

# AnT&CoW: Share, Classify and Elaborate Documents by means of Annotation

Gaëlle Lortal, Myriam Lewkowicz,  
ICD-Tech-CICO, University of Technology of Troyes  
10010 Troyes Cedex, France  
lortal@utt.fr, lewkowicz@utt.fr

Amalia Todirascu-Courtier  
LILPA, Marc Bloch University  
67084 Strasbourg Cedex, France  
amalia.todirascu@umb.u-strasbg.fr

**Abstract**—As collective and mediated work spread out, digital data, and particularly documents, become predominant. In this paper, we describe how to support document management and especially document classification within a mechanical engineering design team working in an asynchronous and distributed way. The team members exchange comments to plan their project, to share documents, and to elaborate new documents. These comments are annotations linked together and linked to document(s). Annotations enable users to understand who is playing which role in the project and how collaborators understand a document and classify it. Observing this team led us to design an annotation tool (AnT&CoW) that we have implemented to support its collective activity. We conclude this article by focusing on the classification functionality, based on the use of Natural Language Processing tools.

## I. INTRODUCTION

The working environment continuously changes due to people mobility, their geographical distribution, and to the increasing amount of digital data. The management of working documents used within a group (project, team, community, ...) should be adapted to follow this digital revolution. In the digital world context, when document elaboration is a collective activity, document edition and document publication is an individual activity. The important amount of digital documents requires information structuring and documents classification to improve document retrieval. Bibliographers are then pushed into further thinking about classification.

In fact, traditionally, documents archived in libraries were kind of proof document stored in order to inform, to teach, or to exemplify. But, nowadays, the documents which are used during a project in progress are temporary, transitory and shared by a team. They enable the team to build their common ground [1] as well as the elaboration of new documents. Though, while working, team members have to classify permanent documents as well as fragments of documents according to a classification which is meaningful within the context of the project and within their point of view. In this context, bibliography deals with new kinds of documents: objects acquiring their documentary status [2] as soon as they are placed in an organized, meaningful relationship with other objects [2]. A digital document can then be seen as a documentarized representation of an object of the world, a textual, audio-, video-, physical object.

In order to support these new management practices based on this broader definition of documents, we observed a mechanical engineering design team re-using a car engine to build an aero-engine. It appears that the team members are mainly using various types of annotations in order to exchange, to build solutions and to elaborate documents. Following this study, we propose an annotation tool enabling the team members to use, to classify and to elaborate documents cooperatively through annotations.

In this paper, we first present the definitions of document and digital document that we adopt, and then some basic concepts about classification in cooperation. We continue with the observations we made, and the main practices to be supported: to plan the project, to share documents, to classify documents and to elaborate documents. We finally present our annotation tool and focus on the classification functionality based on Natural Language Processing tools.

## II. NEW ISSUES INDUCED BY THE MANAGEMENT OF DIGITAL DOCUMENTS

Bibliographers used to consider document as a textual record or at least a “flat record” (from Ranganathan in [3]). Documents are then a combination between a medium, a message and a meaning [3]. This combination is stored as it is, containing its context through metadata or keywords. But digital technology sets again the old question of *What is a document* [3] in bibliography. In a digital context, the concept of medium appears to be less satisfactory than a functional approach. In a more semiotic view of documentation, we can define documents as anything stored as “the vehicle of meaning” [2], each object that is stored because it is meaningful in a specific context.

The document as defined in [4] is used in three mediating contexts: private, collective and public. In a collective context, documents are used to structure a group, its identity, its activity, its cohesion. Still in the collective definition of R.T. Pédaque [4], the document is defined as a medium which has four main properties: memorization, organization, creation and transmission. Memorization and organization are properties illustrated in our project by “proto-documents” used to organize ideas within a document. An annotation is a kind of proto-document supporting memorizing as well as passing on ideas or reviews. Annotations can be brought together within one document since they are part of a document to be organized. Annotations gathered to create one document

acquire thus a new meaning by the renewal of their relationships within a new context.

