

# INDICATIONS OF DESIGN QUALITY: USER INPUT AND THE DEVELOPMENT OF THE DESIGN QUALITY INDICATOR TOOLKIT

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**ABSTRACT:** The Design Quality Indicator (DQI) toolkit has now been launched across the UK built environment sector. The indicators complement existing mechanisms for improving the quality of the built environment by providing an assessment tool for evaluating the design quality of buildings. The aim is for 20% of all UK projects (having a value in excess of £1 million) to use it by the end of 2007. This paper describes the authors' involvement in developing the toolkit; it reports on user feedback from the beta-testing phase and outlines the development of the interactive web-based interface. It then reflects on current and potential future use of the tool, giving ideas for further research.

**Keywords** – design quality, indicators, measurement, users.

## 1. INTRODUCTION

The Design Quality Indicator (DQI) toolkit was launched at the Treasury on October 1<sup>st</sup> 2003. It consists of a set of indicators which explore aspects of design quality in buildings. These indicators complement existing mechanisms for improving the quality of the built environment. Their use is written into government policy, with the aim for 20% of all UK construction projects (having a value in excess of £1 million) to utilize them by the end of 2007. The DQI toolkit is managed by Construction Industry Council (CIC) and supported by the Commission for Architecture and the Built Environment (CABE); Office of Government Commerce (OGC) and Strategic Forum for Construction (SFfC). It is online at <http://www.dqi.org.uk/>.

This paper reports on the authors' involvement in developing the toolkit; discusses user feedback from the beta-testing phase and outlines the development of the interactive web-based interface. Earlier research and development work has been described in previous papers (Gann, Whyte and Salter 2003; Gann, Salter and Whyte 2003; Whyte, Gann and Salter 2003). Like these, this paper presents work-in-progress and ongoing research undertaken in the context of application, rather than the traditional, discipline-based university research with which academic communities are more familiar (Gibbons, Limoges et al. 1994). It has been exciting to act as research input on a project of such industrial relevance and to be involved in all stages of its development, working closely with industry and government bodies. However researchers are not the sole drivers in such a project and the wide number of stakeholders presents challenges to consistency of approach which would not be present in the academic laboratory. Hence, the work can be seen as a form of action research, which is a growing tradition of work in this applied field (e.g. Cushman 2001).

In the next section we recap some of the prominent features of the policy background and give the theoretical basis for the approach. In section 3 we then outline the indicator development process. In section 4 we describe the beta-testing phase or 'trail-blazing' scheme, in particular the feedback that was obtained by systematically using the version on real-projects. In section 5 we describe the development of the web-based version and the

current status of the toolkit. Finally in sections 6 and 7 we reflect on the process, draw conclusions and give ideas for further research.

## **2. POLICY BACKGROUND AND THEORETICAL BASIS**

Performance measurement has been emphasized by the UK government as a key policy instrument for improving practices in the construction sector (Egan 1998). This measurement strategy has been adopted from manufacturing: lessons have been drawn from literature on lean production and Japanese approaches to quality management (Schonberger 1982; Monden 1983; Womack and Jones 1996). Interest in performance measurement has led to the introduction of a suite of benchmarking techniques and the development of key performance indicators (KPIs) for use in the construction sector (<http://www.kpizone.com/>). The focus of these measurement efforts has primarily been on processes: headline indicators have included metrics relating to time and cost of production. Metrics associated with the quality of production have also been developed and implemented, with the focus on waste and defects. Yet this overall approach to measurement says relatively little about the design quality of the products or outputs of the construction process.

In response to this gap in measurement systems for the UK built environment, the CIC was commissioned to develop a new toolkit for assessing design quality in buildings. This work was initially for the former Department of the Environment, Transport and the Regions (DETR) and later, after government reorganization, for the Department of Trade and Industry (DTI). The authors acted as the research team on the project, which started in 1999, working closely with the CIC, a steering group and a large industry reference group. The indicators of design quality that have been developed are seen as an extension of the Egan agenda of mapping, measuring and managing the design and construction process, but place particular emphasis on the quality of design embodied in buildings – the products or outputs of construction.

