

Applied Knowledge Research Institute

Using Knowledge Structure Maps as a Foundation for Knowledge management

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Abstract:

A methodology known as 'Structural Knowledge Auditing' (SKA) has been developed in cooperation with several organisations. Successful pilot trials of the method took place at British Aerospace (Samlesbury) in November 1998 and led to changes and developments in the way knowledge was viewed and organised by managers at that site. Since then, several papers have been produced that discuss the methodology, a number of projects have been carried out in large (eg Rolls Royce) and small (eg Promethean) organisations and projects have also been conducted with sector based groups such as the off-licence retail sector.

The aim of the method is to provide a visualisation of a knowledge area that is supported by descriptive data to help managers take direct control of a knowledge resource. A software tool (SKAT) assists in the capture of the knowledge structure and its subsequent interrogation. The information provided forms a common, easily interpretable knowledge structure (map / graphic) that managers can use as the basis for decision making in the knowledge domain and also as a way of bringing information about the knowledge resource to bear on other issues.

SKA can provide a justification for the use of other KM tools and methods.

1. Introduction:

There are many approaches to Knowledge Management (KM). Rather there is a subject area called Knowledge Management that is extremely diverse, encompassing almost anything that is connected with a knowledge resource. Typically data and information sources are targets for Knowledge Management Initiatives.

1.1 A Knowledge Resource

In spite of the diversity of Knowledge Management as a discipline, it is still possible to look at what knowledge is and what the management of knowledge means in a more focused and analytical way. This is not to say that the diversity of issues addressed by the broader term of KM are wrong, it is simply pointing out that there is a core and can be a focus for KM.

A responsible definition of knowledge would reflect the point that knowledge is something that rests in people's heads. Knowledge relates to knowing things. Books and documents cannot know things and at present, neither can computers. It is true that books, documents, web sites etc can be a source of knowledge when people interact with them; however, they are not knowledge in themselves.

A (more focused) knowledge resource must therefore be something that an organisation accesses, develops and manages through its staff. This means that an organisation possesses a knowledge resource that is potentially mobile, comes equipped with an in built mechanism for applying knowledge and can be supplemented at source by problem solving and decision making capabilities that integrate fully with the knowledge resource at all times.

This is a very encouraging picture of what an organisation knowledge resource actually is. It also implies that a failure to manage such an important and powerful resource means that a large part of the organisations capability is applied by virtue of the control of other related things.

1.2 Managing Knowledge

If something is being managed in the business sense, it is being controlled or administered by someone with responsibility for the thing being managed. It is easy to shy away from the management of the sort of knowledge defined in section 1.1. There are many factors that make such knowledge difficult to manage directly but the indirect management of people could be thought to achieve the same results. Regrettably, there is a lot of evidence from recent business history to show that managing the people is not the same thing as managing knowledge. Could organisations have made such devastating mistakes in their bid to cut costs as to decimate essential knowledge resource components if they had been informed of the effects of their actions in advance?

If the problem of managing the invisible knowledge resource that is contained within people's heads explicitly is to be addressed, then the first step is to make the knowledge resource visible in some meaningful way.

When managers and staff can share a common view of the knowledge resource then it will become necessary to provide some additional information about the resource to help managers arrive at decisions regarding the development, protection and growth of the resource.

Supported by a clear and unambiguous visualisation and information that is able to discriminate amongst issues of concern regarding knowledge, explicit management of the knowledge resource becomes possible.

1.3 Visualising Knowledge

The visualisation to be described in this paper is a Knowledge Structure Map (KSM). This may be referred to loosely as a Knowledge Map but it is not so much a map of knowledge but more accurately a map of the way that human experts acquire knowledge. The structure is controlled by 'Learning Dependency'. Maps of this sort will be described more fully in section 2.

There are many other definitions and interpretations for knowledge maps. Many organisations consider knowledge maps to be directories of who knows what or pointers to knowledge resources.

2. Mapping the Structure of Knowledge

In this work, the term 'knowledge structure' is used to refer to knowledge items or labels that are linked together based on their learning dependency. The example in figure 1 illustrates this point.

