

# Applied Knowledge Research Institute

## Understanding human knowledge resource

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An entire discipline called Knowledge Management (KM) has grown over more recent years to account for the high value that organizations now place on knowledge. Unfortunately, the discipline seems to have become very diverse and poorly focused. As a result, Knowledge Structure Mapping (KSM) has been developed, following a lengthy collaborative investigation into the knowledge resource. It takes a more focussed view of the knowledge resource than the one generally adopted for KM, which means that objective studies of the knowledge resource can be controlled by a well defined methodology. KSM is part of a Structural Knowledge Auditing (SKA) process that provides a complete knowledge resource tool for organizations.

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### Introduction

An objective look at what any organization does, cannot be complete without careful consideration of what the organization knows - particularly, what it needs to know in order to enable it to do the things that it does. This is not the same as asking what information does an organization possess or what information it may need in order to make specific decisions. Rather, it refers to how the decisions are made, how actions are designed and implemented and what information is needed in order to make decisions, etc. This requirement is also applicable to parts of an organization and even job roles. For instance what things does a person need to know in order to carry out the role of a waste management specialist?

### Knowledge management

In recent years it has become clearer to many organizations that knowledge is a central issue for the success of that organization. This was always known implicitly, and it is the reason why so much is spent now on recruitment, education and training. However a more explicit view of organizational knowledge is now common and the term 'knowledge management' is commonly used. Unfortunately, the term 'knowledge management' (KM) has now become confusing, because it has been defined in so many different ways and there have been so many different claims as to how an organization should implement it. It is not uncommon for an organization to make a decision that it needs to examine and implement KM, yet be unable to

make any significant progress because it is not clear what should be done.

#### Difficulties in planning specific actions

Several years ago I attended a seminar given by a well-known KM professional to see what others were doing in the area. The main delegates at the seminar were engineering managers from manufacturing companies. The presenter gave a very clear and professional account of KM. He explained what it was and stated the benefits of investing in KM.

The presentation was well received, at least until the question and answer session at the end. Several questions about KM were fielded and answered well by the presenter. That is, until one engineering manager stated that his company had already made a decision that it should invest in KM and was ready to do so.

The question raised was what exactly should be done first, and what was desired was a practical straightforward answer about what things the company could actually do to manage its knowledge more effectively. The presenter spent several minutes stating that KM was a diverse field and that there were many things that could be part of a KM initiative. But the manager's question about what should actually be done was not answered, in spite of his repeating his question several times.

This is a real-life incident and regrettably also highlights a problem felt by many organizations. It is true that there are many things that can be done in the name of KM and that KM is a diverse discipline, supporting a wide range of opinion and advice. It is also true that there are many things that are sold under the banner of KM that are really miss-named, even though they may be useful things for an organization to do.

The problem with having such a broad ill-defined term such as knowledge management is that it becomes very difficult to decide what to actually do about it. The engineering manager in the incident narrated simply wanted to know where to start; he did not want the presenter to solve everything there and then. Unfortunately he left the seminar no wiser than when he entered, even though he had listened to a good professional presentation.

#### Developing a focused approach

The Applied Knowledge Research Institute (AKRI) has been involved in research, development and implementation in the knowledge resource area since 1994. Between 1994 and 1998 it carried out a significant collaborative research project that aimed at investigating organizational needs and perceptions concerning knowledge and its use. During this time an experimental software system was developed (known as KM1) that embodied all of the ideas that emerged from the project and formed the foundation and direction of subsequent AKRI activity in this area

Following this early work, the AKRI developed a more focused approach to KM that would have provided the engineering manager at the seminar with a definite answer to his question and a complete strategy for a way forward.

This article will discuss the organizational knowledge resource and attempt to define what it is. It will then develop an explanation of the approach invented by AKRI and now used internally within Rolls-Royce plc, and also employed in specific projects by large and small organizations, including BAE Systems. The intention is to show how the most valuable component of an organizational knowledge resource (the knowledge that employees possess), can be visualized, evaluated and from there managed. In this way it is hoped that readers will be able to see at least one well-defined way forward for developing and protecting the knowledge resource.