The theoretical basis for the toolkit was developed through the initial scoping study of performance measurement in design (Torbett, Salter and Gann 1999) and through our ongoing learning. Our work is part of an international body of work that has begun to assess the quality of the built environment. Particular attention is being paid to mapping and measuring the value of the construction process (e.g. Gibson Jr and Gebken II 2003; Thomson, Austin et al. 2003). The DQI toolkit focuses on the product. We see the toolkit as an example of a 'user toolkit' which allows a variety of users to articulate their preferences and input into the design process. However we are cognizant of the fact that it requires craft knowledge to use the tools within the toolkit (Brady 1995) and we see its use being a facilitated process. Within the management literature, there has been growing interest in the use of user toolkits to enable end-users to input into the debate around design (von Hippel 2001; Jeppeson 2003). Whilst the DQI toolkit is different in function from the user toolkits described by Hippel and Jeppeson, we see it as part of this body of work.

We have also learnt from comparison of the DQI with multi-criteria mapping tools developed for social appraisal of sustainability and technological risk. In the development of indicators for soft issues such as design or sustainability we face serious theoretical and methodological difficulties. We felt that there was much to learn from the development of indicators in a range of fields such as agricultural and environmental policy (e.g. Stirling and Mayer 2000), where systematic public participation is seen not as an issue of political efficacy and legitimacy but as a matter of analytic rigour (Stirling 1999). In developing the DQI we faced similar issues to those faced by these researchers, of the selection and framing of 'problems' and 'options'; treatment of deep uncertainties; and the 'impossibility' of

aggregating in analysis the divergent social interests and value judgements which govern the prioritisation of the different dimensions (Stirling 1999). Hence our approach has been to involve a range of stakeholders in all stages in the process.

### 3. INDICATOR DEVELOPMENT

As the research team we worked with a steering group and reference group to develop the basis for the DQI toolkit, which consists of the basic conceptual framework, data collection tool and weighting algorithm. The relationships between these three parts are shown in Figure 1.

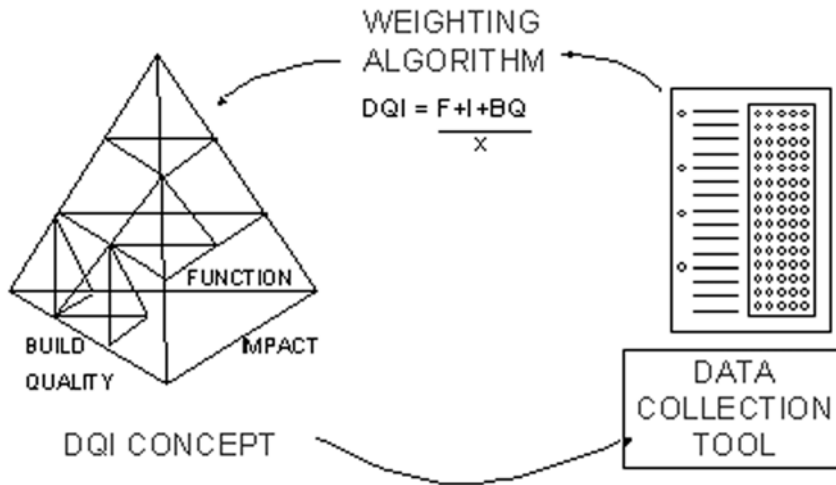


Figure 1. The DQI Toolkit: concept, data collection tool and weighting algorithm

We adopted an applied method of research and development involving a series of iterative steps in close collaboration with industrial users. This allowed us to integrate knowledge from practitioners and test this in subsequent versions of the tool. The research team drew from the background literature and made presentations to the steering group over a period of several months. The steering group set the agenda for the research, guiding the research questions and the development process according to their over-arching perception of what was needed. The specification for the DQI thus evolved through time during the first year of the project and was formalized after several iterations, as shown in Table 1.

Table 1. Specification for the Design Quality Indicator

<p>The resultant DQI should</p> <ul style="list-style-type: none"> <li>• assist in informing choice in design decisions;</li> <li>• be useable by anyone – including professional designers and lay users;</li> <li>• raise public awareness of the importance of design;</li> <li>• be capable of measuring an individual’s view of design quality against their own chosen intent for the building;</li> <li>• allow participants to compare and contrast different options;</li> <li>• be of a flexible, multipurpose and generic nature, useable on many different types of buildings;</li> <li>• be useable at different phases in a buildings’ lifecycle – conception, design, construction and in-use; and</li> <li>• be swift to use, with a simple and clear interface.</li> </ul>
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Existing tools have been used as a starting point for the development of the DQI. There is considerable overlap between our approach and several of the previous attempts to understand the quality of buildings. Unlike previous tools, however, the DQI focused on design quality and could be used across all stages of a building’s life, including conception, design, construction and in-use. User input has been key to the development of the DQI and has been obtained through the steering group and reference group and piloting of the tool on real projects. The structure of the data collection tool and each of the questions on the data collection tool (shown in figure 2) was developed through extensive consultation.

