

# **Risk, Gap and Strength: Key Concepts in Knowledge Management**

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## **Abstract**

This paper argues that there are certain concepts within the general domain of Knowledge Management that have not been fully explored. The discipline will benefit from a more detailed look at some of these concepts. The concepts of Risk, Gap and Strength are the particular concepts that are explored in some more detail within this paper. A reason for describing these elements as concepts rather than terms is discussed. More precise definitions for the concepts described can provide management support about the knowledge resource in decision-making. Several function definitions for Risk, Gap and Strength are offered. Finally, the paper considers how these concepts can influence organisational knowledge management schemes.

**Keywords:** Knowledge - management; Risk; Gap; Strength; Knowledge-resource

## 1. Introduction

In 1994, a group of people from various business sectors in Lancashire, UK, began looking at business problems related to the inappropriate management of knowledge. They believed strongly (in common with other commentators at the time) that knowledge was an important and valuable organisational asset and that it needed to be identified, safeguarded and developed. At the time there were no standard practices or verifiable procedures to use for these tasks, so the group began with a basic question to be asked of each of the member companies: -

'If a system (computer system perhaps) already existed that could answer any questions that you may find useful concerning your organisation's knowledge resource, what questions would you ask of such a system?'

Many of the suggested questions referred to whether the organisations possessed adequate knowledge to cope with a variety of typical scenarios. The participants then realised that they needed some way of assessing this. If the system gave answers that cast doubt on the organisation's ability to cope with the scenario, then the managers wanted to have some sort of measure as to the size of the problem. Measures were subsequently evolved and the work was first published in [1].

Between 1995 and 1998, the group worked on a co-operative Knowledge Management project involving companies and organisations from various sectors. The development of solutions in this instance was driven by the problems and needs of contributors from business and industry and not by the availability or otherwise of any specific software tools. The focus was on a company's ability to manage knowledge and avoid the sort of problems that had been faced and that had prompted this collaborative work. By the end of the project a demonstrator system had been developed that embodied the needs and expectations of the companies involved. This system considered the supply of and demand for knowledge within the organisations as elements surrounding a central and quantifiable knowledge resource. The resource itself could be interrogated in various ways and visualised through maps and graphs. A more detailed description of this work is available in [1].

During recent years, there have been considerable developments in available approaches to knowledge management. Many of these options are based around the ability to archive, search and retrieve knowledge and information. Systems that facilitate these options are becoming more focused and offer a great improvement for organisational knowledge, over options available in 1994. The concentration has been on archiving of knowledge, accessibility of the knowledge and prevention of loss. These concepts refer to the knowledge resource and have been the driving concepts of many system developments. The main thing that they offer, as far as the knowledge resource is concerned, is protection or insurance.

There are however, other equally important concepts within the knowledge management domain that are based around the organisation's ability to manage knowledge as opposed to protecting it. Such concepts should correctly be related to the term 'manage' and the term 'knowledge'. There are those who would argue that any real attempt at managing knowledge is unlikely to lead to success and even the term 'knowledge management' itself has been described as an oxymoron. These people are wrong and have probably come to this conclusion because they have not investigated the concept of 'knowledge management' in enough detail.

This work does not set out to make any bold statements about knowledge management. Instead it intends to promote a more analytical approach by considering concepts within the domain of knowledge management that are more focused on the area of an organisation's ability to take control of and to directly manage its knowledge resource.

## **2. Concepts to Support Knowledge Management**

(As stated earlier), some of the important concepts that have emerged in a desire to increase the manageability of knowledge, relate to the ability to take informed decisions about how to proceed during the general management of change within the organisation. The central concepts that will be described in this work are those of Risk, Gap and Strength. We have described these as concepts rather than terms because they each refer to an approach and do not necessarily have a particular definition and utility.

### **2.1 Risk**

Risk can be associated with a knowledge resource in a variety of ways. The way risk is perceived, by those who have contributed to this set of projects, is in the sense that some pieces of knowledge rightly demand more urgent attention than others, because the organisation may lose this knowledge or in some other way make it unusable. Risk also infers that the item of knowledge that may be lost is important to the organisation and would cause problems if it were lost.

