Application of Semantic Analysis Method (SAM) to the Design of an On-Line Portal

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Abstract. The Semantic Analysis Method (SAM) was used to design a Portal for the SEDITA Project. The paper describes the application of the SAM and the various stages in designing the Portal. It also presents a description of the final portal.

Keywords: Semantic analysis, Portal requirements, ontological dependency

1 A Brief Introduction TO SAM

Understanding the business itself is the foundation for any successful IT systems analysis and design. To successfully model an organisation requires proper understanding, interpreting and applying domain experts/users business knowledge into IT design and implementation. It is essential that the meaning of the business knowledge, the semantics of the information of the organisation is correctly understood.

Semantic analysis is a method of studying the semantics of an organization and its behaviours. It is a method of knowledge elicitation and specification, which was first proposed by [6]. An objective of semantic analysis is to establish a requirement model in which basic patterns of behaviour are represented and semantics are expressed [9]. A detailed discussion of Semantic Analysis can be found on the SEDITA Portal www.orgsem.net. This paper highlights some of the key concepts of SAM as applied in this context.

1.1 Affordance

The key construct in semantic analysis is the idea of an "Affordance". Gibson introduced the word 'affordance' for whatever behaviour some feature of the world makes available to an organism. Thus a flat terrain 'affords' locomotion to a land animal and objects bigger than the animal 'afford' it hiding from predators or prey [2].

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In the context of semantic analysis, since a person perceives things by recognising what he or she can do with them or to them, a thing can be defined by the repertoire of behaviour that it permits to the observer. Affordances are thus defined as an "invariant repertoires of behaviour".

Note that this implies the meaning of a thing is observer dependent. Objects, which in other forms of analysis would be seen as constants, in semantic analysis might yield very different affordances. Thus a van may to its owner be seen as supporting commercial activities, delivering and raising income from its use; to a salesman it may represent the opportunity for a sale with associated commission and trade-in possibilities.

A repertoire of behaviour is just a menu of possibilities; in general some outside trigger is required to initiate one of these possibilities. An order has to be received or a customer has to show an interest. Some affordances can initiate behaviour, thus a salesman can reduce the price of a van; a transport manager can schedule a pick-up; such affordances are called agents.

1.1.1 Agent

Agent is defined as a responsible person or organisation. For example, a person, company, committee, or office, which is able to act responsibly and fill the function of an authority, can be an agent. An agent is itself an affordance and can also initiate new affordances.

1.2 Ontological dependency

Affordances can spawn other affordances. For example once an operator has a van they can engage in other activities such as deliveries and collections. A delivery is also an affordance, a recognisable pattern of behaviour, but it is dependent on having the van, should the van be broken we are unable to initiate any more deliveries.

This dependency of the existence of one kind of behaviour upon another is called “ontological dependency”. Ontological dependency tells us about the intrinsic logic of the existence of things, determined by the hierarchical structure in our repertoires of behaviour.

This dependency hierarchy has its root in the commonly accepted norms of the society in which it operates so we will usually find the affordance Society (the capital letter indicates a particular social context) as the common root. All other affordances have antecedents, and are dependent on the existence of other affordances. For example, a delivery is dependent on a van and driver, the availability of the van may be dependent on it being owned by the operator, the driver may have to be an employee of the operator etc.

1.3 Roles

When an agent and an affordance are linked with each other by ontological dependency, the agent may take a special form of role. Thus an employee may be

engaged in driving a vehicle, discharging the role of “driver”, on another occasion the same employee may be carrying out routine maintenance, discharging the role “mechanic”.

1.4 Universals and particulars

Agents and affordances can be either universal or particular. A universal refers to all instances of the kind while a particular refers to a specific instance. In general we model universals, the particulars emerge during the behaviour being modelled. Thus the affordance "delivery" universalises all the particular instances of delivery that the operator performs.

1.5 Determiners and determinants

Determiners are properties of affordances which apply to all instances of a kind. Thus a van has an engine size and each van has an identifiable value representing the size of its engine. Such a value, called a determinant, may be measured in a number of different ways, cylinder capacity, horsepower, kilowatts etc. A full description would specify the units of measurement or other standards by which the values of a determinant is to be understood.