**Build Quality**

For sections N to P please additionally circle the 3 statements with in each section that you feel are the most important for your building

**N PERFORMANCE**

	Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree	Not Applicable
01 The building is easy to clean	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
02 The building will stand wear and tear in use	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
03 The building is easily maintained	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
04 The building design has responded to the site microclimate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Figure 2. Part of an early data collection tool as part of the Design Quality Indicator

A number of views of the DQI emerged during the early period of validation. The original aim was to develop a tool for benchmarking design quality, however, over time the focus changed. At the first meeting of the Steering Group, it was agreed that there could be no single, universal result from analysis of design quality of a building. Rather, design quality reflects multiple viewpoints from communities of design professionals and from user-groups including lay people. Individuals needed to be provided with an opportunity to express their intentions and viewpoints in order to create a dialogue between all the different actors involved in the design and building process. The authors’ sought to create an interactive, user-focused approach to design quality. The DQI consists of three elements: a conceptual framework, a data-gathering tool and a weighting mechanism. The relationship between these different parts is shown in Figure 2.

As the DQI was developed, it was increasingly seen as a mediator between customers, end-users, designers and producers. It structured questions about the process, providing information that is easily accessible to architects, engineers and constructors. It enabled design teams to explore differences in expectations across professional and user groups. A key element of our approach to developing the DQI was our focus on the intent for the building. This made our indicator different from others that had been developed previously. The steering and reference groups suggested that the tool should draw out from respondents their intent for the building and that design quality should be assessed against this intent. This was a turning point in the process and reflected the widespread view that imposing one model of design on the tool would be unrealistic. Each score would be a reflection of the score of the building assessed against individual respondents’ personal and/or professional views.

In developing a mechanism for visualizing the results from the toolkit, we were keen to show both the weighting with regard to intent and the score within each section. Hence we developed a ‘doughnut’ visualization at this stage of the project. In Figure 3 the first

‘doughnut’ shows the results when each section is weighted equally and the given the full score. The second doughnut is a result from a real project, where function, build quality and impact have been weighted differently and the score within each section is good, but not 100%.

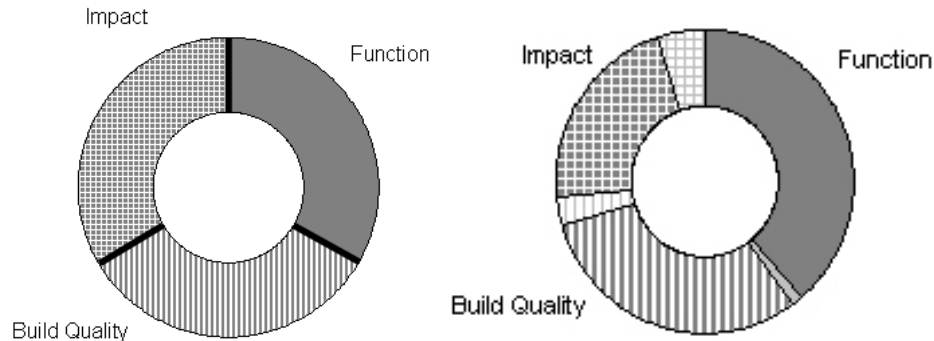


Figure 3. Visualization of results from the DQI Toolkit

If we consider the DQI from a product development perspective, it is possible to distinguish different phases of the development process. At the research phase limited pilots were carried out to test early prototypes of the tool. These are described in previous papers (Gann, Whyte and Salter 2003; Gann, Salter and Whyte 2003). Lessons were learnt from these pilots and the tool was redesigned to reflect this learning. There followed an interim phase during which the business plan for wide scale deployment was developed and comparative pilots were conducted within different sectors. The DQI then went through a beta-testing phase: a Trailblazing Scheme has been set up by CIC in order to pilot the use of the product on live projects across the sector. This rigorous beta-testing of the tool ran alongside the development of a web-based version of the tool and the refinement of its components. This has been described in Whyte and Gann (2003) and will be further considered in the following sections.

