Evaluating and Designing Web Site Quality

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The 2QCV3Q model helps developers evaluate Web site quality from both owner and user viewpoints. It highlights elements that, when suitably combined, permit thorough site assessment and guide development.

There are many reasons to evaluate a Web site's quality. The growth of e-commerce, for example, has made a company's success more dependent on the quality of its Web site, whether its goal is commerce or content presentation. For every site, regardless of its mission or objectives, the competitor is only a link away, and attracting and keeping users becomes paramount. In this sense, a "high-quality" Web site is one that meets its owner's and users' requirements.

The ISO defines quality as "the totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs."[1] Two requirements for Web site evaluation emerge from this definition:

1. general evaluation of all the site's characteristics, and

2. evaluation of how well the site meets specific needs.

In many respects, these goals resemble those for defining and assessing the quality of industrial products, including software applications.[2]

The 2QCV3Q model

We developed the 2QCV3Q model to help site owners and developers evaluate Web site quality and incorporate these findings into site design. Starting with the assumption that a Web site is a hypermedia system primarily concerned with communication, we used classical rhetoric to create this model. Our theoretical reference scheme uses Cicero's seven *loci* or *argumenta*[3] in *De Inventione* and redefined in medieval treatises. Since the 1940s, journalism has applied a simplified set of these loci in the form of five questions: who, what, why, when, and where (coordinates that make an expression into a communicative act).[4] These principles let the model meet the first requirement, the need for completeness.

To account for specific site purposes, 2QCV3Q permits a multistakeholder approach that considers the viewpoints of all involved: the site's sponsor (usually the owner), its users, and those involved in its design and implementation. This becomes crucial when we consider that people involved in site development—graphic artists, marketing staff, Webmasters, software engineers, and so on—have different skills and therefore different priorities and attitudes.

Graphic designers, for example, often oversee Web site development projects but may be unaware of the characteristics of the technology determining the site's performance. Likewise, software engineers unacquainted with semiotics, graphics principles, or marketing, may create a site that fails to convey the company's image and therefore to achieve its goals.

The 2QCV3Q model takes its name from the initials of the Ciceronian *loci* on which we based it. The model's first version (2QCV2Q)[5] focuses on site evaluation following six main dimensions, corresponding to six *loci*. The second version, extended for site design, includes the seventh *locus* included in classical rhetoric lists. This lets us consider especially important elements for Web site development projects.

Our model structures site evaluation and design as a series of replies to the questions set by the Ciceronian loci. These principles, along with an analysis of existing models (see the sidebar "What Is Web Site 'Quality'?") and experimentation, have helped us define the dimensions as they correspond to the seven *loci* and identify attributes that determine Web site quality (Figure 1).

Table 1 (on p. 36) shows the complete model. The interrelated dimensions can affect each other in various ways.

Identity (Quis?)

A site with a strong brand identity remains impressed on the minds of those who visit it and forcefully conveys the company's image. Examples include the Ferrari site, which uses the color red (http://www.ferrari.com), and the site for Benetton's *Colors* Magazine (http://www.benetton.com/colors). A personal site uses charis-

What Is Web Site Quality?

Awareness of quality issues has affected every industrial sector in recent years, particularly services and advanced technologies. Contributions to the field and schools of thought encompassing the study and application of "quality" have pointed out the concept's complex and not easily identifiable nature.[1] In particular, prolonged experience in the field has shown that a balanced approach to the definition and measurement of quality must account for the trade-off between the need to be well-established and flexible enough to permit its application in diverse contexts.

We see in the literature three general approaches to evaluating Web site quality:

1. models for evaluating software quality,

2. usability-focused approaches stemming from human–computer interaction (HCI) research, and

3. models introduced specifically for Web site evaluation or design.