1.5 Generic and specific types

A type of affordance may include distinct specific subtypes or may itself be a specialisation of a more general type of affordance. Thus to a salesman our "van" may be just an example of a light vehicle including cars, MPVs and other distinct subtypes. To the transport manager his stock of vans may be distinguished by maximum pay load. Modelling can often be simplified by the use of generic/specific hierarchies.

2 Overview of SAM

SAM is usually applied iteratively over a number of phases. The method is described in a number of publications [1], [4];[5];[7]; [3]; [8] from which this list of key phases in applying SAM is drawn:

(1) Problem Definition

Problem Definition is the first phase of applying SAM. Starting with a written document in which the problem is defined, analysts(s) work with user(s) to articulate the problem.

(2) Candidate Affordance Generation

The second phase is to generate a list of candidate objects, which may indicate possible affordances and agents.

(3) Candidate Affordance Classification

This phase involves examining the role of each candidate in the problem domain. At this stage one should refine the list of candidates identifying aliases and also uncovering any overlooked affordances.

(4) Ontology Chart Generation

By considering each affordance and its antecedents a number of segments of ontological dependencies can be constructed. These separate parts of an ontology chart can be integrated one global chart of affordances link by ontological dependencies. The main task of this phase is to construct the ontology chart and iteratively revise it accordingly. In examining the proposed ontology the following rules must be observed:

a) There must be a root – all ontological dependencies should stem from a single root, Society.
b) Two antecedents maximum.
c) No recursive dependencies.

3 Applying SAM to the Design of the SEDITA On-line Portal

3.1 Problem definition

The SEDITA (Semiotic Enterprise Design for IT Applications) project [10] is funded through by United Kingdom Engineering and Physical Sciences Research Council (EPSRC) and is jointly conducted by Staffordshire University and Reading University. SEDITA aims to make the MEASUR (Methods for Eliciting, Analysing and Specifying User Requirements) methods accessible to industrial users, other practitioners and to researchers.

One objective of SEDITA is to disseminate the results of the research to the potential users and researchers. An on-line portal is to be designed to support the community of those who are interested in MEASUR [9] methodology. Research Works of all types, documents, films, diagrams etc. can be made available to members of the community through the Portal. Works are identified by a title, a list of authors and an abstract or summary. SEDITA Portal users should be able to browse the content of the portal by selection or searching and then access and download selected works. Authorised users will also be able to upload research works. Access to some works will be restricted to identified groups of registered users, and usually only a limited group of users will be able to edit works. The portal should be able to encourage user(s) to leave feedback and participate in discussions.

3.2 Candidate affordance generation

From the above problem definition, a list of candidate affordances was identified:
SEDITA, Sedita Portal, users, community, download, authorised users, upload, edit, research works, feedback, participate, discussion, groups of users, having access, being editors, title, list of authors, summary or abstract, browsing the portal, selection or searching, selected work.

3.3 Candidate affordance classification

In this session, various descriptors have been added to the candidate affordances for the problem domain. A thorough understanding of the semantic units of the candidate affordances is required. One task in classifying the candidate affordances is to identify the agents. Considering the scenario of the on-line portal, descriptors have been added to the candidate affordances above.

Person	In this context a person is anyone who has access to the Internet and may be interested in MEASUR. [agent]
SEDITA	A project, which stands for "Semiotic Enterprise Design for IT Application". [particular]
research works	A possible contribution to the MEASUR or a work of potential of interest to the MEASUR community. Works appear in a variety of formats including books, pamphlets, periodicals, maps, manuscripts, graphics, audio recordings, video recordings, motion pictures, microfiche, microfilm and digital files.
SEDITA Portal user	Any one with access to the Internet may access the Sedita Portal. Whilst doing so they are a Sedita Portal user. [agent]
Feedback	Response, including corrections, additions, and approval, made by users of the portal.
authorised user alias=member	Means a person or entity with authorized access. [agent]
Title	The name of a book, essay, story, play, poem, picture, statue, piece of music, film, etc. [determiner of a Sedita Work]
Community	Community refers to the set of persons (as defined above) who have an active interest in the Sedita project or the MEASUR method.[particular]
abstract/ summary	An abstract is simply an abbreviated summary of a work. In some cases it is a copy of the abstract integral to the work itself, sometimes a summary or abstract has to be created to represent the work. [determiner of a Sedita Work]
list of authors	the authors of a work [determiner of a Sedita Work]
having access	Ability to read and download some works may be limited to certain registered users. Those users have access. As the portal has the objective for diffusing information the default is that all works will be open to all users, however some works may be in draft form or in preparation for publication and it may be appropriate to restrict access.
being editors	Many works on the Portal are finished published works, but as suggested above some may be work in progress and a limited number of users may have the right to edit, change or comment on such works. These users many not be identical with the list of authors of the work.
Browsing	The portal will contain many hundreds of documents, the user needs to be able to browse through lists of documents, make a selection and then access the selected work
selection or searching	To reduce the volume of works to be browsed the user needs to be able to create subsets of works either by selection from categories (e.g. publications, conference papers) or by executing searches which can look for words or phrases in the title, summary or list of authors.

