

WORKING INGREDIENTS

IN THE KNOWLEDGE STRUCTURING PROCESSES

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Abstract

Problems with constructing knowledge management systems (KMS) are in most cases related to the knowledge elicitation and knowledge structuring processes. We will focus on specific details of methods that can be used to extract descriptions of knowledge that people can comprehend and reuse. We will refer to these specific details as working ingredients in the knowledge structuring process. The purpose is to distinguish a number of “stand alone” working ingredients. All of the case studies that have been carried out aimed at investigating if the working ingredients are suited for eliciting and restructuring knowledge for knowledge management systems. We present the final results in the form of 1) Interview techniques, 2) Iteration of presentations as a method to refine a structure, 3) Talking back as a method for confirming a structure, 4) Using Examples and Analogies to facilitate comprehension, 5) Generalising information in order to arrive at a natural indexing of the information, 6) Using rhetorical questions to arrive at the deeper logic of how parts are related, 7) Using peoples need of self esteem as a driving force, 8) Using playful competition to stimulate creativity. The results from empirical studies show that the working ingredients can be applied stand alone and are well suited to be used as a toolbox of techniques whenever knowledge is to be elicited for a knowledge management system.

INTRODUCTION

Problems with constructing knowledge management systems (KMS) are in most cases related to the knowledge elicitation and knowledge structuring processes. We will not make references to research related to these problems since the discussions concerning how tacit knowledge can become explicit, why people are not motivated to contribute knowledge, or why the represented knowledge is not used, are very well documented in the knowledge management community (Stenmark 2001). Here we will instead focus on the solution of the part of the knowledge elicitation process that is related to the structuring of knowledge. We will focus on specific details of well-known methods that produce explicit and well-structured knowledge. We will refer to these specific details as the working ingredients in the knowledge structuring process.

Before we go into details describing the working ingredients of the structuring process we will present four types of structuring approaches applicable to knowledge structuring:

1.1 Top-Down Structuring

Top-Down structuring base the distinction between super classes and subclasses on the most discriminating features, as will be exemplified below. Most of Top-down structuring is carried out from an intuitive perception of how to divide something into parts. According to organisational theory as described by Chandler (1992) an organisation can be looked upon from various perspectives. This determines how people will relate to the organisation and will affect how the organisation performs. In the following example it is possible to see how the Top-Down structuring determines how we name the parts of the organisation. For each presented perspective we will show how this affects how we categorise the parts.

- Division from functions. In hierarchical descriptions based on the function of work processes, the organisation tends to become divided into units with names like: Department of economy, Department of Human resources, Department of production, etc....
- Division from market. The management may believe that the most important policy is to focus and specialise on various groups of customers. With such a perspective the division may have names like: Department for elderly consumers, Department for company customers, Department for teenagers, etc....
- Division from products. Here we will find department names like: Automobiles, Trucks, Aeroplanes, etc...
- Division from processes. Here we will find department names like: Preliminary refinement of raw oil,....., Final refinement of specific chemicals for pharmacy, etc...
- Division from geographical location. Here we will find names like: The London department, The Paris department, etc...

The common denominator of the perspectives when we do a Top-Down structuring is that the structure should support efficient information processing. The structure should be based on the most important feature for the survival of the organisation. The advantage with a Top-Down structuring is that it supports a consistent and efficient communication. The disadvantage is that it is often based on tradition that makes it resistant to necessary change. This has been described by Senge (1990) and Argyris (1991).

1.2 Automated Top-Down Structuring

In the area of machine learning we have a number of methods for structuring information automatically. When there are no human experts to determine the most important features, this can be done through various mathematical algorithms. Within the area of inductive learning there is a method called C5. It was developed by Quinlan (1993) and it works in the following way:

- All attribute-values in all classified objects are compared.
- The attribute that discriminates the most between the classes is selected as suitable for being the root node in the hierarchy, and thus each of the attribute values form a new sub-tree.
- For each sub-tree a new identical calculation is made. All attributes in this sub-tree are compared and again the attribute that discriminates the most is selected as being used for dividing the sub-tree into further branches.
- The whole process continues until there are no more attributes to insert in the tree structure.

The advantage with automated methods for Top-down structuring is that computers are much more efficient than humans in dealing with large quantities of raw data. The disadvantage is that all automated methods require pre-classified objects described in a standardised way.