Risk is attached to the current state of an item of knowledge and risk within this context will change over time. It may be that reward or recruitment policies lower risk, or staff reduction policies increase risk. It could also be the case that changes in technology for instance, make some areas of knowledge less important and therefore less vulnerable to risk (less risky). An organisation can take action to reduce or remove risk by employing technology (to replace human skill and knowledge or to help in capturing the knowledge) or by taking some actions related to retaining and developing the human knowledge resource.

North West Water Ltd are now using computers to replace the knowledge once owned by experts.

- A computer case based reasoning system is used to give expert advice to employees working in the customer advice centre, so that they can deliver reliable information to customers.
- The complex task of scheduling hundreds of work tasks is now partially undertaken by a computer based scheduling system.

Risk is therefore directly affected by certain actions that are taken by an organisation, often in areas where the knowledge resource has not been considered.

There is then a risk associated with losing knowledge but there could equally be a risk associated with not acquiring knowledge when certain developmental plans are made. An organisation wishing to shift its direction may need to acquire knowledge as a result of this change.

### **2.2 Gap**

Gap is associated with the difference between the knowledge that an organisation needs to fulfil its obligations and the knowledge that an organisation possesses as a result of employing staff, or maintaining other forms of knowledge resource. It should be noted that possessing knowledge in the form of a computerised knowledge archive is not the same as being able to deploy and use knowledge to carry out organisational business.

Knowledge Gap can refer to knowledge owned and archived or it can refer to knowledge that is deployable. The situation, where a member of staff possesses some knowledge and,

because of promotion or redeployment, is no longer in a position to use this knowledge, is not uncommon.

Companies can therefore create knowledge gaps when some knowledge is made inactive, by moving members of staff to other posts (promotion or redeployment) where some of their knowledge is no longer used. Examples of this exist in North West Water Ltd but it is generally true of most companies. Some companies still see promotion to a management position as the only way of rewarding valued staff and paying them more. They may do this to preserve part of the knowledge resource, but in doing so, areas of important knowledge may become unused.

## **2.3 Strength**

It is often the case in life that someone knows the answer to a problem but does not possess the knowledge that would be necessary to derive that answer. That person could simply have met the problem before and been told the answer. It is difficult to associate this position with strength of knowledge (how much knowledge about a certain topic a person may possess). However, it is also common that there are degrees of knowledge acquisition, particularly in the case of human expertise, where a novice knows less about a certain topic than an expert. The novice may know enough to carry out certain tasks but the expert may be required for some more difficult situations. This is where the term 'strength of knowledge' can be applied. As the novice learns more about a certain knowledge topic, his or her strength could be said to increase.

Other terms could be used in this situation, but the concept of 'strength of knowledge' would be needed to correctly estimate a knowledge gap. An organisation may possess adequate knowledge of a certain topic but not possess that knowledge to a degree required to solve new problems or carry out different tasks.

A good example of knowledge strength is safety knowledge required by Operations managers at North West Water Ltd. A novice manager is continually asking for advice whereas an experienced manager has enough knowledge to run a treatments works safely. However, the experienced manager would not have enough safety knowledge to be able to solve problems at other sites

## **2.4 Why These Concepts Are Important**

If knowledge management is to be anything more than the straightforward integration of a fairly simple computer system then it is worth considering the component concepts that integrate to deliver the larger concept of knowledge management. It is argued here that three of the most important concepts to consider in relation to the knowledge resource are Risk, Gap and Strength.

Risk, Gap and Strength are important because they provide a way of supporting management decision making with regard to the knowledge resource. To manage knowledge effectively it is not enough simply to be able to store and retrieve knowledge. Storage and retrieval are about the existence and ownership of knowledge. Risk, Gap and Strength are about supporting informed decision making regarding knowledge and they are about the application of knowledge.

Other concepts are equally important. One of the most important issues regarding any work on knowledge is 'correctness', 'validation', or 'justified belief'. This particular concept really requires a separate study and will not be dealt with here.

### 3. Terms in Current Use

What are some of the most significant terms in current use and what do they mean within each context?

#### **(i) Explicit Knowledge**

Knowledge that can be represented in words, drawings, plans, equations, or numbers, which can easily be communicated between people.

It is possible to assess the strength of explicit knowledge by formal methods and then begin to assess any gaps that might exist with respect to time, and the risks associated with the knowledge.