Models in the first group include the ISO models, particularly ISO 9126[2] for characteristics and ISO 14598[3] for process guidelines, and the IEEE's approach.[4] The 2QCV3Q model has some items (attributes and subattributes) analogous to those of ISO 9126, except that 2QCV3Q considers Web sites' communicative and multimedia nature. In particular, we see significant differences in the identity, content, and feasibility dimensions, the latter being linked to project management.

Another approach starts with the Internet's hypermedia nature and the importance of interface design to the speed of information access and to HCI in general. This approach defines quality in terms of usability (see for example, http://www.useit.com/alertbox), used as a driver to gather information for a qualitative evaluation. The HCI takes the user's viewpoint. Our approach is more general in that it considers the needs and objectives of all involved parties.

Models designed explicitly for Web site evaluation—principally in a business context—generally apply to specific site types such as e-commerce or libraries. They might be domain-dependent and defined ad-hoc for a particular application (see the references at http://www.cs.unitn.it/WebSiteQuality). The 2QCV3Q model has proved to be particularly flexible: The Ciceronian *loci* give a theoretical framework that lets us map existing approaches' characteristics as instances or specialization of (some of) its dimensions (that is, to operate as a metamodel).

Evaluating the impact on quality in use remains problematic, and research must continue to define and test the relationships between measuring and controlling internal product properties (that is, internal quality indicators) and external product behavior. In this respect, models to link the product view to user needs for quality should be used.[5]

The Web site quality assessment process also raises controversy. We summarize the factors characterizing the evaluation process as the articulation of the planned phases, the emphasis on the activities, and their degree of standardization. Compare, for example, the "seven steps recipe" proposed by the Eagles Research Group (http://issco-www.unige.ch/projects//eagles/ewg99/7steps.html) and the evaluation procedure given in the last version of the ISO 14598. Many approaches have a highly standardized evaluation process thanks to rigid domain and application specialization. Web site evaluation consultants also provide personalized evaluations based on user needs, and the guidelines accompanying the ISO 9126 quality descriptions underline the need to adapt the evaluation process to stakeholders' needs. Based on these considerations and our experience, evaluators must tailor application of the 2QCV3Q model's specific modalities to each project, considering the numerous elements present in the evaluation's larger context.

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ma and authoritativeness (see, for example, http://www.gerhard-schroeder.de/).

We can evaluate how design affects a site's character using the industrial design approach, which seeks to combine artistic and graphical aspects with product functionality. This considers both graphical presentation and the use of other elements that make the site attractive to

Quis? (Who)	->	Identity
Quid? (What)	->	Content
Cur? (Why)	->	Services
Ubi? (Where)	->	Location
Quando? (When)	->	Management
Quomodo? (How)	->	Usability
Quibus Auxiliius? (With what means and devices)	->	Feasibility

Figure 1. Ciceronian loci and dimensions of the 2QCV3Q model.

Table 1. The 2QCV3Q model.

Ciceronian Loci	Attributes
Quis	**Identification**
(*Persona:* Who?)	Brand (organization or company); charisma (individual)
Identity	Image
	Characterization
	Design
	Personalization
Quid	**Coverage**
(*Factum:* What?)	Domain referred to owner's and users' goals
Content	Value of information and links
	Accuracy
	Quality of information
	Source(s), author(s)
Cur	**Functionalities**
(*Causa:* Why?)	Adequacy to owner's goals
Services	Adequacy to users' goals
	Control
	Correctness
	Security, ethics, and privacy
Ubi	**Reachability**
(*Locus:* Where?)	Intuitive URL
Location	Retrieval
	Interactivity
	Contact information
	Community building
Quando	**Currentness**
(*Quando:* When?)	Updates and revisions
Management	Dates
	Maintenance
	Check-up
	Tools
Quomodo	**Accessibility**
(*Modus:* How?)	Hardware and software requirements
Usability	People with disabilities
	Navigability
	Structure, orientation
	Download times
	Understandability
	Languages
	Level of terminology
Quibus Auxiliis	**Resources**
(*Facultas:* With what means and devices?)	Financial and human resources
Feasibility	Time
	Information and Communication Technology
	Hardware (computer, networks)
	Software (implementation, integration)

visitors. The site must also be able to adapt its identity to the user by personalizing its content or functions. The overall objective is to increase the user's trust in the site owner.

