KNOWLEDGE SYSTEMS SUPPORTING EDUCATION AND UNIVERSITY COOPERATION

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ABSTRACT

The article presents the knowledge-based systems developed by using the ATOM software and the experience with their application for teaching and university cooperation. The theoretical bases of the solution are Topic Maps; a software tool is introduced and individual cases of knowledge-based systems are described. The article reflects the years of experience in the cooperation of the knowledge-based systems development.

KEYWORDS

Knowledge System, education, university cooperation, Topic Maps, ATOM, MENTAL, MilUNI.

1. INTRODUCTION

The joint article of the software company representative, the ATOM (Aion Topic Maps Engine) software (SW) creator, and the representative from a university environment presents several years of experience in the creation of knowledge-based systems and an indication of their potential to support teaching and university cooperation.
Here are some examples of the use of the ATOM software for creating knowledge systems, which have become the source of our experience and lessons learned as well as the cornerstone for further application in the university environment.

1.1 Digital encyclopaedias

In the past, encyclopaedias were the carrying projects of AION CS, Ltd. The most important Czech encyclopaedias were digitized in the range of many tens of thousands of pages [1] and were presented in various forms - from CD versions, via web applications to content management systems intended for the preparation of new encyclopaedias.

A number of techniques and applications, from special XML schemas to innovative networking of information, have been developed for this reason. These techniques have been gradually transformed into standard Topic Maps in the ATOM SW environment. The main advantage of the ATOM environment in terms of encyclopaedia makers is the repeated use of information for typesetting of books and creating of web or mobile applications.

1.2 MENTAL

The research defence project "Knowledge Management of the ACR NEC - MENTAL" [2] resulted in a Knowledge Management System (KMS) whose aim was "to carry out the analysis of knowledge approaches, ontologies and ontology languages, and to assess their suitability for using them in the Army of the Czech Republic (ACR); to evaluate the security state solution; to formalize the ACR Network Enabled Capability (NEC) strategy and develop a vocabulary of NEC terms; to propose a methodology for knowledge systems development in the ACR; to elaborate a knowledge system proposal in the ACR NEC administration and to implement it." [8]
The accomplishment of the project was assured by successful cooperation of researchers from the University of Defence with the AION CZ (www.aion.cz) and TOVEK (www.tovek.cz) companies.

1.3 „Laws for people" – a new concept of the legal system

The service Laws for People brings the users the regulations of the Law Digest of the Czech Republic in the current consolidated version [3]. It is accessible for free, without registration, with easy use, simply "for people", yet with many unique features allowed by the ATOM SW application.

For example, there are inside efficient search with faceted filtering of results or an assistant for creating citations. The service Laws for People was launched in the summer 2011 and has been visited by unexpectedly large audience in the Czech and Slovak Republic.

1.4 MilUNI

The aim of the knowledge system Military Universities [4] is to provide an explicit platform for the cooperation of military universities in teaching, research and exchange of teachers and students.
The system contains information on universities, their structure and focus, members of universities; it includes publications from conferences in full text so that they can be studied or cited by partners. The system includes data on study and research activities and is publicly available at http://atom.miluni.eu; it will be complemented by a public Web interface application in the near future.

1.5 Seminar of the subject called Competitive Intelligence

Competitive Intelligence deals with collecting information obtained from public information sources, their evaluation and presentation. It is a wide variety of methods and procedures based on inf. management, knowledge management and psychology, whose purpose is to build an effective bridge between knowledge owners and decision makers.
The knowledge-based system was successfully used to education of the subject in 2010-2011 at the University of Economics in Prague and the Faculty of Business at the University of Technology in Brno. In total, more than 600 students worked at the web database while mapping topics as "water" or "solar energy".

2. TOPIC MAPS: THEORETICAL BACKGROUND

Why will be the solution of the knowledge system based on the Topic Maps principle? The main reason is that knowledge representation is intuitive; it keeps information in context, and conforms to human thinking more than other knowledge organization principles.

