specified interface. ▪ *Recoverability*: Attributes of software that bear on the capability to re-establish its level of performances and recover the data directly affected in case of a failure and on the time and effort needed for it. ▪ *Availability* (Quint2): Attributes of software that bear on the amount of time the product is available to the user at the time it is needed. ▪ *Degradability* (Quint2): Attributes of software that bear on the effort needed to re-establish the essential functionality after a breakdown.
Usability. A set of attributes that bear on the effort needed for use, and on the individual assessment of such use, by a stated or implied set of users. ▪ *Understandability*: Attributes of software that bear on the users' effort for recognising the logical concept and its applicability. ▪ *Learnability*: Attributes of software that bear on the users' effort for learning its application (for example, control, input, output). ▪ *Operability*: Attributes of software that bear on the users' effort for operation and operation control. ▪ *Explicitness* (Quint2): Attributes of software that bear on the software product with regard to its status (progression bars, etc.). ▪ *Attractivity* (*Attractiveness* in Quint2): Attributes of software that bear on the satisfaction of latent user desires and preferences, through services, behaviour and presentation beyond actual demand. ▪ *Customisability* (Quint2): Attributes of software that enable the software to be customized by the user to reduce the effort required for use and increase satisfaction with the software. ▪ *Clarity* (Quint2): Attributes of software that bear on the clarity of making the user aware of the functions it can perform. ▪ *Helpfulness* (Quint2): Attributes of software that bear on the availability of instructions for the user on how to interact with it. ▪ *User-friendliness* (Quint2): Attributes of software that bear on the users' satisfaction.
Efficiency. A set of attributes that bear on the relationship between the level of performance of the software and the amount of resources used, under stated conditions. ▪ *Time behaviour*: Attributes of software that bear on response and processing times and on throughput rates in performing its function. ▪ *Resource behaviour*: Attributes of software that bear on the amount of resources used and the duration of such use in performing its function.
Portability. A set of attributes that bear on the ability of the software to be transformed from one environment to another. ▪ *Adaptability*: Attributes of software that bear on the opportunity for its adaptation to different specified environments without applying other actions or means than those provided for this purpose for the software in question. ▪ *Installability*: Attributes of software that bear on the effort needed to install the software in a specified environment. ▪ *Replaceability*: Attributes of software that bear on the opportunity and effort of using it in the place of specified other software in the environment of that software. ▪ *Co-existence* (not included in Quint2): The capability of the software to co-exist with other independent software in a common environment sharing common resources.
Maintainability. A set of attributes that bear on the effort needed to make specified modifications. ▪ *Analysability*: Attributes of software that bear on the effort needed for diagnosis of deficiencies or causes of failures, or for identification of parts to be modified. ▪ *Changeability*: Attributes of software that bear on the effort needed for modification, fault removal or for environmental change. ▪ *Stability*: Attributes of software that bear on the risk of unexpected effect of modifications. ▪ *Testability*: Attributes of software that bear on the effort needed for validating the (modified) software. ▪ *Manageability* (Quint2): Attributes of software that bear on the effort needed to (re)establish its running status. ▪ *Reusability* (Quint2): Attributes of software that bear on its potential for complete or partial reuse in another software product.

Table 1. Model Quality Characteristics

- Detailed design of software, including the databases.
- Codification and test, of the different software components and the databases.
- Software integration, where the software components are integrated and proven if necessary.
- Test of software, that is, the test of qualification based on the specified requirements.
- Integration of the system.
- Test of the system.
- Installation of software, in the final exploitation environment where it is going to work.

It is important to emphasize that these activities must not to be developed sequentially, because, due to the characteristics of the web development, it will be necessary to use models more iterative even more flexible developments without following formal methodologies [5].

3. Analysis of Existing Metrics

3.1. Surveyed Metrics

For the present study, we have surveyed different works related in some manner with web topics. We have reviewed about 60 papers, from 1992 to 2003. From all these works we have selected the ones (about 40) where metric proposals (considered useful for our classification purposes on WQM) were included, discarding some other works where the proposed metrics were not really applicable in our context and do not provide any relevant information. Examples of the discarded metrics include all the process metrics, focusing, then, our work only on the product metrics. We also discarded repeated metrics, i.e., those metrics proposed by more than one author. We included one instance of such metrics only. Finally, 326 metrics were selected, which are listed in the Appendix of this paper. Finally, we want to note that the process of classifying metrics is not a simple task. So, we are conscious that some of the assignments done may be arguable.