1.3 Bottom-Up Structuring

Clancey (1985) has shown that people often use something that can be described as “heuristic classification” when they impose structure on information. Heuristic classification can be done in a number of ways, and the following is only one simplified example:

- The features of a new specific description are generalised.
- The new generalised description is classified.
- The new class of a description is regarded as an instance and is compared with stored similar general instances of classes of descriptions.
- Information from similar old stored instances is mapped onto the new generalised description.

To add information to an object by comparing it with stored similar object structures is a method suitable to be used in weak theory domains, i.e. domains where well defined or established descriptions of the logical relationships between the objects in the domain do not exist. The disadvantage with the method is the difficulties encountered when mapping stored information on to new information. It is difficult to know how the retrieved information shall be utilised and thus this mapping may require expert knowledge.

1.4 Automated Bottom-Up Structuring

Sometimes the available information does not contain pre-classified objects but it does contain distinct descriptions of the features of the objects. In such circumstances there are automated methods based on measures of similarity for comparing objects. If we, for instance, have two sets of attribute values we can compare these two sets and get a similarity measure. In order for this measure to be precise we probably need to consider whether some attributes are more

important than others. When we, for instance, compare which car to buy the attribute “colour” of the car is probably less discriminative than the attribute “horsepower”.

The following is a simplified example of how clustering can be carried out:

- All objects are compared for similarity and similar objects are grouped into clusters.
- For each cluster we create general objects consisting of a set of attribute-values where each attribute-value is associated with how frequently it occurs in the examples and how important it is considered to be.
- All general objects (corresponding to the created clusters) are compared for similarity and similar general objects are grouped into even more generalised clusters.
- The process is continued until we have a tree structure of groups of objects (clusters) where each group corresponds to a general object.

The advantage with clustering is that it can be applied in weak theory domains. It does however require that the attribute-values themselves are described in some kind of standard way that allows the clustering process to work. In areas of machine learning, data mining, and discovery the necessity of such standard is often referred to as the pre-processing of information (Usama 1996).

1.6 Why the Described Methods cannot be applied

The examples provided in previous sections illustrates that several well known structuring methods exists as long as the information to be structured is distinctly described or pre-processed in a correct way. We have, however, after analysing these methods, come to the conclusion that all of them do depend on an already existing well defined body of information or knowledge. This was not at all the case with the knowledge elicitation methods we investigated in our work. The target knowledge at focus in our work was the kind of knowledge that is often referred to as tacit (Polanyi 1967), or implicit (Dixon 2000). In order to find structure to this kind of knowledge one needs entirely different techniques from the ones used for explicit knowledge. The following paragraphs will describe how we have created and evaluated a number of new strategies more applicable to weak theory domains.

1.5 Knowledge structuring in Weak Theory Domains

Within the knowledge management community there have been innovative propositions to adopt knowledge structuring as is exemplified in methods from: 1) Anthropology (Tyler 1969), 2) Ethnography (Forsythe 1992), 3) Ontology building techniques (Uschold & Grüninger 1996), 4) Cognitive flexibility theory (Spiro et al. 1988). Although these methods are remarkably different from each other they exhibit similar features when it comes to the structuring of knowledge. Instead of adopting one of these methods we will focus on the detailed features of the way they propose that knowledge can be structured.

The reason we choose to focus on details in the knowledge elicitation process is that it is difficult to apply any of the mentioned methods without depending on the routines developed in that specific context. It is difficult to distinguish what is domain specific or situation specific in the various methods. It could be argued that it is possible to transfer knowledge from one discipline to another in the form of frameworks, guidelines, checklists, strategies etc. But such theoretical constructions are often resisted because:

- They were developed and tested in a domain specific context and we cannot be certain that they can be used in a similar way in another context.
- One does not know if it is the specific combination of parts in the methods that makes them work or if the positive results springs from only some of the ingredients in combination with external influences.
- People are often reluctant to base their work on “ready to use recipes” unless they understand how these recipes work. It is much easier for people to adopt practical “stand alone” techniques that can quickly be understood and verified.
- An activity that encourages learning is also a motivating activity. If people instead choose to adopt a theoretical construction that somebody else has developed the motivation sprung from developing and refining one’s own routines will be lost.

The purpose of this paper is to distinguish a number of “stand alone” working ingredients in methods for knowledge elicitation and structuring. We have studied the structuring processes in the type of knowledge elicitation that is carried out in a dialogue between two individuals and we have tried to verify their advantages and drawbacks by analysing results from empirical case studies with each one of them. The expected results are assumed to provide information about how and when the various techniques work well. We hope that by doing this we can free the person working with eliciting knowledge (the knowledge manager) from depending on any kind of formal method and instead support him/her in creating his/her own tailor suited combination of knowledge elicitation steps.