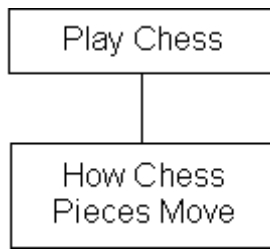


Figure 1: Learning Dependency

Figure 1 illustrates that if someone knows how to play chess then it is assumed that they must already know how chess pieces move on the chessboard.

2.1 Learning Dependency

The example shown in figure 1 takes a simple look at learning dependency by showing that in order to know one thing assumptions about prior knowledge exist. This particular example can be expanded to show more of the knowledge that is prerequisite to the knowledge of playing chess.

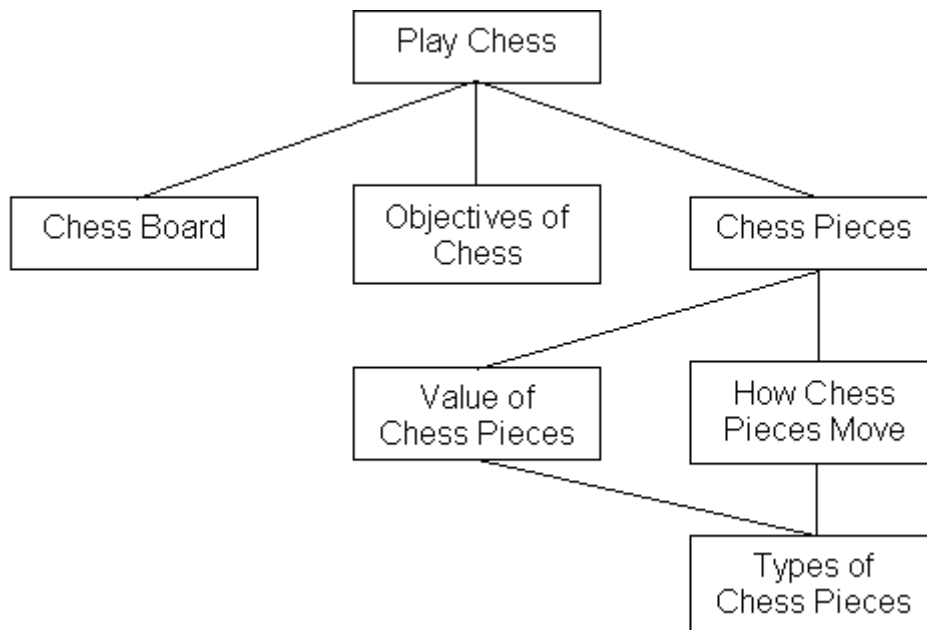


Figure 2: Chess in more detail

Figure 2 considers more of the learning dependency that exists within the knowledge of playing chess. It is still not complete because it misses important areas such as strategy. The interested reader may like to produce a more complete version of the knowledge structure map of chess organised by learning dependency that includes knowledge about strategy etc and expands the areas shown.

In figure 2, there are three knowledge items that are shown as necessary prerequisite knowledge of chess playing and the original prerequisite from figure 1 is not one of these. The knowledge of how chess pieces move is now seen as a necessary prerequisite of the knowledge of chess pieces. This knowledge is seen to rely on a prior knowledge of the value of chess pieces as well. The map shows that both 'value of chess pieces' and 'how chess pieces move' relies on a prior knowledge of the types of chess pieces.

2.1.1 Developing the Knowledge Structure Map

The Knowledge Structure map is the focal point of the entire methodology and must be created with care by people that have some practice and appropriate background knowledge.

2.1.2 Implications of a Learning Dependency Structure

Mapping the structure of knowledge in this way links the map directly with the human knowledge resource because it mirrors the way that expert knowledge is acquired. One of the implications of this is that the map can be used directly to assist in the management of training and education as a knowledge resource development option.

Many organisations waste money by sending the wrong people on training and learning programmes. The organisation is often focused on the outputs of the programme and often ignores the required prerequisite knowledge assumed by it.

Organisations can get more value from testing people before they are sent on a course than after they have finished it (when it is too late).