2.1 ISO Standard 13 250: Topic Maps

The TM model consists of the three basic elements: topic, association between topics, and occurrences of the topics [5]. The TM is standardized in ISO/IEC 13250:2003. The new promising development possibilities of the TM include filtering by scopes, TM merging and TM Query Language (TMQL).
The topic contains denominated subject of interest. It stands for a subject we want to discuss; it is its substitute in the computer. Each topic represents just one subject. It is a place in TM where all known information on the given subject is available by means of relations and occurrences.
Subject is a part of the real world, which is described in TM. Each subject is represented by one topic and it can be anything: a person, thing, entity, process, etc. The subject is unambiguously addressed by identifiers:

- Subject Locator – for information sources.
- Subject Identifier – for other subjects.

Associations represent relationships between topics, are bidirectional, and express relationship between subjects; they are not oriented and may have an arbitrary form:

- Unary – represents the characteristic of a subject, e. g. has-seaside.
- Binary – forms a relation between two subjects, e. g. is-a member of a company.
- N-nary – generic relation, e. g. export (from where, to whom, commodity).

Occurrences are formed by information relevant to a given topic; they can refer to information or they might just contain it. There are two types of occurrences:

1. Internal occurrence that represents the topic characteristics and is placed directly in TM.
2. External occurrence as a reference to an external information source. It connects the information and the knowledge layers.

2.2 Implementation of TM in ATOM SW

One of the goals and benefits of the ATOM SW is to support the implementation of projects of knowledge systems, especially effective development of powerful web applications.
This has necessitated some extensions or specification of the TM standard. Changes in the processing of occurrences of classes, work with

associations and development of the user interface, to name some of them.

2.3 Extending Internal occurrences

A simple set of basic features for TM Internal Occurrences has been renamed to a Variant type property. The following data types have been further complemented:

- Code and Ident – for the unique identification of the entity, where uniqueness is checked directly in the SW.
- Group Tree – a simple built-in taxonomy. Taxonomy is the fundamental building block of knowledge systems; in the TM standard it is necessary to create them always from the beginning, which is time consuming and difficult to maintain.
- Selection – forms a one-level code list, applied cardinality 1: N and M: N.
- Text – this feature allows inserting text in XHTML; provides the built-in text editor.
- Picture, File –storage of images and files.

2.4 Extending or changing Associations

In the definition of associations the following changes were finalized:

- Order (Sort) – each association can provide a structure of embedded occurrences.
- Power of relationship in % (Rate), e.g. to express supplier-consumer relationship.
- Hierarchy – a special type of association for Parent-Child relations. This feature is for example the basis for hierarchical view of documents related to legislation within the service Laws for People (see 1.3).
- The starting types of the ATOM SW associations are binary associations. Unary associations are replaced by an extended set of features; especially Group Tree and Selection. The main reasons for the use of N-nary associations are addressed through Sort, Rate and Hierarchy.

The above mentioned changes in associations are appropriately reflected in the creation of web applications in higher performance of applications and further in saving the lines of code which is needed for the service.

2.5 User layer of ATOM SW

The ATOM SW has been designed to build knowledge based applications. Such applications require a precise application layer and work with users. The authorization of users shall be under control, i.e. the settings of the activity in the ATOM SW which can the user perform in the knowledge system. It is necessary to monitor the user's activities, i.e. what object the user created, modified or even opened in the knowledge system.

3. RELATIVE WORKS TO MILUNI

A similar example of the military universities information source is the free encyclopaedia "Wikipedia". On this website, we can find a heading named "Military Academy" [6]. The choice done by the system is to sort military universities by the country. Although this classification is easy to be executed, it does not permit the users to find a university by the domain of study.

