Can We Codify Professional Knowledge?

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INTRODUCTION

The management of organizational knowledge has become an issue of immense strategic and economic importance. There are many types of organizational knowledge including administrative, professional, structural and relationship knowledge (Roos and Roos 1997). Here, we will mostly confine ourselves to the issue of *professional knowledge* (PK) which we define as the knowledge required to perform a professional task such as auditing a company, designing a shock absorber or preparing a contract. There has been little research in this area and our understanding of such knowledge is still vague (Haider 2003).

Most of the knowledge management literature is concentrated on the soft techniques of managing knowledge such as KM strategies, knowledge transfer mechanisms, cultural issues etc (Amaravadi 2005). But as IS professionals, it is also incumbent on us to address the issue of technology support. A study of KM practice by the American Council on Productivity concluded that without an information technology model, KM efforts will end up in chaos (Amaravadi & Lee 2005). Most of the available KM technologies provide passive support in the form of ability to store knowledge, but they fall short in retrieval. Query capabilities based on keywords are contingent on entering the correct keywords. In addition, precision and recall could be affected by large volumes that are expected in KM systems. Ontological methods are intended to address this problem, but have several limitations. They are tailored to a particular domain and have limited ability for question answering (Anonymous 2007, Davies et al. 2003). Artificial Intelligence based approaches are more promising in this respect, but here also there are classic stumbling blocks, the most challenging of which is knowledge codification. Codification has been addressed primarily in the context of knowledge-based systems which use rules and frames. The domain models are classified as shallow rather than deep. For example, an expert system for stock selection will be able to explain rules used to select stocks, but will not know the difference between a common stock and a preferred stock. To properly manage PK requires deeper models for which we have to rely on logic or semantic nets. A representation scheme known as AEI-3 to manage administrative knowledge has been proposed in the literature (Amaravadi 2005). In this paper, we will first discuss the nature of PK, introduce AEI-3 and use it as a platform to model professional knowledge.

THE NATURE OF PROFESSIONAL KNOWLEDGE

There is a paucity of literature concerning organizational knowledge and especially more so in the case of professional knowledge. Lacking empirical evidence, we will hypothesize some characteristics based on samples from Luthardt et al. (2005). In their foreword, they state "The American Institute for Chartered Property Casualty Underwriters and the Insurance Institute of America are committed to *expanding the knowledge of professionals* in risk management, insurance, financial services, and related fields through education and research." Thus their comments establish the rationale for using the text as an example of explicit professional knowledge. A few representative samples are illustrated in *Table 1*.

Instances of PK in the insurance domain appear to exhibit one or more of the following characteristics:

a. They elaborate or define the concept as (*item#5)*, The concepts are both *concrete* such as "automobile," "property," and "underwriter" as well as *abstract* such as "loss" "depreciation," and "indemnify" but tend to be predominantly abstract. Abstract concepts are usually defined in terms of other concepts. For example, *mortgaged asset* is defined in terms of *asset.*.
b. They elaborate or define the concept with additional conditions or restrictions,
c. They describe structural relationships (*item#1*).
d. They describe axiomatic, mathematical or logical relationships (*item#4*).
e. They describe abstract and complex relationships such as an obligation to act in a certain way (*item#7*), f) They describe events, actions, objectives or policies.

It is the arbitrary and complex manner in which concepts, relationships and conditions are combined that makes knowledge engineering for PK a daunting task.

KNOWLEDGE ENGINEERING FOR PROFESSIONAL KNOWLEDGE

The objective of the representation is to serve as a foundation to manage professional knowledge. Since visual representations facilitate this task, we are committed to one that has a graphical notation. Additionally, the representation ought to provide sufficient storage mechanism or *expressivity* so that knowledge may be stored and queries, answered (Davies et al. 1993). Here, we will focus only on intensional or conceptual knowledge. The ability to *draw inferences* is a potential ancillary benefit.

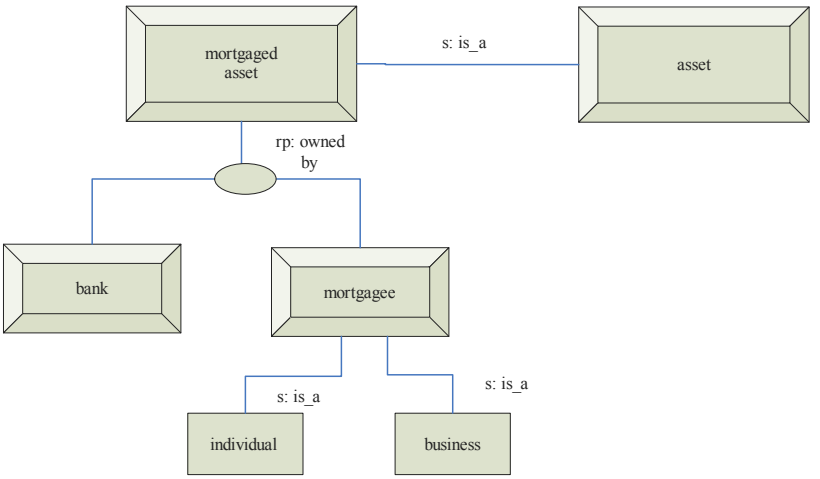
A method to represent administrative knowledge known as AEI-3 was recently proposed. AEI-3 is based on semantic networks and makes use of two node types