3.2 Filling the Cells of the Cube

Although the model does not restrict the number of cells that can be assigned to a given metric m, for the sake of simplicity and practicality we tried to minimize this number assigning the metrics to the cells where the metric could be more useful. To avoid unnecessary complexity, we decided to show in the WQM model only the quality characteristic assigned, instead of the precise sub-characteristic.

In general, the classification of a metric has been done taking into account the metric author opinion. However, this information was not complete (with respect to WQM) and we have made the classification attending to our own understanding. In

validation (theoretical and empirical) we have used the results exposed in the reference.

Assigning metrics to life cycle phases was not easy. We have taken some special consideration for the exploitation and maintenance stages. In the web world, where typical timeline in web development is 3-6 months [42], it is difficult to distinguish when exploitation finishes and maintenance begins. In case of doubt we have classified metrics in both phases.

3.3 The Resulting Cube

The list with the detailed assignments of metrics to cells is included in the Appendix. However, due to the extension of that list, in this section we will summarize its main figures using one table (table 2) that shows the number of metrics in each cell of the dimensions. In the row "% Absolute" the sum of the values is not exactly 100% because a metric can be classified in more then one cell in the cube. We have prorated these results in the below row, in order to get a 100% total. So, "% Prorated" values represent the probability a metric to being to a specific cell.

	Quality Characteristics						Lifecycle Processes			Website Features		
	Functionality	Reliability	Usability	Efficiency	Portability	Maintainability	Design	Exploitation	Maintenance	Content	Presentation	Navigation
Total	50	21	263	47	40	79	64	267	162	99	179	67
% Absolute	15%	6%	81%	14%	12%	24%	20%	82%	50%	30%	55%	21%
% Prorated	10%	4%	53%	9%	8%	16%	13%	54%	33%	29%	52%	19%

Table 2. Metrics Classification.

Figure 2 shows metric distribution across the three model dimensions: web features, quality characteristics, and lifecycle processes, using prorated figures. Next subsections present several conclusions that we can extract from it.

3.3.1 Web Features Dimension

About 52% of the metrics were "presentation" metrics. This value confirms the tendency in the web world of giving the most importance to the web end-user making the sites as attractive as possible.

At this point it is convenient to remark that usually there is a confusion between presentation and navigation [7] so, perhaps the results for the navigation could vary depending on the person who made the classification.

3.3.2 Quality Characteristics Dimension

Most of the metrics (53%) are usability metrics. Recording that this data is prorated, because if we examine absolute data (table 2) we can see that 81% of metrics are

related to usability. Again this value confirms the end-user focus trying to design usable web sites that attract users.

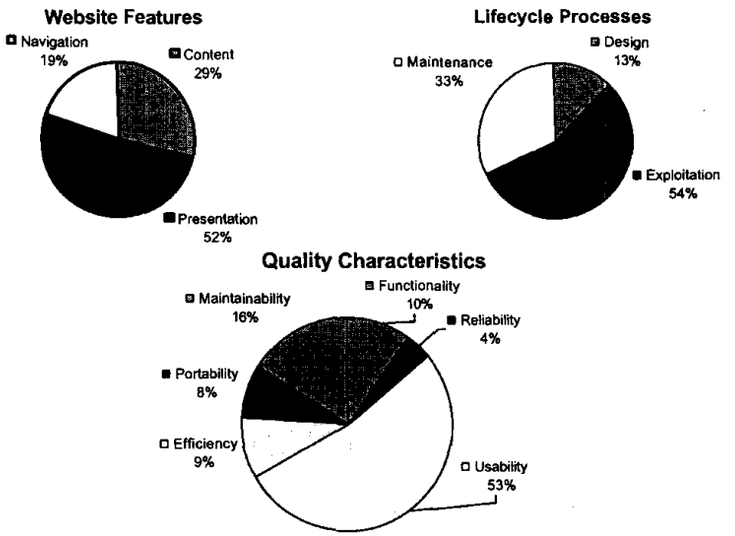

Figure 2. Metric Distribution across the Model Dimensions

However, it is curious that only 4% of metrics focuses on reliability, when this characteristic it is also extremely important for customer acceptance of web sites. Perhaps, reliability metrics for web do not differ too much from reliability metrics for other kind of software or systems.

Finally, we think that the appearance of new devices (as PDA, mobiles, ..) will encourage the definition of new portability metrics.

3.3.3 Life-cycle Dimension

Finally, the fact that exploitation and maintenance are the phases with more metrics can be justified taking into account the evolutionary nature of the web.