#### 4. FEEDBACK FROM THE TRAILBLAZING SCHEME

Between July 2002 and July 2003 the DQI Trailblazing Scheme represented the major design evaluation activity within the UK built environment sector. It was the first opportunity for organizations to sign up and use the DQI assessment on live projects and represents a step in the process of moving the DQI from a research project to widespread industrial use. The scheme allows thorough testing of the DQI in development.

Construction Industry Council and the DQI Management Group provided training for DQI Facilitators as part of the Trailblazing process. The training aimed to giving facilitators the background information required about the DQI project to enable them to lead the process of beta-testing the tool on projects within their organizations. One hundred and forty-three construction professionals have attended on one of four facilitator training events, and 72 Trailblazing organizations recruited, 57 have at least one trained facilitator (Construction Industry Council, 2003).

At the launch of the Trailblazing Scheme the questionnaire used for data-gathering was professionally produced along with the promotional material. It is a paper-based tool, partly because of the short development time and resources available, but also to ensure that

Trailblazers return data to CIC. We would have liked users to have had more opportunity to play with the tool, however centralised data collection and analysis means that all of the data from the Trailblazers is available for benchmarking and statistical analysis.

The Trailblazing scheme started in July 2002 and by February 2003 seventy-two Trailblazers had been recruited: six contractors; 36 design firms; five private clients; 22 public clients; and three other types of organisation. At this stage trailblazing organisations had declared 150 uses of the DQI. These actual uses represent about £900 million of construction output, on projects ranging from £900 thousand to £450 million (Construction Industry Council 2003). All the major procuring civil government departments were directly or indirectly using the DQI to aid project procurement (Construction Industry Council 2003). However a problem encountered by many commercial Trailblazing organizations is that the uncertain nature of the construction process and the long lead times involved makes it difficult to use the DQI on six projects within one year as originally planned in the Trailblazing process.

Table 2. Main themes emerging from the review conference

Theme	Respondent Comments
<p><b>The role of facilitation</b> The role and responsibilities of a facilitator were seen as vital to the use of the DQI tool. There is a need to structure the process within which the DQI is used.</p>	<p><i>‘The tool must be part of a logical evaluation process which for large projects will be very complex and small projects less so, but there must be a minimum set of steps/stages to the process.’</i></p>
<p><b>The usefulness of discussion about design quality</b> The use of the DQI within a team context was seen by many participants as one of its key attributes. Participants liked the way the DQI gave users a voice and formed the basis for dialogue about design and construction. They were keen for these aspects to be maintained when the tool is transformed into an interactive web-based tool.</p>	<p><i>‘The discussion element of the paper-based questionnaire is one of its greatest strengths. How will this be achieved on line?’</i> <i>‘Sole use of a web site facility misses a valuable opportunity to deal with the ‘human angle’ – the need/advantages of bringing people together. Perhaps the ideal is for full-scale initial web site enquiry/response followed by meeting(s).’</i></p>
<p><b>Benchmarking</b> Different opinions were voiced about the usefulness of benchmarking design quality with other projects and with the same project throughout its project life cycle. There was a discussion about access to aggregate information at the industry, project and individual level; and the question of whether users would pay for benchmarking against similar projects. There was also a discussion about the information required to interpret responses at these different levels.</p>	<p><i>‘Aggregate information must be clearly referenced to numbers of projects involved and other background info, e.g. range of cost, form of procurement etc.’</i> <i>‘Use will be layered, i.e. simple on top – but if you want more detail you can get it. Also can ‘mine’ the database for more information.’</i></p>
<p><b>Visualization of results</b> A need was expressed for simple graphics and headline statements regarding results. The web-based tool provides the opportunity to provide one or more sophisticated forms of visualization to help users understand their data.</p>	<p><i>‘Its value would be to help people communicate and discuss different perceptions and priorities. Fast appearance of their different spider diagrams so they could see these differences is vital for such discussion.’</i> <i>‘a numerical/mathematical result as well as a visual result would help in making comparisons between different designs for the same project.’</i></p>

The qualitative feedback gained from the Trailblazing Process is of key importance in shaping the ongoing web development work. Facilitator training exercises threw up differences in the way that the tool could be used at early stages of the design process (where

little may be known about the design or about the clients' aspirations) and at the post-occupancy phase (when the building is finished and in use).

