

Semiotic approach for object abstraction

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Abstract

Within the Object-Oriented Analysis (OOA) paradigm there exists a lack of consensus as to how or where to start object abstraction as part of object modelling. In order to gain a common or less ambiguous formalism for abstracting objects it is proposed that other scientific traditions and disciplines be reviewed. The research project of which this paper forms part investigates the concept of viewpoint analysis for modelling systems as would be observed when abstracting system models from UoD domain vocabulary as discourse.

This paper specifically investigates the concept of "viewer" as found in the object abstraction paradigm offered by Booch [Booch 1994] from a semiotic sign abstraction framework Deely et al. [Deely 1990] and subjectivist analysis techniques (eg. MEASUR) Stamper et al. [Stamper 1994]. The discipline of semiotics (the science of signs) was selected as it contains a rich diversity of opportunity encompassing significant theoretical and abstraction foundations to be discovered from the study of linguistics and discourse analysis techniques. The resultant description from this research provides a conceptual base for object viewer and vocabulary identification where a single objective object abstraction could be seen to be inadequate.

Keywords

Semiotics, Object-Oriented Analysis, Object Abstraction.

1 PROBLEM STATEMENT AND RESEARCH METHOD

1.1 Problem Domain

During 1993/94 the author undertook a quality audit for a higher education degree course using ISO9001 standard [BIT94]. And found that when stakeholder groups were identified and surveyed for various aspects of quality that the quality outcomes measured revealed both objective and subjective aspects which required to be analysed and modelled. When approaching this domain problem object-oriented methods were considered because of their ability to cope with the static, dynamic and functional aspects of a specification. But the Object-Oriented Analysis (OOA) paradigm lacks consensus as to how or where to start analysis in deriving objects or object abstraction when developing an object model for this problem. Some would suggest, for example, to begin by deriving objects from the behaviour of objects, yet others suggest an extended entity relationship approach, etc. [Eckert 1994, et al.]. An integral part of object abstraction and the area which is under consideration for this paper is the term "viewer" and "viewer vocabulary" as observed from the objectivist and subjectivist ontologies, and offered as part of the object abstraction definition proposed by Booch [Booch 1994 , p41]. It is taken for granted that these terms are understood, any definition of viewer for object abstraction and therefore viewpoint (vocabulary) is currently left to the analyst to intuitively derive as part of the single objective view. Eckert and Golden [Eckert 1994] state further that little literature exists which deals with the requirements specification phase of the object-oriented analysis method, the stage where these terms are most prominent.

As stated "viewer" is taken for granted - perhaps this is because object-oriented methods have close links with other more traditional methodologies which include Entity Relationship modelling, Structured techniques, etc. [Rumbaugh 1991, et al.]. This presupposition suggests that viewer subjectivity is subsumed into an objectivist realism where the normative object-oriented model becomes the product of earlier analysis and processing intuitively derived. Stamper [Stamper 1992, 92a, 92b], et al. would argue the opposite should be true ie. that subjectivity subsumes objective realism, but from literature reviewed there does not appear to be a definitive solution or common framework approaching this dichotomy. Stamper [Stamper 1992, pp143/4] has strongly challenged the dominating objectivist paradigm, showing that it is assumed by most that those making a sufficiently careful investigation of the UoD will arrive at the same true picture of the world. He argues that where ideas, values and actions come into conflict, the subjectivist paradigm serves us better than the objectivist (same world) paradigm. This point of view immediately challenges the objective reality paradigm which influences the object-oriented modelling approach of Booch et al. What is envisaged is that an object model will not have a single universal view but a pluralist view which should influence the design process. The legal system (refer Stamper, et al.) would possibly offer the example where an objective law will be subject to interpretation and reinterpretation through individual application via testing in court. At no time, it would seem, will complex laws be interpreted with a single universality but subjectively, as is

the case with criminal laws such as murder where it could be said every case is subjective as no two judgements are the same.

