AN ASSESSMENT OF QUALITY MEASURES FOR ENGINEERING INFORMATION SOURCES

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1 Introduction

This paper deals with an analysis of existing methods for analysing and 'providing' document quality that have been tried in a number of different domains. It then highlights the issues associated with applying these techniques in the engineering area in general and the engineering design area in particular.

2 Background

Throughout the design process, engineers make decisions based on information from various sources. In the conceptual design stages **[1]**, information about competitors' products, the state of the art, or a requirement specification etc. may be used. Through embodiment design **[2]**, material properties, part data, costs, and so on, may all be consulted. Locating relevant documents is often relatively simple, especially with the advent of Internet search engines and data libraries, however determining the quality of the information found is much more difficult. Since it is heavily relied upon and critical to the success of a design, it is crucial that poor quality information is not used. However, much of the time, engineers will simply use the first piece of relevant information they come across, since they are not aware of issues of quality.

There are many factors that can influence the quality of information, such as accuracy, currency and ease of use, in addition to relevance to the user's needs. Even if the information user were to consider all of the factors that comprise quality, it would still be very difficult to establish how high a document's quality is, or which, out of a number of documents that present contradictory information, should be used. Assessing the quality of information is also an arduous process that adds to engineers' workloads.
Since the assessment of quality is highly subjective, it is very much dependant upon the experience of the user; a subject expert would probably assess a document's quality more accurately than a non-expert, and quality assessments made by different individuals may well conflict. The quality of goods manufactured by an organisation can, to a degree be guaranteed by certifications such as ISO 9000. No such guarantee exists for their information, so it is generally down to the user to evaluate quality.

A thorough literature review has been undertaken to determine what work exists regarding information evaluation. Below is a summary of this work, focussing primarily on tools for the assessment of information quality, but also considering other related information quality issues.

2.1 Engineering

In 1968, Gerstberger and Allen **[3]** examined the criteria that research and development engineers use to select information resources. The engineers consulted were asked to rank the various channels of information they used according to accessibility, ease of use, technical quality of the information, and the degree of experience they had with each channel. They found that the most critical factor determining the extent to which a channel is used was accessibility. Engineers primarily use the most accessible channel, with quality only affecting their selection to a minor extent. This study was, however, mainly concerned with channel selection, and quality assessment was found to take place after the channel is selected. This research, although not recent, indicates where, within the information seeking process, a quality assessment tool may be most useful; a user would locate numerous Web sites, magazine articles etc. that appear to be relevant for their needs, then utilise an assessment tool to determine which are of sufficiently high quality.

2.2 Academia

Ciolek has reviewed the 'six quests for the electronic grail' **[4]** – six current approaches to tackling the issue of information quality of Web resources.

- *Programming approaches* use software to organise, channel and guide publishing and communication activities on the Web in order to reduce the scope for common errors and blunders.
- *Procedural approaches* use sets of instructions and rules, that when followed by an information author, ensure the quality of their content is high.
- *Structuring approaches* use electronic metadata, or 'information about information', captured in various fields that can be searched electronically to find relevant information on the Web.
- *Bibliographic approaches* deal with inconsistent scholarly referencing of Web resources, with the aim of producing a de facto standard.
- *Evaluative approaches* use scores and ratings to differentiate resources by their quality.
- *Organisational approaches* address the need for organisations to provide stable, quality and standardised systems for coordinated distribution of networked information.

Separately, Ciolek has developed an evaluation checklist for networked information facilities **[5]**. His criteria stipulate that resources provide their own original information, are useful and informative, easy to find, universally accessible, well structured and organised, well formatted and edited, and easy to establish, run, maintain and improve upon.

Wilkinson *et al's* **[6]** detailed study into Internet information quality evaluation involved the identification, consolidation and evaluation of criteria from various sources and the development of an evaluation tool. Independent panellists rated the importance of each of the 125 criteria and the half that were considered the least important were discarded. The resulting tool consists of seventeen questions, split into five categories - credibility, organisation, links, graphics and overall rating. The user subjectively rates each category out of five, based on quality criteria within it, resulting in a total score out of twenty.