3.4 Metrics Properties

We have also evaluate the metrics considering the following properties [9]:

- *Granularity Level*, depending if the metric focuses on a single web page (47%) or a web site (53%).
- *Theoretical Validation* helps us to know when and how to apply metrics.

- *Empirical Validation,* here the objective is to prove the practical utility of the proposed metrics.
- *Automated Support,* i.e., whether or not there is a support tool that facilitates the calculation of the metrics (79% are automated).

The results of this evaluation are shown in the Appendix of this document, which contains the values assigned to the features of each metric. As we can see there is a balanced distribution of metrics defined for web pages and web sites. The results for the validation confirm that unfortunately in the web metrics world validation is not considered as a main issue, specially theoretical validation (4%) but also, empirical validation (32%). A big amount of metrics are automated. This is very important if we want that metrics are really used in web development and maintenance projects.

4. Conclusions and Future Work

There have been many metric proposals for web quality, but no consensus has been reached for their classification. To advance in this area, it is essential to rely on a model that allows us to classify and systematize metric use. In this paper we have presented such the WQM and we have surveyed the most relevant web metrics.

Nevertheless, this is only a first approach that needs to be reviewed until arriving at a definitive and complete version that can be used with total reliability and guarantee of success.

Regarding to the model, some modifications could be carry out in the life cycle dimension including a project process (following the standard ISO 15288, System Life Cycle Processes [21]) in order to include in the WQM proposals related to web estimation effort [28].

Regarding to the metrics, we do not claim this survey is complete. It would be necessary to make an even more exhaustive study of the state of the art. We also intend to define new metrics in those "cells" in which the nonexistence of metrics is detected.

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Appendix

	Metric	Ref	WQM Quality Characteristic						WQM Lifecycle Process			WQM WebSite Feature			Granularity Level	Theor. Valid.	Emp. Valid.	Autom
			Func	Reliab	Usab	Effic	Port	Maintn	Dev	Eval	Maint	Cont	Pres	Nav				
1	Distance	17			X			X		X		X		X	Web		X	X
2	Depth	17			X			X	X	X				X	Web		X	X
3	Breadth (Width)	17			X			X	X	X				X	Web		X	X
4	Diameter	17			X				X					X	Web		X	X
5	Radius	17			X				X					X	Web		X	X
6	Converted Out Distance (COD)	7			X			X	X		X			X	Web Page		X	X
7	Converted In Distance (CID)	7			X			X	X		X			X	Web Page		X	X
8	Converted Distance (CD)	7			X			X	X		X			X	Web		X	X
9	Relative Out Centrality (ROC)	7			X			X	X		X			X	Web Page		X	X
