

PERCEPTIONS OF DESIGN RATIONALE

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KEYWORDS Design Rationale, Design Space Analysis, Uptake, Perceptions, Evaluation.

ABSTRACT Design Rationale is a family of HCI approaches that purports to support design reasoning. We report on an evaluative study of the particular Design Rationale approach denoted Design Space Analysis. Twenty three students with some design experience reported their perceptions of the approach after having worked with it on a design task for two weeks. They were in general able to make good use of the approach, although they reported both positive and negative perceptions. In particular they found the approach very useful for organisation and documentation purposes, but less useful for communication and reflection. The implications for training are discussed.

INTRODUCTION

Design Rationale has in the last years received considerable attention in the field of Human-Computer Interaction (Moran and Carroll, in press, *Human-Computer Interaction*, 1991). Design Rationale is a generic term comprising a number of approaches that purport to facilitate two aspects of design: one concurrently in the design process, e.g. supporting design reasoning and providing structure to the design space, and one retrospectively by providing the rationale of why the system is the way it is.

In this work we focus on one particular version of Design Rationale denoted *Design Space Analysis* developed by Allan MacLean and colleagues (MacLean et al., 1991). Design Space Analysis comprises two major components: guidelines for conducting a analysis and a semi-formal graphical notation for representing the ensuing design space.

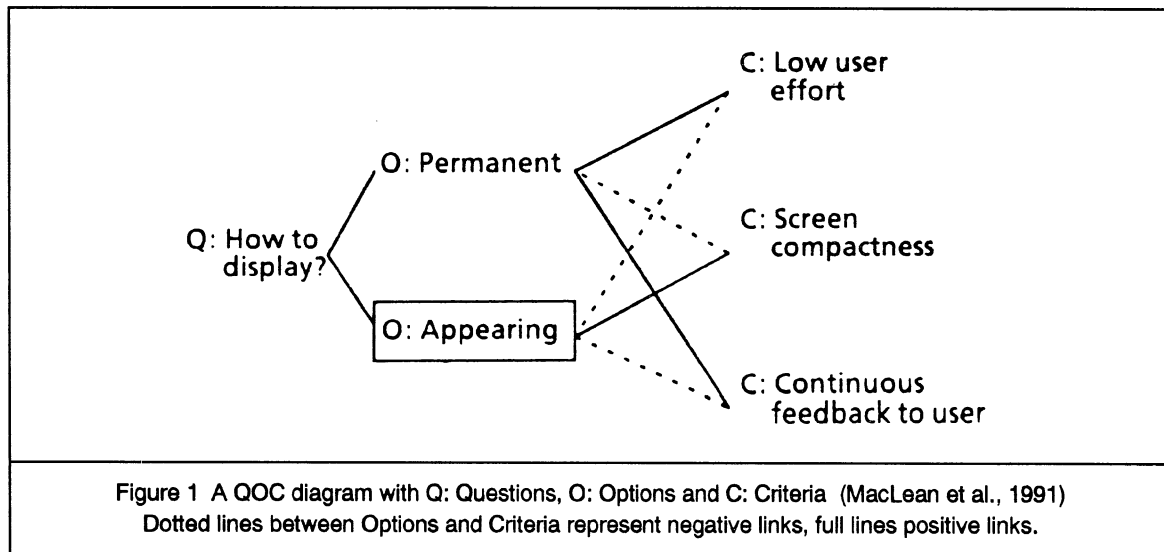
The guidelines comprise a five-phased model of developing a QOC diagram:

- 1) *Identify relevant information*
- 2) *Structure material into rough QOC*
- 3) *Flesh out design space*
- 4) *Reformulate design space to tidy it up*
- 5) *Make design decisions.*

These are meant as rough guides and are seen as overlapping. A set of heuristics for coping with the opportunistic aspects of design are also provided. Examples of these are *Use Options to generate Questions* and *Represent both positive and negative Criteria*.

The semi-formal graphical notation has three main constituents (see figure 1): Questions (addressing salient issues in the design space), Options (alternative answers to the questions), and Criteria (the basis for selecting amongst the options). In the following we refer to Design Space Analysis by the term **DR/QOC** in order to distinguish it from other approaches and as QOC diagrams are the core of the approach.

