

## Teaching tunnels: knowledge management and on-line databases

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**ABSTRACT:** We present the structure and the use of a knowledge database of tunnel for teaching purposes. This database, called KBT, is complementary to the e-learning tool DIDACTU. The development of KBT will give an important help to teaching providing text and images to illustrate courses.

### 1 INTRODUCTION

During its last meeting, in Singapore at ITA/AITES symposium, the Working Group n°18, that works for providing new materials for teaching undergrounds works, decided to improve its action for teaching tunnels giving to teachers and students new tools by the way of the WEB. This paper describes one aspect of these efforts about a database named KBT.

Teaching is a way for the transmission of the knowledge from elder to younger. In a prospective approach of knowledge about tunnels we can define knowledge under three forms that are:

- Concepts, for which we can use glossaries and ontology's.
- Conceptual relations that we find in text (granite IS A rock) and that we find in algorithms (calculation codes),
- Selected cases for case based reasoning (in fact a combination of the two previous item).

An e-learning tool, the educational software DIDACTU that was presented at the Singapore conference (Faure et al, 2004), is a tool for the transmission of knowledge. We can find in it a glossary, some on line codes, texts in which rules are expressed in usual language, not with the usual formalism of logic, and the description of some cases of tunnels.

This tool appears as an important step in knowledge management, but not the last one, because there is not a strong formalism for these three kinds of knowledge and systematic and automatic acquisition of knowledge is not possible. It is a little more than a course in which the professor selects and presents documents, and as it is done with usual navigation tools, the use of this knowledge depends mainly of the user. (Faure, Thimus, 2004)

In a brief first part, this paper presents the bases of a classification of concepts used in tunnel works, with a clear definition of each one. Some possibilities of this formalism are mentioned.

In a second part, as it was decided in WG 18, we describe the KBT database of tunnel cases that we have developed and implemented through the net. The selected cases of tunnels must have an interest for teaching and even they are not numerous, the singularities of the cases must be described with accuracy. So, for a better use of the database, KBT is closely linked with the e-learning tool DIDACTU.

A third part describes the use of KBT.

### 2 CLASSIFICATION OF CONCEPTS USED FOR TUNNEL WORKS

Knowledge is expressed with words, so knowledge representation begins with words, said Sowa, (Sowa,

2000). Words are ambiguous, so we must express them with definitions in order to resolve their ambiguity. A word and its definition is what we call a “concept”, which refers to every and each item which matches the definition and – hence – the name. So, that we call concept is each thing and tool clearly identified in tunnel works. A jumbo, a beam, a computer code, a theory are concepts. The identification of these concepts is done by automatic language treatment running on chosen texts. An expert of the world of tunnel give definition for any concept and set it in a tree that checks subsumed relations (IS A) between all concepts.

The same process applies to various relations between concepts, mainly aggregation (IS A PART OF); the sum of these various trees, featuring the same concepts, offers a kind of common reference for concepts organisation in the field of tunnels. This helps to define some conceptual neighbourhoods, which, we hope, will allow some reasoning in a next future or for the educational software DIDACTU a new kind of navigation and for the knowledge base KBT a new query mode.

This part is still under development, and shall be presented next symposium.

### 3 MAIN CONCEPTS LEADING TO THE KBT DATABASE

#### 3.1 *What is an “interesting” tunnel and for what use?*

When teaching, examples are used for showing some feature or some problem that may occur during the

construction of a tunnel. Interesting tunnel are those where something unexpected occurs and where an original solution must be founded. For a teacher, but also for a young engineer, the discussion that can develop when showing the case is usually fruitful, and the student will remember the causes of the incident and its remedial. Several cases, well chosen, would be an appreciated help when teaching, or for new engineers, who wish to upgrade their own knowledge.

#### 3.2 *What were the previous works about databases?*

The previous works about on-line databases are numerous, and the authors contributed to these progresses (Faure et al, 1992). A recurrent subject of discussion about that kind of database is the property of the data. In the WASSS project (Faure, 1999), (Faure et al, 2001) we have decided to share the data into two parts, the first one that we call meta-data, which are information on the data, and the data itself. The meta-data are access free, but the detailed data remains under the acknowledgement of its owner. It is quite heavy and we worried about the management of the rights (Faure et al, 2002). For the actual release of KBT we skip that approach and we think that all data must be free for a gentle use of the database.

One other aspect of that kind of database is the feeding of it. Preparation of a case must be very light, if we want obtain numerous cases. We observed that for a men knowing correctly the case he want to display, the capture of the structured data all must no be longer than few minutes, and we conceive KBT as to agree with this constraint. The building of the web



Figure 1. First page when entering DIDACTU with the link to KBT.

pages presenting the case may be longer, but as the form is completely free, it is easy for the writer to describe his case generally already existing on another format, and he can use images, maps, sketches and also web links. The WEB page(s) is written in his own language, as KBT allows the use of several languages.