Content (Quid?)

To evaluate content, we assess how well the site covers its domain in terms of site owner and user requirements. For example, if a site's purpose is to

offer an online sales service, it must contain all information a user needs to make a purchase—specifically, on the product and payment. We also evaluate the information's value and originality, which includes examining links to see whether they connect with pages users will find helpful. We should also check links that lead users to external resources, given that these may induce users to abandon the Web site. Since information's value correlates with its quality and accuracy, we must assess its precision and reliability, which in turn depends on the source of the information itself.

Services (Cur?)

We evaluate site functions from both owner and user viewpoints. The owner generally wants functions that achieve certain business or personal goals. Users access the site to find certain information and, according to the site type, expect to find functions to help them accomplish specific tasks. Furthermore, site developers' knowledge of Web tools and technology innovations will help them envision and develop new services.

Besides the adequacy of the functions provided, we should also evaluate their correctness and security and the secure use of personal information. For example, an online flight booking service should offer the same guarantees as a travel agency.

Location (Ubi?)

This dimension concerns both the site's reachability and the user's ability to interact with the host and other users. Users can easily identify a site if it has an intuitive URL that incorporates the organization's name or refers to its business. To help users locate the site with search engines, site developers must employ available devices to improve its ranking. Developers can also support the site's interactivity by providing the owner's or Webmaster's email address, postal address, and telephone and fax numbers.

The site should also provide functions for managing virtual communities through newsletters, mailing lists, membership plans, or guestbooks (see, for example, http://www.harley-davidson.com).

Management (Quando?)

Web site management involves updating the information it provides. The prices and schedules posted on the Greyhound site (http://www.greyhound.com), for example, must be constantly updated to be informative. Other useful indicators include dates for the site's establish-

> **Site developers should minimize user disorientation by providing a site map or online help and, more importantly, by structuring the site to facilitate navigation.**

ment and its last revision. True site management is corrective: it guarantees the site's stability so that a server crash doesn't prevent users from accessing it. It also checks the site's function—ensuring, for example, that no broken links exist. Adaptive and perfective maintenance are also needed to ensure that the site uses up-to-date technology and tools.

Usability (Quomodo?)

This dimension concerns all aspects that enable relatively undemanding site use in terms of cost, time, or cognitive effort. We first evaluate the hardware and software required to access the site. For example, users should be able to access a site using any browser, preferably without plug-ins. It must also offer access to people with disabilities or special needs (including users who connect with cellular phones, mobile devices, or Web TV). Site developers should minimize user disorientation by providing a site map or online help and, more importantly, by structuring the site to facilitate navigation. Page download times should be reasonable even for users with relatively slow connections. Finally, an efficient site also offers a choice of languages and uses easily understandable terms and symbols.

Feasibility (Quibus auxiliis?)

The model's final and newest dimension accounts for elements essential to Web site development (project management). Stakeholders particularly need to assess the financial and human resources required to design and subsequently manage the site. These resources, together with time and information technology costs, constitute the owner's investment in the site. The eval-
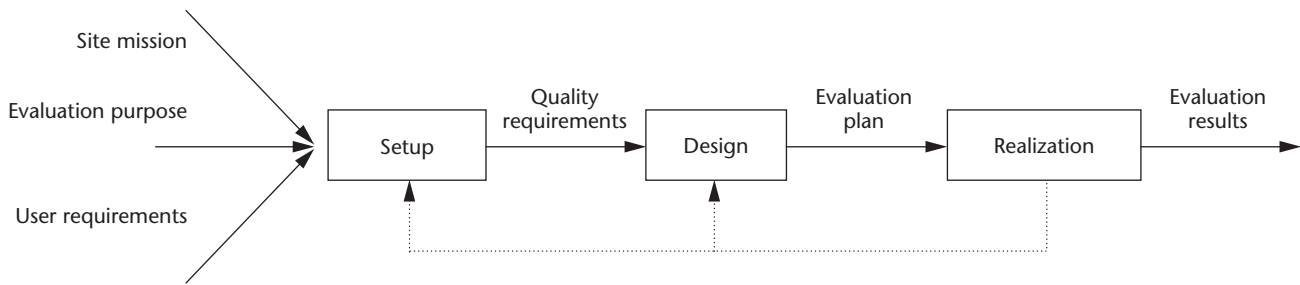
Figure 2. The 2QCV3Q site evaluation process.