In software design practice, designers are constantly presented with new tools and methods – as software design is a rapidly developing area. Thus approaches that enable designers to reap immediate and substantial benefits will stand a better chance of becoming incorporated in their repertoire of tools and methods. Thus designers' perceptions are important.



Recently a survey study of Design Rationale approaches have appeared (Buckingham Shum & Hammond, 1994). They conducted a thorough survey of the literature on Design Rationale approaches. So far primarily two aspects in the transfer of Design Rationale approaches to practioners have been studied: the utility and the usability. They conclude that so far there is little empirical evidence (other than anecdotal) that supports the claims about Design Rationale.

Our study addresses two aspects of DR/QOC. Firstly, the claims about DR/QOC, where we will focus on the purported design support: organisation, documentation, communication, and reflection (McKerlie and MacLean, 1993). Secondly, we address issues of teaching DR/QOC to designers.

The study is part of a larger endeavour in the AMODEUS-project of transferring HCI techniques to practioners and evaluating them (Buckingham Shum et al., 1994).

METHOD

As we wanted the participants to work with DR/QOC for a considerable span of time, not just for a few hours in the lab, we had to use students who had some design experience. Simultaneously, it was an

opportunity to train the next generation of interface designers.

Twenty-three graduate students participated. They were doing the second term of a 3-term course in Human-Computer Interaction at Psychological Laboratory at Copenhagen University run by one of us (AHJ). Fourteen of the students had design experience (in average 2.8 years) while 9 had no experience. They were between 22 and 35 years of age (in average 25.6 years). They worked in 7 groups with 3 or 4 in each.

Two kinds of data collection methods were employed: questionnaires and reports written by the students themselves. These self-reports lend themselves to well-pondered, unbiased and succinct statements. This method differs from the approaches employed in most previous studies of Design Rationale (e.g. Buckingham Shum & Hammond, 1994), where designers' work in the lab was video recorded and analyzed by researchers.

Teaching DR/QOC

The DR/QOC teaching and assignment took place over a five week period with a weekly 2-hour class. In the three weeks the students made themselves familiar with DR/QOC through reading, discussion and a small assignment. In the last two weeks the students used DR/QOC on a larger design assignment.

In the first week the students read an introductory paper to DR/QOC (MacLean, Bellotti, and Shum, 1993). It describes the main components (5-phase model, heuristics and QOC diagrams) and presents a worked example. In the second week the students worked with a small assignment on the design of the arrangements of doors in the hallway at Psychological Laboratory. This was discussed thoroughly in the third class, in particular the problems the students had run into, for example finding the right point of attack. This discussion was followed up by presentation of guidelines from a tutorial on DR/QOC (MacLean and Bellotti, 1993). We also showed a short video called *QOC in Action* (McKerlie and MacLean, 1993). It explains how to work with DR/QOC and presents the purported benefits in design.

During the third week, the first of three questionnaires was filled in, probing the students' starting situation before embarking on the larger assignment. Most of the students seemed well prepared: 68% had read the papers and 84% had worked for 1–2 hours with the initial assignment and made QOC diagrams. All except two felt they were ready to embark on the larger assignment (the two because they hadn't yet read the papers).

The Assignment

The larger assignment was a design task denoted Small Screen Map, where a tourist information system with screens located around a city had to be designed. It supported tourists finding their way round the city and finding places of interest. The main design issue was that the screen couldn't accommodate the map in full so some form of reduction or split was required.

The task comprised both analysis and design as the assignment suggested three screen designs: split screen, bifocal display, and fisheye display. The students' task was to provide usability guidance on the three designs and come up with ideas for alternative designs. The assignment was chosen because it is concrete with the three suggested designs, thus lending itself to using DR/QOC in the argumentative or reflective mode (Buckingham Shum et al., 1993). It also invited to develop new design ideas and to develop the suggested designs further, i.e., it lent itself to using DR/QOC to support evolving design.

The assignment ran over two weeks and resulted in written reports including 1) a description of their design process, 2) a description of the design solution and possible alternatives, and 3) an analysis of and reflection on the role of DR/QOC in the design process.

After the assignment one questionnaire was handed out on personal data and one on their views on the assignment. This presented the students with claims like *The assignment was interesting* and *DR/QOC was useful for documentation*. Answers were given on a five point scale ranging from *Completely agree* to *Completely disagree*.