The review conference held at CIC in December 2002 was attended by eighty users and most Trailblazing firms were represented at it. Break-out groups took place after a series of presentations of pilots and development work and a number of themes emerged as shown in Table 2.

At the review conference it became clear that there are tensions between the use of the tool for open discussion within the project team; and its use to position a project within a wider benchmarking of design quality across the industry. Hence, categories of users – central government clients; client bodies; contractors; design firms; local government and others – have different interests in the use of the tool. Its impact on potential public and private sector users is different and the development of a web-based version must accommodate such variety. However, it is difficult, and perhaps not desirable, to accommodate the whole range of sometimes unanticipated ways that the DQI is currently being used in procurement processes; in consensus-building and in discussion with project teams, clients and end-users.

## 5. THE WEB-BASED TOOL

Transforming the DQI from a paper-based tool to a fully interactive web-based one has not been a simple operational task, but required strategic decision-making about the nature of the DQI and structure of the process within which it is used. The web development sub-group, which was chaired by the second author, worked closely with the software company to guide the development process. The Trailblazing review conference was a critical moment in this transformation process as it was at this point that DQI Facilitators raised a number of key concerns. However, as discussed above, participants didn't speak with one voice: a wide range of views were expressed and questions were raised from different stakeholder perspectives.

The design of the interactive web-based tool will have a major impact on the structure of the evaluation process within which the DQI is used. Following the conference a number of strategic decisions were made regarding this application infrastructure. The prototype in development gives the facilitator a leading role, with choice over how to structure the process and present the results back to users. It consists of a Reception area, DQI Leader area and Respondent area and the questionnaire as shown in Figure 4.

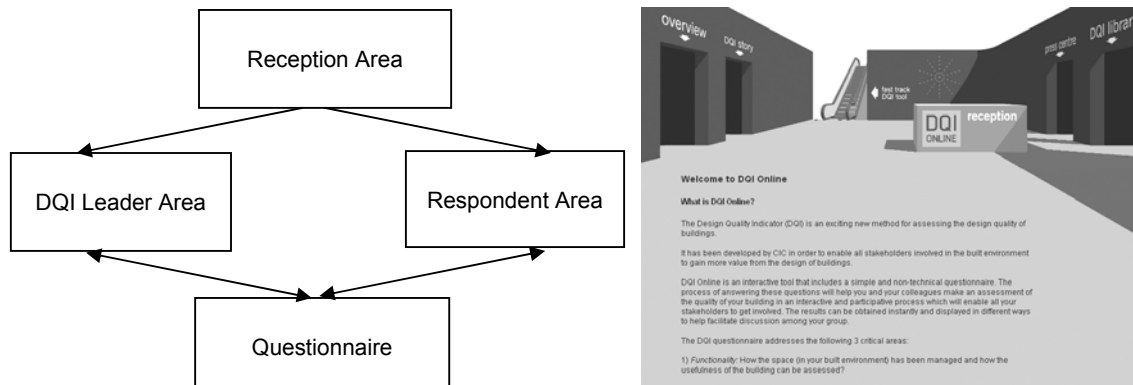


Figure 4. Structure and screenshot of the interactive web-based tool

Within the DQI Leader area, the facilitator enters the project details and context information. The context information provides details of the resource envelope – the set of conditioners or constraints and enablers within which design quality is being assessed. These include human resources, natural resources, time and finance. After obtaining a DQI Leader key, either by purchasing one directly from the site or by contacting CIC with a purchase order number, the ‘New Assessment Page’ is the first page that a facilitator will reach when initiating a new assessment. Following this the facilitator sees the ‘Project Details’ page, which captures headline information about the project being assessed and effectively binds a DQI Leader key to a particular project, ensuring that the key can be used once only. The facilitator then has full access to the DQI Leader area. In the DQI Leader area, the facilitator can move freely between different parts of the site which show generic resources; details of the project; and detailed results and outputs.