Edit	To correct errors within, or modify, a computer file, a geographic data set, or a tabular file containing attribute data.
upload	Works that exist in computer readable form outside of the Sedita Portal can be published through the portal by uploading them.
download	Once a user has selected a work they will usually wish to read it in detail and to do this they must download it or open the source document in their browser.
discussion	The portal should support discussion through a conventional forum through which registered users can suggest topic and comment son them and the comments placed by other users.

The following affordances are not identifiable from the problem statement but emerged when creating ontology charts

administrator	A person who administers the portal. [role]
SEDITA work alias=disseminated work.	A Sedita work is any of the research works which the community have caused to be made available through the Sedita portal. A Sedita work has a title, a list of authors and an abstract/summary. These may reflect the corresponding components of a research work or may be constructed specially to mark its Sedita-Portal presence. This would be the case, for example, where the work was a diagram or video.
selected work	During the browsing process a user will identify a particular work of interest and call up the full description: title, authors, abstract. This is the selected work.
selected list	During the browsing process the user will typically create, by selection of searching, a list of potentially relevant works. By inspecting the list in detail the user can determine which, if any, they wish to download. this is called the selected list
Society	The root agent of all. [particular]

3.4 Ontology chart generation

It would be possible to create a single large ontology chart detailing all the affordances revealed by the semantic analysis, however this is not very practical for two reasons:

- Presentation: figures limited to A4 are much more practical to handle and discuss,
- Modularisation; the affordances do group naturally into distinct areas and this makes the charts easier to understand and contributes to subsequent system design.

This initial discussion revealed *users* and *works* as the key affordances so charts were constructed around these concepts. Two other charts focus on significant functionality of the portal, the *searching/browsing* and the *discussion forum*.

Note that as each chart is a sub-set of the conceptual complete integrated chart, there is no reason why affordances should not appear in more than one chart, however, of course, any ontological dependencies should be consistent across all charts.

3.4.1 Ontology chart notation

The ontology chart is a graph which sets out the ontological dependencies between the affordances we commit ourselves to in a given domain of activity. Basically it represents affordances joined by arc to their antecedents: antecedents are always shown to the left. Notations are listed below:

——— :	Ontological dependency
# :	Placing `#' before a determiner name, for example, # weight
——▶ :	From specific to generic. Also shown by a box containing a list of specific types.
– – – – :	Represents a communication, usually relevant to the creation or ending of an instance of an affordance
[Role-name] :	Role name is held in a pair of square bracket.

3.4.2 Ontology of a research work

Fig. 1 shows a (research) work defined externally to the Portal with a number of authors [role o person]. Works may be of different type, traditional documents or multimedia contributions, each sub type of work is made up of a number of parts of different types.

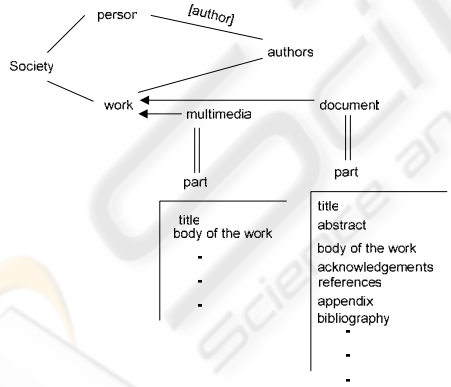

Fig. 1. Ontology Chart of Work

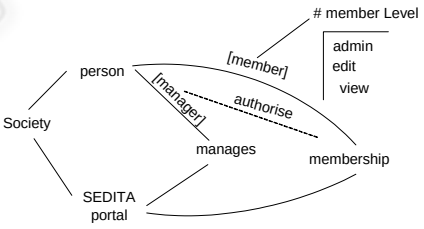

Fig. 2. Ontology Chart of Member

3.4.3 Ontology of members and manager

Fig. 2 shows the Portal as a particular which relates to people in two ways. A person has the role of manager in managing the Portal, many people can have the role of member by becoming authorised users. The authority for becoming a member is granted by the manager.