## 4 THE ON-LINE KBT DATABASE

KBT means: "Knowledge data Base for Tunnels". The word knowledge is used in its full signification, that is to say, that we want collect not only information about tunnel, but also reasoning about it when an incident occurs. For this, when filling the database four kinds of data are asked in a chosen language among French, Italian, Spanish, German and English.

### 4.1 What data for KBT?

#### 4.1.1 General data about the tunnel

These data are asked in a form, the user must fill:

Name of the tunnel

Country

GPS coordinates of the two entrances

Owner of the tunnel

Builder (name of the company)

Number of tubes

Mean declivity

Shape of section (circular, horse shoe shape, elliptic, rectangular...) (a combo list)

Length of the tunnel

Excavated volume

Name of the road (railways) that uses the tunnel

Date of the opening

Date of writing the form

Name of the writer

Used language for web pages.

References: other documents in which information about the tunnel can be found.

Internet address: where the tunnel is presented, if any.

#### 4.1.2 Meta knowledge

It is a list of questions with answer: "yes or no". If the feature is present or developed in the web pages the writer clicks on the yes button. The first questions are about:

General map,

Profile,

Geotechnical report,

Calculus references,

Photos,

Experimentation or particular study,

Other: if any other kind of information, one line for answer.

The other questions concern the following themes, if they are developed or not in the web pages. Those themes are:

Do you meet difficulties with a weak soil?

Do you have problems with water?

Do you have problem during building?

Do you have problem of subsidence?

Do you have problem with the driving of TBM?

What other problem do you have for this tunnel?

(One line for answer)

#### 4.1.3 Some information about the works and the design

All these information are predefined and the writer has only to click on combo list. This information will be used for querying the database, and is stored in an access like database. As a tunnel is a linear structure this information is required three times, for each portal and for the most difficult section.

#### I) Caractéristiques générales de l'ouvrage (obligatoire):

Nom de l'ouvrage	[ ]	Pays	[ ]
Coordonnées GPS du début de l'ouvrage	lat [ ] ° [ ] ' [ ] "	Coordonnées GPS de la fin de l'ouvrage	lat [ ] ° [ ] ' [ ] "
	long [ ] ° [ ] ' [ ] "		long [ ] ° [ ] ' [ ] "
	z : [ ] [m]		z : [ ] [m]
Maitre de l'ouvrage	[ ]	Maitre d'oeuvre	[ ]
Nombre de tubes	[ ]	Pente moyenne [%]	[ ]
Forme de la section	[ ] <input checked="" type="checkbox"/>	Longueur de l'ouvrage [m]	[ ]
Section excavée [m <sup>2</sup> ]	[ ]	Itinéraire	[ ] <input checked="" type="checkbox"/>
Date de saisie [jj/mm/aaaa]	[ ] [ ] [ ]	Date de mise en service [jj/mm/aaaa]	[ ] [ ] [ ]
Rédacteur	[ ]	Références	[ ]
Adresse(s) site internet	[http://]		[http://]

Figure 2. Part of the form for entering general data.

KBT presents combo lists for:

*Geological stage for soil:*

(mainly rock as soil is “quaternary”)  
Cambrian (Cambrien),  
Carboniferous (Carbonifère),  
Cretaceous (Crétacé),  
Devonian (Dévonien),  
Eocene (Eocène),  
Jurassic (Jurassique),  
Lias (Lias),  
Miocene (Miocène),  
Ordovician (Ordovicien),  
Pliocene (Pliocène),  
Precambrian (Précambrien),  
Quaternary (Quaternaire),  
Silurian (Silurien),  
Trias (Trias).

*Lithology:*

a short list chosen by some tunnel experts.  
Amphibolite, (Amphibolite),  
Andesite, (Andésite),  
Anhydrite, (Anhydrite),  
Slate, (Ardoise),  
Clay (Argile),  
Clayshale (Argile schisteuse),  
Claystone (Argilite),  
Arkose, (Arkose),  
Basalt, (Basalte),  
Limestone, (Calcaire),  
Calcareous shale, (Calcschiste),  
Coal, (Charbon),  
Cellular dolomite, (Cargneule),  
Cinérite,  
Conglomerate, (Conglomérat),  
Cornéenne, (Cinérite),  
Chalk (Craie),  
Diorite, (Diorite),  
Dolerite, (Dolérite),  
Dolomite, (Dolomie),  
Gabbro, (Gabbro),  
Gneiss, (Gneiss),  
Granit, (Granite),  
Granodiorite, (Granodiorite)  
Sandstone, (Grès),  
Gypsum, (Gypse),  
Halite, (Halite (sel gemme)),  
Felsite, (Leptynite),  
Brown coal, (Lignite),  
Marble, (Marbre),  
Marl, (Marne),  
Calcareous Marl, (Marno-calcaire),  
Siliceous limestone, (Meulière),  
Micaschist, (Micaschiste),  
Microgranite, (Microgranite),  
Pelite, (Pélite),

