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Argumentation-based Design Rationale - The Sharpest Tools in the Box

In this paper the three main argumentation-based design rationale methodologies - IBIS, QOC and DRL – will be discussed with illustrations of particular points drawn from a working example. The areas of scope, expressiveness in terms of design space and argumentation representation and the resulting usability by human and computer will be examined. Particular attention is paid to how the development of the artifact is being controlled by the evaluation of intentions and objectives that allow consistent goals throughout the design to be formulated, evaluated and modified. Furthermore, decision making within an argumentative context is highlighted.

1 Introduction

The area of problem solving has been scrutinised intensely and with it the kinds of problems that we are faced with. Clearly there are problems that have only one true solution and allow themselves to be analysed, specified exhaustively and a solution to be generated on the basis of information gathering, analysis, specification and development.

In design - as a sub-part of problem solving - this approach often does not seem to help. The difference lies in the type of problems that design tries to address: the problems are ill-defined, a solution is not true or false but rather better or worse and no stopping rule can be defined to the specification process. To tackle these 'wicked' problems (Rittel & Webber 1984) we need special tools which fall outside the traditional - or first-generation - design methods. Second generation design methods (Rittel 1984) involve a process of argumentation which allows the problem situation to be explored and solution possibilities to be discussed by stakeholders in the design.

Design Rationale is intended to capture the reasons why a certain artifact is designed the way it is and might not only provide support for future reflection upon the artifact but also support the process of designing and choices that are made in the design context. A wide variety of argumentation-based approaches to design rationale have been proposed since. Some case studies as to the application of these models have been carried out and the main focus has been on three models in particular: gIBIS (Conklin and Begeman, 1988), Questions Options Criteria – QOC - (MacLean et al, 1996), and Decision Representational Language - DRL (Lee and Lai, 1996).

These models are based on the notion of argumentation to arrive at a design rationale, however, they differ in the extent of aspects they aim to capture and functions they support, by the way these models are used in a representation. The examination of the scope of functions supported by these models will be discussed in section 2. This will lead us on to discuss how the design space is represented as a result of their scope in section 3. As some models place their emphasis on different aspects of design rationale the design space structure will also emphasis these aspects whereas others only survive in a reduced form. The models’ kinsmanship with the argumentation structures put forward by Toulmin (1958) is evaluated in section 4. All representations of the design space and argumentation structures are in the context of how usable they are by either humans or computers, or both. Semi-formal notations, such as IBIS, QOC and DRL claim to facilitate the interpretation and support by computer systems whilst at the same time not denying the spontaneity of human use. Implementations of these models in terms of computer support are introduced and their usability by both computer and human are highlighted in section 5 and 6. Once we have advanced the understanding of how argumentation-based models differ in their representation and functions we pay particular attention to the development of the artifact by controlling the evaluation of intentions and objectives that allow consistent goals throughout the design to be formulated, evaluated and modified in section 7. Considering that the problems in design are of a wicked kind that do not have a stopping rule, decisions are notoriously hard to make. The support necessary for designers to reach consensus and commit to a design decision are discussed in section 8.

1.1 The Beach House Example

In 1974 Fred Brooks set about to build his beach house and documented his reasoning for features throughout the time of design and construction. The document outlines the main objectives and constraints to be achieved by the construction and gives a summary of design decisions and associated reasons why the design was chosen. Interestingly, it also contains evidence of changes which were made after initial design and before, during or after construction, and an assessment of how the design of the beach house stands up to the original criteria.

This Design Rationale (DR) document is used in this paper to evaluate the different design models and their representations by drawing on a concrete example to highlight salient points.

Only a small aspect of the complete design was executed in the three representations, however, the detail was chosen because of its interesting characteristics in terms of change and evaluation. The relevant schema are attached in appendix 1 (IBIS), appendix 2 (QOC and appendix 3 (DRL).

A copy of the design rationale document is attached to this paper.

2 Scope of design methods

Design Rationale is intended to capture the reasons why a certain artifact is designed the way it is and might not only provide support for future reflection upon the artifact but also for the process of designing and choices that are made in the design context. Various models have been proposed that are based on the notion of argumentation to arrive at a design rationale, however, they differ in the extent of aspects they aim to capture and functions they support.

Having its history in planning and policy problems, IBIS (Kunz & Rittel, 1970) addresses design problems by using argumentation structures to facilitate a discussion amongst the stakeholders about design issues, which allows the problem to be explored and framed. Design issues can entail such varied items as questions, concerns and even discussions about procedural aspects of the design which need to be resolved before progressing. IBIS therefore enforces a structure on how issues are discussed but not how the problem is explored, how alternatives are elicited and evaluated or how consensus is reached. Its main advantage is the fact that design rationale can be captured at an early and informal stage to ensure that design issues, their respective possibilities and their justifications are fully understood but IBIS on account of its representation cannot make use of a structured exploration of issues. Indeed, control is very much placed in the hands of the designer and stakeholders who are left to investigate feasible avenues and not get sidetracked.

In contrast to a representation in which the path through the design is very much steered by the stakeholders, Questions, Options and Criteria (QOC), developed by MacLean et al (1991), highlights the exploration of a space of design alternatives, the design space, and the choice amongst them. It therefore enforces a structure mainly on the process of how alternatives are generated and evaluated. This representation allows the explicit representation of a structured space of design alternatives and the considerations that lead to their choice. Design Space Analysis is carried out as a co-product of design to facilitate the elicitation of features in which the design could differ and give the designer the ability to assess alternative against criteria relative to other, alternative, design options.