The greatest advantage of Wikipedia is the fact that this encyclopaedia is free and so many people can add some information about the subject. It increases clearly the number of inputs into the information source. There is a great risk to have erroneous information, and thus to harm the credibility of the information source because of the lack of hierarchy and user role. Wikipedia still remains an efficient model for obtaining a great quantity of information; however, we must stay aware that some of them could be wrong.

It is not difficult to obtain information resources on universities. Just enter the word "university" in the internet search engine and get a number of results, which are not organized and you can never be sure that the result is complete. Another possibility is to find a link to universities in the national search engine or to search the site of the Ministry of Education with an overview of the universities, or find a website with a list of universities, e.g. http://www.vysokeskoly.com, where you can search high schools in the Czech Republic by type, orientation and geographic location.

All of these references, however, only lead to a basic overview of the university, mostly with regard to the needs of future students considering a university to enrol at; it is not a complex material supporting collaboration, and moreover, only in the national environment.

4. ATOM SOFTWARE

At first, the ATOM SW is briefly characterized, its principle of operation is described and the details of functional possibilities of the Data Editor and the Editor of the ontology scheme (part of ATOM Studio) are added.

4.1 Basic Characteristics

ATOM is a SW for sharing data with co-workers, customers, or friends via web browsers. ATOM is a non-programming web database SW that does not require special knowledge. Anyone can easily construct a knowledge system on the web.
The ATOM web database can be used for intranets with more powerful features than typical shared spreadsheets like SharePoint or box.com.
It can be used as a construction kit for building web applications with powerful information retrieval, and for various encyclopaedias, dictionaries, knowledge bases in applications where wiki approaches are not enough.

4.2 How does it work?

At first, create ontology of your problem domain in the Ontology designer module.

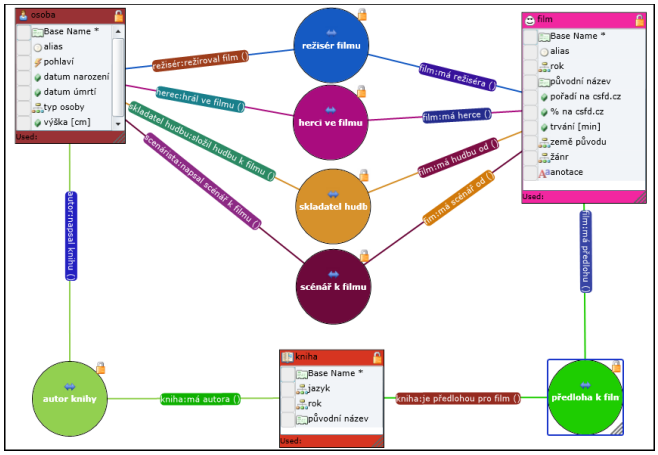

Figure 1. Ontology design in ATOM

You can design the ontology by drawing which is similar to drawing on a flip board or writing it through filling in forms and using pre-prepared templates and adjusting them to your needs (see Figure 1).
Immediately you can enter data through the forms which are generated on-fly from the ontology in the Data Editor module, see Figure 2.

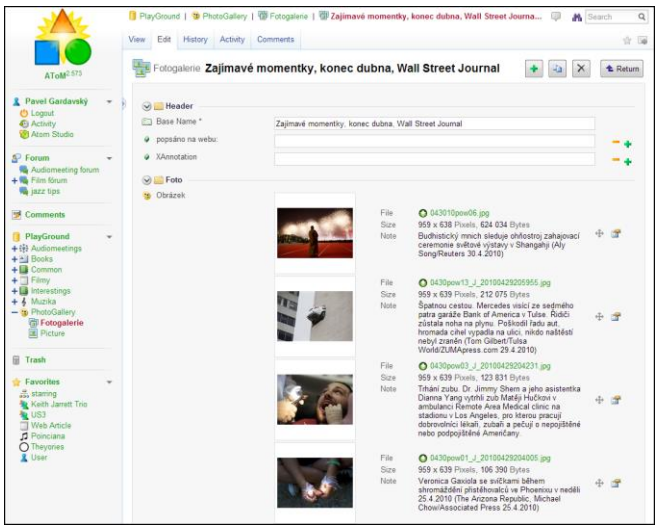

Figure 2. Entering data

And after that you are able to work with data, realize information retrieval (see Figure 3) or even visualize them, see Figure 4.