The research project of which this paper forms part investigates viewer and viewer vocabulary when deriving and verbalising conceptual models. In order to gain some insight into a common or less ambiguous formalism for determining the role of the viewer and viewer vocabulary it is proposed to review other scientific traditions and disciplines where such interpretive requirements exist, semiotics being one such discipline under review as it contains a rich diversity of opportunity encompassing significant theoretical foundations for abstraction, language and logic. Semiotics being defined as "*the discipline or science of signs*", with sub-disciplines such as pragmatics, semantics, logic, syntax, language, hermeneutics, etc.

Regardless of the approach taken for object abstraction, if one takes the semiotic framework then the argument of realism vs nominalism (objective/normative vs subjective) is subsumed by the nature of signs ie. signs as systems and their actions [Culler 1976], where a sign is "something that stands to someone for something in some respect or capacity" [Deely 1990]. The significant issue with semiotics is that all significations whether in language, icons, objects, etc. are designed for communication and that communication is between agents [Deely 1990] of which the object-oriented viewers as agents act as a creators and consumers of signs.

The object modelling environment may well be objectivist in that it will express what is known as a single viewpoint, but falls short when one attempts to contextualise that knowledge by asking to whom or what is this representation meaningful. Given the presupposition that object abstraction is about modelling "what is knowable" it is argued that the "someone" of semiotics or the "viewer" of object abstraction is integral to a maintainable representation of any generalisation of objects and object classes.

1.2 Research Method

This paper addresses the question:

"can and if so what insight or clarification of "viewer" in the Object-Oriented Analysis (OOA) object abstraction method can be gained when viewed from the semiotic framework?"

The anticipated outcome from this study includes:

- a richer conceptual base for identification of objects, viewers and their role in object abstraction process where viewer subjectivity is desirable.

Object abstraction as proposed by Booch [Booch 1994] and the viewer object analysis approach (ref sec.4 of this paper) applied to a domain problem (Higher Education, BIT Quality project [BIT94]) has been specified for this study because:

- A case based approach is suggested by Galliers et al. [Galliers 1992] as appropriate for testing interdisciplinary equivalence, in this case OOA and semiotics.
- Booch has incorporated within the latest published revision [1994] considerations of other object abstraction and analysis techniques by Rumbaugh et al.
- The findings from the research can be summarised in terms of a single object abstraction method without distinctions which may occur between Booch and other object abstraction interpretations.
- The knowledge distilled from this case can be further tested by application to other modelling approaches and test scenarios.

The paper presents:

- A synopsis of the object-oriented analysis and object abstraction approach of Booch [Booch 1994 , Eckert 1994, et al.] {Booch suggested that the definition of objects begins with the viewer and entity abstraction relative to core requirements of the problem or solution domain Universe of Discourse (UoD)} and of the semiotic framework [Deely 1990, Sebeok 1976, Johansen 1993, Stamper 1992, et al.].
- A synthesis of the semiotic and object approaches described in order to provide a series of analysis steps which allows clarification and generalisations to be made for the object abstraction methods.
- A test case which required a subjectivist approach to a complex viewer oriented vocabulary.
- A summary of viewer oriented analysis this and future work using a semiotic framework and discourse analysis approaches.

This study is limited to a narrow subset of possible synthesis of concepts in semiotics and only one object abstraction approach, although the wider research project reviews other methods available through the application of Discourse Analysis techniques to other conceptual modelling approaches.

2 OBJECT-ORIENTED ANALYSIS & OBJECT ABSTRACTION

In brief, object-oriented analysis is a method of analysis which is initiated from the perspective of requirements, where objects and object classes are identified from what is stated in the vocabulary of the UoD. As with a number of analysis methods, they have emerged as a result of formalising systems development procedures around a given

programming process; eg. structured techniques and object-oriented techniques. The emphasis of object-oriented analysis being to model objective reality (real world things) [Booch 1994 , Eckert 1994, et al.].