Before embarking on the analysis of the results we should acknowledge the potential influence from the educational setting. One thing is that the participants were students with some design experience, but their work with DR/QOC took place in an educational setting. The goals and expectations differed from those in real design projects (e.g. to please the teacher or to write a report that passes). DR/QOC was clearly the top item on the educational agenda. On the other hand, we stressed that they should comment frankly on DR/QOC and the assignment – which they certainly did. Thus we tried to strike a balance between the educational and research aspects.

RESULTS

Judging from the students' reports and the questionnaires, all groups had done a serious job. The reports were 25 pages in average and the groups had on average spent 104 hours on the assignment. All the reports comprised QOC diagrams. Some groups had only developed one iteration of a set of diagrams while others had done up to five iterations. The most comprehensive diagrams comprised 17 Questions, 41 Options, and 46 Criteria; the smallest 3 Questions, 3 Options, and 7 Criteria. All the groups reported positive as well as negative aspects of DR/QOC and the assignment – some groups raised even very strong criticism of DR/QOC. Most of the students found the assignment interesting and instructive.

DR/QOC is an open-ended technique. A Question can address any issue at any level in any direction in the design space. An Option can be anything that comes near to an answer to the question. Therefore it

is impossible for us to judge the 'correctness' of the students' application of DR/QOC. This, however, was not the aim of the study, but rather the students' perceptions from their course of work, their difficulties, their views, their intentions, their satisfaction, etc.

Use Up Front

First we will report a striking feature: all the groups tried to use DR/QOC up front in the assignment, whether they started out to analyze the three suggested designs or developed their own design ideas. Three of the groups ran into severe trouble early on and never really got back on their feet to using DR/QOC in a constructive manner. This "up-front" approach may correspond to the *paradox of the active learner* that Carroll and Rosson (1987) have identified with users of interactive computer systems: users learn while they work – as opposed to learning first and later use for work. The groups could have approached DR/QOC more cautiously by doing some joint exercises, thereby developing a shared understanding of the nature and potentials of DR/QOC. They could also have approached the design task using traditional and well-known methods and gradually having tried to integrate DR/QOC. This has implications for training in DR/QOC: the lesson learned is to stress to use it initially as a *structuring vehicle* on information generated by other means and only gradually apply it in evolving design.

The Five-Phase Model was important to many of the groups. Five of the seven groups approached the design task using this model. One group followed it slavishly and arrived at an elaborated design. The four other groups used it more or less implicitly. One group made an early explicit decision to use it – but came to a halt. They then decided to abandon it and continued with a brainstorm, only later to discover that they in fact unknowingly had gone back to the model by using QOC diagrams to structure the result of the brainstorm.

The heuristics were used by all the groups, but mostly implicitly; rarely the groups tried to follow them strictly. A striking statement was *"We only discovered afterwards that we had used the heuristics."* In contrast another groups' application of the heuristics initially lead to further entanglement and confusion.

Organisation

Six of the seven groups report on this aspect. Five of these were positive – with *"Quite excellent"* and *"QOC diagrams are brilliant as information organizers"* as the most positive. Contrasting this, one group claimed *"DR/QOC is not helpful to organise – making drafts [using other techniques] before using DR/QOC was indispensable for us"*. There are, however, scattered evaluative comments in the reports on this issue that can be expressed as *"QOC diagrams are good when information has been generated – they are not good at generating the information"*. This should be stressed in training. Another issue – quite generic – was the ease with which new aspects could be integrated in QOC diagrams (e.g. a new option) and also the difficulties in handling large QOC diagrams, in particular comparing and integrating different diagrams.

Documentation

Five of the groups mentioned this aspect. Even a group that had substantial trouble stated *"The documentary ability is incontestable"*. The others were also generally positive. Another group noted *"Good to document the design solution and the arguments that made us arrive at the solution. But QOC diagrams can't stand alone, they are a skeleton upon which documentation can be organised – elaborated explanations can be added, especially the Criteria"*. The group went on about a salient potential of DR/QOC: *"Traditional documentation usually focuses on the positive sides of the chosen solution, DR/QOC provides a comparison of all the solutions and thoughts during the design"*. One group had great trouble with their Criteria. They note the importance of writing down the detailed meaning of the Criteria, otherwise endless discussion of the Criteria is likely to result.