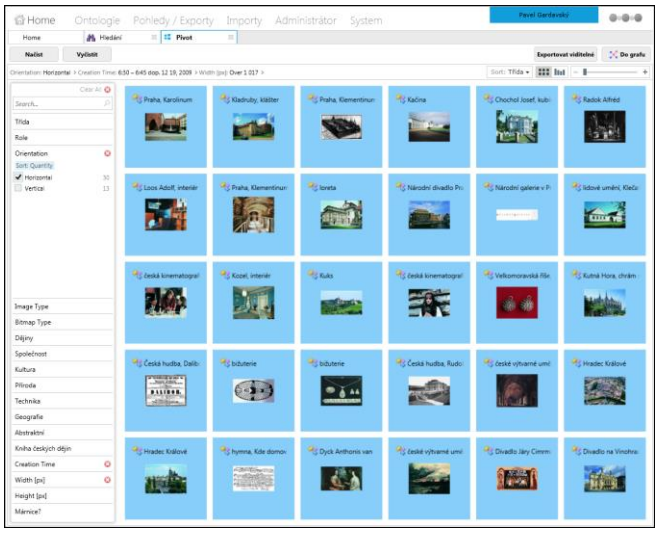

Figure 3. Information retrieval through ATOM Studio

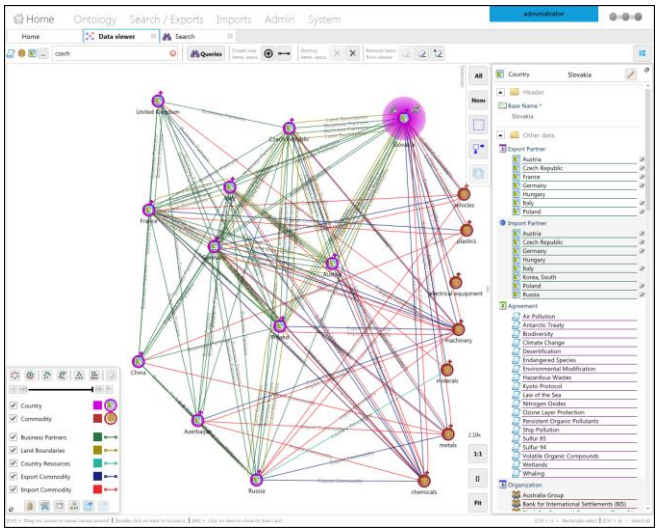

Figure 4. Visualizations of information

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4.3 ATOM Data Editor – 25 facts

1. The Data Editor is used to enter, edit, and delete instances of the class; such as person, organization, and event.
2. The occurrences of each class have their own form in the editor.
3. The user can further customize the forms and their distribution to suit the requirements.
4. The occurrence contains the properties and roles in associations with other occurrences.
5. The structure of the occurrence is defined in the ATOM Studio.
6. With each node of select and group properties it is always shown how many occurrences are assigned.
7. Group tree individual nodes can be moved, deleted, expanded and merged.
8. The history of all changes is archived together with the date and the user who made the change.
9. Each occurrence includes the possibility to comment on it and lead discussion about it.
10. The Data Editor provides a centralized view of the comments and discussions with the information about the number of views.
11. The editor also includes a forum with the usual functionality of web forums.
12. Individual occurrences, their lists, and a number of other views can be included in the list of favourite items.
13. The list of favourites can be maintained.
14. The changes in occurrences, classes, and projects can be distributed via e-mail.
15. E-mails can be sent immediately or as a daily / weekly summary.
16. The Data Editor besides Homepage can have multiple work spaces.
17. The work spaces are personalized.
18. The work space can contain other panels, such as articles or prearranged lists.
19. The prearranged lists are created via saved queries.
20. The stored queries can be shared between users, and used more than once at different work spaces.
21. The Data Editor offers full-text search with powerful faceted filtering.
22. It is not necessary to open the detected occurrence to determine its content; just point the cursor and the preview appears.
23. The items of the occurrence preview and their order can be configured.
24. The editor is also an interface for login and user account settings.
25. The registration of user accounts from the Web can be enabled or disabled.