Object abstraction as defined by Booch [Booch 1994 , pp41-49] is expressed as:

" the essential characteristics of an object that distinguish it from all other kinds of objects and thus provide crisply defined conceptual boundaries, relative to the perspective of the viewer." (p41.)

This identification of conceptual boundaries in object abstraction leads then to the need to address several open issues which are relevant to this study:

- What exactly are classes and objects? [Booch 1994 , p79]
- How does one properly identify the classes and objects that are relevant to a particular UoD? [Booch 1994 , p79]
- Identification of the relevant hierarchy of viewers and object roles [Calway 1994].

Object modelling describes the structure of objects in a system - their identity, their relationships to other objects, their attributes and their operations; expressing the essential framework into which the dynamic and functional models can be placed [Rumbaugh 1991, p17]. The abstraction process extends to identification, classification, generalisation, etc. where identification of classes and objects is seen as the hardest part of object abstraction [Booch 1994]. Booch [Booch 1994 , p146] further suggests that identification involves both *discovery* and *invention* to capture object descriptions through discovery, in order to recognise the primary abstractions that form the vocabulary of the problem domain, and through invention to deliver generalised classifications based upon how objects collaborate.

Abstraction also includes the following spectrum of perceptions ordered from least to most useful [Booch 1994 , pp42-43];

- coincidental abstraction an object that packages a set of operations that have no observable relation to each other.
- virtual machine abst. an object that groups together operations that are all used by some superior level of control, or operations that all use some junior-level set of operations.
- action abstraction an object that provides a generalised set of operations, all of which perform the same kind of function.
- entity abstraction an object that represents a useful model of a problem-domain or solution-domain (UoD).

3 SEMIOTICS

The subject matter of semiotics is the exchange of messages and of the system of signs which underlie those messages; hence, semiotics is most commonly regarded as a branch of the communications discipline [Sebeok 1976, p1]. Messages may be transmitted and received by both in-organic and organic agents (viz. eg. machines and animals respectively) or component parts of either or both eg. the chemical transmission of the motor neuron of the nervous system.

The semiotic framework currently described by Barthes, Eco, Deely, Sebeok et al. consists of a binary and a triplet representative form. The binary form represents the communication scenario which exists between two parties or agents. This communication may exist between organic and/or inorganic agents, in that one agent constructs a signifier which is to be communicated, while the second agent constructs a signified to interpret the communication. The triplet form of signification suggests that there exists a system of signs, objects of the signs, and interpretants of the signs. Peirce [Deely 1990] is quoted as suggesting that an actual thing on being seen may not be recognised, therefore he defined it as a *thing*, but upon being known and having substance, is perceived as an *object*. If that *thing* is recognised, it not only exists as an *object*, but also as a *sign* to someone. Peirce therefore has stated that "a sign is something which stands to someone for something in some respect or capacity".

Peirce [Sebeok 1976, p6] further contended that all dynamic action, whether physical or psychical, or actions of brute force etc. are between pairs and therefore a subjective interaction. Peirce defined semiosis, the action of signs, as meaning "an action, or influence, which is, or involves a co-operation of *three* subjects, such as a sign, its object, and its interpretant". What is equally important is that not all three elements need exist as actual things. Deely [Deely 1990, p23] gives the example that in other actions between existing things the actors are correlative and hence the action between them regardless of number is essentially dyadic and dynamical, ie. for an event to occur both actors must exist. A car cannot hit a tree unless the tree is there to be hit. But a sign on the other hand can signify an upcoming tree which may in fact no longer be there. Such interactions are always involved in the action of signs, but they surround the semiosis as its context and condition.

4 VIEWER OBJECT ANALYSIS DEFINITION

The semiotic discipline is not one which has appeared extensively in information systems modelling research to date, but has been shown to be of value as documented by Stamper, Andersen, et al. and has appeared in the FRISCO project notes of the IFIP Working Group 8.1. Stamper points out [Stamper 1992a, p24] that any definition of semiosis emphasises three aspects of a sign:

- some physical representation,

- something to which this refers or alludes,
- somebody able to interpret this relationship.