#### **(ii) Tacit Knowledge**

Knowledge that is not easily visible and expressible. It is hard to formalise, making it difficult to communicate or to share with others [2].

In terms of Risk, Gap and Strength, tacit knowledge is very difficult to assess. It is important to acknowledge its importance, yet it is impossible to measure its strength unless it has been converted into explicit knowledge, a process that is difficult and time consuming if indeed it is possible at all. If it is possible to acknowledge the possibility of the existence of a gap in tacit knowledge, how is the gap to be assessed in the absence of explicit knowledge and how is it possible to plan how to fill that gap? The possession of certain elements of tacit knowledge may be the main reason why a company has competitive advantage, yet if its existence is not manifest, how can anyone realise that its loss would be a major setback and how can they assess the risk of losing it?

Nonaka and Takeuchi place great stress on the need to convert as much tacit knowledge as possible into explicit knowledge in order that the knowledge can be shared. This will have the additional benefit that strength of knowledge in individuals, gaps in their knowledge and the degree of risk attached to that knowledge can all be assessed.

#### **(iii) Knowledge Mapping**

This is a process that defines the structure of domains of knowledge and the links between different domains. This is highly important in assessing risk. A particular element of knowledge could be fundamental to several other vital elements or domains of knowledge. A company is potentially at high risk of having some of its vital operations weakened if that knowledge is lost or the strength of that knowledge begins to fail.

#### **(iv) Knowledge Auditing**

This assesses where knowledge is located, in what form and at what strength. It is a vital process in project planning. It can be the single mechanism of identifying gaps in knowledge. It enables the acquisition of additional knowledge through recruitment or knowledge creation strategies and activities.

### 4. Symbolic Definitions of Risk, Gap and Strength

The group associated with this work has been considering these concepts for several years and has attempted to use them in an integrated approach to knowledge management. It is difficult to develop a single functional definition for these concepts because a particular organisation may have a specific knowledge management strategy to be reflected in the

definition. For instance, should risk take into account all of the knowledge within the organisation or only that knowledge that can be mobilised.

This section offers some flavour for the debate that may surround the development of a working definition and in doing so, offers some starting points. Some specific definitions have been offered in earlier work [1]) but their application is rather general in nature.

#### 4.1 A Definition of Risk

An analytical approximation for a concept such as risk should be easily useable and fairly reliable within the context that it was derived. A fuzzy result such as 'very high', 'high', 'medium' etc may be desirable but even this would probably ultimately be derived from a numeric. A numeric can be used in fuzzy computation if desired or fuzzy rules can be applied to an analytical derivation. A numeric that has no ceiling value may be of little use. If risk is 1, 10, 100, 1000, 10000 etc, what does this imply. If a ceiling is to be applied then it may be simpler to assign values for risk of between 0 and 1 from the outset. Therefore, a result of 0 would imply no risk and a result of 1 would imply maximum risk.

One of the elements that may come into the computation of risk would be a factor that described the relative risk for specific age groups. The figure below shows a typical representation of this where risk is highest when people are more mobile within employment or are nearing retirement.