2. METHOD FOR EXTRACTING WORKING INGREDIENTS

The aim of this study was to find working ingredients in the knowledge structuring process when individuals are contributing knowledge to be reused by someone else. When studying literature concerning the reasons why people might be unwilling to contribute what they know we found the following:

- People often do not know what they know (Nonaka 1994).
- People have a conception that they will not benefit by sharing but, on the contrary, they think that they may benefit from keeping what they know to themselves (Argyris 1991, Armstrong 1999).
- People do not know which type of knowledge is relevant. They often think that the type of knowledge they are familiar with is not relevant since they feel that it is simple and obvious (Polyani 1967).
- People have seldom classified the parts of the knowledge they use into any type of standard semantics (Van Krogh et al. 2000).

The reasons described above show that it is necessary to motivate people and to support them in their knowledge structuring process. As there exists no established tradition for how this should be carried out we assumed that the most efficient way to find the working ingredients was to adopt an approach that can be classified as prototyping. We decided to implement a number of case studies and case studies in order to distinguish how knowledge can be structured when there is much uncertainty about the availability or quality of the knowledge. The case studies were carried out in the following steps:

1. Find a suitable population.

2. Test a refined (from earlier case studies) combination of knowledge structuring processes on the population.
3. Evaluate the results.
4. Extract and refine the best working ingredients.

The steps above were applied over and over until we could verify that the extracted ingredients worked well and were approved of by the participants of the case studies.

2.1 The Six University Courses

The processes for extracting working ingredients have been developed and tested in six university courses. In all of these a number of students (in each case more than 50) have been continuously working with redefining and restructuring knowledge. In order to find reliable information and also enough quantities of information from the case studies we combined inquiries, individual interviews and case studies. The first year the case studies gave questionable results since more coordination and research was needed than initially estimated. On the last three courses the results were very positive. The general conclusion from these studies was that the method worked well and could be recommended for being used on larger scale in Swedish Universities (Kjellin et al 2002).

2.2 The Seminars at Companies

Initially we started with a type of knowledge elicitation seminar of which we had practical professional experience from our work as consultants. From this we started to make small case studies with groups of people. The case studies showed that parts of the seminars were efficient for extracting the type of knowledge structures we were looking for. Results from this is described in Kjellin and Stenfors (2002). Once we had a stable and well routine for the seminars we started to apply them on a large scale in organisations. We tested them with:

- Sales managers at the largest Telecom organisation in Scandinavia
- The National Society for Journalists in Sweden
- A society of medical experts
- A software company with approximately 105 technical consultants of which all participated in the study
- Health care consultants

We introduced many variations in the case studies in order to be able to test various aspects of working ingredients. Whenever something worked as intended or sometimes better than intended we analysed why it did and tried to exploit this feature further. Whenever some part of the seminar did not work as expected we analysed it most carefully and unless we could find a good reason for keeping this part or evaluate it once more we removed it from the seminars.

3. RESULTS FROM TWO YEARS OF PROTOTYPING

For practical reasons we applied no formal method for extracting the final working ingredients. Instead we decided that when we had found working ingredients that worked well in several independent environments and had been verified in case studies and case studies, we would be

satisfied with these results. In the following sections we will present each single working ingredient separately.

3.2 The Adaptive Listener

Most listening techniques show how people tend to be inspired to share what they know when they feel understood and accepted and when they are not being interrupted in their associations. This is, for instance, accomplished in psychotherapy by the therapist being very cautious in not breaking the clients chains of associations with a disturbing question but instead formulates questions that are a little positive or a little negative, and that are also closely related to the direction of the clients associations (Spradley 1979). Results from case studies using this technique showed that it works well also in knowledge structuring sessions.

3.2 Iteration

The participants in the case studies were asked to describe the knowledge repeatedly over and over again and each iteration they should try to add a general feature to the description. Although the case study was artificial most subjects claimed that in the end of the session they were able to describe the essence of the knowledge in a much better structured way than they could in the beginning of the case studies. However, some subjects found it frustrating and could not improve their descriptions because they found no sense in repeating things over and over. One conclusion from the case studies with iteration is that the iteration process needs to be motivated by an introduction of its possible effects in order to allow people to accept the unnatural side of it. Similar results have been described in (Perris 1988).