Cooke **[7]** conducted a PhD study into the development of a tool for assessing the quality of Internet-based medical sources. The study included investigations into users' information seeking and quality assessment behaviour and concluded that an assessment of information quality is highly dependent upon the individual user's needs. An assessment tool was developed, which included an exhaustive list of criteria against which a document's quality can be assessed. This tool was published in a guide to finding quality information on the Internet **[8]**. The guide clearly describes the various features of resources that should be considered in quality assessment, but does not use any rating system to measure the quality level, since it was considered to be dependant on the user's needs. Although the relevance of an information source is certainly user need dependent, there may be other quality measures that are universal.

2.3 Medicine

The quality of information is crucial in the medical field, since using poor quality information can have potentially tragic circumstances. Various groups have carried out work on medical information evaluation.

Three organisations; Health on the Net **[9]**, The British Healthcare Internet Association **[100]** and Medical Matrix **[11]** have developed codes of conduct for the production of medical information available on the Internet. These codes give recommendations of information that should be included in such documents, such as its provenance, intended audience, references, conflicts of interest etc. Quality assessment of documents produced using these codes is subsequently much more straightforward, as the information required to make judgements is clear, however, the inclusion of such information does not necessarily guarantee the quality of a document.

Medical Matrix also has a project that ranks Internet resources, based on their utility for point of care clinical application. The rankings of one to five stars are based on scores achieved with their resource evaluation form **[12]**. The form assesses documents in six categories; peer review, application, media, feel, ease of access and dimension.

Mitretek **[13]** have developed a tool for user-assessment of medical resource quality. It features 21 uncategorised questions, with each 'yes' answer receiving a score, weighted depending on the answer's effect on quality. The total score (out of one) indicates the quality of the document tested.

2.4 Libraries

One of librarians' key duties is the selection and filtering of information. Various librarians and members of the library community have produced lists of assessment criteria for use by themselves and other information users.

Bopp and Smith's **[14]** evaluation criteria include format, scope, relation to other works, authority, treatment, arrangement and cost, but no formal rating system, so the quality measurement is purely subjective. Alexander and Tate **[15]**, Caywood **[16]**, Fenton **[17]**, Grassian **[18]**, Hinchcliffe **[19]**, Kwan **[200]**, Rettig **[211]**, Smith **[22]** and Tillman **[23]** have all compiled similar lists of criteria in the form of questions that

should be asked of resources when assessing their quality. Most of these are intended primarily for use with Web resources, however many of the criteria within them are also applicable to other types of resource. These checklists do not use any formal rating systems.

McLachlan **[24]**, and Payton **[25]** have coupled their evaluation criteria with rating systems, which allow a resource to be given a quality score. McLachlan's 24 criteria are categorised into first look, information providers, information currency, information quality and further information. Each criteria question scores one point for yes, and no points for no or not applicable, giving a total out of 24. Payton's twenty criteria are split into design, content, technical elements and credibility categories. Each criterion is scored between one and five, one indicating poor, and five exceptional, giving a total out of 100.

2.5 Internet Document Searching Services

There are various services on the Internet devoted to collecting, reviewing and searching for information.

The Google search engine **[26]**, launched in 1999, uses the PageRank Citation Ranking to determine the importance of search results to the user's search query. A document's PageRank is generated based on the number of links to the page. Linking pages, that are themselves frequently linked to, also have a high PageRank, which in turn further increases the PageRank of the original page. The search engine then sorts the search results in order of their PageRank, with the highest scoring Web pages appearing first.

Citeseer **[27]** autonomously locates and downloads papers from the Web, converts them to an electronically searchable format and extracts citation information from them. Citeseer's search engine then uses this citation information to help users locate high quality documents. Search results are indexed according to the number of citations recorded for the documents. Citeseer can also be used to produce citation indexes, which are particularly helpful for literature searches. Additionally, it allows users to find related and similar documents directly and much more easily than with other search engines.

2.6 Metadata

The simplest definition of metadata is "structured data about data" **[28]** and is basically descriptive information about a resource. Metadata is a relatively modern term and is generally used in relation to electronic resources, but can equally be applied to physical resources. For example, a traditional card index is, in effect, a collection of metadata, as it contains information about other information. Metadata is used primarily for locating relevant resources.