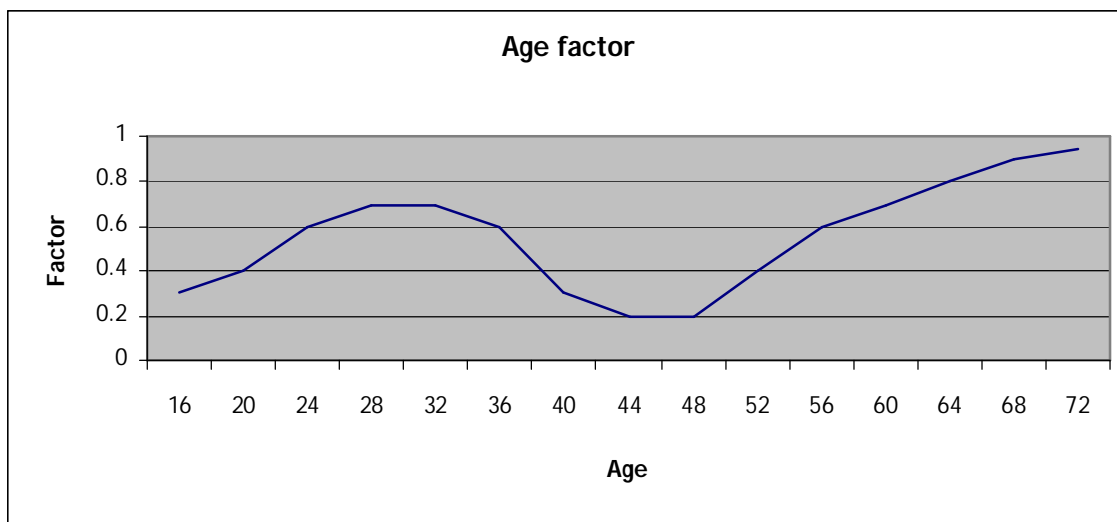


Figure 1: Age Factor Profile

A company may wish to adjust this, based on experience from specific regional influences, or may wish to have alternative charts for male and female staff.

The next consideration is how many people possess the knowledge in question and what sort of output this influence is to have. Consider the following terms:

- R** = Age Risk Factor (the numeric for each individual derived from the figure above)
- p** = Person number n
- N<sub>p</sub>** = Number of people (staff)
- N<sub>pk</sub>** = Number of staff with this knowledge
- A** = Age factor (an overall age factor for all staff)

An overall age factor could be computed as a simple average, taking into account the number of people who possess the knowledge only. The formulae below would compute this overall age factor 'A'.

$$A = \frac{\sum_{P=1}^{P=N_{pk}} R_p}{N_{pk}}$$

**Figure 2: Overall Age Factor**

An alternative to computing an average for the overall age factor would be to compute a product. Given that the risk factor for an individual represents the likelihood of that area of knowledge being lost, then the overall risk for the organisation is the probability of losing that area of knowledge from each individual. This would give a simple risk factor that may require no further computation.

If 'X' = overall risk factor for an area of knowledge 'K'

$$X = \prod_{P=1}^{P=N_{pk}} R_p$$

**Figure 3: Overall Risk Factor**

This function has been tested on data derived in a typical large manufacturing organisation and generally agrees with informed opinion about risk within the sector studied. It is also suggested that it does not really matter how many people in the company have the knowledge as long as the associated risk is sufficiently low. Whilst risk will always be relatively high where only a single individual expert exists, the presence of many experts in the organisation is not inherently any protection if they are all over 60, as they will all retire soon, so risk will still be high.

The result derived above would provide very low values where just one or two low values exist in the set of separate individual age numbers. This may be acceptable. Alternatively the computation could employ alternative approaches to representing the number of people who possess the critical knowledge. For example:

A straight line relationship of the form 'Y = Mx + C' would indicate that if no staff have the knowledge, the risk is 1 and if all staff have the knowledge the risk is 0 (or reflective of A).

$$X = A - \frac{A N_{pk}}{N_p} \quad \text{Where: } X = \text{The overall risk factor}$$

**Figure 4: Straight Line Relationship**

This function provides a straight line where the risk tends towards the individual age factor  $N_{pk} = 1$ . Clearly,  $N_{pk} = 0$  should be treated as a special case and is not catered for in this function definition. Risk is 0 in the case of  $N_{pk} = N_p$ . This is a problem since clearly this falls down if all the members of the organisation have high individual risk factors. This will be particularly true for small companies, where  $N_{pk}$  and  $N_p$  are both small. An example might be in a small e-commerce start-up where there are a high proportion of a small number of staff with key knowledge who are potentially highly mobile. In such a situation, risk will tend towards 0 whilst the reality is more serious.

An alternative definition for risk was derived in [3]. This definition relied on the availability of other matrices for separate knowledge items and combined them to form a measure of risk. Although this measure is quite different from those described here, it also provided a useful management support option within the context of the work being developed.

## 4.2 A Definition of Gap

Continuing the discussion of the form of result a function should provide, from section 4.1, a result for gap may need to include negative values. Positive and negative values would be able to represent surplus and deficit respectively. Therefore, in this case, we may wish to create a function that provides a result from -1 to +1.