10	Relative In Centrality (RIC)	7			X			X	X		X			X	Web Page		X	X
11	Status	7			X			X	X		X			X	Web Page		X	X
12	Contrastatus	7			X			X	X		X			X	Web Page		X	X
13	Prestige	7			X			X	X		X			X	Web Page		X	X
14	Compactness	3			X			X	X		X			X	Web		X	X
15	Stratum	3			X			X	X		X			X	Web		X	X
16	Impurity Tree	3			X			X	X		X			X	Web		X	X
17	Number IN Links (NIL)	3			X			X	X	X				X	Web		X	X
18	Number OUT Links (NOL)	3			X			X	X	X				X	Web		X	X
19	Connectivity Density	28	X		X			X	X	X				X	Web		X	X
20	Structure	28			X	X		X	X	X				X	Web		X	
21	Total Link Count (NL)	38			X		X	X	X	X				X	Web		X	X
22	Number Broken Links (NBL)	36		X	X			X		X	X			X	Web		X	X
23	% Broken Links (%BL)	36		X	X			X		X	X			X	Web		X	X
24	Number of Different Broken Links (NDBL)	36		X				X		X	X			X	Web		X	X
25	% Different Broken Links (%DBL)	36		X				X		X	X			X	Web		X	X
26	Images Count	36	X		X		X		X	X		X			Web		X	X
27	Link Image Count	3			X	X				X				X	Web Page		X	X
28	Surface of Images	3			X					X			X		Web Page		X	X
29	Different Image Count	36			X				X		X		X		Web			X
30	% Image Redundancy	36			X			X			X		X		Web			X
31	Page Count	28			X		X	X		X	X	X			Web		X	X
32	Media Count	28	X		X		X	X	X		X	X			Web		X	X
33	Page Complexity	28			X					X			X		Web Page		X	X
34	Media Duration	28				X				X			X		Web			X
35	Quick Access Pages	38			X	X				X				X	Web Page			X
36	Program Complexity	28			X			X	X				X		Web		X	X
37	Program Count	28	X	X	X		X	X		X	X	X	X		Web		X	X
38	Page Allocation	28				X				X		X			Web Page		X	X
39	Total Page Allocation	28			X		X			X		X			Web		X	X
40	Total Media Allocation	28				X				X		X			Web		X	X
41	Total Code Length	28				X		X		X		X			Web		X	X
42	Media Allocation	28				X				X		X	X		Web		X	X
43	Audio Complexity	28			X	X	X		X			X	X		Web		X	X
44	Video Complexity	28			X	X	X		X			X	X		Web		X	X
45	Animation Complexity	28			X	X	X		X	X		X	X		Web		X	X
46	Code Length (LOC)	28	X				X	X	X			X			Web		X	X
47	Code Comment Length	28	X					X			X	X			Web		X	X
48	Image Allocation	28			X		X		X	X		X			Web		X	X
49	Reused Media Count	28						X			X	X			Web		X	
50	Reused Program Count	28						X			X	X			Web		X	
51	Total Reused Media Allocation	28						X			X	X			Web		X	
52	Total Reused Code Length	28						X			X	X			Web		X	
53	Reused Code Length	28						X			X	X			Web		X	
54	Reused Comment Length	28						X			X	X			Web		X	
55	Total Page Complexity	28						X		X	X	X			Web		X	X
56	Cyclomatic Complexity	28	X		X				X					X	Web		X	X
57	Graphic Complexity	28			X		X			X			X		Web Page		X	X
58	Suitable Information	14			X					X		X			Web			
59	Updated Information	14			X			X		X		X			Web			
60	Degree of Interest	18			X					X		X			Web			
61	Reused Docs	27		X				X			X	X			Web		X	X
62	Formatted Docs (.doc, .pdf, .ps...)	28	X		X					X			X		Web		X	X
63	Size Formatted Docs (.doc, .pdf, .ps...)	28			X					X			X		Web		X	X
64	% Dead Pages	38		X				X		X	X		X		Web			X
65	% ALT Text	38			X	X		X		X			X		Web			X