4.4 ATOM Studio – 25 facts

1. The ATOM Studio is used for creating and maintaining ontologies, batch exports and imports, advanced search, visualizations and complete system management.
2. Users do not even suspect its existence.
3. Ontology consists of a scheme, projects and folders.
4. Projects and folders are used to organize the scheme e.g. for using the Data Editor.
5. A scheme is managed by a Schema Editor.
6. A diagram consists of classes, associations between classes and properties of classes.
7. Projects can mutually share properties and associations.
8. Ontology elements (not only schema, but also projects and folders) can be described.
9. Classes, properties, and associations can be set as visible, invisible or mandatory.
10. Search allows queries across various even into themselves embedded associations.
11. In the search results, the columns with selected properties and associations can be added, removed or rearranged.
12. Clicking on a search result or any property / association can view their details.
13. Various questions can be added to the search results and thus a cumulative list can be created.
14. The search results are editable; editing is similar to working with spreadsheets.
15. The search results can be exported to XML, .txt, .tsv, or .json formats.
16. Export in .tsv can be opened in Excel.
17. Export in .json format can be opened in Google Refine – a tool for batch editing data and identifying connections. The results of the Google Refine can be updated through the .json format data in ATOM again.
18. The same formats can be also imported through the Data Import component.
19. The Pivot component is a graphical alternative of imaging results.
20. The data in context can be visualized in the Chart through the Data Viewer component.

21. The Data Viewer provides opportunities to work with the visualized data, including the creation of new occurrences and association.
22. The projects can be exported and imported into other ATOMS through the editor.
23. Projects can be interconnected at the level of schemes by intersection or union.
24. The users can be assigned to roles.
25. Rights to individual applications of the ATOM can be assigned to different roles.

5. EDUCATION SUPPORT

The chapter presents the possibilities how to use the knowledge-based systems that apply the ATOM system in learning and support education.
The procedure and method of teaching the knowledge approaches and creation of knowledge-based systems to students model the methodology used in the project MENTAL. An example is from the domain of conferences.
At first, the basic concepts and work with information sources are introduced to students, and simultaneously, the used SW is described.
The task assignment for student work is intentionally general and ambiguous, so that the students have to search their own approach to the analysis of information sources. For example:

"Analyse the information sources of the conference, produce an overview of the information systems field, the processing of knowledge, social networks and communication systems that were discussed at conferences".

Without any more details stated in the assignment, the students are expected to carry out analysis of information sources, and to select the articles that cover the given field and examine them in detail. The students are supposed to find the details of each article (about the authors and their workplace, research and implementation tasks carried out, methods and tools used, the results obtained).

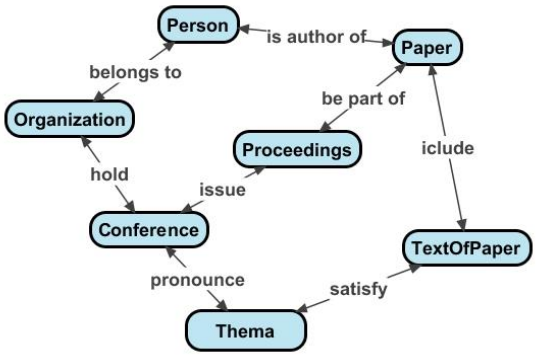

Figure 5. Ontology design on conferences

If the students' reports on processing the information sources are not satisfactory, they have to correct them. At the same time, the students get familiar with the specific domain, as a preparation for building the knowledge base.
Consequently, the students are introduced to knowledge approaches, creating ontology and the ATOM SW environment. The assignment is built on the previous activity; for example:

"*Create a knowledge base on the conference; within the knowledge base, process selected articles on information systems, knowledge processing, social networks and communication systems".*

Table 1. Classes and their characteristics

	Conference	Proceedings	Paper	TextOfPaper	Theme	Person	Organization
Name	X	X					X
Firstname						X	
Secondname						X	
Title			X	X	X	X	
Abbreviation	X						X
Date	X						
Abstract	X		X				
Place		X					X
ISBN		X					
WWWpage	X	X				X	X
Text				X		X	X

It results in the ontology design in Visual Understanding Environment [7] (see Figure 5), characteristics definition and their assignment to the classes (see Table 1). Then the ontology is prepared to implement into ATOM environment and the knowledge base prepared, see an example in Figure 6.
The opportunity of the KMS for the learning results from its characteristics. The embedded information and knowledge can be divided into small parts and connected in a requirement net.

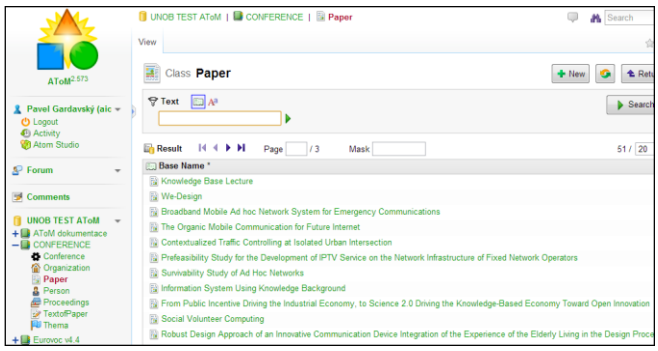

Figure 6. Ontology and data in the ATOM environment

The ontology driven system offers the chance to study various themes according ontology concepts (classes). Each occurrence of the class is a starting point for the new study problem, see Figure 7. The next advantage is complex environment where it is no problem to add or to change a new study material.

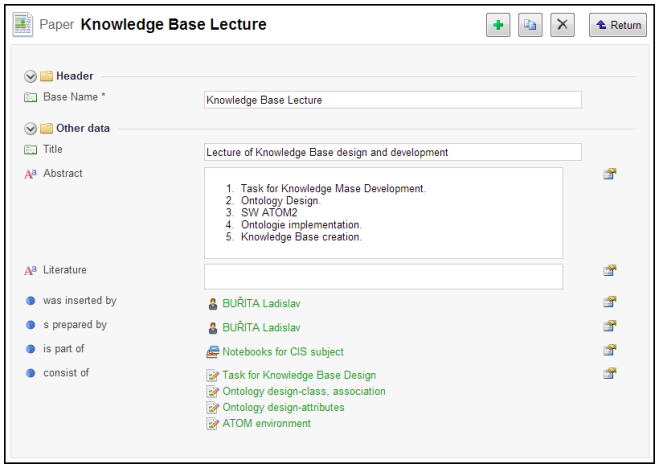

Figure 7. Various starting points for the study

6. UNIVERSITIES COOPERATION

The first aim of the Knowledge Management System (KMS) is to support the cooperation among NATO Military Universities and facilitate education and research of information about the universities' members. In order to fulfil this goal, the content of the KMS was built according to a specific organization and has to respect the following:

- Universities and research organizations have to be related to the NATO countries, then European Union (EU) countries (non-NATO) and European countries (non-EU).
- The domains of interest include many fields of interest, as Military Science, Engineering, ICT, Medicine, Social Science, etc.
- The universities are linked to the countries and cities. They highlight international cooperation among educational institutions in the EU.
- The system contains NATO Centres of Excellence, Network Enabled Capability (NEC) events and institutions and is related to the field of interest.