A learning dependency map can show in some detail, what the assumed learning standard of a particular piece of knowledge is. A learning dependency map represents full and complete knowledge for each knowledge node present. That is an expert level knowledge; the level that the organisation would aspire to. It is not desirable or practical that the map should show a proportion of knowledge (say 45%) that it is OK to achieve before moving on to the next level.

2.2 Additional Information About the Knowledge Resource

When a knowledge structure map has been created, it contains information that can be of use to the organisation by virtue of its method of construction. The structure of a larger map of about 120 nodes can show knowledge overlap between areas, knowledge subsumed by major work areas, knowledge that is supportive of many other areas etc. An illustration of the sort of analysis available directly from map structure is shown in figure 3. This is a typical map of a business knowledge area where shaded nodes show the knowledge that is common to two major knowledge areas.

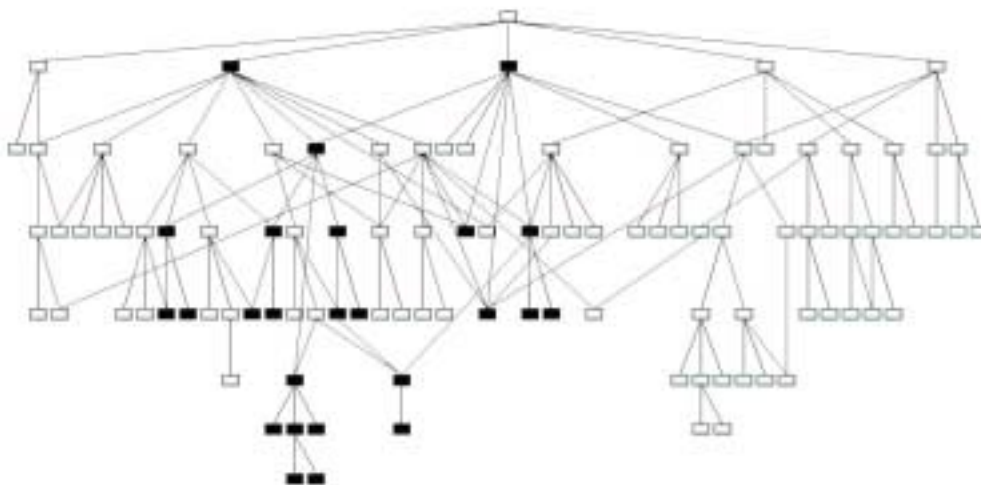


Figure 3: Typical map showing knowledge overlap between two main areas.

The Structural Knowledge Auditing (SKA) methodology includes the elicitation of several parameters concerning each of the knowledge nodes on the map. Parameters are assigned values during interviews. The value of these parameters reflects the views of

the experts in the area about each particular item of knowledge. The subjective source of this information is controlled by validation and the methodology includes structures to support validation and conflict resolution. The parameters are listed in table 1.

<i>Parameter</i>	<i>Description</i>
Importance	How important is the knowledge to the company?
Difficulty	How difficult would it be to replace this knowledge?
Study – Experience	Is the knowledge acquired mainly from study or practice?
Known By	What proportion of the staff in the knowledge area know this?

Each of these parameters will have a value attached between 0 and 9.

0 -> unimportant, not difficult, non of it etc.

9 -> core knowledge, very difficult, all of it etc.

Table 1: Knowledge Analysis Parameters

Parameter values can be used in various ways to interrogate the map and provide information to assist managers in the development and protection of the knowledge resource. Knowledge can easily be ordered by parameter value with for instance, the knowledge known by least people appearing at the top of the table. These values can also be reflected as a colour coded map (e.g. a colour coded version of figure 3) where red represents areas requiring most attention. Parameters can also be combined in tables and in colour coding to allow more complex interrogation.

3. A Review of Previous Work

Mapping the structure of knowledge in the manner described in chapter 2 has proven to be a powerful organising and representational strategy for a knowledge resource. It focuses on the knowledge that is needed to do the things that an organisation does. One of the main strengths of this method is its focus.