Peridotite, (Péridotite),  
Pumice, (Ponce),  
Quartzite, (Quartzite),  
Rhyolite, (Rhyolite),  
Sand (Sable),  
Schist, (Schiste),  
Serpentinite, (Serpentinite)  
Syenite, (Syénite),  
Sylvinitic, (Sylvinitic),  
Tephra, (Téphra),  
Volcano tuff, (Tuf volcanique),  
Trabertine, (Travertin).

*Digging system:*

Drill and blast, (Abattage à 1 explosif),  
TBM, (Tunnelier),  
Roadheader, (machine à attaque ponctuelle),  
Digger, (pelle mécanique),  
Rock breaker, (brise roche).

*Soil treatment:*

Freezing, (Congélation),  
Jet-grouting, (Jet grouting),  
Injection, (Injection),  
Water lowering, (Rabattement de nappe).

*Mucking system:*

Rails, (système à rails),  
Lorries, (Camions ou charge et roule),  
Conveyor, (Bande transporteuse),  
Pipe line, (Pipe line).

*Reinforcement during digging:*

Bolts on front face, (Boulonnage du front),  
Pre-mill shell, (Voûte pré découpée),  
Fore polling, (Poussage de tubes),  
Umbrella arch (Voûte parapluie),  
Umbrella arch et pre-cutting, (Voûte parapluie et pré découpage).

*Support:*

Formed concrete, (Béton coffré),  
Extruded concrete, (Béton extrudé),  
Sprayed concrete, (Béton projeté),  
Bolt, (boulon),  
Bolt + Sprayed concrete, (Boulon + Béton projeté),  
Rib, (Cintre),  
Rib + sheeting, (Cintres + Blindage),  
Rib + Sprayed concrete, (Cintres + Béton projeté),  
Rib + bolt + Sprayed concrete, (Cintres + Boulons + Béton projeté),  
Concrete segment, (Vousoir béton),  
Metal segment, (Vousoir métal).

*Structure:*

Vault, (Voûte),  
Cut and cover, (Tranchée couverte),

Slurry wall, (Paroi moulée).

*Portal:*

Embankment, (Remblai),

Without embankment, (à l'air libre),

Retaining wall, (Soutènement de paroi),

Safety net, (Filet de protection).

*Lining:*

Reinforced concrete, (Béton coulé armé),

Formed concrete, (Béton coulé non armé),

Sprayed concrete, (Béton projeté),

Massonery, (Maçonnerie),

Concrete segment, (Vousoir béton),

Metal segment, (Vousoir métal).

*Waterproofing:*

Global watertightness system, (Dispositif d'étanchéité global (DEG))

Liner on the back of the vault, (Géomembrane en extrados),

Drain + Cavity membrane, Drain + géoespaceur),

Waterproof coating on the vault, (Enduit hydrofuge en intrados),

Bituminous sheet on the back of the vault, (Membrane bitumineuse en extrados),

*Water outlet, (Exhaure)(a number with unity),*

*Max depth of the tunnel (overburden), (Profondeur maximale du tunnel).*

#### 4.1.4 Web pages

The web page(s) that we can add is really the transcription of the knowledge, the writer want to deliver about this tunnel. A photo, a sketch or a few lines may express this knowledge very simply, but it can also be developed, if necessary, on several web pages. All these pages are linked to the previous data.

#### 4.1.5 Commentaries

The writer can express there his opinion, or the reason why he find this case worthy to be stored and shown to all people, and why it can be useful for teaching.

### 4.2 The use of the database KBT

#### 4.2.1 How to fill the database?

Who wants to present a case inside KBT, must first build freely the web page(s) presenting the case.

After that, he goes on the web site of KBT, and fills the form we describe upper. After that he send by e-mail

the web page to the web master of KBT. The page is read and the web master put all the information in KBT. For any problem detected by the web master an exchange of mails will solve it, the data are and remain under the responsibility of the writer and the web master will never modify anything without the acknowledgement of the writer.

#### 4.2.2 How to query the database KBT?

Directly from a list of cases or from a map where all cases are displayed with icons, the reader can reach any case.

By a serial query language (SQL like), the reader makes a choice of all tunnels corresponding to his criterias.

## 5 CONCLUSION

KBT appears as an easiness to manage database, a powerful complement to DIDACTU, and as it is in all main language, we hope that it will grow quickly.

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