The Military Universities (MilUni) KMS is prepared in a simple, but still complex shape; see the user interface for editor role in Figure 8 (set of universities). The main feature is a user friendly access to the information about the structure of the system, its main educational areas, program of the faculties' education, list of departments, research and conference activities, etc.

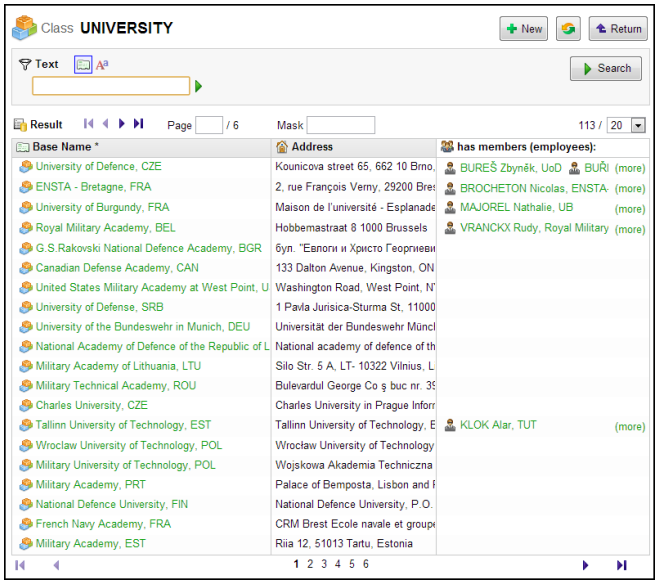

Figure 8. MilUNI - user interface, class university

The ontology consists of classes: university, university-part, organization, product, country, city, person, document, document-part, document-text, conference, conference centre, activity, domain and domain-area.

The system is composed of nearly 100 universities divided into 279 university parts (Faculties, Departments, etc.) in 40 countries. The domains of interest are subdivided into domain areas; they are linked to the conferences and papers.

In order to find information the user has more ways of information retrieval. The user is able to execute a search procedure by using classes, by travelling all over the full text and the data arborescence, or by using the global search bar.

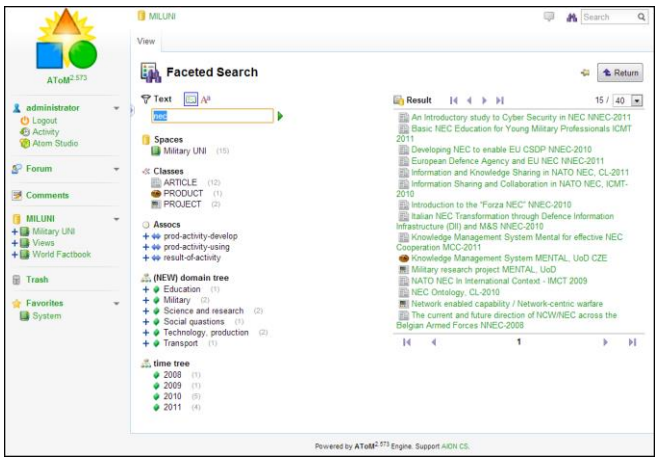

Figure 9. Search procedure of the paper about NEC

Another way is using a local class search field and its incorporated filter by putting parts of words or key words in it. The search procedure (example at Figure 9) using classes are based on the summary table which is displayed by clicking on the system name; the user could also reach this menu by clicking on the class.

If you know the nature of the searched item or have a global idea of it, this way could be the easiest and the most effective one. Another way is based on the use of the data hierarchy.

7. CONCLUSIONS

The article presents a large variety of areas and ways how the ATOM SW was applied while creating the knowledge-based systems supporting learning and cooperation between universities. It also introduces the experience and the best method how to teach the creation of knowledge-based systems and how to use them in practice.

The created knowledge systems based on the ATOM SW are only at the mere beginning of the application process, but they convincingly demonstrate the wide range of application possibilities.

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