Then, the documents should also be structured all together through a shared classification, and we assume that this classification could also be seen as a digital document. In fact, in a mediated work this structure is available. This classification underlying the project could be collective and should be built in cooperation.

### III. MANAGING ANNOTATIONS AS PROTO-DOCUMENTS

Annotations are active elements of document creation and become fragments of a written document. From [5], we can define several types of annotation: (1) The gloss which is a fragment of text explaining a part of a document, (2) the underlining mark pointing parts of a document, (3) the note paraphrasing the main point of a document, (4) the comment bringing new ideas out, and (5) the discursive comment which is an arguing and organized comment built cooperatively by exchanges among authors. These annotations are firmly linked to a document or to a topic.

From a Semantic Web (SW) perspective [6], an annotation enriches the document in order to improve automatic document indexing and retrieval [7]. Annotations are then used for Electronic Document Management (EDM), document content processing, document structuring, services interoperability, and for some specific types of cooperation (as in [8]'s scenarios of cooperation). We can quote among others [9], [10], [11], [12], [13] where annotations are used to index and enable search engines to retrieve documents.

But annotation is also an activity enabling the interpretation of a document and the sharing of a common interpretation with others users. In our framework, annotating a document means enriching it by linking an advice or innovative ideas [14]. When annotating, a user contextualizes the document by associating it with a social interpretation [15]; as he/she relates an annotation to a document, he/she enriches it with traces of his/her interpretation rising from his/her experience.

This sense of annotation - a text fragment bound to a document, or a topic supporting exchanges among users - refers to a very ancient activity coming from a medieval practice of text interpretation; annotations enabled expertise sharing through hard copies diffused around the world. By means of annotation, users enriched documents with individual knowledge built during reading. This knowledge was built cooperatively and shared by other members through exchanges based on different interpretations. Nowadays, in a computer supported activity, as in a newsgroup or a blog, annotations could be seen as posts bound to a discussion thread. They are structured around a topic, by means of rough metadata (author, time, reply to), and supported by Social Web tools [16] [17].

In fact, we can quote several annotations tools which permit to annotate documents in order to share opinions and beliefs [18], [19], [20]. These tools support the emergence of new communities (newbies, specialists) sharing their expertise. Annotations are also well-known means for collaborative writing [21], [22]. Annotations contain several users interpretations, and once collected, they represent a basis to

write a new document. The draft created by the collection of these annotations is a multi-authored text involving a community of authors. Annotations are then means to link several users and to help them to cooperate, and to create a community.

However, to understand and to reuse the annotations, users should store the context of their creation by classifying them on the basis of other annotations and stored documents. We then designed a tool to help users to integrate a community by supporting shared interpretation through exchanges. But our tool should also support collaborative annotation structuring and indexing according to a shared classification in order to help all users to retrieve their documents. Capturing and structuring annotations is then crucial to enable users to exchange and to understand others' interpretation.

### IV. A SHARED CLASSIFICATION SCHEME TO SHARE DOCUMENTS

#### A. *The sociolect as the basis of a shared classification*

Some annotation tools are based on ontologies, which enable document structuring and categorization, as recommended by the Semantic Web [6]. But ontologies are too detailed and fixed to be useful for our purpose. In ontology-based tools, classifications are often defined by a domain expert (and reflect expert's point of view), or reused from another domain or purpose, or even built automatically from statistical tools. Sharing such a classification is not easy since it does not match the community's classification, or even the terms used by the community. These classifications hardly accept the creation of new concepts and neology too. In fact, community members are linked together, not only by a topic of interest, but also implicitly by the "sociolect" [23] (their "jargon") they develop when they communicate and exchange information. A sociolect is the way a social group is speaking i.e. the lexicon and the connotations shared. This sociolect enables them to share a "common ground" and to identify themselves as being a part of the same community. To classify their annotations, documents, and topics, community members will use this shared vocabulary. In fact, this sociolect enables to grasp community concepts because the community is defining a classification scheme (CS) which will help its members to structure the concepts they handle [24]. This shared language is working as a "folksonomy", a social classification [25]. These folksonomies allow identifying knowledge creation process by looking at the indexes which are newly created for a document collection. Folksonomies as sociolectal classifications could strengthen the community because they enable its members to use the terms they consider representative and useful. Folksonomies are often opened and evolve continuously. Thus, community members are involved in the building of their own specific Classification Scheme (CS) and they will be able to use it properly during their activities, and to make it evolve when needed. Sharing a common classification enables project members to understand the communication rationale [26] of the project.