Within the Respondent Area, other users will have access to the Questionnaire and to their own results but only more limited access to other data. The questions which make up the online questionnaire are entirely generated from a database, which is in turn populated from a spreadsheet – this enables the tense of questions to be correctly displayed, as dictated by the lifecycle stage of the project being assessed. Work is currently progressing on a number of visualization methods for presenting the results, including the 3D stacked bar chart.

## 6. CONCLUSIONS

The DQI project has raised the profile of design quality within the UK built environment sector and opened up the debate. Industry has ‘bought-in’ to the process and supporters of the DQI are a broad church: the tool brings together government clients, client bodies, contractors, design firms, local government and others to address issues of design and design quality.

However a number of tensions are inherent within this DQI development process, which balances the political will for benchmarking across projects with the desire of professionals to represent and discuss the complexities of design issues within individual project teams. Developing the tool involves a widening number of stakeholders, and as it becomes increasingly multi-voiced, resolution of diverse views of the function and potential uses of the tool becomes increasingly problematic. It is useful to reflect on the nature of the DQI toolkit and on this ongoing process of prototyping and testing and to consider it within the context of other tools for mapping subjective judgments. A number of conclusions can be drawn from the project.

First it is clear that the DQI is highly successful in framing discussion of design quality by providing a common language, through which the diverse stakeholder groups and the end-users of their buildings can discuss design quality. However there is a danger of adding complexity to the analysis, hence removing transparency. We consider the tool as a form of user toolkit (von Hippel 2001; Jeppeson 2003) to involve a range of stakeholders in the design process. Within a tool that sets out to involve a range of different users and hence democratize design it is of paramount importance that the weighting mechanism is apparent and can be challenged by end-users.

The use of a tool such as the DQI in benchmarking requires further consideration and the validity of such use needs to be tested. As noted by Stirling and Mayer (2000) there can be no single objective resolution of divergent subjective perspectives. It is our belief that the values and judgments of the same people looking at different options can be compared, but we are skeptical about the potential to compare values and judgments of different groups

looking at different options. The challenge is to ensure a valid process, making explicit the assumptions in the model, the characteristics of different user groups and the degrees of uncertainty and ambiguity associated with different responses.

Finally it is of critical importance that the users understand and can visualize the results of the DQI. We have explored different ways of graphically representing the same data, developing three visualizations which show the same results from the DQI at the basic (fundamental), added value and excellence levels. We presented these representations to the core DQI team, in order to discuss the future development of the visualization tool. So far these representations only show the score attained with no indication of the maximum score at each level. As sub-sections have varying numbers of questions in the basic (fundamental), added value and excellence levels – with some of the sub-sections containing no excellence questions – future representations will need to make this explicit to the user.

## **7. FURTHER WORK**

We see the DQI process as a test-bed for ongoing research. One area of the DQI that has not been stabilized is the format visualization of results will take and this is the subject of ongoing work. The quantitative data that is being captured in this beta-testing phase offers a rich source of data that can be analyzed to deepen understanding of how different stakeholder groups view design quality, as well as to better understand use of the DQI tool and potential improvements to it. The DQI is not going to hit on the winning formula without careful consideration of how to foster humility, completeness, benefits and justifications, participation, transparency and diversity within the approach. We are cognizant of the enormity of the task ahead. The validity of the tool must also be rigorously tested, and if the tool is to be used for benchmarking then the user-groups that fill it in, and the process by which they complete it has to be standardized. However, in our view the DQI is most fruitfully thought of as a tool-for-thinking – sparking rich discussions and debate about design issues and design quality. For this the timing of feedback is important – as it is not the visualization itself but the process of using the tool that is interesting.

## **8. ACKNOWLEDGEMENTS**

The development of a tool such as the DQI involves a very large number of individuals and organizations sharing information and ideas and working collaboratively. Hence the paper describes work that has been jointly developed with the Steering Group and Reference Group in the research phase, the DQI Core Team in the interim phase and the DQI Management Group; DQI Web Development Sub-Group and the Trailblazers in the beta-testing phase. We would like particularly like to acknowledge the help of CIC and Illustra, and especially mention William Hawkins and James Beevers who administer the process at CIC. We would also particularly like to acknowledge the help of Amal-Lee Amin who was a member of our research team in the early stages of the work. The characterization of the process and the views expressed in this article are the authors alone and we bear full responsibility for any errors and omissions.

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