uation will therefore influence decisions made in designing a site that will meet the needs of the owner, users, and professionals involved in developing and maintaining the site.

On a macro level, such evaluations then affect which information technologies are perceived as "necessary" for a project. The choice between a commercial and a public domain (open source) architecture, identification of development tools and standards to adopt for site implementation, and integration with existing technological platforms all represent typical development phases where we'd want to coordinate operative decisions with strategic information and telecommunication technology targets.

Deploying 2QCV3Q

The 2QCV3Q model provides a conceptual framework for identifying aspects that determine overall Web site quality. Applying the model to a site doesn't require a particular evaluation process, but thus far we've followed some general guidelines for adopting a problem-solving approach to quality evaluation. In short, the evaluation process requires

▊ an initial setup phase that includes evaluation requirements analysis and specification,

▊ a design phase that defines the evaluation plan and techniques, and

▊ a realization phase that applies survey techniques and measurement modalities specified in the evaluation plan.

Figure 2 illustrates the process.

Evaluation setup

The quality requirements definition and specification must consider certain elements, including

▊ the evaluation's purpose,

▊ the type and domain of the site(s) to be evaluated,

▊ the site's development phase,

▊ the site owner's objectives, and

▊ users and their profiles.

An evaluation can arise from very diverse needs—for example, to extend services offered on an e-commerce site, identify why marketing strategies were unsuccessful, design a site that outperforms competitors' sites, or make a classification scheme of competitors' sites. Understanding these factors, together with the site type and domain and its development phase at the moment of evaluation, is essential to specifying the analysis context. Moreover, in accordance with the general principle of quality—it's not an absolute property but depends on use context—we must also identify site owner and user objectives. The latter category also includes site designers, who seek to develop a site that's also easy to maintain and update.

Based on the information gathered in this first phase, we can then define the evaluation requirements in detail. We describe quality requirements using 2QCV3Q dimensions. In particular, for each dimension we must establish the analysis' degree of detail, structured as a hierarchy of attributes to consider and their relevance. Often we can describe the "quality profile" at the level of the model's seven dimensions, associated with the objectives defined.

Evaluation design

We next identify the appropriate assessment modalities for the 2QCV3Q attributes, accounting for the quality requirements defined during setup.

In this phase we must determine survey modalities, which can vary depending on the techniques and tools adopted and on evaluators' number, roles, and competencies. When choosing a technique, evaluators might refer to a classification proposed in the human–computer interface literature, which distinguishes empirical and analytical techniques.[6] The decision to use one method over another depends on such factors as the project's stage of advancement, user profile, data requested, availability of and access to experts or users, and available time and resources. Nonetheless, evaluators should employ diverse techniques, and to further integrate the results they should defer to experts (a study exists giving useful advice regarding the number of experts[7]) for some attributes and to online surveys for others.

The trade-off of quantitative and qualitative evaluation can prove critical and must be managed with extreme attention, keeping in mind the effectiveness and cost of the techniques used. For some characteristics the adoption of quantitative metrics is linear; for intrinsically qualitative factors we need to establish appropriate scales that evaluators can use to guarantee transparency even in a qualitative evaluation.