Of importance to this discussion are the latter two points but in particular the statement - "somebody able to interpret this relationship". One could suggest, as an example, the issuing of an Invoice which is brought about by the purchase of goods, which to someone familiar with Retailing is perceived as production of commission, the idea of commission being at that point purely subjective. Here the object of the invoice (as sign) is the purchase of goods, but the element of interpretation enters when the invoice is used by the Retailer to represent commission, and for the Purchaser, to represent description of goods and payment details.

Therefore there exists at least two roles in semiosis which become very important to this discussion about definition of *viewer and UoD vocabulary in object abstraction*, those of sign production ie. *signifier (Sr)* and of sign interpretation ie. *signified (Sd)*. Stamper [Stamper 1992a] has observed the need when analysing systems to identify from the problem or solution domain, (UoD), objective items which he called signs, passing through the system and the normative behaviour or heuristic of these things within the system as a starting point. These items (as significations) are created by some agent and consumed by one or more agents. For the signifying agent it is necessary to provide sufficient signification or denotation so that any future interpretation will not lack attribute representation, objectification or contextual meaning. The representations are the "signs" of communication and function to convey information concerning the identity of individuals or groups and to transmit information necessary for the co-ordination of an action. Signs can act as representations of a complex reality and contain indication or denotation of the structure of such a reality [Guiraud 1975, pp53-59]. Guiraud [Guiraud 1975, p54] further states that all knowledge consists of the establishment of a system of relations between the elements which constitute the field of an experience, and once these relations have been observed or postulated they must be signified.

By *identifying the viewer as a signifying agent* and categorising that agent's role the opportunity exists to approach sign development (or object-orientation) from a semantic perspective ie. sign representation, sign context and meaning and sign object. Abstraction of these signifiers, having identified and categorised agents and roles, allows the analyst to deliver multiple signifier denotations which can either be synthesised into a single system denotation and/or translation of individual connotations into a denoted form for use in the wider systems analysis.

By *identifying the viewer as the signified agent* the interpretant behaviour is seen as pragmatic and may or may not observe the normative behaviour established by the signifying agent denotation. An example would be the creation by one agent of a hammer with the normative behaviour of hitting nails but the signified agent may create another behaviour by using the hammer as a paper weight. The latter behaviour in no way modifies the normative paradigm (signifier) established by the signifying agent, it simply temporarily modifies the semantics by creating a new pragmatic signified.

Within a system analysis then, it is initially the signifying agent relationships which are of primary interest where analysis is looking to capture the normative behaviour, state and identification of objects. But when considering uses of these objects it becomes necessary to then delineate behaviour, identification and state characteristics connoted by the signified agent. This allows a clarification of the role of the *viewer as signifying agent* of the system abstraction, and the role of the system in terms of the *viewer as signified agents*.

In any system *things* are able to interact, initiate and consume signification [Guiraud 1975, Culler 1976, et al.]. This indicates that a considerable amount of systems vocabulary can exist outside of the human context and therefore an object can also exist as a viewer within a structured context. The position of the viewer may propose many structural relationships. Examples would include a chronological order and heuristically or thematically based continuity.

As the analyst then, the starting point for Viewer Object Analysis (VOA) as stated is to begin with the signifier side of the semiotic equation:

1. Ask what are the signs of the UoD (one method would be that of Stamper et al. using MEASUR) - simple signs appear within the inputs and outputs of the UoD, ie. objective reality as things.
Ask who are the agents for the UoD - those organic and in-organic actors who could participate to create or consume signs (these may or may not be obvious at the outset, but will be known by the completion of all steps of VOA).
2. Determine the immediate context of each sign; here immediate context is the material relationship, and asks to whom or what does this thing mean something - this beginning identifies viewers from both the signifying and signified perspective. A differentiation at this point is necessary ie. signifying agents (*Sr*), signified agents (*Sd*).
3. Determine the wider context of signs, signifiers and signified. This will show compound interest in a signification, and sign authors with more than one signifying relationship, also the objective and subjective relationships.
4. Where a sign exists with a signified agent but no signifying agent - discover that agent. This is important to determining the correct meaning for an object and object relationships.
5. Determine the object sign relationship for signifiers - this is the first point at which to begin object abstraction for objects active within the UoD of a normative nature.