Lee and Lai (1991) argued that an representation should support a number of design tasks such as answering questions about the progress of design, the alternatives generated, the evaluations leading to the choice of particular alternatives and the possible knowledge transfer to future design and other people. Out of these functions that the representation should enable, Decision Representation Language (DRL) was developed to express all of the above questions. It is not like IBIS a ‘rule book’ that covers how discussions are carried out nor does it help to generate design options like QOC. Indeed, it does not include any deliberations about how to generate alternative designs but instead places its emphasis on managing the qualitative elements of decision making and dependency management, and is therefore more of a decision rationale management system. The method stresses the evaluation of alternatives by reference to explicit goals which capture the objectives of the design process, rather than concentrating on exploration of a design space. It is not the process of framing or exploration of the problem that is enhanced by the use of DRL, instead the focus is on managing the weight for a particular design decision in a fair and consistent way.

How does this affect the beach house design? Obviously, as we are rationalising after the design has taken place we need to be careful how the designer would have applied these models or indeed, which models would have suited his design method. For example, the designer of the beach house stated his objectives that he wanted to be reflected in his design right from the start and alternatives, as they appear throughout the design process, are justified according to these design criteria. For example, the alternative of casement windows is justified by reference to the increased air flow through the house, which satisfies the objective of exploiting the sea breeze. Bearing in mind that QOC and DRL include criteria and goals as explicit parts of their representation whereas IBIS does not, the use of the representations preclude or include certain methods of working and designing. This might place a restriction on the working method of the designer and forces him to conform to the working method of the representation. Of course we can also make use of criteria as justification in IBIS but with the important difference that these become implicit in the argument structure. Furthermore, decisions about features in the beach house design are taken against these justifications without generating an enumeration of other design alternatives, as QOC would encourage the designer to do. It could be argued that both DRL and IBIS encourage a kind of ‘depth-first’ search in the design space whereas QOC emphasises a ‘bread-first’ search of alternatives, which are then evaluated. This might discourage a commitment to a design alternative which is committed to without understanding the context of other, perhaps better, options. Through the choice of a particular DR representation some aspects in the design will be supported explicitly, others are reduced and the overhead to deal with dealing with implicitness is placed on the designer. Depending on the context of the representation the criteria that evaluate the design alternatives might be minimised in favour of the interrelatedness of problem areas or highlighted to support functions that are seen to be important.

3 Representation of the Design Space

With the previous section in mind we can now address the representation of the design space. As some methods place their emphasis on different aspects of design rationale, the design space structure will also emphasis these aspects whereas others only survive in a reduced form, if at all. With its function as a structure for design argument, IBIS models the design space as a network of issues which are discussed in the course of design. Issues, Positions and Arguments can be 'generalised' or 'specialised' by the same node type (e.g. an Argument can generalise another Argument) and any other node can 'question' or 'be suggested by' an Issue. In the example of our beach house design (see appendix 1), the issue of ‘How to exploit sea breeze?’ is specialised by ‘How to keep the house open to breeze?’. In turn ‘How to keep house open to breeze?’ suggests yet another issue ‘How to avoid moisture and salt spray entering into the house?’. Any node can branch out by an 'other' link to an Other node. Furthermore, a notion of progress as time passes can be shown by an Issue 'replacing' another Issue. The design space is a complex network of logical and historical relations out of which the design decisions emerge. In our working example this meant that there is a rich network of issues, some of them are off-shoots that are only resolved incompletely, relying on the skill of the designer to make sense of the complete network as a collection rather than individual components. It seems that one of IBIS' weaknesses is that the resolution of arguments necessitates the designer to understand their implications and dependencies in a complex situation. Furthermore, some areas of the design space are more fully explored than others, whereas other issues are neglected. Conklin and Begeman (1988) reported that uncontroversial items are often more discussed and structured than controversial, more important issues. PHI, Procedural Hierarchies of Issues (McCall, 1991) tries to address this pitfall by enforcing inheritance and generalisation of issues which facilitates functional decomposition, forcing the effort to be concentrated around what parts are important to complete the design, and structuring the design space more rigorously.

An enforced structure of the design space can also be found in QOC. The design space is structured by Questions and possible answers to Questions are shown as Options. Each feature of an artifact usually represents an Option and can generate a new Question. Our example in appendix 2 shows that the Question 'How to capitalise on sea breeze?' entails the Options 'Have an open front deck', 'Give every bedroom ocean frontage' and 'Keep house open to breeze'. The latter option in turn generates the Question of 'How to keep the house open to breeze?'. It should be noted that the role of Questions is generative not evaluative and should encourage the exploration of the space, delineation of local contexts and generation of Options. Criteria form the bases for evaluation and choice amongst the Options in the design space, representing desirable properties of an artifact and requirements that it must satisfy. These can be attached to Options with a positive or negative "strength of satisfaction", creating a logical account of the argumentation process rather than providing historical information of how the process played out. For example, the use of casement windows in the beach house design was evaluated against the criteria of maximisation of opening area, increased scooping in of sea breeze and lack of steel corrosion. Individual Assessment provide a context for an overall judgement of the suitability of an Option, backed by Arguments referring to Data, Theories or even Ad Hoc Theories constructed by the designer. Indeed, application of QOC to the beach house example leads to the juxtaposition of alternatives from which to choose rather than evaluation of a particular alternative, forcing the designer to consider the choice not only on their justification alone but also by reference to other alternatives and trade-offs performed amongst the alternatives.