3.1 Expectations and Possibilities

In the second half of 2001, a meeting was held with all of the organisations that had commissioned SKA projects. An improved methodology for SKA resulted from this and several subsequent meetings. The main improvement was in the support offered to organisations concerning the implementation of SKA outputs. Information about what sort of things can be expected from a SKA was made clearer. Typical additional information given includes:

- 1) Typical areas of general concern to organisations include:
 - a. Staff turnover
 - b. Recruitment
 - c. Major Business decisions such as acquisition, outsourcing etc.
 - d.
- 2) Typical specific business issues that SKA can address include:
 - a. Identifying knowledge needed in a particular business area
 - b. Uncovering high risk knowledge areas and targeting management action
 - c. Investigating knowledge used in existing processes in order to improve efficiency, delivery, service etc.
 - d. Map a business knowledge area so that it can be relocated or duplicated in other locations
 - e.

This list is not exhaustive but reflects the issues brought to the table by the organisations that had actually benefited from these sorts of findings.

3.2 Target Areas for SKA

Table 2 provides some information concerning many of the actual SKA projects that have been carried out. The table shows the topic areas that have been studied for each organisation. It can be noted that the topics studied with SKA have been very diverse. This supports the view that a knowledge resource is part of probably any activity that involves human practitioners.

	<i>AUDIT</i>	<i>SIZE</i>	<i>START</i>	<i>END</i>	<i>TOPIC</i>
1	Aerospace	Large	05:11:98	25:11:98	High Tech Fabrication
2	Prototyping Business	Small			Engineering Prototyping
3	Utility company	Large	12:03:99	26:03:99	Safety
4	Engine Manufacturer	Large	24:01:00	17:02:00	Business Winning
5	Business Consultant	Small	10:04:00	14:04:00	Consultancy Activities
6	Off-licence Retail Group	Small	09:05:00	06:06:00	Off-licence Retail
7	Industrial Doors	Medium	07:06:00	05:07:00	Industrial Door Repair & Service
8	Computer Peripheral	Medium	20:10:00	14:11:00	Engineering Services
9	Computer Peripheral	Medium	18:12:00	06:02:01	Sales & Marketing
10	Computer Peripheral	Medium	16:02:01	27:03:01	After Sales (installation, maintenance)
	Computer Interface	Medium	02:04:01	04:05:01	Cross Audit Analysis
11	Hotel	Medium	25:06:01	13:07:01	Hotel Operations

Table 2: SKA projects carried out

Table 2 shows that each project has lasted between 3 and 4 weeks.

3.3 General Findings from the projects

There is only space here to discuss general findings from the projects. These can be considered in several categories.

3.3.1 Parameter Value Results

Each project reveals particular and specific results that can be used to derive recommendations and can in turn be used to inform the decision making process within the business. When results are considered together, some trends do emerge.

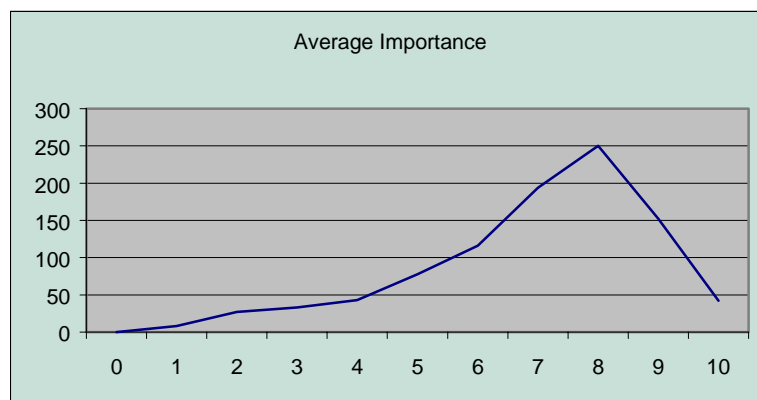


Figure 4: Average project results for importance

Figure 4 shows that staff generally view knowledge as an important resource. This may not be a surprising result but a project result that differs from this trend would be interesting. The graph also shows that there is at least a little knowledge that is considered to be unimportant; why should this be so?