For the 2QCV3Q dimensions, examples of intrinsically qualitative subattributes include image or design, corresponding to the Identity attribute. Evaluating these attributes usually requires experts' participation. This case involves evaluating graphic aspects such as color and background, page layout, and so on, without losing sight of user objectives and profiles by applying marketing principles for company sites and considering the site's overall mission. Furthermore, even for subattributes for which we can find identifiers linked to physical parameters (such as average time to download a site's home page) we can't establish absolute reference values—user needs determine suitable download time. Also relevant are the network characteristics and mode of entry, whether via modem from home or high-speed office network.

In cases requiring a quantitative evaluation, we can adopt an approach based on the use of identifiers, the value of which we can assess using a checklist.[8] We can also adopt relatively sophisticated statistical-mathematical techniques to consider the relative importance of the model's subattributes and handle cases with mandatory attributes or subattributes. For examples, see the QEM[9] method, and the use of fuzzy logic to associate judgments expressed with linguistic labels.[10]

Conducting the evaluation

To evaluate a site, we apply survey techniques and the measurement modalities specified in the evaluation plan. Normally we base the evaluation on one or more visits to the site, but in some cases we may need to access files or information available only to the Webmaster. Using appropriate methods, we compare the results with the quality profile defined in the first phase. We can enrich this comparison by graphically presenting the evaluation results. Radar diagrams, for example, highlight a site's weak points.

Whatever the site evaluation's purpose, we can group the results in a report whose structure reflects evaluation objectives, with content organized according to 2QCV3Q model items. Viewing the process as iterative lets us repeat different phase activities for different site versions or later in the site's life cycle.

We can partially automate evaluation of some attributes using software tools. We experimented with Web site watchers and validators—tools for constructing a site map—to acquire information on site file types and links, discover when a site was last updated, gauge page weights, and so on. (Readers can find a list of these tools at http://www.usableweb.com; see also the Web Design Group site http://www.htmlhelp.com/tools.) Examples include Mercury Interactive's Astra SiteManager (http://www.merc-int.com), Watchfire's Linkbot (http://www.watchfire.com), and Bobby (Center for Applied Special Technology, http://www.cast.org). These tools signal instructions incompatible with a certain HTML version or browser and determine the degree of accessibility for disabled users. We also used freeware tools like Webcopy (Victor Parada, vparada@inf.utfsm.cl). You'll find the evaluation output for the University of Trento Faculty of Economics site at http://www.cs.unitn.it/WebSiteQuality.

We used search engines to assess the reachability attributes. We also developed some JavaScript routines to obtain useful data rapidly when visiting a site. Project management tools proved useful for assessing the final dimension, feasibility. Our experiments confirmed that we can use support tools mainly for the location, management, and usability dimensions, which are least tied to syntactic aspects and least dependent on contents (and therefore on semantics).

Applications of the 2QCV3Q model

During the three years since we developed 2QCV3Q, we've applied it to tourism, education,

Table 2. Applications of the 2QCV3Q model.