In DRL the design space is constructed out of a collection of spaces - argument space, alternative space, evaluation space, criteria space and issue space - which hold parts of the information about the complete design. Arguments and alternatives are allowed to be associated historically or logically. Alternatives are evaluated by drawing on its arguments. Evaluation of Alternatives is produced by drawing on the criteria space, where arguments can be grouped or weighted and therefore changes in importance can be managed. Relationships among criteria are represented in a hierarchical fashion e.g. as relations as subgoals. In the beach house design using the DRL representation (see appendix 3) the decision problem of capitalising on the sea breeze is broken down into 'provide front deck', give every bedroom ocean frontage', 'use casement windows' etc. which provide an alternative to the decision problem. The alternatives are related to the criteria space by reference to goals that the alternative achieves, such as 'increased airflow through house, 'low maintenance' etc. The arguments 'subject to corrosion', 'maximise opening area' denying or supporting these connections form the argument space. To model the dependencies between decisions the issue space is developed to indicate how decisions are related. This web of spaces and relationships results in a complex network of nodes and links when applied in practice and does rely heavily on computer support to underpin the evaluation of decision problems. If carried out with pen and paper, as in the beach house design, it helps to make the objective explicit and promotes consistent design by applying goals across all alternatives. However, the search for alternatives is curtailed in favour of evaluation.

4 Representation of Argumentation structures

All three models claim kinsmanship with the approach to argumentation put forward by Toulmin (1958). Toulmin maintained that the argumentation procedure starts with the formulation of a problem in the form of a question, then enumerates the possible solutions which are evaluated by weighing the solutions against each other. This procedure is field-invariant. Furthermore, Toulmin defined the necessary structure of a valid argument to consist of data leading to a qualified claim where the inference is achieved via a warrant which in itself can have certain backing. A claim can then be rejected by a rebuttal. A warrant in this respect is the grounds or justification which allows the inference of a claim from the data. It is the implicit warrant which gives the argumentation procedure its grounding in the area of application and adds a field-dependent component.

Although this relationship with Toulmin schemes is claimed by the design rationale representations, the transfer is only achieved in a loose method rather than literally.

IBIS has nodes which are categorised as Issues, Positions, Arguments and Others. Any question or concern is captured as an Issue in the IBIS method and associated Positions can be expressed. Arguments are used to either support or object to the Positions, whereas 'Other' nodes can contain any other information such as procedures, code etc. The nodes can only be connected by legal moves along the nine link types: only Positions can 'respond to' an Issue, whereas Arguments must be related to Positions via 'supports' or 'objects to'. It seems that IBIS tries to emulate the step of a claim as the relation between Issue and Position, where the place of warrant is taken by the Argument supporting the relation of Position to Issue. However, rebuttals as understood by Toulmin schemes are not explicitly represented and can only be achieved by arguing via an opposing, and mutually exclusive, Position.

Similar to IBIS, in QOC possible answers to Questions are shown as Options. Criteria form the bases for evaluation and choice amongst the Options in the design space and are attached to Options via a positive or negative link. The links provide an individual Assessment backed by Arguments referring to Data, Theories or even Ad Hoc Theories. Toulmin schemes are made use of in the relation between Criteria and Option where assessments are made backed up by Arguments. This is reminiscent of the warrant feature in Toulmin schemes which allows the inference between data and claim to be drawn.

DRL in the main bears the least surface resemblance to Toulmin schemes and introduces instead a set of interrelated spaces to capture argumentation: argument space, alternative space, evaluation space, criteria space and issue space. Arguments are drawn from these spaces to justify the relations between the components of the representation.

Although these representations have obviously been inspired by Toulmin, their interpretation of how the argumentation scheme should be structured differs vastly. This can be understood if it is realised that Toulmin only proposes the argumentation schema to make one valid argument but does not take into account a process of argumentation with different strands of arguments which might be closely interrelated. If a more dialectic stance is taken to argumentation Toulmin schemes are less useful than originally they seem to appear. An argument necessarily takes into account that one argument wins whereas another loses and that argumentation proceeds in phases and changes over time. Argumentation therefore has perhaps more to do with defeasible logic rather than propositional logic. The key points within an argument, which all DR representations capture, is the commitment to a standpoint, the acceptability of which is furthered (or lessened) by arguments. Added to this is the notion that concurrent viewpoints can be held on arguments (such as my-side, other-side, probability and assumptions) which need to be managed and evaluated.

5 Computer-based support

All representations are in the context of how usable they are by either humans or computers, or both. Strictly informal representations are in the main only usable by humans whereas at the other end of the scale purely formal representations are mainly only of use to computers. Semi-formal notations, such as IBIS, QOC and DRL claim to facilitate the interpretation and support by computer systems whilst at the same time not denying the spontaneity of human use. Computer support mostly concentrates around navigating the network, allocation of nodes and links and evaluation of alternatives whilst also providing support for co-operative working. Indeed some of the focus more on the difficulties of underpinning access and use by a multitude of users rather than specific help on the intricacies of using the representation.