The Dublin Core Metadata Initiative (DCMI) **[29]** is a group committed to the widespread adoption of interoperable metadata standards and the promotion of metadata vocabulary development. The Dublin Core Metadata Element Set (DCMES) is their metadata standard, consisting of fifteen semantic definitions representing a core set of elements that are applicable to a wide range of industries and disciplines.

They include title, creator, subject, description, publisher, contributor, date, type, format, identifier, source, language, relation, coverage and rights. Various Web search engines have incorporated this metadata set into their systems to assist in the location of documents relevant to users' needs.

2.7 Discussion

The various information quality assessment methods discussed above vary in the criteria they use and method of execution, but they share many common features. Three categories have been identified, (discussed below), each differentiated by their contribution to the process of document assessment. An overall map has been developed by the authors, which illustrates the whole process. This is shown and explained below.

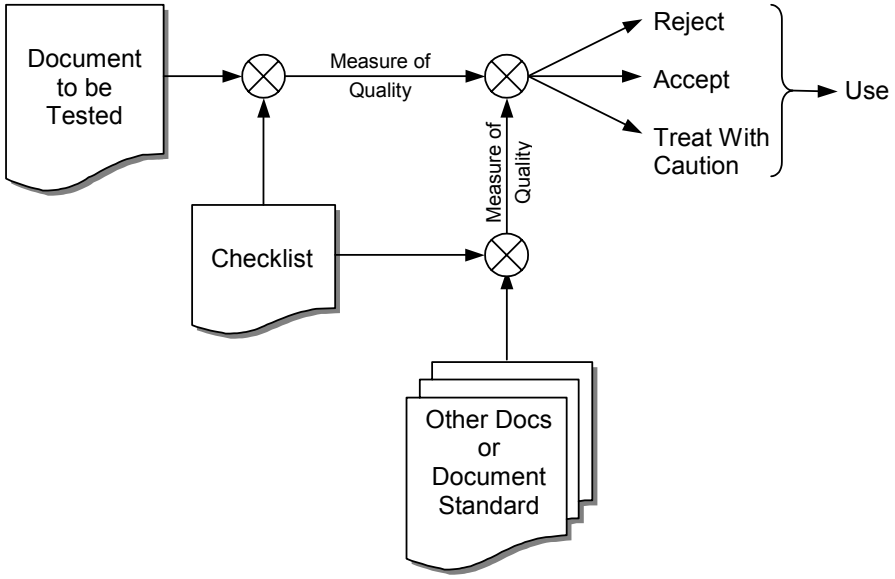

Figure 1 – Overall map of the document assessment process

In general, a checklist of assessment criteria is applied to a document that needs to be tested, resulting in either a formal rating or subjective opinion, which forms a measure of the document's quality. The document under test's quality measure is then compared with that of one or more other documents or a document standard, which have been assessed using the same criteria. A decision will then be made as to whether the document should be accepted for use or rejected, based on these comparisons. Sometimes, the document may be accepted, but it will be treated with caution and not relied on heavily. The end user will then use the information within the document.

2.8 User Audit Tools

Examples of user-audit tools are those developed by Cooke **[88]**, Bopp and Smith **[14]** and Payton **[25]**. User audit assessment tools consist of a list of quality criteria, sometimes with a scoring system that gives a formal rating to the quality of the document. The stages of application to documents and comparison to other documents, along with the decision on whether to accept or reject them are all carried out by the end user.

2.9 Critique of Existing Assessment Methods

The majority of existing user audit tools are designed for use with Web-based documents. Although many of their criteria are applicable to all types of resource, some, such as 'download time' and 'availability of site mirror' are only relevant to Web-based resources. Of all the tools found, only two are applicable to non-Web sources in their entirety.