Project	Evaluation purpose and goals	Evaluation modality	Methodological goals and results
Dolomiti Superski (1999), http://www.dolomiti.superski.com Ski consortium: 12 ski resorts with 164 companies	Redesign site. Define business objectives: online market research, profile future skiers.	Evaluation by domain and marketing experts, analysts. Quantitative approach.	Fine-tune 2QCV2Q. Experiment with application modalities.
University of Trento Economics Faculty (2000), http://www.unitn.it Midsized university (13,000 students)	Redesign site. Expand market, evaluate competitors' sites (four northern Italy faculties of economics).	Evaluation by domain experts and analysts. Questionnaires and direct interviews (students); quantitative approach.	Verify model's applicability in diverse domains, support requirements analysis.
Plose Systems Service (2001), http://www.plose.it European trucking services company	Redesign site. From presentation to e-commerce: determine feasibility, offer new services online, analyze competitors' sites.	Evaluation by four five-person work groups of four competitors' sites. Quasiquantitative approach.	Introduce seventh model dimension, Feasibility. Verify coherence of evaluation results obtained from different evaluation groups.
Born to Walk Award (2001), http://www.borntowalk.com Mountain Film Festival, Trento, Italy; competition among sites dedicated to the mountain	Identify winner among 23 competing sites. Develop proposal to redesign winning site and (as additional prize) provide in-depth evaluation of winning site.	Domain expert evaluation of semantic dimensions (identity, contents, and services) using qualitative approach. Analyst global evaluation of winning site using quantitative approach.	Verify model's applicability for a competition and usability by people outside the information technology field.
No pain for children (2001), http://www.nopainforchildren.org Nonprofit association for promotion of antalgic treatments	Design site. Form environment favorable to antalgic treatments of children's diseases; fund raising.	Direct user interviews. Expert evaluation of sites with similar content using qualitative approach.	Verify requirements analysis support for different user types, such as medical professionals, families.
E-tourism (2001), http://www.cs.unitn.it/etourism/ Research group applying Information and Telecommunication Technologies for Alps tourism industry	Design site. Support and document completed projects, create virtual community of Alpine tourism experts and operators (long-term goal).	Experts, analysts, graphic artists: requirements analysis of semantic dimensions; session-style rapid applications development using qualitative approach.	Verify model's effectiveness to support communication with graphic artists and project managers.
Public Tourist Boards (PTB) in the Alps (ongoing). Public companies promoting Alps tourism	Design sites. Define reference model for development of a PTB Web site, analyze relationship among PTB's organizational structure, function, and site.	Domain experts and analysts: requirements analysis of semantic dimensions; direct interviews with PTB managers.	Verify model's applicability in a heterogeneous organizational context.

business, and customer service sites. These sites resided in distinct domains and also had different quality assessment objectives. Table 2 shows current model applications and highlights the projects' diversity in terms of both the complexity and the number of sites involved. For each project it presents a brief description of the most relevant setup and design elements and the principal methodological results. The table also provides the name of the organization requesting the evaluation, the domain analyzed, the evaluation's purpose, the owner's or sponsor's objectives, the application mode of 2QCV2Q/3Q, and results reporting (expert involvement, qualitative
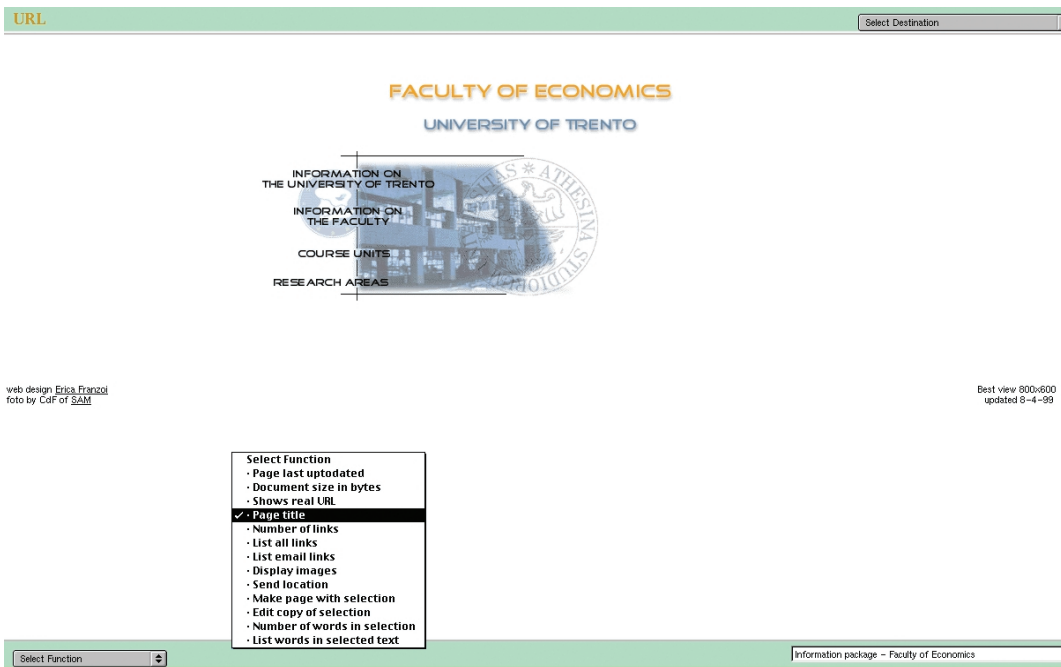
Figure 3. English version of the Trento University Faculty of Economics home page (2000).