Conklin & Begeman (1988) introduced a hypertext-based tool for capturing design rationale based on the IBIS model. gIBIS was implemented with a graphical window-based interface, allowing users to browse, see a hierarchical index to all nodes, access a control panel and inspect attributes and contents of nodes and links. Context sensitive menus ensured that only legal moves can be carried out in the creation of nodes, which implies that nodes must be linked to be created i.e. no node can be created without being first classified and also linked to an appropriate node. It is therefore impossible to define a node, then classify is as a Positions and work backwards to Issues, unless this is itself framed as an Issue. Chains of Issues, their positions and Arguments can be collapsed into an IPA sub-net, however, links to outside nodes are not displayed and the semantics and interrelations of issues is lost. In the main, gIBIS is set up as a navigation tool through the network of issues rather than providing support for evaluation or decision making, being little more than a bulletin board for stakeholders to post their contributions attached to Issues.

Although semi-formal notations claim to be intuitive for humans to use, some provide such complex representation that the management of them goes beyond the natural capabilities of human beings and require detailed computer support. DRL with its interrelated spaces is one such representation. The DRL concept was implemented as SYBIL with a number of objects and legal moves between the objects. Any option considered is called an Alternative and a Goal is the desirable state or property used for comparing Alternatives. These can be linked by relations, which in DRL is called a Claim. The evaluation of an Alternative is carried out with respect to a Goal by arguing about the Achieves relation between an Alternative and a Goal. A Claim can be supported or denied by other Claims. Each claim has attributes, such as plausibility, degree (extent to which claim is true) and evaluation (a function of plausibility and degree). The measure of an Alternative is arrived at by evaluating the Achieves Claims and also how subgoals interact. SYBIL comes into its own by displaying a decision matrix which summarises the evaluation of alternatives to the designer, providing pre-set evaluation schemes. Computer support for DRL is then more akin to dependency and evaluation management rather than exploration of the design space and navigation the network.

In contrast to both gIBIS and SYBIL, the QOC method has been used mainly as a pen and paper notation rather than developing specific computer support systems. This might be due to the fact that its simplicity as a purely logical account and its emphasis on reframing and renaming does not necessitate computer support. However, it remains to be seen whether QOC stands up in a large-scale project over a long period of time where complexity increases dramatically and needs proper tools to support users to access the network created.

6 Human usability

Having examined computer support for the DR models we now turn our attention to human usability. There are some drawbacks with all notations in terms of cognitive overheads in that users have difficulty to break their thoughts into units and express them:

"...in the moment of struggling to solve the problem, the cognitive overhead required to segment the "muck " into discrete thoughts, identify their types, label them, and link them is prohibitive." (Conklin & Begeman, 1988)

An argument can therefore be made for the adoption of 'protonodes' in this fragile and critical phase where contributions from stakeholders are not categorised into specific nodes initially. The adoption of protonodes could be compared to the process adopted in the brainstorming technique, where the generation of ideas is encouraged and differentiated from an additional step to impose order and categorisation. QOC encourages a systematic development of alternatives and justifications for choosing amongst them. The focus on criteria makes the deliberation process explicit as a co-product of design, allowing design requirements, constraints and change within them to be captured. DRL in contrast suffers from a weak representation of the alternative space, including the lack of support for generating alternatives as discussed earlier. Added effort is placed on the designer to ensure that consideration is given to alternatives that might exist, without explicit prompting from the model.

7 Intentions and Objectives

In our working example the designer first articulated some constraints and objectives to which the design had to conform. It can be argued that all problems have this loose framing of criteria and that the difficulty of the design task is to ensure that the solution addresses these limits and intentions while at the same time implementing a functional artifact. These criteria need not be specifically documented but it has been shown (McDonnell 1997) that values that the designer holds, also called design commitments, influence the problem framing and inform the design process. Furthermore, some criteria only crystallise during the evaluation of the artifact: generation of criteria by the way the problem is re-framed. Conklin and Begeman (1988) noted that of critical importance seem to be the notion that relevance, salience, confidence all change over time and can 'poison the network'. Critiques of the design process, as for example in JANUS (Fischer et al, 1996), are made by explicit reference to the violation of the objectives, criteria and intentions that the design has to fulfil which leads the designer to reflect and re-frame the problem.

Are design methods that explicitly model criteria better than ones that don't? And how can design methods deal with the changes in criteria?

Let us look in more detail at our example to see how this is handled. The design part models the objective to exploit the sea breeze whilst also enjoying good views from the house and ensuring that the 55' plot is fully utilised. Low maintenance is of importance but is traded off against the previous main objectives. As part of the fulfilment of the objective to fully utilise the sea breeze through the beach house, several alternatives are proposed and one alternative in particular, the choice of casement windows to facilitate air flow through the house, is examined. It is noteworthy that reflection on the part of the designer after construction of the house has been completed indicates that casement windows are not as good a choice as previously thought as the operators are of steel and subject to corrosion due to salt spray and moisture entering the premises. This brief example demonstrates the main criteria to be satisfied, the trade-offs amongst them, change of importance and effects on the design if previously 'implicit' criteria become explicit. Some criteria are deemed 'primary' or most constraining, such as the 55' plot constraints, better views and exploiting the sea breeze. However, it can also be observed that low maintenance, a relatively unimportant and implicit criteria changes in its importance because of some design decisions made and indeed assumes a main role in the later evaluation of the design decision, used as a 'global criteria' which informs the complete design process.