6. Determine the syntactic and semantic detail ascribed by the signifying agent. This will include such things as state, behaviour (normative), identity, etc.

At this point (6), the signifiers having been objectified using object abstraction, should contain considerable syntactic and semantic structure within a contextual framework. It should be noted that agent signifiers are of primary interest for analysis, as agent signified relationships are behavioural views ie. interpretations of significations (viewpoint) derived and can change arbitrarily. Also, although the steps can be applied in a linear form, revisiting any point in the sequence may be required and/or desirable.

Similar steps can be taken to abstract the signified objectification - the significant difference being that the relationship of signified to signifier is pragmatic in nature. This nature can affect signifiers by allowing modification of signifiers to undertake new roles. It should also be noted that where signifier and signified are meant to be equal, ie. an agreed signification, a simple test of equivalence will determine shortcomings in the analysis.

Definitionally then:

Objects - are expressed as an instance which can be expressed using state, behaviour and identity [Booch 1994].

Object abstraction - is the essential characterisation of an object that distinguishes it from other objects relative to the perspective of the viewer [Booch 1994].

Viewer - for the purpose of object abstraction is therefore defined as an organic or inorganic actor/agent which either creates and/or consumes signification, where signification is something (in this case objects) that stands to someone (viewer) for something in some respect or capacity.

5 PROBLEM DOMAIN CASE STUDY

The case under consideration stems from studies conducted during 1993/94 by the author when undertaking a quality audit (BIT Quality Project) for a higher education degree course using ISO9001 standard [BIT94]. A problem arose when qualitatively and quantitatively measuring quality and defining product and customer for the standard by stakeholder group - where a stakeholder is someone or something which may have an interest in the various outcomes from processes within the degree program. In this case an Industry Based Learning program for degree students. Four distinct stakeholder groups were identified and surveyed for various aspects of "quality". It is no surprise that

perceptions of who was the customer and what product quality outcomes were anticipated and how to measure the objective and subjective aspects of quality abounded. The following is an extract from the BIT Quality Project report which outlines why the various definitions of 'product' and 'customer' were important during the abstraction process.

" Stakeholders as 'Customers'

A major issue associated with the ISO9000 standard application to an educational program revolved around the definitions of 'customer' and 'product'. A clear understanding of these terms is assumed for ISO accreditation. In an industry setting, customer and product are generally well-defined and understood. In a university setting, the term are generally not used and the application of such terms is generally resisted.

For the BIT program, the diagnostic 'customer' was interpreted as being the stakeholders; that is, students, industry (particularly program sponsors), university and the community at large. 'Product' raised differing opinions. It was interpreted by various stakeholders as being the student, the graduate, the program material as well as the process itself. From section to section of the audit, product was interpreted as having different meanings. To fully develop a quality management system involving ISO accreditation, specific definitions of these terms need to be established in relation to specific standards." [BIT94, pp157/158].

When approaching this domain problem object-oriented methods were considered because of the ability to cope with the static, dynamic and functional aspects of a specification. What was discovered was the necessity imposed, when considering object abstraction, to reduce the specification to a single agreed viewpoint ie. a single objective reality. This aspect was considered inconsistent with the plurality of viewers, viewpoints and vocabulary demanded by the BIT Quality Project team. Stamper [Stamper 1994] when defining MEASUR, a method based upon a semiotic framework, provided one of two approaches which allows conflicting or inconsistent viewpoint the other being Soft Systems Methodologies (SSM) Checkland, Wilson, Lewis et al. Both Stamper (MEASUR) and SSM were not taken further as neither method was readily available to the BIT Quality project implementation team, rather OO methods were adapted in order to deliver the plurality of views for the signifier objects and then the signified subjective objects.