Table 1. Samples of professional knowledge (Luthardt et al. 2005)

Item#	Example
1.	Property includes real property and personal property. Real property is land, buildings and other property attached to it. §1.6.
2.	A liability loss exposure is any condition or situation that presents the possibility of a claim alleging legal responsibility of a person or business for injury or damage suffered by another party. §1.6.
3.	Types of insurers include stock insurers, mutual insurers and reciprocal exchanges. §1.11.
4.	Underwriting expenses include acquisition expenses, general expenses, premium taxes and licenses § 3.8
5.	Contingent commission is a commission that an insurer pays, usually annually to an independent agency based on premium volume and profitability of the agency's business with that insurer § 4.15.
6.	Depreciation is allowance for physical wear and tear or technological or economic obsolescence §6.14.
7.	A contract of good faith is an obligation to act in an honest manner and to disclose all relevant facts §7.7.

Note: "§" refers to section numbers, there are no page numbers in the cited reference.

Figure 1. Modeling concepts with AEI-PK



("class," "instance") and two link types ("structural," "descriptive.") to represent administrative knowledge. In this respect, it is similar to protégé a public domain ontological project (anonymous 2007). AEI-3 is designed to represent large volumes of routine knowledge such as "Manugistics is a client of BSS" or "the van leaves BSS at 11:00 am." It overcomes some of the traditional limitations of semantic nets such as tractability, separation of descriptive and structural knowledge and the ability to handle large volumes (Amaravadi 2005) but is a minimalist design owing to the relative simplicity of administrative knowledge. The basic ability echoed in all conceptual models including AEI-3 is to model concepts and relationships. In view of the nature of PK we will impose further requirements on the representation scheme.

Complex concepts such as premium are defined in terms of other concepts such as insurance coverage which may themselves be complex. Therefore it is convenient to refer to such concepts without having to redefine the entire concept, leading to the requirement of *supporting abstractions*. Abstractions support modularity and reuse. Another issue that arises is the *multiplicity* of definitions. A single concept has alternative definitions making this a requirement as well. For example, the value of an asset could be defined by its market value or by its book value. *Relationships* among concepts can be simple (concrete) or complex (abstract). A class-subclass relationship is an example of a simple relationship. Abstract relationships are complex because they are qualitative, involve multiple concepts and involve complex conditions. Thus the second requirement is to model both simple and complex relationships. We will not attempt to model mathematical and logical relationships (>, <) here because they do not lend themselves to visual schemes. Using AEI-3 with enhanced semantics, we will explore the question posed by this research.

AEI-PK

We will refer to our scheme as AEI-PK. Following the discussion from the previous section, the scheme will have constructs to model concepts and associations. Unlike in AEI-3, we do not have classes and instances. Instead we have concepts which are either atomic or complex. The former are depicted by rectangles while the latter by double-walled rectangles. At the present time, there does not seem to be any satisfactory way to demarcate concept boundaries except by drawing dotted lines around it. AEI-3 supported only one type of structural relationship and any number of descriptive relationships. In contrast, AEI-PK has an additional type of structural relationship for "part-subpart" relationships, abbreviated as "p-sp." Instead of descriptive relationships, we have "p:" links to depict properties of a concept and "rel" links to depict non-structural type of relationships. Some properties are required properties. Consider, *the board of directors consists of elected officials*. Here the required property is that officers must be elected. Such properties are depicted by "rp:" link types.

Testing AEI-PK with examples of knowledge indicated that well defined knowledge items are readily modeled. For example a mortgaged asset is defined as an asset for which some percentage is owned by a bank i.e. rest is owned by the mortgage. As shown in Figure 1, *mortgaged asset* is connected by "s:is_a" structural link to *asset*. It has the required condition that it should be partially owned by a bank. There is an "rp: owned by" link between the *mortgaged asset* and *owners* which in this case are both the *bank* and *mortgagee*. Note the use of ellipse for multiple arguments. A more abstract concept such as *insurance coverage* is difficult to represent. *Insurance coverage is the legal obligation of an underwriter to compensate the insured in the event of a loss.* The concept is challenging because it involves a number of abstract concepts such as "legal obligation," "compensate," and "loss." It needs to be represented as three assertions:

Event1: insured suffers loss
Event2: underwriter compensates insured
Axiom: If Event1 then Event2 with the restriction that compensation <= loss amount.

The representation can deal with depicting Events1 and 2 individually, but cannot deal with the idea that Event1, 2 and the axiom together define insurance coverage. It also fails if we have to define conditions. The issue becomes even more important when there are other ideas such as *salvage rights* that require using part of the knowledge about insurance coverage: Event1 with the restriction that it is a property loss and Event 2 and an additional fact that underwriter owns damaged property.

CONCLUSIONS

We have started with AEI-3 and attempted to add additional link types such as "p:" "s:p_sp" "rp:" in order to enhance the semantics. Even with certain simplifications, the modeling task is awkward. The main stumbling block is that abstract ideas are inherently complex and cannot be easily represented. The challenge arises from ideas being defined in terms of other complex ideas and having conditions/relationships, both of which can also be complex and interrelated. It is also difficult to represent PK without mathematical and logical foundations both of which are difficult to achieve in graphical form. The answer to the question posed by the research, "can we codify professional knowledge," is "not yet." Further research is required in understanding the nature of abstract ideas and in expressing conditions.

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