	Metric	Ref	WQM Quality Characteristic						WQM Lifecycle Process			WQM WebSite Feature			Granularity Level	Theor. Valid.	Emp. Valid.	Autom
			Func	Reliab	Usab	Effic	Port	Maintn	Dev	Eval	Maint	Cont	Pres	Nav				
66	Number of Panes Regarding Frames	38			X	X				X			X		Web Page			X
67	Freq. Broken Links per Hit Pages	39		X				X		X	X		X		Web			X
68	Images per Page	38			X	X	X			X			X		Web Page			X
69	Coherence	5			X				X			X			Web Page			
70	Local Coherence	5			X				X			X			Web Page			
71	Global Coherence	5			X				X			X			Web			
72	Cognitive Overhead	5			X				X			X			Web Page			
73	Coupling Information Across Docs	5			X				X			X			Web			
74	Local Coherence due to Relationship between Information Chunks (LCRIC)	5			X				X			X			Web Page			
75	Local Coherence due to Sort Term Memory (LCSTM)	5			X				X			X			Web Page			
76	Global Coherence due to Hyperlink Within Application (GCHLWA)	5			X				X			X			Web			
77	Global Coherence due to Cognitive Jumps (GCCJ)	5			X				X			X			Web			
78	Cognitive Overhead due to Consistency (COC)	5			X				X			X			Web			
79	Cohesion (COH)	5			X				X			X			Web			
80	Coupling (COU)	5			X				X			X			Web			
81	Download Time	5			X	X	X			X			X		Web Page			X
82	Invalid Links Count	38		X						X	X		X		Web			X
83	Unimplemented Link Count	38		X						X	X		X		Web			X
84	Spelling Errors	38		X				X		X	X		X		Web			X
85	Deficiencies or absent features due to different browsers	38		X				X		X	X		X		Web			X
86	Deficiencies or unexpected results independent of browsers	38		X				X		X	X		X		Web			X
87	Orphan Pages	38		X				X		X	X			X	Web			X
88	Destination Nodes Under Construction	38		X	X			X		X	X			X	Web			X
89	Support for Text-Only Version	38				X				X			X		Web			X
90	Image Title	38			X	X		X		X			X		Web			X
91	Global Readability (without browsing images)	38				X				X			X		Web			X
92	NON-Frame Version	38				X				X			X		Web			X
93	Table of Contents	38			X				X	X			X		Web			X
94	Site Map	38			X				X	X			X	X	Web			X
95	Subject Index	38			X				X	X			X		Web			X
96	Alphabetical Index	38			X				X	X			X		Web			X
97	Chronological Index	38			X				X	X			X		Web			X
98	Geographical Index	38			X				X	X			X		Web			X
99	Other Indexes (audience, format, hybrids, etc.	38			X				X	X			X		Web			X
100	Quality Labeling System	38			X				X	X			X		Web			X
101	Audience-Oriented Guided Tour	38			X					X			X		Web			X
102	Conventional Tour	38			X					X			X	X	Web			X
103	VR Tour	38			X					X			X	X	Web			X
104	Global Help	38			X				X	X			X		Web			X
105	Specific Help	38			X				X	X			X		Web			X
106	E-mail Directory	38			X					X	X	X			Web			X
107	Phone-Fax Directory	38			X					X	X	X			Web			X
108	Post mail Directory	38			X					X	X	X			Web			X
109	FAQ Feature	38			X					X	X	X			Web			X
110	What's New Feature	38			X					X	X	X			Web			X
111	Questionnaire Feature	38			X					X			X		Web			X
112	Comments/Suggestions	38			X					X			X		Web			X
113	Subject-Oriented Feedback	38			X					X			X		Web			X
114	Guest Book	38			X					X			X		Web			X
115	Cohesiveness by Grouping Main Control	38			X					X			X		Web			
116	Direct Control Permanence	38			X					X			X		Web			
117	Indirect Control Permanence	38			X					X			X		Web			
118	Stability	38			X					X			X		Web			
119	Link Color Style Uniformity	38			X				X				X		Web			
120	Global Style Uniformity	38			X				X				X		Web			
121	Foreign Language Support	38			X				X	X	X	X	X		Web			X
122	Global	38			X					X	X		X		Web			X
123	Scoped (sub-site or page)	38			X					X	X		X		Web			X