Most of the tools do not use rating systems, and therefore, the assessment of quality is completely subjective, even when using guideline criteria. It is difficult to accurately compare two documents using only an opinion or 'feeling' of their quality level. It is clearly even more difficult to compare a document with a required standard. Eight of the tools mentioned above do use rating systems. Four of these **[6,12,25,26]** require various categories, such as currency, to be rated on a scale. Each of the categories includes numerous criteria, but the categories are only rated as a whole. No indication is given of the relative importance of these criteria, and it is down to the user to determine this in order to rate each category. The results produced using these methods are therefore likely to be inconsistent between users.

User audit itself presents a number of problems. The assessment process can be long and arduous, especially if a user needs to audit a large number of documents. Services like EEVL and BIOME ease this burden by pre-auditing the documents they include, but aside from accepting 'good quality' resources and rejecting 'poor quality' resources, the user is given no further quality measurement, so comparison with documents from elsewhere is difficult. Also, acceptance into the services does not necessarily guarantee high quality and the range of resources that they can provide is also limited.

The service offered by review Web sites is useful, however their assessment processes are highly subjective, and are not consistent. Also, reviews simply do not exist for most documents.

2.10 Identification of Requirement

There is clearly a requirement for a user audit tool that allows information users, from those with little experience to experts, to easily and consistently assess and quantify a document's quality. To achieve this it should differentiate between more and less important criteria, and eliminate the subjective grading of documents on a scale. This would allow straightforward comparison of a document's quality level to either a minimum requirement or that of another document.
A further development would be for documents to be pre-audited prior to dissemination, with their quality rating displayed within the document. This would simplify and accelerate the document selection process, as a user could simply glance at the document's quality level – much like one would consider a hotel's star rating – and decide whether it reaches their requirements. Displaying a quality rating within the document does however introduce the issue of ratings fixing, which could be dealt with by using independent assessors, or requiring registration and certification for information producers to allow them to self-assess their own documents.

Also, it would be very useful if a set of guidelines were available to help document creators ensure that the information they produce is of the highest quality, thus allowing them to achieve the best possible rating using the assessment methods above.

3 Quality Criteria

The following section involves collecting and refining the information assessment criteria from existing tools, to provide a sound basis for the production of an assessment tool with excellent provenance.
Gathering Criteria

Firstly, the criteria used in each of the various existing information quality assessment tools discussed in Section 2 were evaluated. These variety of tools, some 21 in total, cover both Web and traditional document types and numerous different fields, including medicine, engineering and libraries. The criteria were initially collected together in an Excel spreadsheet, then duplicated criteria were deleted and very similar criteria were rationalised. No judgements of their value were made at this stage. This resulted in a comprehensive list of 94 criteria, encompassing every criterion used by the 21 existing tools. These criteria were then split into twelve categories, each comprising between four and thirteen criteria.

Access / Usability (13 Criteria)
Stability, supported formats, hardware and software requirements, software bugs, access time, downtime, registration requirements, payment requirements, information security, traffic levels, geographical access restrictions, copyright issues, metadata.

Identification / Documentation (6 Criteria)
Title, fields covered, audience, mission / purpose / scope / limits, content description, improper / controversial materials.

Currency (4 Criteria)
Creation date, Web publishing date, last revision date, update frequency.

Author (9 Criteria)
Identification, qualifications, affiliations, position / rank, experience, reputation, previous work, contact information, other contributors.

Organisation (5 Criteria)
Identification, legitimacy / reputation, purpose, content control, inherent bias.

Structure / Design (6 Criteria)
Headings, content matches abstract, graphics, unique features, appropriate format, language.

Relevance / Scope (5 Criteria)
Suitability, detail, originality, completeness, retrospective coverage.

Validity (10 Criteria)

Methodology used, citation, peer review, primary / secondary information, verifiable statistics, independent reviews, usage, source reliability, age, research basis.

Accuracy / Balance (8 Criteria)
Spelling / grammatical / typographical errors, misleading omissions, balance, author bias, consistency, stereotyping, accuracy from knowledge, ability to inform of inaccuracies.

Navigation (10 Criteria)
Ordering, menus, logical arrangement, index / search, sitemap / contents, sense of place, link to homepage, navigation, conciseness, help system.

References / Links (10 Criteria)
Inclusion, visibility / ease of use, completeness, author opinion statement, value, relevance, description, links to resources or list of resources, stability, reliability.