In the gIBIS schema criteria cannot be explicitly modelled as such, except bound up in an Argument. It is not clear however, how the interrelatedness of certain criteria can be shown and exploited in the discussions about design decisions and exploration of trade-offs, other than re-use of the Arguments. To compensate for this omission, Fischer et al (1996) in their JANUS application to kitchen design use IBIS structures combined with a knowledge base to facilitate critiquing of design decisions. In this context the IBIS structures are used to provide the critique in the form of supporting or objecting arguments concerning a particular design move, explaining why the move violates good design. Criteria, such as adherence to building codes, safety codes and personal preferences are contained in a separate knowledge base and are linked to the IBIS structure that link explicit arguments to the criteria. Rather than exploiting a natural feature of the IBIS structures, the knowledge base needs to be kept up-to-date and is 'grafted on' to make up for the absence of explicit criteria in IBIS.

How do other design methods shape up that allow criteria to be specified explicitly, such as QOC and DRL?

In QOC Criteria form the bases for evaluation and choice amongst the Options in the design space, representing desirable properties of an artifact and requirements that it must satisfy. These can be attached to Options with a positive or negative "strength of satisfaction". Negative links semantically mean that the criterion is not satisfied, indeed, that the choice of the alternatives will adversely affect the design objective to be satisfied. Individual Assessment provide a context for an overall judgement of the suitability of an Option in relation to other alternatives, i.e. the assessment is made in a local, not global, context among the alternatives in the current scope of the Question.

Although QOC allows us to name criteria as 'global criteria', they are usually reserved for abstract terms which then get refined in the local context. As criteria are only applied to one question chain at a time, it is difficult to keep track of how Questions interrelate through bridging criteria, especially if the network is complex.

DRL instead, in its categorisation as Goals, manages to achieve some form of consistency of criteria that informs the whole design, however, DRL only has positive links between alternatives and Goals. This omission, although seemingly trivial, has vast semantic implications. For example, does this mean that the absence of a link signifies the non-achievance of a goal or even the detriment of a goal? How can we show the trade-offs amongst alternatives if we cannot express that some alternatives actually hinders us from achieving a goal? Detailed investigation of SYBIL has so far not provided an answer to how this problem has been addressed and we can only conclude that this leaves the representation seriously flawed.

Change management in the methodologies concerns the change of importance and indeed the making explicit of previously implicit or non-existing criteria. With the support of appropriate structures, such as QOC and DRL, criteria become explicit at a much earlier stage as the designer is actively reminded to reflect upon the objectives shaping the design.

However, MacLean (1996) have referred to the fact that in case studies using QOC re-evaluation of the design space does not take place with changing criteria. This is odd considering that QOC is touted as an exploration of design space. Clearly the exploration of design space also needs to be supported by the designer’s openness to explore new possibilities or backtrack to explore other alternatives without premature commitment to a particular direction. Furthermore, the task definition in the particular case study needs to be examined for evidence that it encouraged the designers to adopt a certain strategy. In the case study a pair of professional designers were asked in a ‘zoo’ setting to analyse the design of a Fast Automated Teller Machine (FATM), critique it relative to a standard ATM and suggest design alternatives if appropriate. It could be argued that this task does not constitute problem-framing activities, and hence encourages problem-solving strategies rather than reflection of the problem situation and re-structuring of the design space. Also, think-aloud protocols do not allow the inspection of implicit multiple viewpoints which are held as design progresses. In that case the original viewpoint is not revised as a change of criteria occurs although other implicit viewpoints have been evaluated.

DRL in contrast can identify and support change management through links in the issue space by application of evaluation algorithms which ripple through the system.

But does this actually support the task of designing? It could be much more beneficial to provide the designer with the differing viewpoints that these present as part of the argumentation and an instigation of reflection upon what this will bring to the design.

8 Decision Making

How can we support designers reach consensus and commit to a design decision? Considering that the problems in design are of a wicked kind that do not have a stopping rule, decisions are notoriously hard to make. It is not known whether the solution is ‘good enough’ and the decision can be committed to. General Utility theory does not help us in this respect as it necessitates the problem area to be completely explored before decision making is applied. However, in design this is not at all possible as decisions are mainly made in a local context where the outcomes of other areas might not be known yet. Indeed, local context itself can generate and constrain the development of other decisions. Decisions in design cannot be viewed as linear but must be seen instead as a rapidly intersecting network of decisions, one which actually grows in the process of decision making. In this situation a satisficing strategy might be more helpful, according to which we make local decisions based upon bounded rationality (Simon, 1969). Rather than exploring the whole context we only explore a local context and base our decision based on the information available.

How do we judge the outcomes and give it a measure of acceptability of a solution? In framing our problem we model a possible solution so it brings us closer to the goals that the solution needs to achieve. In a recurrent step of this framing and matching exercise we apply the values of criteria which we hope to hold constant. With respect to design options that lie before us we do this by considering the arguments which allow us to infer the relative position of the alternative to the value of the criteria. However, if only one alternative is considered then we might well be stuck in a local minima, that is the alternative might achieve some aspect of the criteria but another alternative might do even better. Therefore, the fit to objectives can give us a clue to whether the design alternative is better or worse in relation to other alternatives. To encourage decision making we need not only compare an alternative to a criteria but also to compare alternatives to each other.