or quantitative approach, and particular surveying techniques).

To illustrate 2QCV3Q's application, we discuss the main assessment steps for the University of Trento Economics Faculty Web site (Figure 3). Recent legislation introducing greater competition among Italian universities made site assessment necessary. According to the official organization of Italian universities, the faculty is responsible for teaching and corresponding services. Each faculty includes departments that carry out research. The Trento Faculty of Economics' objectives included attracting students from a wider geographic area and exploiting its own Web site. We therefore decided to compare our site's quality with that of other university sites (competition analysis) to redesign it. The comparison included four economics faculties' sites in northern Italy, specifically, two private universities (Bocconi University of Milan, http://www.uni-bocconi.it, and Libero Istituto Universitario Carlo Cattaneo, http://www.liuc.it), and two public universities (Cá Foscari University of Venice, http://www.unive.it, and the University of Modena, http://www.unimo.it), all of similar size to Trento.

While not losing sight of the faculty's objectives, we analyzed the site from the perspective of students who must interact with it, and therefore considered their needs and expectations central to the results. We divided site users into

Figure 4. Sample questions for evaluation of the coverage attribute.

four categories: high school students, first-year university students, second year and above students, and graduating students writing their theses. We specified their needs using interviews structured according to 2QCV3Q.

We found the students' requirements to be linked mainly to the content and services dimensions. Students listed the information and services they expected to find on a Web site, and we used this to more closely evaluate each site in relation to content and services dimensions. We also asked students to evaluate the sites, navigating alongside an analyst who helped them interpret some model items without influencing them when assigning scores. To evaluate some attributes (content coverage, for example) we created a Boolean list of questions regarding information the user expects to find in the site (Figure 4) and applied standard statistical techniques to assign a comprehensive value to the attributes. We used a numeric scale from 0 to 4
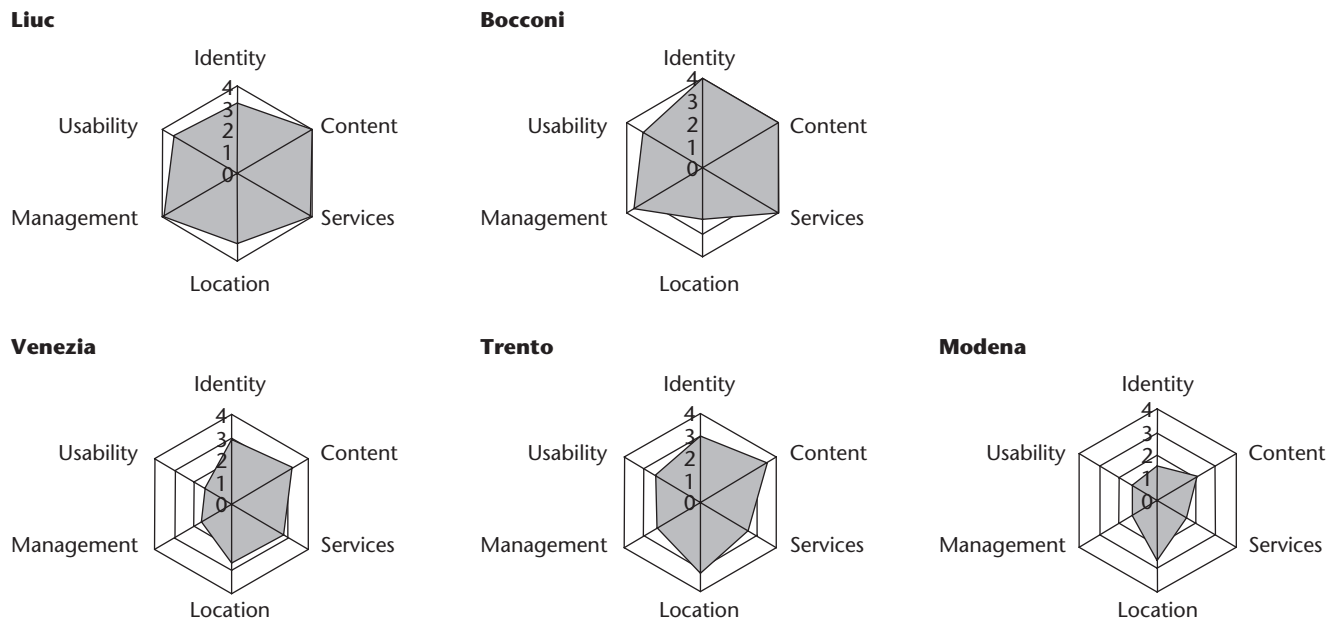
Figure 5. Web site quality evaluations for five Italian faculties of economics.