Aesthetic / Affective Aspects (8 Criteria)
Use of accepted graphic and text design principals, readability / legibility, originality / creativity, professional / appealing design, consistency, distraction, advertising.

3.1 Assessing Criteria

The complete list of criteria and the 21 existing tools were assembled into a matrix, and the criteria were matched with the tools that include them. A abridged version of this matrix is shown in 2, with some of the criteria and tools omitted for clarity.

Category	No. of Criteria	No. of Tools Using Criteria		
		Min	Max	Ave
Currency	4	5	18	11.8
Relevance / Scope	5	3	17	10.8
Structure / Design	6	4	15	9.6
Aesthetic / Affective Aspects	8	4	14	9.0
Navigation	10	2	18	8.8
Identification / Documentation	6	1	15	8.7
Author	9	1	14	8.4
Organisation	5	1	15	6.8
References / Links	10	2	16	6.8
Access / Usability	13	2	11	6.7
Accuracy / Balance	8	1	9	5.3
Validity	10	1	8	3.7

Table 1 – Numbers of tools using the criteria within each category, sorted by decreasing mean average.

The most populated categories, as shown in Table 1 were relevance / scope and currency. Structure / design and aesthetic / affective aspects also scored very highly. Surprisingly, validity and accuracy / balance, factors that would normally be considered to heavily influence the quality of the information within a document, scored very low. This suggests that in general, the guides were less concerned with the information content than the format. This may reflect the heavy Web bias of the guides, as Web resources can be easily differentiated by the ease of use and appearance, but less easily by the information itself. The work in this research

addresses this issue and acknowledges the importance and influence of all categories on document quality and reflect this in the quality rating system.

	Cooke	Wilkinson	Mitretek	Rettig	BIOME	Smith	Hinchcliffe	Tillman	Fenton	EEVL	Magellan	
	1	2	3	4	5	16	17	18	19	20	21	**TOTAL**
Access and Useablity												
Stability	○	○				○		○		○		**7**
Supported Formats		○				○	○	○	○	○		**10**
Hardware / Software Requirements	○				○	○		○	○	○		**8**
Free of Bugs		○								○		**3**
Access Time	○	○			○	○		○				**11**
Downtime	○	○			○	○				○		**9**
Registration Required	○	○			○	○			○	○		**7**
Payment Required	○	○			○	○	○		○	○		**9**
Security of Information / Payment Information		○	○									**4**
Traffic Levels	○	○			○	○						**7**
Geographical Access Restrictions	○				○					○		**3**
Copyright Issues	○				○	○			○	○		**7**
Use of Metadata for Search Engines	○											**2**
Validity of Content												
Methodology Used to Develop Content		○							○			**2**
Referencing by Recognised Authority	○	○							○	○		**6**
Peer Review Process	○	○			○			○		○		**8**
Primary / Secondary Information	○	○				○			○			**5**
Verifiable Statistics to Support Conclusions		○										**1**
Independent Reviews	○					○						**3**
Usage / Counters	○				○							**2**
Reliable Sources	○		○						○	○		**6**
Provenance / How long the resource has been available					○							**1**
Research Basis				○	○				○			**3**
Accuracy and Balance of Content												
Spelling / Grammatical / Typographical Errors	○	○			○							**6**
Misleading Omissions		○		○								**2**
Balanced Viewpoint		○	○				○		○			**4**
Identification of Author Bias		○	○		○	○		○	○			**8**
Consistent Quality of Information		○										**1**
Biasing or Stereotyping	○	○	○		○	○		○	○			**9**
Factual Accuracy From Knowledge	○			○	○	○			○	○		**9**
Ability to Inform of Inaccuracies	○				○							**3**
Navigation												
Organisational Scheme (Ordering By…)	○	○	○	○		○	○	○	○	○	○	**18**
Topical Narrowing by Menus etc.	○	○			○	○		○		○		**12**
Logical Arrangement	○			○		○			○	○		**10**
Index / Search Function	○	○	○	○	○	○			○	○		**13**
Site Map / Contents Page	○	○			○				○	○		**7**
Sense of Place (Page Numbers, Chapter etc.)		○										**2**
Links to Homepage		○							○			**2**
Ease of Navigation between Sections	○	○	○		○	○		○	○	○	○	**15**
Concise Information		○										**3**
Help System	○	○			○	○				○		**6**
References / Links												
Inclusion	○	○	○	○	○	○			○	○		**16**
Visibility / Ease of Use	○	○										**3**
Completeness / Use of Standard Referencing		○							○			**4**
Statement of Author's Opinion if No References			○			○						**2**
Value	○	○			○	○			○			**9**
Relevance / Appropriateness		○	○	○		○			○			**10**
Information About Links	○	○				○				○		**6**
Links to Resources or Lists of Resources		○				○						**2**
Stable / Up-to-date Links	○	○	○	○		○			○	○		**12**
Reliability of Links, Inward or Outward Linking		○	○						○			**4**
Aesthetic and Affective Aspects												
Accepted Graphic Design Principal Use	○	○		○	○	○				○		**13**
Accepted Text Design Principal Use	○	○		○	○	○				○		**12**
Readability / Legibility	○	○		○		○				○		**14**
Originality / Creativity of Design		○									○	**4**
Professional / Appealing Design	○	○		○	○					○	○	**12**
Consistent Presentation		○			○					○		**4**
Distraction of Design	○	○			○	○						**9**
Advertising Distraction	○				○					○		**4**
TOTAL	**60**	**75**	**27**	**27**	**53**	**47**	**18**	**21**	**45**	**47**	**8**	