This might explain why some design methods do not support the users in making decisions. IBIS for example does not have a definitive way of showing that agreement has been reached on an issue. Indeed, the argumentative structure of IBIS encourages the stakeholders to continue to discuss and explore the issues as long as possible, without anyone ‘winning’ or ‘losing’ the issue. This might be due to the implicit nature of criteria in IBIS which do not allow a ‘yardstick’ to be applied measuring whether a local solution (the alternative in question) is good enough to commit to it.

DRL on the other hand is pitched as a decision support system which provides assessments against each alternative as to which one is doing better than others against some set of goals. But with the serious flaw of the inability to express negative, distracting connections between criteria and alternative looming in the background it is not clear whether this is actually a fair way to reach a decision. It seems much more fruitful to provide the designer with means to assessing the fit themselves, forcing them to reflect on a design.

QOC does not yield choices by adding up assessments but instead provides a discussion for trade-offs. The strength of assessments is also influenced by other design decisions and other “chains” of Questions and Options which entails that all Assessments are relative and interact across different Questions or within a Question structure. This has of course the drawback that it is very hard to keep track and interpret the assessments made if the emphasis of the designer’s criteria is not known. Indeed, it is difficult to see how designer’s can keep in touch with any decisions that interrelate with other design alternatives, especially in a context of previous decisions and interdependencies or “design commitments” which appear within the process of design.

The challenge of decision making within the design context is to support the designer with tools that allow situation modelling and repetitive steps which bring the way that the problem is framed closer to the criteria applied. At the same time the designer needs to be encouraged to consider the alternative not only in its relation to the criteria but also to other alternatives.

9 Conclusion

In this paper we have looked at IBIS, QOC and DRL with illustrations of particular points drawn from a working example. Although each is based on using argumentation as the tool to drive design forwards, the argumentative structures and functions associated differ between them. It would be interesting to explore which other argumentative functions and structures have been suggested by linguistically or psychological theory, and I propose to research argumentation theory not only from a rationalist but also from a dialectic standpoint.

By applying the representations to an example of the design process the importance of criteria and their management has been highlighted. It should be noted that making criteria explicit as a category seems to ensure consistent design (but this should be traded off against the advantage of exploring design alternatives, issues etc.). Evaluation against the criteria as to the choice of alternatives seems a fruitful exercise, assuming that in no way it is limiting to design creativity. The support needed is not in terms of prescriptive utility theory but should inform designers where further re-evaluation needs to take place, perhaps in the form of critiquing. The re-evaluation does not only take into its context established criteria and generation of alternatives but also how the process of applying criteria and their emergence over time influences decision making. Some progress has been made with this approach in the field of critiquing in design environments but further work is to be encouraged.