	Metric	Ref	WQM Quality Characteristic						WQM Lifecycle Process			WQM WebSite Feature			Granularity Level	Theor. Valid.	Emp. Valid.	Automation
			Func	Relia	Usab	Effic	Port	Mainty	Des	Exp	Maint	Cont	Pres	Nav				
124	Screen Resolution Indicator	38			X					X	X		X		Web			X
125	Global Search	38	X							X			X		Web			X
126	Scoped Search	38	X							X			X		Web			X
127	Level of Retrieving Customization	38	X							X			X		Web			X
128	Level of Retrieving Feedback	38	X							X			X		Web			X
129	Indication of Path	38	X							X				X	Web			X
130	Label of Current Position	38	X							X				X	Web			X
131	Contextual Permanence Controls	38	X							X				X	Web			X
132	Contextual Stability Controls	38	X							X				X	Web			X
133	Vertical Scrolling	38	X							X			X		Web			X
134	Horizontal Scrolling	38	X							X			X		Web			X
135	Link Title (with explanatory help)	38	X							X				X	Web			X
136	Quality of Link Phrase	38	X							X				X	Web			X
137	Quick Browse Controls	38	X							X			X	X	Web			X
138	Number of Navigational Contexts	1			X			X		X				X	Web	X	X	
139	Number of Navigational Links	1			X	X		X		X				X	Web	X	X	
140	Density of a Navigational Map	1			X					X				X	Web	X	X	
141	Depth of a Navigational Map	1			X			X		X				X	Web	X	X	
142	Breadth of a Navigational Map	1			X			X		X				X	Web	X	X	
143	Minimum Path Between Navigational Contexts	1			X					X				X	Web	X	X	
144	Number of Paths Between Navigational Contexts	1			X					X				X	Web	X	X	
145	Compactness	1		X	X	X		X		X	X			X	Web	X	X	
146	Fan-In of a Navigational Context	1			X					X				X	Web	X	X	
147	Fan- Out of a Navigational Context	1			X					X				X	Web	X	X	
148	Number of Navigational Classes	1			X			X			X			X	Web	X	X	
149	Number of Attributes	1	X					X			X	X			Web	X	X	
150	Number of Methods	1	X				X	X			X	X			Web	X	X	
151	Number of Building Blocks	44	X	X			X	X	X		X	X			Web			X
152	Number of COTS Components	44		X			X	X	X		X	X			Web			X
153	Number of Object or Application Points	44	X					X	X			X			Web			X
154	Number of XML, SGML, HTML and Query Language Lines	44	X					X		X			X		Web			X
155	Number of Web Components	44	X		X		X	X		X	X	X	X		Web			X
156	Number of Scripts (Visual Language, Audio, Motion, and so forth)	44	X		X	X		X		X	X		X		Web			X
157	Function Points	33	X				X		X			X			Web		X	
158	Object-Oriented Function Points	33	X				X		X			X			Web		X	
159	Reuse Level LOCs	33	X								X	X			Web		X	
160	Reuse Level DOFPs	33	X								X	X			Web		X	
161	Total Number of Flash Animations	31			X	X				X			X		Web		X	
162	Total Number of Icons/Buttons	31	X		X				X				X		Web Page		X	
163	Average Length Audio Clips	31			X	X	X			X			X		Web		X	
164	Average Length Video Clips	31			X	X	X			X			X		Web		X	
165	Total Embedded Code Length	31	X					X			X	X			Web		X	
166	Size CFSU	31	X					X			X	X			Web		X	
167	Number of Entities	6	X					X	X	X		X			Web		X	
168	Number of Components	6	X		X			X	X	X		X			Web		X	
169	Number of InfoSlots	6	X		X			X		X		X			Web		X	
170	Slots Semantic Association	6	X		X					X		X			Web		X	
171	Slots Collection Center	6	X		X					X		X			Web		X	
172	Components Entity	6	X					X		X		X			Web		X	
173	Slots Components	6	X							X		X			Web		X	
174	Semantics Associations	6	X							X		X			Web		X	
175	Semantics Association Centers	6	X		X					X		X			Web		X	
176	Segments	6	X								X	X			Web		X	
177	Nodes	6	X		X		X	X		X				X	Web		X	
178	Navigational Slots	6	X		X					X				X	Web		X	
179	Nodes Cluster	6			X			X		X				X	Web		X	
180	Slots Node	6			X					X				X	Web		X	
181	Clusters	6			X					X				X	Web		X	