3.3 Talking Back

When a person feels confident that what he/she says is accepted, the person may tend to continue for too long with describing already known or unnecessary details. In such a case the listener should present a summary of his/her conception of what has been said. The case studies showed that this technique gave optimal results when it was not applied too early in the dialogue because there it might take the speaker by surprise. In the book "Common Knowledge" (Dixon 2000) there are many similar examples showing that knowledge transfer works best in a dialogue where the recipient of the message repeats how s/he has understood the content.

3.4 Examples and Analogies

The importance of examples and analogies are emphasised in most pedagogical literature. The knowledge management community has also realised the importance of storytelling in the knowledge transfer process (Orr 1990).

Whenever a person is asked to present an example of how something is carried out, the example usually provides the structure that is needed for the listener to understand. Such an example may provide information that was not considered important the first time the process was described. The listener can also ask if the process is always carried out in the described way and thereby the listener will find out if there exists exceptions or subclasses of the process description. If the listener feels that the example contains too many unfamiliar domain specific details the listener

can demand a simplified example of how the principles could be applied in related domains. In such a case we would refer to the example as being an analogy. Analogous relations can be used to form the backbone of a new formalised knowledge description.

3.5 Generalising

Whenever the question “Why?” is asked in relation to any statement, the speaker is forced to reconsider his/her knowledge from a more general perspective in order to find an answer to the question. And as soon as the speaker has managed to provide a clear enough answer the interviewer can ask “Why?” again until the root node of the complete knowledge structure has been reached. Once the root node is reached it is easier to create a complete hierarchy of knowledge. The subjects reported that they experienced the reorganisation of the knowledge structure as being rewarding, since they could relate all parts of the structure to one point of reference and thus create a balanced structure. The power of generalising before comparing objects is also described in (Clancey 1985).

3.6 Require Logic

When a complete hierarchic structure begins to take shape one could scan the structure in order to try and find things that are not coherent, natural, or appealing. An analysis can be made in order to define what it is that is out of the ordinary. If this analysis leads to a specific definition of something that is not logical, the subject who has contributed with the knowledge can focus his/her energies on reorganising the structure until it becomes consistent. To apply a critical perspective can be a powerful tool. The drawback may be that the criticism kills the whole structure and the subject is not enough motivated to try to recreate a better one.

3.7 Status and Social identity

When people present their ideas and receive feedback about the quality of different ideas they learn to argue for what they believe in. A spin-off effect of this is that people may experience a feeling of becoming more certain about what they know and who they are in relation to other people. This certainty can be used as a motivating force in the knowledge structuring process. In several case studies subjects reported that the main reason for enjoying the knowledge structuring case studies was that they felt they had achieved a certainty about their own knowledge and competence after having received personal feedback from other participants. One conclusion drawn from these case studies is that any method for restructuring knowledge should be based on intensive communication between all participants in the process. How getting feedback on the quality of their work motivates people is described in Maslow’s well known theories (1970).

3.8 Competition

Some case studies were based on competition as the force motivating the participants to design knowledge structures that were as appealing as possible. The case studies were found to work well but when using this method thorough instructions for the participants are needed to guarantee that people feel secure enough to proceed even though they may experience some negative or threatening feelings. One conclusion drawn is that any kind of competition should be

carefully developed in many small competitive steps in order to make the participants feel successively more secure and confident.

3.9 Double Feedback Loops

Case studies confirmed that learning is a strong motivating force in the knowledge elicitation and knowledge structuring process (Kjellin 2002, Kjellin & Stenfors 2002). Some participants have reported that they did not only get a clear view of their own and the other participants' knowledge structures but they also experienced that they learned how to convey complex ideas. In some case studies the participants were instructed to give feedback to the quality of the feedback they were receiving. The difficulty of this task created some confusion but in many cases it was found that the response to the way the communication in itself was carried out was a stronger motivator than the response about the content of the communication. One conclusion drawn was that it can be most rewarding to have an informal and personal approach to the knowledge elicitation process and that a considerable part of the process should focus on the tuning of the communication process in itself.

4 CONCLUSIONS

Most of the presented results from our case studies verify existing theories from social sciences. The results indicate, however, that each of the proposed ingredients can be applied "stand alone" when eliciting and structuring knowledge. This demonstrates that a knowledge manager does not necessarily need to use one complex method for knowledge elicitation and knowledge structuring, but can instead apply his/her own combination of working ingredients and adjust these to the specific situation of the organisation. A good cook can always improvise and if the cook does not improvise his cooking never improves.

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