Figure 2 – Abridged sample of tool comparison matrix, omitting some criteria sections and tools.

3.2 Filtering Criteria

One of the intentions of the work has to be to allow the comparison of documents and assist the user in selecting information resources. Eight key document types used by engineers have been initially identified; magazine articles, journal articles, academia, books, conference papers, Web pages, government documents, reports, e-mails and memoranda. The work must be capable of assessing each of these document types equally and fairly against the same quality criteria.

The criteria that were included in few of the existing tools were next considered, to identify those that had little effect on document quality. Some of the criteria were included much less frequently than would be expected, for example 'identifying the document's title'. It was concluded that the tool authors likely overlooked them as they were deemed to be obvious. These criteria were not removed from the criteria list as they were still considered to be important quality measures. Other criteria appearing in less than five existing tools were removed from the list unless it was clear that they had an important influence on quality. Some criteria were not deleted, but combined, as they referred to the same document features. This resulted in 46 criteria, which were seen as crucial in the work.

4 Discussion

This section brings together findings from the research described above, building on them and discussing some of their implications.

4.1 Information Quality

Many individuals have attempted to address the issue of information quality, producing various quality assessment procedures. Combining the findings of 21 existing assessment tools indicates that there are at least 94 different factors that indicate or influence the quality of a Web-based information resource. Many of these factors are relevant only to Internet documents, however 69 of them are equally applicable to other types of resources, such as books, reports, magazine articles, etc. Each of these factors affects document quality to a greater or lesser extent. For example, heavy bias in a document would have a greater effect than a lack of graphics. Also, some factors will have a negative effect, reducing a document's quality, such as spelling/grammatical errors, whereas, others will have a positive effect, increasing a document quality, for example the author having an excellent reputation. Information quality is also partly user-dependant, since many of the quality influencing factors relate to the suitability of the document for the user's needs.

Information quality can be broken down into four distinct categories, or 'dimensions', which encompass all of the quality factors. *Authority* represents how authoritative those responsible for the document (authors and organisations) are, and therefore, how well the content can be trusted. *Validity* represents how the document's content can be validated for its accuracy, using information other than that about the creator, such as

peer review, citation in other documents and document age. It supports authority by verifying the content's accuracy. *Relevance* relates to the user-dependant elements of quality that are determined by the suitability of the information for their needs. *Structure* represents the visual and organisational elements of a document that improve ease of use, and also indicate the author's concern for quality and attention to detail.

4.2 Document Trends

An audit of various document types has been conducted. Some documents of the same type, e.g. standards, were found to share many common attributes, and thus the differentiation between them was low. Other document types, however, exhibited a much greater range of scores. Web pages, especially, varied considerably in their scores.