	Metric	Ref	WQM Quality Characteristic						WQM Lifecycle Process			WQM WebSite Feature			Granularity Level	Theor. Valid.	Emp. Valid.	Automation
			Func	Relia	Usab	Effic	Port	Mainty	Des	Exp	Maint	Cont	Pres	Nav				
182	Publishing Units	6	X							X			X		Web		X	
183	Presentation Links	6			X					X			X		Web		X	
184	Sections	6			X					X			X		Web		X	
185	Word Count	24			X	X	X			X	X	X	X		Web Page		X	X
186	Page Title Word Count	24						X		X	X	X			Web Page			X
187	Overall Page Title Word Count	24						X		X	X	X			Web Page			X
188	Invisible Word Count	24		X	X					X	X			X	Web Page			X
189	Meta Tag Word Count	24						X		X	X	X			Web Page			X
190	Body Word Count	24			X	X	X			X	X	X	X		Web Page		X	X
191	Display Word Count	24			X					X	X		X		Web Page			X
192	Display Link Word Count	24			X					X	X		X		Web Page			X
193	Link Word Count	24			X					X	X			X	Web Page			X
194	Average Link Words	24			X					X	X		X		Web Page			X
195	Graphic Word Count	24			X	X				X	X	X	X		Web Page			X
196	Ad Word Count	24			X	X				X	X		X		Web Page			X
197	Exclamation Point Count	24			X					X	X		X		Web Page			X
198	Spelling Error Count	24		X	X			X		X	X		X		Web Page			X
199	Good Word Count	24			X					X	X	X			Web Page			X
200	Good Body Word Count	24			X					X	X	X			Web Page			X
201	Good Display Word Count	24			X					X	X	X			Web Page			X
202	Good Display Link Word Count	24			X					X	X	X			Web Page			X
203	Good Link Word Count	24			X					X	X	X			Web Page			X
204	Average Good Kln Words	24			X					X	X	X			Web Page			X
205	Good Graphic Word Count	24			X					X	X	X			Web Page			X
206	Good Page Title Word Count	24			X					X	X	X			Web Page			X
207	Overall Good Page Title Word Count	24			X					X	X	X			Web Page			X
208	Good Meta Tag Word Count	24			X					X	X	X			Web Page			X
209	Reading Complexity	24			X					X		X			Web Page			X
210	Overall Reading Complexity	24			X					X		X			Web Page			X
211	Fog Word Count	24			X					X		X			Web Page			X
212	Fog Big Word Count	24			X					X		X			Web Page			X
213	Overall Fog Big Word Count	24			X					X		X			Web Page			X
214	Fog Sentence Count	24			X					X		X			Web Page			X
215	Overall Fog Sentence Count	24			X					X		X			Web Page			X
216	Text Link Count	24			X					X				X	Web Page			X
217	Page Link Count	24			X					X				X	Web Page			X
218	Redundant Link Count	24			X					X				X	Web Page			X
219	Redundant Graphic Count	24				X		X			X		X		Web Page			X
220	Graphic Link Count	24			X					X				X	Web Page			X
221	Graphic Ad Count	24			X		X			X	X		X	X	Web Page			X
222	Animated Graphic Ad Count	24			X		X			X	X		X	X	Web Page			X
223	Emphasized Body Word Count	24			X					X	X		X		Web Page		X	X
224	Bolded Body Word Count	24			X					X	X		X		Web Page			X
225	Capitalized Body Word Count	24			X					X	X		X		Web Page			X
226	Colored Body Word Count	24			X					X	X		X		Web Page			X
227	Exclaimed Body Word Count	24			X					X	X		X		Web Page			X
228	Italicized Body Word Count	24			X					X	X		X		Web Page			X
229	Underlined Word Count	24			X					X			X		Web Page			X
230	Serif Word Count	24			X					X			X		Web Page			X
231	Sans Serif Word Count	24			X					X			X		Web Page			X
232	Undetermined Font Style Word Count	24			X					X			X		Web Page			X
233	Font Style	24			X					X			X		Web Page			X
234	Minimum Font Size	24			X					X			X		Web Page			X
235	Maximum Font Size	24			X					X			X		Web Page			X
236	Average Font Size	24			X					X			X		Web Page			X
237	Body Color Count	24			X					X			X		Web Page			X
238	Display Color Count	24			X					X			X		Web Page			X
239	Text Positioning Count	24			X					X			X		Web Page		X	X
240	Text Column Count	24			X					X			X		Web Page			X
241	Text Cluster Count	24			X					X			X		Web Page		X	X
242	Link Text Cluster Count	24			X					X			X		Web Page			X
243	Border Cluster Count	24			X					X			X		Web Page			X
244	Color Cluster Count	24			X					X			X		Web Page			X
245	List Cluster Count	24			X					X			X		Web Page			X
246	Rule Cluster Count	24			X					X			X		Web Page			X
247	Non-Underlined Text Links	24			X					X	X		X		Web Page			X
248	Link Color Count	24			X					X	X		X		Web Page			X
249	Standard Link Color Count	24			X					X	X		X		Web Page			X
250	Minimum Graphic Height	24			X	X	X			X	X		X		Web			X
251	Maximum Graphic Height	24			X	X	X			X	X		X		Web			X