The function defined below is derived from earlier work that, more simply, plotted separate graphs for knowledge needed and knowledge possessed on the same axes. This is a sensible way of approaching GAP and allows the user considerable flexibility in interpretation of the results. The formula below is extracted from this work to provide a single value for GAP, by dividing people knowledge (possessed) by project knowledge (required). This function has the problem that it does not provide the positive and negative values discussed above. However, when tested on real data from a major manufacturing company this formula can be shown not to work, since the use of averages leads to inaccurate predictions of gap. For example, where we have one person with strength 6 and one task requiring strength 7 and another requiring strength 3 then this function yields a value of 1.2, indicating no gap, whilst intuitively we would expect a gap to be indicated since total requirements > total capability.

$$G = \frac{\sum_{p=1}^{N_p} S_p}{\sum_{a=1}^{N_a} S_a} \cdot \frac{N_{pk}}{N_{ak}}$$

Where: S<sub>p</sub> = Strength for one item of Knowledge  
 N<sub>p</sub> = Person number n  
 N<sub>pk</sub> = Number of people (staff)  
 N<sub>pk</sub> = Number of staff with this knowledge  
 a = Activity or project number n  
 N<sub>a</sub> = Number of activities  
 N<sub>ak</sub> = Number of activities requiring this knowledge  
 G = Knowledge gap for one item of knowledge

Figure 5: Calculating Gap without Normalisation

Taking the ratio of total strength of people, over total strength required, yields values which can be interpreted better in terms of what is and is not a gap. However, this function did not provide a normalised resulting value and no positive and negative values were derived.

An alternative derivation that does satisfy the constraints stated above would be the following function.

$$G = \frac{\sum_{p=1}^{N_p} S_p}{N_{pk}} - \frac{\sum_{a=1}^{N_a} S_a}{N_{ak}}$$

Figure 6: Normalised Equation for Gap

In this case, 'G' will be greater than 1 if the gap is a surplus and less than 1 if the gap is a deficit because, in the former case, there will be more knowledge available from people than is required by projects or applications. Since values for 'S' will all be between 0 and 1, G will be a value in the range of -1 to +1. However, this formula also suffers the same problem as the first; in terms of the scenario posed there it would yield a gap of 0.1, indicating no gap, which is clearly not the case.

Another way to look at gap, is in terms of maximum strength available and maximum strength needed. For each item of knowledge

$S_{maxp}$  the maximum strength available from all members of staff

$S_{maxa}$  the maximum strength required by all (any) projects.

These values (for each item of knowledge) can be plotted on the same graph, providing a different but equally useful representation of knowledge gap.

An organisation should normally operate with a significant positive gap. Attempts to improve efficiency by narrowing the gap are likely to prove a risky business. However, large positive gaps in areas that have become secondary to the organisations main activities could be scrutinised.

### 4.3 A Definition of Strength

Earlier experimental work in this area used a single number from 0 to 10 to represent strength. Where 0 is no knowledge and 10 represents full and complete knowledge. We also used text phrases during elicitation to substitute for the numeric scale.

<b>Numeric Scale</b>	<b>Text Phrase Substitute</b>
< 2	Simply knows of the concept and some basic facts
2 - 4	Understands the basic principles
4 - 6	Has a general functional knowledge
6 - 8	Has a full working knowledge
> 8	A full working knowledge plus extensive problem solving and development capability.

**Table 1: Text Phrase Substitute for Numeric Scale**

As the discussion in sections 4.1 and 4.2 show, it would be better to use values for strength between 0 and 1. The values in the table above should therefore be divided by 10. Unfortunately, the concept of strength of knowledge is more demanding than the simple allocation of a numeric score. The elicitation of strength to support a knowledge management scheme is also difficult. One problem is to decide upon whether the strength that is being represented is relative to the knowledge needed by the organisation or relative to the knowledge known by the human race. In the former case, there will be a full spread of strength values within the organisation for most items of knowledge. In the latter case, strength is always likely to be on the low side and therefore the values will be less discriminating.

The terms used to determine a value for strength are more useful. At each stage, a person can compare his or her knowledge with a definition.

Strength of knowledge is a useful concept in supporting the allocation of staff to various tasks. It is possible to adopt different strategies but these will reflect on the calculation of

gap. In [3] the strategy adopted is one of mapping the detailed structure of knowledge so that the only valid strength is a full understanding.

## 5. How Concepts Influence Knowledge Management

Although knowledge management has become a broad school incorporating almost everything from document storage to Applied Artificial Intelligence, it can still form the framework for management decision-making concerning the knowledge resource. The argument presented here is that a richer and more analytical approach to the subject can lead to greater reward. Considering some of the concepts associated with knowledge management in more detail will help organisations define their own needs, rather than take the ready to wear solution that never quite fits.