The appeal of Stamper's work lies in the ability to consider view objectivity to be subsumed into view subjectivity. The VOA strategy (ref sec.4 of this paper) outlined earlier emanates from this same approach and allows the viewer based specification using

an object-oriented method. The following detail displays the application of the strategy on a limited subset of the problem domain.

- Point 1. What are the signs and agents from the UoD (inputs, outputs, etc.)?
 eg. *UoD* (BIT Program Quality Audit)
Signs Program detail, ISO9001 standard, etc.
Agents University, Students, Employers, etc.
- Point 2. Determine the immediate context of each sign.
 eg. *Sign* ISO9001 standard.
Sd 1. Auditor, 2. University
Sr ?
- Point 3. Determine the wider context of signs, signifiers, signified.
 eg. *Sr* Auditor
 (the auditor interprets the standard created by the standards organisation in order to create workable standards definitions eg. customer, product etc.)
Signs Interpreted ISO9001 standard - revised definitions.
Customer - as Stakeholder group (there are many of these)
 Product - as Stakeholder group expressed objectives.
Sd Stakeholder group (Students)
 Product = program relevance, employability, etc.
Sd Stakeholder group (Employer)
 Product = qualified graduates, etc.
 (the auditor creates Stakeholder group views cognisant with customers as signifiers)
- Point 4. Signified agent but no signifying agent?
 eg. *Sign* ISO9001 standard
Sd Auditor, University
Sr Accrediting organisation (refer point 2 above)
- Point 5. Determine object sign relationships for signifiers.
 eg. *Sign* ISO9001 standard
Class Product
Object Product Objective (for Stakeholders), etc.
- Point 6. Determine syntactic and semantic detail ascribed by the signifying agent.
 eg. *Sr* Auditor
Object Product Objective (for ISO, Stakeholders, etc.)
 - object model
 - object dynamics
 - object functions

A tabular approach to identification of viewers, view objects and subsequent object abstraction would provide a suitable mechanism for repetitive analysis and checking of discovered detail. UoD discourse was found to provide an enormous resource when identifying agents, viewers, objects, signs, etc. This conceptual base (VOA) has as yet not been applied widely and requires refinement in order to minimise what initially proved to be a disjointed conglomeration of material. An ontological approach could offer further insight to this and other modelling environments.

6 SUMMARY

Even with this brief synopsis it becomes evident that similarities exist within semantic modelling and the semiotic tradition. Such terms as viewer (as agent) and viewer vocabulary (as signification) are often well defined or formalised within the semiotic framework and therefore offer insight or clarification, in this case, for the object abstraction approach. Within the semiotic tradition the terms best combine in the binary communication form, known as the signifier on the one hand and signified on the other. It is suggested that the starting point for analysis of viewer vocabulary is in terms of signifiers, ie. of the signifying agent denotation and the sign representation (state, norms and identifiers), as communication.

A number of conceptual modelling notations exist which attempt with varying degrees of success to capture the specification of a system principally in terms of the written and verbal representations offered by the viewers as agents within or expressing the system. If narrative or verbal representations are used to express the expectations of a system specification then there is a likelihood that contextual relationships between significations as objects will be lost when modelled. Loss of context may create innumerable problems when dealing with viewers (agents) outside the system who wish to interpret the system content, or even within the system when one technological representation of the system is to replace another. Reflecting back on the case study it can be seen that an external agent (sponsors, government, community, etc.) can modify the originating agent (University as the UoD Expert) signifier but only on the side of the signified. What would be of benefit is for the signified agent to be able to conceptualise a system as a conceptualisation of objects and maintain these signifieds, not unlike software maintenance achieved through the specification not through the applications code. This suggests then that the specification of signifiers be conducted and maintained from the perspective of all the signifying agents. The resultant conceptual base from this study suggests then a richer formalism for viewer and viewer vocabulary identification in object abstraction can be achieved when using a semiotic perspective.

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