#### Human knowledge resource

A resource is something that is needed in order to achieve some goal. It is the means towards an end. One of the things that an organization needs in order to function is knowledge. Often, knowledge is the most important thing that is needed and without it, many of the other resources are ineffective.

#### Defining knowledge

Without delving into a philosophical debate about knowledge, it is nonetheless important to understand what knowledge is, in order to understand the knowledge resource. Many will argue that knowledge, and particularly a knowl-

edge resource, is almost everything that is known by people, written in books, papers, documents, contained on a website or in a computer database. Aside from being wrong, this would make a knowledge resource very difficult to manage as one entity. A simplified definition of knowledge is "something that someone knows". This is different from simply believing that same thing. Risks taken, based on sound knowledge, are more justifiable than risks taken that are based on beliefs. A more in-depth discussion on knowledge is not necessary to appreciate a more general debate about a knowledge resource

#### Staff-based resource

Taking a more focused view of knowledge means that defining a knowledge resource is much easier. Here, let us consider knowledge to be only what people have, since it has not been established that books, documents or even computers can know things. The knowledge resource for an organization then is the knowledge possessed by its employees. Apart from being simple, this view has other advantages. For most organizations, whether it is argued that knowledge is kept or stored, it can only be applied by people. Even if it is said that knowledge is contained in a vast database of organizational documents, this would still require searching, finding, moving to the place that it is needed and then interpreting and applying by people. Even though knowledge-based machines and knowledge-based software exist, these are usually far less flexible than people and very rarely do they update their knowledge or learn from mistakes without human intervention.

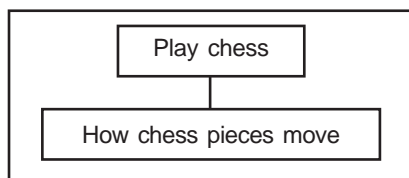
How then is knowledge possessed by the employees managed by managers? Some of the managing is done implicitly through human resource and educational programmes, but operational managers will still have difficulty doing anything explicit about the human knowledge resource.

#### Visualization and analysis

In order to manage anything, a manager must have information about it. In most cases it is also necessary to share a common understanding of that which is being managed with others who together

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Figure 1: Learning dependency



make operational decisions. If the human knowledge resource, as it has been defined here, is to be managed effectively, then several things are required.

- A common visualization of the knowledge resource must be created that can be shared and understood by all those that are to use or control it.
- The visualization must have a logical construction or easily understandable framework, else it will simply add confusion to the activity.
- Information about the knowledge resource must be made available to managers to help them make decisions about it and draw conclusions.

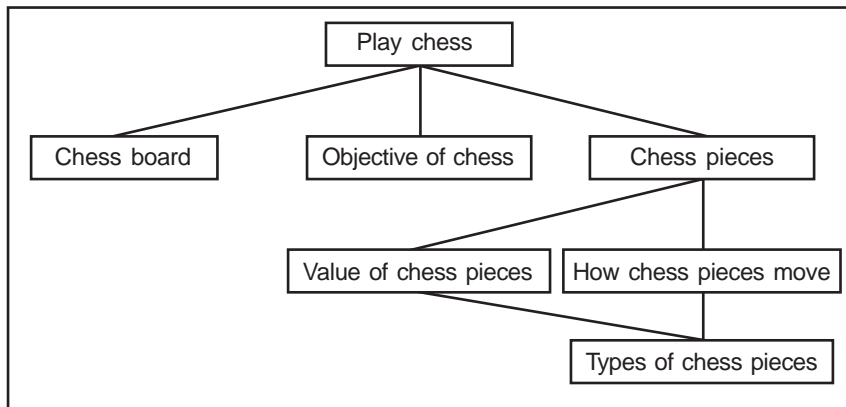
This is what we hope that a knowledge structure map (KSM) and its associated data will provide. Using a KSM approach, a management group can stand in front of a map and see a knowledge resource. They can point to things that need attention and others can see immediately what is being referred to without confusion. Data provided with the KSM can help the managers to see issues, identify risks and discuss actions. The layout or structure of the KSM can help managers to develop better educational support, to organize team work and to identify knowledge links and overlaps within and across knowledge areas, and potentially utilize staff more effectively.