Standards were ranked as having the highest quality, followed by books, reports, journal articles, academia, catalogues, magazine article and finally web pages. Although web pages scored on average significantly lower than other document types, there were some exceptional web pages that scored almost as highly as some journal articles and books, showing that it is possible to find good quality information on the Internet. Table 2 summarises the audit's findings.

Document Type	Average Quality Level	Quality Range
Standards	Very High	Very Low
Books	High	Medium
Reports	High	High
Journal Articles	High	Low
Academia	Medium	High
Catalogues	Medium	High
Magazine Articles	Medium	High
Web Pages	Low	Very High

Table 2 – Summary of findings from document audit

Although these findings alone cannot be used to select which documents to use, since document quality varies within each type, they may be worth considering when deciding, for example, whether to look up a value in a book, or on the Internet.

4.3 Issues for Document Creators

An author can, to an extent take steps to increase the quality of the information they produce in a number of ways. Clearly, some elements of quality, such as authority cannot be artificially emulated, but the maximisation of document quality is often overlooked, and authors omit information that could increase their documents' quality ratings. For example, if an author is affiliated to an authoritative institution, but does not declare this within the document, the assessor can only assume they are not, and thus their documents' quality ratings will suffer. Therefore, by including certain items of information, they would allow a quality tool to most representatively rate a document's quality. Also, if authors properly structure their documents, they will be easier to use and thus will achieve higher scores for the structure dimension. Primarily, when generating information for inclusion in documents, authors should ensure that it is of high quality, from reliable sources, and well backed up with evidence.

4.4 Issues of Document Pre-Audit

The possibility of pre-auditing documents before they are disseminated has been explored. It was found that although authority, validity and structure could easily be pre-audited, relevance could only be determined by the end user. Therefore, a system was developed to facilitate relevance assessment, by condensing the information required to answer relevance questions, so that it could be presented along with authority, validity and structure ratings within the document itself. This 'metadata' consists of a number of keywords describing the document's subject, along with ratings for the documents levels of detail, novelty and breadth, the number of pages and the document's creation date.

Document pre-audit has possible implications for Web searching. If Internet-based documents contained a Quality Rating Data as metadata, hidden within their source code, a very effective quality-based search engine could be created. By extending the usual search query, with user requirements of detail, novelty, breadth and age, documents could be instantly assessed using a relevance criteria, to filter out those that are relevant to the user's requirements, and return the search results ordered from highest to lowest total quality scores. Advanced searches stipulating users' minimum authority, validity and structure scores could also be accommodated.

Some of the assessment questions rely on the assessor's knowledge of things such as an organisation's reputation. This can introduce inconsistency between different users' answers, as their knowledge will vary, a situation that is far from ideal, but very difficult to resolve. A possible solution for this is to link any tool to the Internet. Both academic institutions and journals are ranked by numerous bodies, so the authority and reputation of organisations could be determined from these rankings. Also, Citeseer's source code is freely available, so potentially, a document's citation frequency could be automatically determined by assessment software, along with the authority of authors, based on the citation frequency of their work. This pooling of existing metrics would both facilitate document audit, and increase the effectiveness of the tool, as the assessment would be based on highly reliable information and not users' knowledge.

5 Conclusion

Despite the extensive work that has been conducted there is clearly a requirement for more fundamental research, particularly in the engineering domain. To handle the rapidly expanding volume of information the need for a user audit tool that allows information users, from those with little experience to experts, to easily and consistently assess and quantify a document's quality is an important goal. Importantly it has to be researched properly have a creditability itself.

Another opportunity would be for documents to be pre-audited prior to dissemination, with their quality rating displayed within the document. This would simplify and accelerate the document selection process, as a user could simply glance at the document's quality level – much like one would consider a hotel's star rating – and decide whether it reaches their requirements. This may be an internal or external process.

A further issue is that it would be very useful if a set of guidelines were available to help document creators ensure that the information they produce is of the highest quality, thus allowing them to achieve the best possible rating using the assessment methods above.

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