3.4.4 Ontology of SEDITA work

Fig. 3 shows three new affordances. The disseminate affordance which binds a work to the Portal and creates a disseminated or SEDITA work. The submission of a work comes from a portal member who causes it to be uploaded. Privilege is an affordance which determines how a member can relate to any Sedita work.

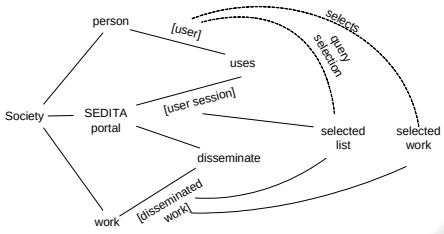

Fig. 3. Ontology Chart of SEDITA Work

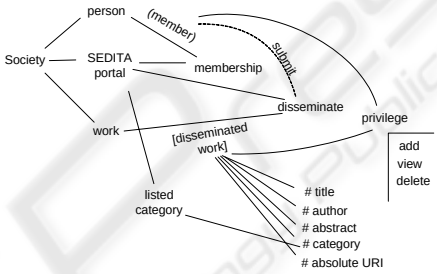

Fig. 4. Ontology Chart of Searching/Browsing

3.4.5 Ontology of searching and browsing

Fig 4 introduces the affordance of a user, this is any person who is accessing the portal, for the duration of their user session they are able to search and browse documents. During this session instances of the affordances "Selected List" and “Selected Work" may be created, these instantiations result from actions by a user.

3.4.6 Ontology chart of forum

Fig. 5. represents the main forum activities of creating topics and adding comments all actions of registered users

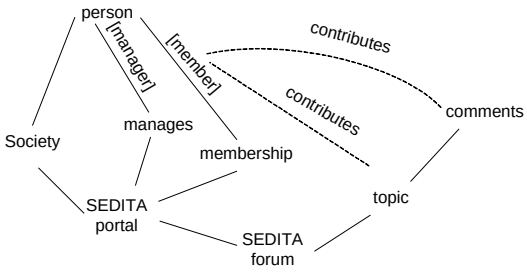

Fig. 5. Ontology Chart of Forum

3.5 SAM as an iterative process

As stated earlier SAM is an iterative process, each phase casts light previous phases, so after having drawn initial ontology charts it was realised that the problem statement was not clear or was incomplete. The problem statement was then modified as well as the following phases. In this paper there is not room to follow all the iteration so we present a converged set of phases, not the first pass through the method.

4 Portal Design

4.1 Problem definition

The preceding semantic analysis leads us to see the portal as having two main interfaces:

1. A document interface which presents documents to the reader (Fig. 1.).
2. A user information interface for managing users, their roles and profiles (Fig. 2.).

Apart from the functions necessary to maintain the above interfaces (instantiation of affordances) we also need views for:

3. Searching and Browsing for documents (Fig. 3. & Fig. 4.).
4. Accessing Documents (Fig. 1.).
5. The forum (Fig. 5.).

In general an application will consist of a number of screen layouts or forms (here called interfaces as the actual graphic interface design is another stage. The ontological dependency diagrams not only tell us what each interface contains but also the access hierarchy of the application. For example the chart for browsing and searching (Fig. 4) suggests that the inspection interface can only be accessed from the short-list interface which itself can be accessed from the session interface, and when the user exits the inspection interface they should return to the short-list level.

4.2 The document interface

The semantic analysis clarified the distinction between a *work* in the outside world and a work made accessible through the portal. Fig. 1 and Fig. 3 distinguish between the determiners of the portal work and the parts of a *work* in general. This is made more apparent if the possibility of storing multimedia works is considered. The work itself may be a video which contains moving images a sound track and maybe some subtitles, the stored-work however would have a title, list of authors and an abstract recorded in text in English.