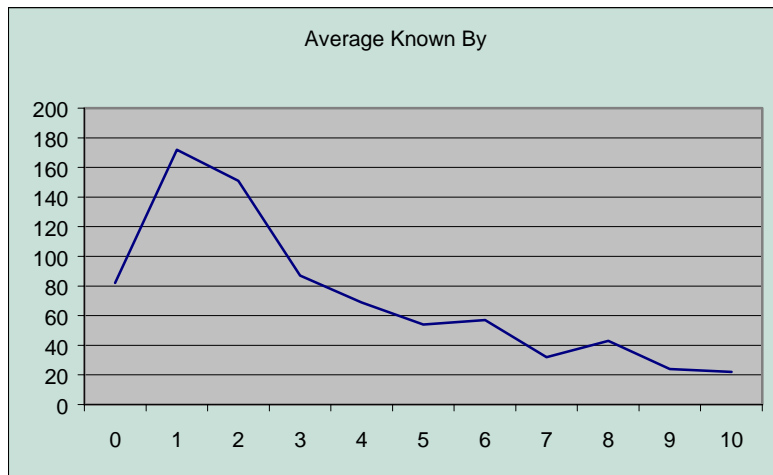


Figure 5: Average project results for Known-By

The graph for numbers of people in a knowledge area that possess individual pieces of knowledge shows that the trend is that the knowledge resource in most organisations is quite specialised. It could be argued that an attempt by management to introduce effective multi skilling measures should result in moving the peak of figure 5 to the right.

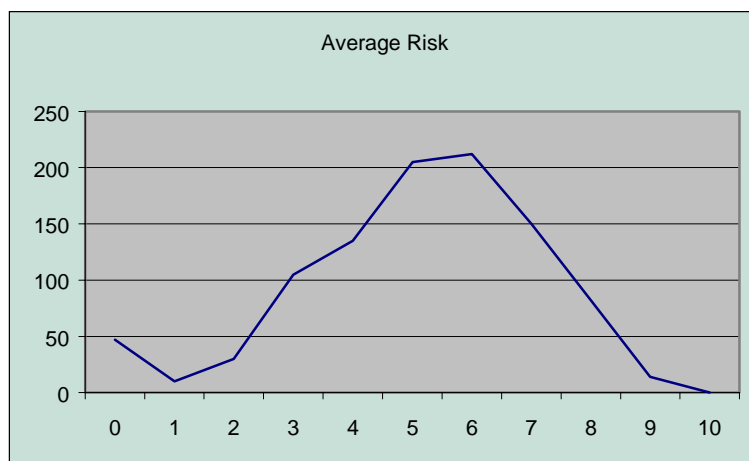


Figure 6: Average project results for knowledge Risk

RISK is defined as knowledge that is most important **and** most difficult to replace **and** gained through experience **and** known by only a few staff. Figure 6 shows that many organisations have some knowledge that can be considered as high risk. Much more of the knowledge resource is medium risk and therefore probably requires sustained if not urgent attention.

3.3.2 Map Connectivity Results

SKA can provide tables of knowledge nodes ordered by the most highly connected. That is, knowledge with the largest prerequisite structures. Tables can also be provided that show which knowledge items are supportive of most other knowledge areas and are therefore key business knowledge components.

Typical results have shown overlap between knowledge areas. Figure 3 was taken from an actual project and the two knowledge areas being tested were 'Installation' and 'Customer Service'. It would be reasonable for a business to for instance, consider outsourcing its installation work so that it could concentrate on what it may see as core business. In this case, the map shows a 31% overlap of knowledge in these two areas.

This does not mean that the organisation should not go ahead with outsourcing, only that it should seriously consider the implications and the potential effect on 'customer services' of doing so.

Another study revealed that the knowledge area of 'product storage' underpinned almost 20% of the entire knowledge map for the business. It was also revealed in parallel that this knowledge area was known by very few people in the business and that it would probably be quite difficult to replace it.

3.3.3 Recommendations

Typically recommendations have lead to:

- I. Changes in information disclosure to competitive organisations
- II. Creating knowledge links from Engineering to Marketing to improve performance
- III. Creating an in house training scheme to share key knowledge
- IV. Re-evaluation of knowledge requirement (and function) in a business area
- V. The creation of a comprehensive sector training scheme

4. A Foundation for Knowledge Management

Structural Knowledge Auditing aims to provide information that will support decision making in matters that involve the knowledge resource.