	Metric	Ref #	WQM Quality Characteristic							WQM Lifecycle Process			WQM WebSite Feature			Granularity Level	Theor Valid.	Emp Valid.	Automation
			Functionality	Reliability	Usability	Efficiency	Portability	Maintainability	Design	Implementation	Maintenance	Content	Presentation	Navigation					
252	Average Graphic Height	24			X	X	X			X	X		X		Web				X
253	Minimum Graphic Wide	24			X	X	X			X	X		X		Web				X
254	Maximum Graphic Wide	24			X	X	X			X	X		X		Web				X
255	Average Graphic Wide	24			X	X	X			X	X		X		Web				X
256	Color Count	24			X					X	X		X		Web Page		X	X	X
257	Minimum Color Use	24			X					X	X		X		Web Page				X
258	Browser-Safe Color Count	24			X					X	X		X		Web Page				X
259	Good Text Color Combination	24			X					X	X		X		Web Page				X
260	Neutral Text Color Combination	24			X					X	X		X		Web Page				X
261	Bad Text Color Combination	24			X					X	X		X		Web Page				X
262	Good Panel Color Combinations	24			X					X	X		X		Web Page				X
263	Neutral Panel Color Combinations	24			X					X	X		X		Web Page				X
264	Bad Panel Color Combinations	24			X					X	X		X		Web Page				X
265	Font Count	24			X					X	X		X		Web Page		X	X	X
266	Serif Font Count	24			X					X	X		X		Web Page				X
267	Sans Serif Font Count	24			X					X	X		X		Web Page				X
268	Undetermined Font Style Count	24			X					X	X		X		Web Page				X
269	Page Height	24			X	X				X	X		X		Web Page				X
270	Page Width	24			X	X				X	X		X		Web Page				X
271	Page Pixels	24			X	X				X	X		X		Web Page				X
272	Vertical Scrolls	24			X	X				X	X		X		Web Page				X
273	Horizontal Scrolls	24			X	X				X	X		X		Web Page				X
274	Interactive Element Count	24	X		X		X	X		X	X	X			Web Page				X
275	Search Element Count	24	X		X		X	X		X	X	X			Web Page				X
276	External Stylesheet Use	24			X			X		X	X		X		Web Page				X
277	Fixed Page Width Use	24			X			X		X	X		X		Web Page				X
278	Page Depth	24			X					X	X			X	Web Page				X
279	Page Type	24			X					X	X		X		Web Page				X
280	Self Containment	24			X					X	X	X			Web Page				X
281	Spamming Use	24			X	X				X	X		X		Web Page				X
282	Table Count	24			X					X		X	X		Web Page				X
283	Script File Count	24			X	X	X			X		X			Web Page				X
284	Script Bytes	24			X	X	X			X		X			Web Page				X
285	Object File Count	24			X	X	X			X		X			Web Page				X
286	Object Bytes	24			X	X	X			X		X			Web Page				X
287	Object Count	24			X	X	X			X		X			Web Page				X
288	Bobby Approved	24			X					X			X		Web Page				X
289	Bobby Priority 1 Errors	24			X					X			X		Web Page				X
290	Bobby Priority 2 Errors	24			X					X			X		Web Page				X
291	Bobby Priority 3 Errors	24			X					X			X		Web Page				X
292	Bobby Browser Errors	24			X					X			X		Web Page				X
293	Weblink Errors	24		X	X					X	X		X	X	Web Page				X
294	Visible Page Text Terms	24			X					X	X		X		Web Page				X
295	Visible Unique Page Text Terms	24			X					X	X		X		Web Page				X
296	Visible Page Text Hits	24			X					X	X		X		Web Page				X
297	Visible Page Text Score	24			X					X	X		X		Web Page				X
298	All Page Text Terms	24			X					X	X		X		Web Page				X
299	All Unique Page Text Terms	24			X					X	X		X		Web Page				X
300	All Page Text Hits	24			X					X	X		X		Web Page				X
301	All Page Text Score	24			X					X	X		X		Web Page				X
302	Visible Link Text Terms	24			X					X	X		X		Web Page				X
303	Visible Unique Link Text Terms	24			X					X	X		X		Web Page				X
304	Visible Link Text Hits	24			X					X	X		X		Web Page				X
305	Visible Link Text Score	24			X					X	X		X		Web Page				X
306	All Link Text Term	24			X					X	X		X		Web Page				X
307	All Unique Link Text Term	24			X					X	X		X		Web Page				X
308	All Link Text Hits	24			X					X	X		X		Web Page				X
309	All Link Text Score	24			X					X	X		X		Web Page				X
310	Page Title Terms	24			X					X	X		X		Web Page				X
311	Unique Page Title Terms	24			X					X	X		X		Web Page				X
312	Page Title Hits	24			X					X	X		X		Web Page				X
313	Page Title score	24			X					X	X		X		Web Page				X
314	Text Element Variation	24			X					X	X		X		Web Page				X
315	Page Title Variation	24			X					X	X		X		Web Page				X
316	Link Element Variation	24			X					X	X		X		Web Page				X
317	Graphic Element Variation	24			X					X	X		X		Web Page				X
318	Text Formatting Variation	24			X					X	X		X		Web Page				X
319	Link Formatting Variation	24			X					X	X		X		Web Page				X

	Metric	Ref #	WQM Quality Characteristic						WQM Lifecycle Process			WQM WebSite Feature			Granularity Level	Theor Valid.	Emp Valid.	Automation
			Functionality	Reliability	Usability	Efficiency	Portability	Maintainability	Design	Implementation	Maintenance	Content	Presentation	Navigation				
320	Graphic Formatting Variation	24			X					X	X		X		Web Page			X
321	Page Formatting Variation	24			X					X	X		X		Web Page			X
322	Page Performance Variation	24			X					X	X		X		Web Page			X
323	Overall Element variation	24			X					X	X		X		Web			X
324	Overall Formatting Variation	24			X					X	X		X		Web			X
325	Overall Variation	24			X					X	X		X		Web			X
326	Median Page Breadth	24			X					X				X	Web			X