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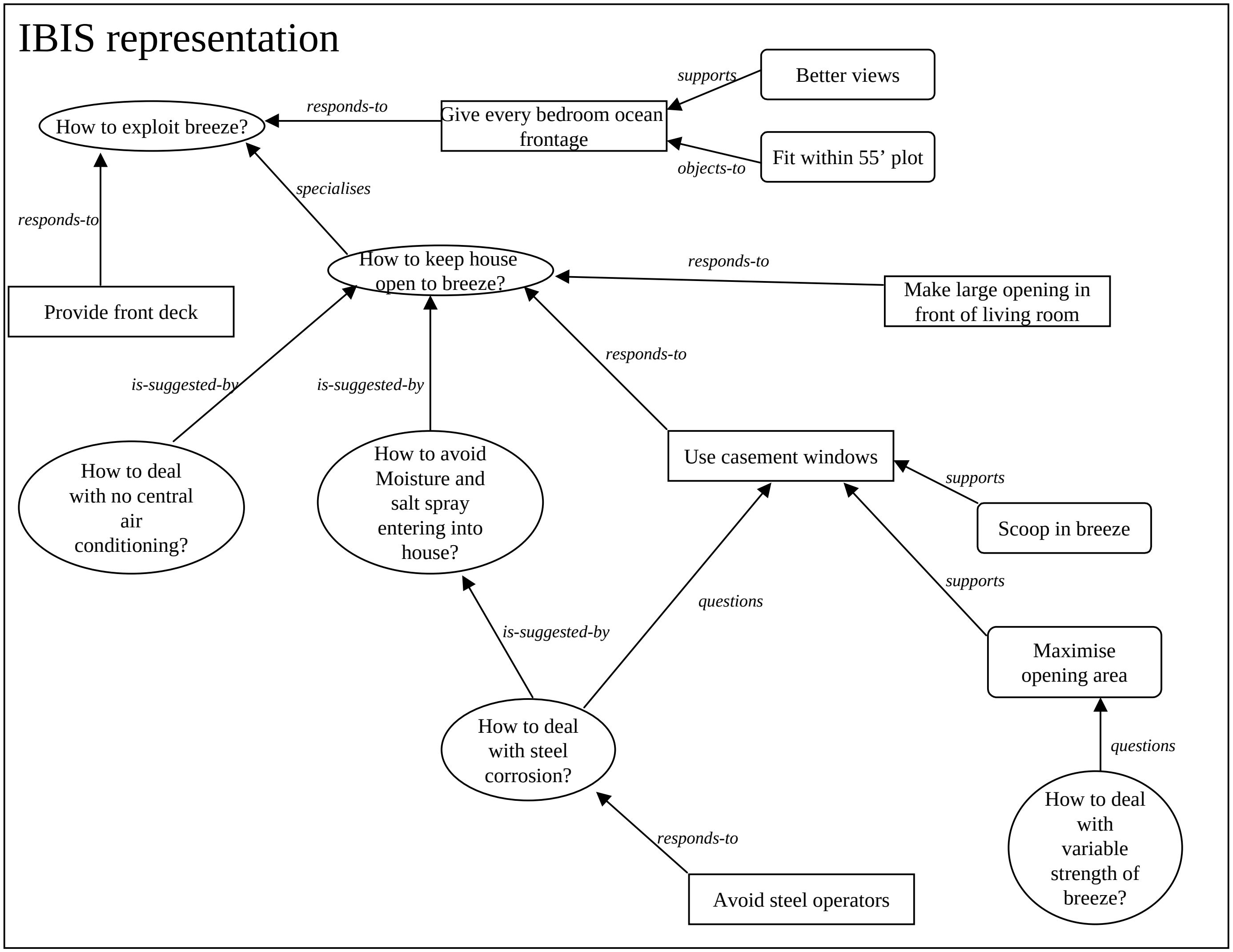
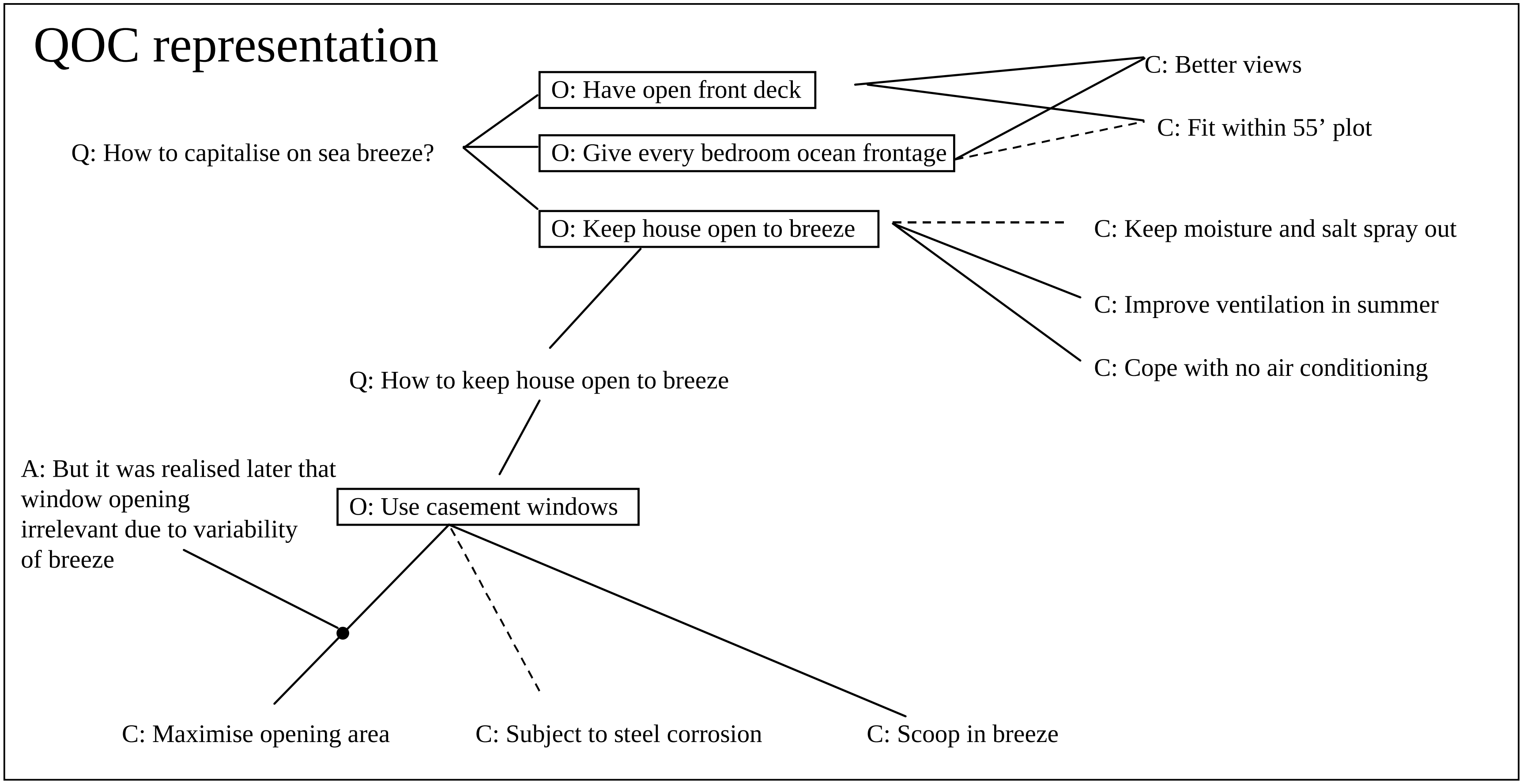
Keywords: argumentation, Design Rationale, evaluation, change management