4.1 Options for High Risk Knowledge

One of the most frequent findings that result from a SKA is the need to address a high risk area of knowledge. Options to address knowledge that is at high risk include:

- I. Recruitment
- II. Retraining
- III. Proceduralisation (Recording process and methods in detail)
- IV. Knowledge Sharing
- V. Intelligent Systems

Having more staff in high risk knowledge areas is an obvious solution but it usually conflicts with organisation staffing policy. Retraining is only possible if there are staff that have the capacity to benefit from the retraining and also have spare working capacity to apply the new knowledge. It is often the spare working capacity that is the problem here.

Documenting the process in detail in an attempt to capture and record the knowledge is a useful option and does not simply have to rely on written procedures. An organisation can use computer graphics, video, audio etc as well as written detail and instructions. In some cases this solution will work. In others, the problem is still in the application of the knowledge by expert staff. An organisation may not desire novice staff to apply critical knowledge even if instructions are available. One of the things that makes the knowledge high risk may be the fact that experience is a major factor. In such cases, creating procedures may be difficult or almost impossible.

Knowledge sharing can take several forms. An organisation could invest in a system for a centralised computerised knowledge resource that staff can add to and interrogate. This could mean that staff applying knowledge can get support at any time for a central data base. Systems like this are now readily available and have proven track records. They will often solve many business knowledge related problems and will also ensure that the organisation itself is better protected against knowledge loss. Some systems also allow for an expert in a knowledge area to be located and contacted by someone with a particular problem. This is not the same as document storage but can be very

effective in some cases. It should be remembered however that document systems themselves, although useful, do not archive knowledge, just information.

So called intelligent systems are now a well established technology capable of taking an organisation nearer to the storage and protection of knowledge than simply document management. Typical systems include Knowledge Based Systems and Case Base Systems. These store information in particular formats and can be used in dialogue about a problem. It is said that the dialogue from such systems act like a discussion with a human expert in that knowledge domain. The drawback is that these systems require considerable investment in time and resources to implement and maintenance of them necessitates a permanent resource requirement.

4.2 General options for Knowledge Management

A survey of Knowledge Management literature, reports and adverts reveals a diversity of options and approaches. Any single organisation will not implement everything that is covered by the term Knowledge Management (KM). What is important though is that the organisation identifies a real need for KM and is clear about what is to be solved, improved or changed by KM.

SKA helps managers to see what the knowledge resource needs and how the knowledge resource interacts with other parts of the business. It is possible that SKA itself can be used to address issues arising from studies. For instance, an organisation may decide to use SKA in a controlled way to investigate knowledge areas. A single project may lead to a requirement to investigate other separate knowledge areas or to investigate certain core knowledge areas in more depth. In this way, an organisation can build a more complete knowledge structure map for essential business areas. In such cases it is still desirable to spend a three to four week period on each sub project. This gives management regular feedback on the exploration of the knowledge resource and regular findings and recommendations. This in turn allows managers to direct or redirect subsequent effort in the light of the latest findings.

Some IT based solutions to knowledge management can require considerable commitment from an organisation. SKA can help to show why these solutions may be required and what they are expected to deliver. SKA can be used to help managers stay in control of a large knowledge management commitment by an organisation.

Some Knowledge Management solutions involve changes in business culture. In such cases, it can be difficult to identify ways to monitor progress let alone justify methods. SKA can show why cultural changes may be needed and can also, in some instances, provide measures that can be used to monitor progress. For instance, a periodic review of map parameter values can identify changes in staff beliefs about the knowledge resource and allow managers to compare these results with the targets initially set for a long term culture change project.

Further Reading

- Gordon J.L. Smith C. Knowledge Management Guidelines. NWAIAAG Publication. 1998. (available from the AKRI)
- Gordon J.L. Creating Knowledge Maps by Exploiting Dependent Relationships in Knowledge Based Systems, Vol13 (April 2000) pages 71 - 79, Elsevier Science
- Gordon J.L. Creating Knowledge Structure Maps to support Explicit Knowledge Management. Applications and Innovations in Intelligent Systems VIII. Pages 33-48. By Springer. (December 2000)