### Risk

Included in the consideration of risk is the possibility that knowledge already held within the organisation will not be applied simply because the system and culture are not in place to ensure its application. Consider the provision of such systems [4] in which a salesman, if unable to answer a question from a customer by using the existing knowledge bases, is able to post a query on the bulletin board (called a 'forum'). Usually the request for help is picked up by anyone who has the expertise in the related subject area. If, however, the request is unattended for a few hours, a forum specialist picks up the query, identifies the specialists and tries to attract their attention to deal with the query. There is also a team of experts with the relevant industrial experience who volunteer to be listed as section leaders, who help answer requests and prepare weekly summaries. If such a system did not exist, then it is likely that expert knowledge could remain untapped or crucial. The risk is of inaccessibility rather than of loss or decay of knowledge.

### Gap

Many schemes for acquiring and codifying knowledge rely on highly formal methods of knowledge acquisition, often for the purposes of formulating rule based or object oriented systems, for precise answering of queries. Most of these systems require completeness of information and rules structures before they are released for implementation. A gap is therefore perceived between the knowledge that exists or has been codified and what is required for a completely functional system. 'Coupling IT systems that rely on incomplete but timely information (rather than complete but old information) with people who can interpret and make sense out of it will give companies significant competitive advantage' [5].

Thus, although a gap exists, it is in some cases mitigated by the resourcefulness of those who are charged with the responsibility of solving the problem. In such cases, they are able to synthesise new knowledge from existing knowledge.

### Strength

The preceding definitions of strength of knowledge have focussed on strength of individual knowledge. However, it can be very difficult to measure or even tentatively assess much of a person's knowledge, particularly tacit knowledge (knowledge which cannot easily, if at all, be articulated). Often a person will use language laced with jargon that can lead to misinterpretation or lack of understanding by the assessor of what the person is trying to say. Faced with this it is difficult to assess the strength of a person's knowledge, yet in Knowledge Management, assessment of strength is a fundamental requirement leading to an ability to plan the present and future knowledge requirements in a company or project

Shadbolt et al [6] report an interesting project in capturing knowledge using structured knowledge acquisition techniques. Their training programme involved not only formalised knowledge acquisition techniques, but also extended this into representing knowledge in web page format. In doing this, they discovered that many relative novices in the domains learned significant amounts about the domains, as they designed the web pages, following the setting out of concepts and knowledge structures in PC PAK. Perhaps such a highly productive approach enables people to formulate a common structure and terminology in the domain, and to be assessed by their colleagues as to the strength and breadth of their knowledge of the domain.

## 5.1 Asking the Right Questions

Many organisations are not used to asking questions about their knowledge resource because there have previously been no answers available. Any management of knowledge that took place was implicit and resulted from the management of other things. More recently, system vendors are offering a broad range of options that can perform a range of functions. It is up to the organisations to at least consider what they need and the reasons they need those services, before attempting to implement a knowledge management strategy. This involves asking questions that may previously have been unthinkable due to the availability of systems and services.

An organisation would certainly want to ask questions about protecting, preserving and developing its knowledge resource. It would want to ask questions about the mobility and availability of knowledge within the organisation. The organisation would also want to consider the application of knowledge and how the knowledge resource may influence other decisions such as outsourcing, acquisitions, down sizing and new products or projects.

Within these questions, the concepts of risk, gap and strength are key components. For instance, a detailed study of knowledge gap within an organisation may lead to new opportunities that can take advantage of available and unused knowledge.

## 6. Conclusions

Knowledge management is more than creating a knowledge archive and invoking retrieving mechanisms. Those who say that organisational knowledge cannot be managed are wrong. However, it may not be easy to design and implement a knowledge management policy that serves an organisation's needs in full. There are two important considerations to face when considering a knowledge management scheme.

- 1) What do we need to know about the knowledge resource in order to manage it effectively? How will knowledge management improve the organisation?
- 2) What exactly is knowledge and how do we want to manage it?

The first point is about asking the right questions concerning the organisation's knowledge resource before designing the framework for a knowledge management scheme. The second point is about knowing what it is the organisation is going to manage and understanding the management approach to this task.

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