(0 = nonexistent, 1 = poor, 2 = adequate, 3 = good, 4 = excellent). We also assigned each subattribute a weight from 0 to 1 to factor in its relevance (determined from the general objectives identified during evaluation setup). We applied the same procedure to the other dimensions, except when evaluating the identity dimension where we asked experts to directly assign a value from 0 to 4.

Figure 5 shows how the Web sites ranked. This representation gives a comprehensive idea of a site's performance for the model's dimensions. We can integrate these dimensions with an analogous representation of the desired quality profile, which may not always coincide with the maximum values.

We used the comparative evaluation results to redesign our site. However, the most important results included detailed site specifications described using the model's attributes and subattributes.

Conclusions

The *loci* or *argumenta* of classical rhetoric give our model a conceptual reference scheme that permits maintaining control of a Web site's multidimensional nature where planning requires competence in information technologies, business, cognition, and other fields. Applying 2QCV3Q produced undoubtedly positive results and showed that the model is

■ *Domain independent.* It can be applied to diverse sectors, from the tourist sector to nonprofit organizations, from service companies to public administration.

■ *General purpose.* It can be applied to various site types, whether corporate or individual, educational or for e-commerce.

■ *Scalable.* The model's structure permits evaluation at varying degrees of detail, based on sponsor requirements and user needs.

■ *Usable.* The model's simple structure facilitates its comprehension and application, and therefore people with different skills can use it.

Furthermore, 2QCV3Q's application doesn't require a large training investment. Our experiments confirmed the possibility of applying the model iteratively at ever-higher levels of detail and calibrating the use of quantitative and qualitative metrics. This lets evaluators quantify only the elements of interest, thereby streamlining the model's application and avoiding partial quality evaluations. The model also accounts for subjectivity and permits a more efficient and cost-effective evaluation process.

The model also plays an important role in facilitating communication and negotiation among those involved in site development and manage-

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ment. When used to design a Web site, the model provides a sound reference framework for requirements analysis and project management. In fact, the availability of increasingly sophisticated software tools facilitates Web site development according to a prototype-based approach. Site owners and developers can therefore use 2QCV3Q in every project phase, involving both the site owner and the user or customer more closely to ensure that the site matches their requirements and can be constantly improved to achieve total quality.

Finally, by highlighting the site's weaknesses, the model furnishes site owners with useful redesign suggestions. Given the model's nature, its application can't be completely automated, but numerous tools can effectively support it. Developers can also use 2QCV3Q to design an integrated support environment. **MM**

Acknowledgments

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