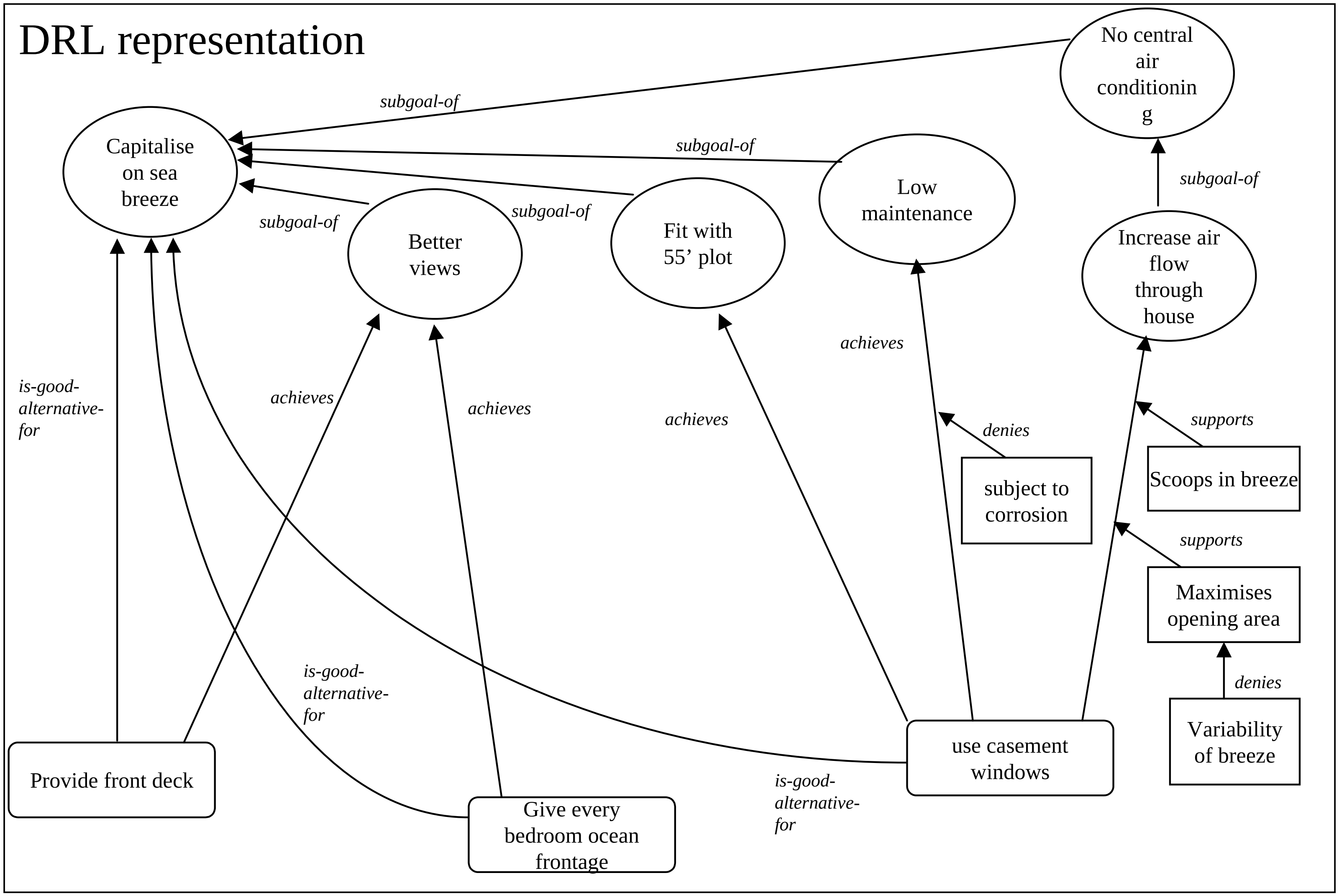
Appendix 1


IBIS representation
How to exploit breeze?
responds-to
Give every bedroom ocean frontage
supports
Better views
Fit within 55' plot
objects-to
specialises
responds-to
Provide front deck
How to keep house open to breeze?
responds-to
Make large opening in front of living room
responds-to
is-suggested-by
is-suggested-by
How to deal with no central air conditioning?
How to avoid Moisture and salt spray entering into house?
Use casement windows
supports
Scoop in breeze
supports
questions
is-suggested-by
Maximise opening area
How to deal with steel corrosion?
questions
responds-to
Avoid steel operators
How to deal with variable strength of breeze?

Appendix 2


QOC representation
O: Have open front deck
O: Give every bedroom ocean frontage
O: Keep house open to breeze
Q: How to capitalise on sea breeze?
C: Better views
C: Fit within 55’ plot
C: Keep moisture and salt spray out
C: Improve ventilation in summer
C: Cope with no air conditioning
Q: How to keep house open to breeze
A: But it was realised later that window opening irrelevant due to variability of breeze
O: Use casement windows
C: Maximise opening area
C: Subject to steel corrosion
C: Scoop in breeze

Appendix 3


DRL representation
No central air conditionin g
subgoal-of
Capitalise on sea breeze
subgoal-of
Low maintenance
subgoal-of
subgoal-of
subgoal-of
Better views
Fit with 55' plot
Increase air flow through house
achieves
is-good-alternative-for
achieves
achieves
achieves
denies
supports
subject to corrosion
Scoops in breeze
supports
Maximises opening area
denies
is-good-alternative-for
Variability of breeze
use casement windows
Provide front deck
is-good-alternative-for
Give every bedroom ocean frontage