It is suggested that the use of the KSM and the associated methodology can help an organization develop, protect and make better use of its human knowledge resource.

### Knowledge structure mapping

Within the context of this paper, a KSM is something that is created during the application of a well-defined methodology. The KSM can become part of a project known as a structural knowledge audit (SKA) that has been carried out many times in business (Table 2). This section attempts to show what is meant by a KSM and also show some of the additional information that is elicited and analysed as part of an SKA.

Figure 2: Learning dependency in more detail



Here, the term 'knowledge structure' is used to refer to knowledge items or labels that are linked together based on their learning dependency. If someone knows how to play chess then it is assumed that they must already know how chess pieces move on the chessboard (Figure 1).

### Learning dependency

Chess is a simple example of learning dependency, showing that in order to know one thing, prior knowledge of part of that thing exists. This particular example can be expanded to show more of the knowledge that is prerequisite to the knowledge of playing chess (Figure 2).

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 organized 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 in 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 (Figure 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.

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

Organizations 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 (knowledge structure) 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 organization would aspire to. It is not desirable or practical that the map should show a proportion of knowledge (say 45 per cent) that it is OK to achieve, before moving on to the next level.

### More about knowledge resource

When a knowledge structure map has been created, it contains information that can be of use to the organization 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. This is a typical map of a business knowledge area where shaded nodes show the knowledge that is common to two major knowledge 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. Each of these parameters will have a value attached between 0 and 9.

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 the least number of people appearing at the top of the table. These values can also be reflected as a colour coded map, where red represents areas requiring most attention. Parameters can also be combined in tables and in colour coding to allow more complex interrogation.

### Applications of KSM

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

### Expectations and possibilities

In the second half of 2001, a meeting was held with all of the organizations

Table 1: Knowledge analysis parameters

Parameter	Description
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?

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

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

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 organizations 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:

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

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

### Target areas for SKA

Table 2 provides some information concerning many of the actual SKA projects that have been carried out. It shows the topic areas that have been studied for each organization. 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 (Table 2).

Table 2 shows that each project has lasted between 3 and 4 weeks. Project 14 was delayed because of fixing dates for the final presentation and the availability of senior staff, but the actual work took about 3 to 4 weeks.

### General findings from the projects

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

### 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). 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?

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 organizations is quite specialized. 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).

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 organizations have some knowledge that can be considered as high risk. Much more of the knowledge resource is medium risk and

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Table 2: SKA projects carried out

	Audit	Size	Start	End	Topic
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 Interface	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
12	Learning council	Large	01:02:02	22:02:92	Skill needs analysis
13	Learning centre	Medium	11:11:02	06:12:02	Senior job role study
14	Aerospace	Large	28:04:03	20:06:03	Continuous improvement