Communication

The groups reported quite different stories here (note that the diagrams we not used to communicate to outside parties). Some groups considered QOC diagrams useful or even a success in communication between the group members because they brought out the underlying thoughts and assumptions in addition to structuring the argumentation. One group noted *"Haven't had a chance to assess as we have worked out the QOC diagrams in collaboration"*.

Reflection

Only two groups addressed this aspect in their report. One group mentioned *"Not managed – required too many resources concurrently"*. Another group was very explicit about this: *"QOC diagrams were not used to understand what went on, but rather to develop new ideas individually and collectively"*. One of the group members used QOC diagrams to get an overview of the three suggested designs and separate out Criteria from them. Also, *"QOC diagrams were good at recording flying thoughts that could be pursued later"*.

DISCUSSION

There is an issue about the *perceived accessibility* of DR/QOC. At a first glance, QOC diagrams look deceptively simple with the plain Question–Option–Criteria structure. We addressed this issue by asking the students in the first and third questionnaire (given before and after the design assignment) to estimate the time it would take them to master DR/QOC "fluently". It appears that 60% of the students' estimates were higher *after* the design assignment while only 10% were lower. This is a strong indication that students underestimate the effort required to master DR/QOC.

An interesting point is whether the QOC diagrams were developed *individually* or *collaboratively*. Only three of the groups initially developed QOC diagrams individually. The first group used these diagrams as a *starting point* for further *joint* development – they did not try to integrate the individual QOC diagrams. They followed the 5–phase model and did well by developing 5 iterations of a set of detailed diagrams. The second group managed to develop a set of QOC diagrams, but it was impoverished by not having any Questions, only the six designs at play as Options and a long list of criteria. The third group barely managed to develop a joint set of detailed QOC diagrams and only by nominating a scribe halfway. He undertook the "QOC-ing" while the others continued doing analysis and design using other methods. Thus DR/QOC did not play any active role in their final design.

The lesson to be learned here is to suggest designers working in groups initially to work on QOC diagrams jointly in order to establish a shared understanding of how DR/QOC is used. The underlying issue here is a

dichotomy of the DR/QOC in being both product and process orientated: It addresses and facilitates the design *process*, but QOC diagrams form part of the *product* early on. Premature product decisions are prone to cause trouble in design – this is also true of QOC diagrams.

Another point of discussion is two uses of DR/QOC i) in either an argumentative, evaluative, or reflective manner or ii) in an evolving or constructive manner. It seems that the groups having embarked cautiously on the assignment (who started out with analysing the three suggested designs) have experienced an easier approach to using DR/QOC. They were able to map the QOC structures directly upon the design space and thereby arrive at their first (and sometimes final) QOC diagram. Other groups adopted from the start an evolving "designing" approach and have run into trouble – the depth of design and task analysis has played a role here. These groups adopted the reasonable and laudable approach of conducting a thorough task analysis early on, including tourist tasks, map structures, map reading, etc. They generated such a large design space that it was difficult for them to map DR/QOC structure onto it.

CONCLUSIONS

The students were in general able to make good use of DR/QOC. In particular they found the approach very useful for organisation and documentation purposes, but less useful for communication and reflection. Their perceptions were in general positive – although all groups raised negative points. The main problems were their attempt at using the approach up front leaving them with design spaces they couldn't map onto a DR/QOC structure and their attempt at using DR/QOC as a means for generating information rather than for structuring information generated by other methods.

The approach appears deceptively simple. Thus in training a cautious approach with focus on structuring information generated by other means and only gradually turning to evolving design must be emphasised.

We will conclude by citing one group as a representative of the groups' conclusions: *"Initially very hard to access – very hard to see where to start this developmental process and even more difficult to*

see why to start here. The strength of the technique lies in the many routes and solutions being analyzed before the final QOC. This enormous work will for sure pay off in terms of less errors in the final design."

ACKNOWLEDGEMENTS

This work was in part funded by EC ESPRIT Basic Research Action 7040 AMODEUS II (Assaying Models of Design Expressions in Use). We thank the students for letting us use their assignments in our research and Simon Buckingham Shum for insightful comments on an earlier draft.

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