The ontology chart in Fig. 3 leads to the specification of the content of the stored-work interface, it tells us the fields associated with a stored-work and ensures that we do not overlook the different access rights the different readers will have. The functionality of the document interface is ontologically dependent on the person accessing it so must be lower in the interface hierarchy than the identification of the user.

4.3 The user management interface

Fig. 2 distinguishes between three types of user, there are people in general there are members of the portal (registered users) and there is a manager role. Membership is authorised by the manager. Members have a general level of access to the portal which is set by the manager.

4.4 The search/browse interface

Whilst the semantic analysis does not deal in any detail in the searching process it does identify the key affordances in the process.

When a user accesses the portal they have the potential to access a very large number of documents. This complexity is managed by allowing the user to create a list of relevant documents by browsing in categories or by using various search techniques. The result of the search process is a short list of more relevant documents. This is an affordance permitting browsing behaviour. The list can be scanned, identifying useful titles, relevant dates, authors etc. Individual documents details can than be called up presenting a full list of the summary information including any abstract. This creates another affordance – the selected document – which supports two main types of behaviour downloading or reading the source document or ignoring it.

Fig 4 shows clearly how the searching process depends on a user starting a session on the portal and then issuing (through the interface) a search or selection command, the user is then in short-list mode where by selection they can enter the selected document mode. On terminating the selected document instantiation they return to the short list mode and on closing that to the general session affordance.

4.5 The discussion forum

The chart shown in Chart 5 for the discussion forum identifies the three level of interface, the forum top level where we can inspect topics, the topic level where topics can be created and the comment level where comments can be read and commented on.

4.6 The user interface design

The previous discussion is about content and functionality of the different interfaces supported by the portal. In selecting a user interface design a familiar layout with a narrow left hand panel containing the main navigation/functions and a large right hand panel for the display of information was adopted, this is shown in Fig. 6.

4.7 The implementation of the portal

In Fig 6 the reader can discern the basic layout of a typical portal page. Printing constraints do not favour a more detailed visual presentation of the portal. The other views of the portal follow closely on the ontological analysis. The interface for managing users and user rights reflects the ontology in Fig. 2. The document browser interface implements the ontology in Fig 3 making public the summary information recorded for each document within the selected browse category or within the returned search result set.

The searching interface, whilst situated in the ontology shown in Fig. 4., necessarily goes further than the ontological analysis in the detail needed to construct a search expression, however the attributes searched and the categories within which searches are conducted are all as specified in the ontology. Having searched for, selected and retrieved a document the document itself is normally displayed in the form produced by the author which is reflected in the generic ontology of a document as shown in Fig. 1. However as the Portal contains many older articles which have had to be scanned in, a certain amount of post-processing was necessary in some cases.

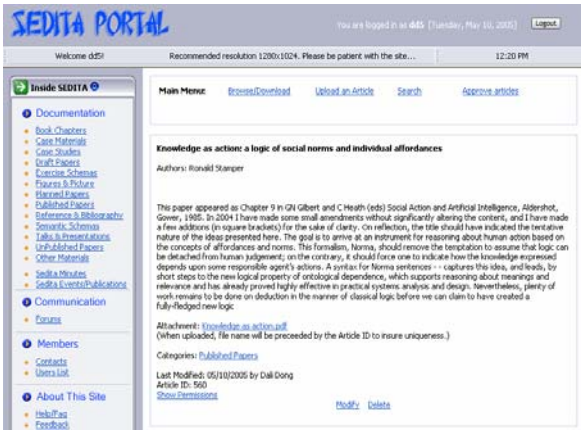

Fig. 6 Document Interface

The forum interface reflects the ontology in Fig. 5. which itself describes the typical structure of a discussion forum.

5 Conclusions

The application of the Semantic Analysis Method has led to the successful implementation of the SEDITA Portal as part of the SEDITA Project. The portal can be visited at www.orgsem.net. The method was used iteratively and several rounds were needed to clarify the original project specification. The strengths of SAM as revealed by this exercise were:

- It led directly to a logical hierarchy for the elements of the application.
- It ensured that navigation on the Portal was ontologically based resulting in clear routes for users.
- The method was particularly good at identifying the security requirement for the management of the published works.

However it did not offer much in the way of support for the visual layout of the GUI. We found this a useful exercise in applying the method to a typical modern on-line application; successfully uncovering the semantic dependencies hidden in the original specification.

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