Figure 4: Average project results for importance

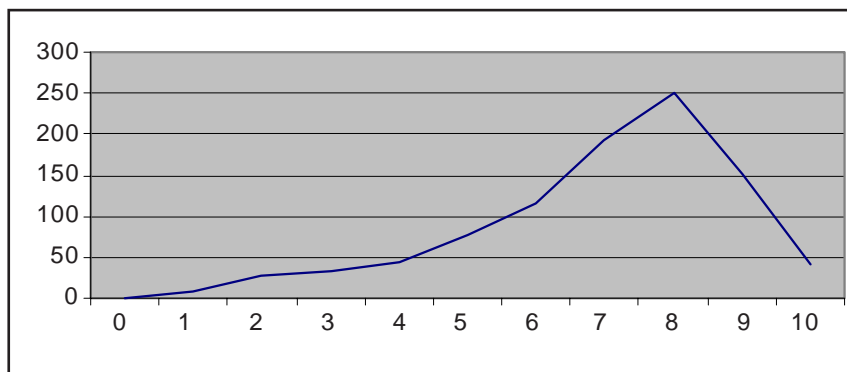
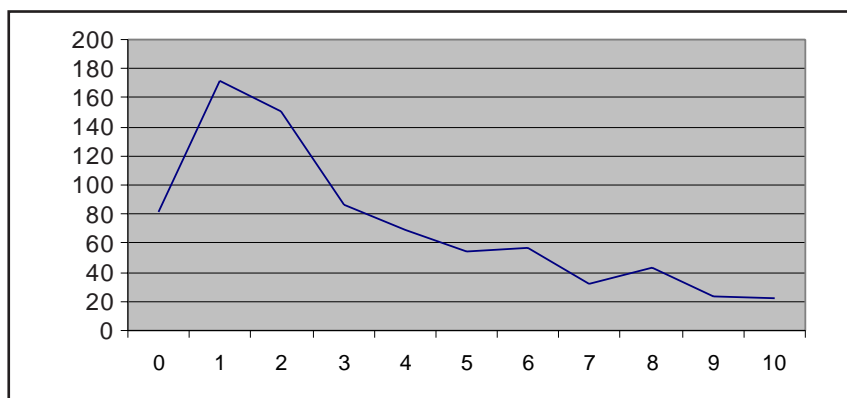


Figure 5: Average project results for 'known by'



therefore probably requires sustained if not urgent attention.

Map connectivity results

SKA can provide tables of knowledge nodes ordered by the most highly connected. That is, knowledge with the larg-

est 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 per cent overlap of knowledge in these two areas. This does not mean that the organization 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 per cent 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.

Recommendations

Typically recommendations have lead to:

- Changes in information disclosure to competitive organizations;
- Creating knowledge links from engineering to marketing to improve performance;
- Creating an in-house training scheme to share key knowledge;
- Re-evaluation of knowledge requirement (and function) in a business area;
- The creation of a comprehensive sector training scheme; and

- Clarifying and duplicating the knowledge area of continuous improvement.

### Uses of KSM

The methodology associated with SKA calls for projects to be completed within 3 to 4 weeks. This means that maps will always be about the same size and similar complexity.

It is possible to study quite small, well-focused knowledge areas such as:

- What one needs to know in order to know how to conduct tests for BT toxin? or

Very much larger knowledge areas such as:

- What one needs to know in order to know how to plan and implement research and development strategy for biotechnology in Japan?

The claim that either of these could be done in the same amount of time may seem unrealistic. However, the difference between the two examples would be that the first study would identify considerable detailed knowledge, whilst the second study would uncover more strategic and less detailed knowledge. Both KSMs would still be correct and they would both satisfy the claim that they represented their designated knowledge area. Clearly one difficulty with the second study would be to get several experts together for an interview. However, if the logistics of the study could be solved the actual project would deliver what it set out to deliver.

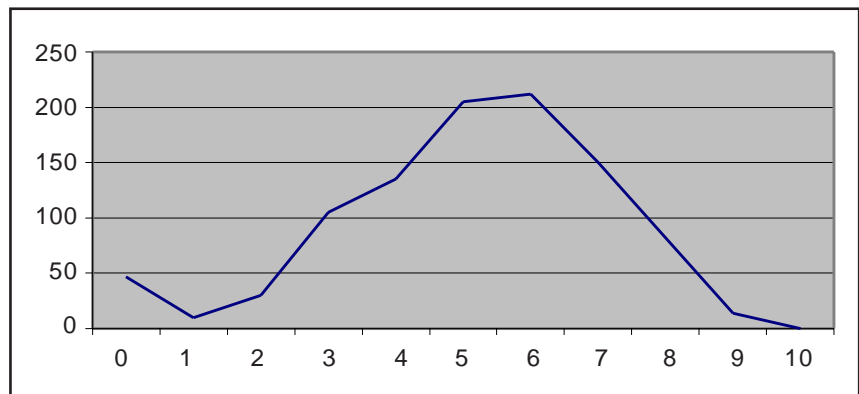
### Projects in incremental stages

If a project is to investigate a large knowledge area and the detail required is significant, then the approach would be to carry out several linked sub projects that each took between three and four weeks. This has several advantages:

- Interim results are delivered early in the full project;
- Managers can review interim results and control the subsequent direction of the project; and
- Managers can review, extend or curtail a project at any of the sub project mileposts.

If a single KSM project uncovers a smaller knowledge area that is interesting to the management group but requires further study, a smaller focused

Figure 6: Average project results for knowledge risk



study could be carried out on this particular knowledge area. The results of the smaller study could either be integrated with the original map or presented separately.

In a study of 'sales and marketing' in an engineering company, the knowledge area of 'negotiation' was identified. In order to clarify this after the initial work was complete, a smaller study of 'negotiation' was undertaken. This led to the creation of a smaller map (about 35 nodes) that had a separate value to the organization.

### Flexible application

There are three typical KSM study options (Figure 7). An organization may choose to study one particular knowledge area, creating a stand-alone map with associated data and knowledge recommendations based on the study analysis. The organization may elect to study more knowledge by carrying out several separate studies in the areas identified. Each of these would deliver separate maps, data, analysis and recommendations. However, since the work would be carried out sequentially, the managers of the project would have options at several interim stages to change the study emphasis or direction, to extend the study or to cut it short. The final option is that of a multiple integrated study. Initially one general global map of a large knowledge area would be created. From this, critical knowledge areas would become the target for separate full studies and in this way extend the depth and detail of the original study. Each of these studies would provide their own map, data, analysis and recommendations but would be integrated

because they would all be extensions of the same initial work. This option also shows that smaller focused studies can be made to clarify particular elements of organizational knowledge that has not been fully investigated during the previous studies. A smaller study like this would lead to a small KSM, and data, analysis and recommendations would be integrated with the initial study report.

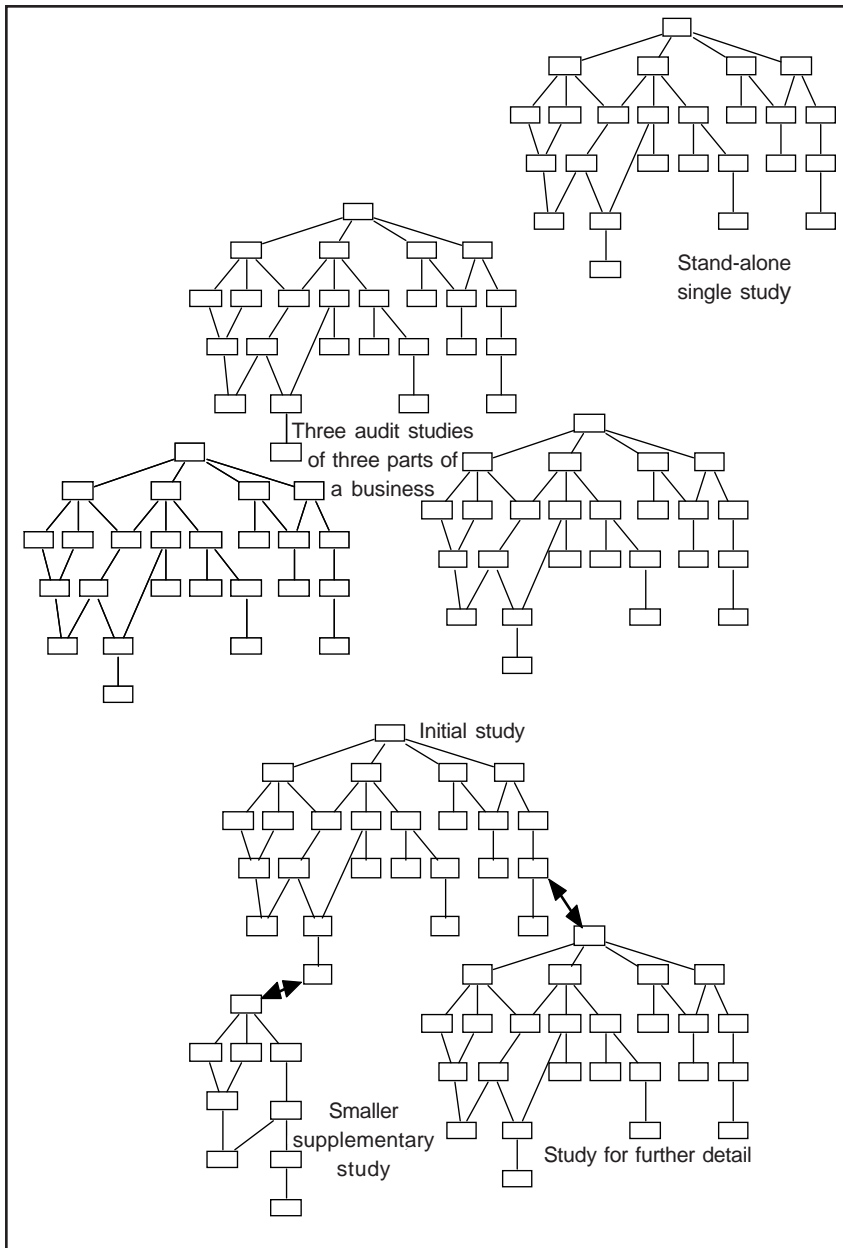
The options presented in Figure 7 are only suggestions for how the KSM methodology could be used to explore more or less of an organizational knowledge resource. In practice it would be advisable to take advantage of the flexibility of the methodology and allow the results of interim work to guide the disclosure of more of the knowledge resource.

### Diverse knowledge domains

Studies have been carried out in a very diverse range of knowledge areas covering technical, entirely non-technical and conceptual areas (Table 2). The claim is that if people need to know something in order to carry out a job role or function, then it is possible to analyse that knowledge resource objectively, using the KSM approach. Within a small business environment, this may include analysis of the knowledge of certain job roles, analysis of planning and logistics and analysis of the knowledge needed for the operation of the business. It would even be possible to study a knowledge-related question like 'What knowledge is needed in order to know how to create and implement a policy to increase the competitiveness of my company in the marketplace?'

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Figure 7: Typical knowledge study options



### Conclusion

This article shows that the term 'knowledge management', as it is generally used, is very broad and far reaching. Such views may not necessarily be incorrect, but they are sometimes unhelpful. The story of an engineering manager who wanted to know where his company was to begin using a KM approach highlights the problems that can arise. A more focused view of knowledge is adopted here, and the KSM methodology should be associated

with this more focused view rather than with KM in its entirety. It was also shown that if the knowledge that is in the heads of organization experts is to be managed at all, then several things must be made available to these managers.

The KSM methodology is focused on the creation of a knowledge structure map. This map shows elements of knowledge that are organized in the way that a human expert would be expected to acquire the knowledge. This

organization has been called learning dependency. A KSM is a visualization of a knowledge resource that can be shared by people that wish to discuss it and make decisions that may affect it. A KSM can provide information directly because of the way that it is constructed. A more complete SKA methodology also identifies some data that relates to the knowledge elements on the map and this data can also reveal issues about the knowledge resource that would be interesting to those that aim to manage it.

The methodology can be applied in several ways and its flexibility is enhanced by the fact that any size of project will have 3 to 4 week delivery points, where progress can be discussed, directions can be altered and interim results can be utilized. The methodology can also be used to justify the application of other elements of a broader approach to KM that may consume greater organizational resources. The results and observations delivered from a complete SKA project provide information and decision support to issues relating to a knowledge resource.

### Further reading

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