### B. A classification scheme based on multiple viewpoints

As we have just shown, a specific vocabulary is used within a community and a CS is developed, based on users' knowledge. As we cannot predict the knowledge and individual CS of each user, members of the community should be able to build their classification and to show the part of the scope they enlighten by their viewpoint i.e. in which way they understand a concept. It is especially true during a multi-disciplinary activity as we often deal with nowadays, in projects for instance. A user can adopt several viewpoints as s/he speaks as a project member having a role within the project (technician, designer, project manager), but also as an individual with an individual background (an apprentice designer, an expert in mechanical engineering, an expert in aeronautical design, an expert in computer science development,...). Each time a member decides to comment a document and to exchange with others members, s/he also includes arguments into her/his comment, letting an arguing viewpoint into her/his comment. For all these reasons, we assume that a CS should represent several viewpoints [27]: micro-organization (role), domain (expertise domain) or arguing (to understand the benefits or drawbacks, to know pro or cons).

Moreover, each user has his/her own point of view and understands a concept in a specific scope, where the concept has specific characteristics. For example, the concept HAND represents (for almost anyone) *the end part of the human arm below the wrist* [28]. Within the sentence:

(1) He writes with his left hand

We find the occurrence of the concept HAND in *left hand*, in a *GENERIC* scope. But if a watchmaker is building the classification, s/he will adopt a *WATCHMAKER* scope, for the concept HAND that occurs in a cotext as:

(2) The little hand is pointing to three

The occurrence of HAND within a *WATCHMAKER* scope is then *little hand* and the meaning is *pointer on a clock, dial, ...* [28].

The CS is shared within a project group and used to classify documents. It is then necessary to index documents and productions with terms employed during the project and related to the specific domain. Following a CS, users can index and retrieve annotations or documents according to shared concepts and topics. Thus, the CS should represent several granularity levels: the viewpoints, the concepts, the terms. These terms are contained in project documents and documents produced during the project. In this context, we are now going to focus on the building of the CS by means of NLP tools.

### C. Supporting the building and the use of the CS by means of NLP Tools

In a digital library with a large collection of documents, building classification resources is a tedious and time-costly activity. To handle the important number of documents, we use a Natural Language Processing (NLP) module enabling the semi-automatic extraction of a structured terminology (terms and relations between the terms) from texts. This NLP module will also help a user indexing her/his annotation.

Using semi-automatic classification, community members will then be able to elaborate and to share their own classification based on their specific vocabulary. Such a classification is easily shared by newcomers since the concepts are related to terms which are themselves related to available documents. They easily understand the common vocabulary as they can find examples of use in documents and comments let about documents. This is especially true when topics are non-specific ones and vocabulary is composed of everyday words that can have several meanings without their cotext. We are now going to illustrate that by an annotating scenario coming from the observation of mechanical engineering design team which is the basis of the development of our tool.

## V. A SCENARIO-BASED DESIGN

### A. Case description

We collected the mediated exchanges between the members of a project involving an association committee (AC) (mainly plane pilots), and a mechanical engineering team (divided into a Design Team -DT- and a technical team -TT-). Their aim is to reuse a car-engine as an aero-engine. Team members participate in the project during their spare time. So, despite members' co-location, the work is asynchronous. Each DT member develops a part of the engine. Mechanical engineering design is a highly collaborative field and consequently, the design team needs perpetual feedback from TT (technicians and suppliers). DT then relays feedbacks from the AC managing expenses. Drawings and documents represent discussion basis between TT and DT about technical feasibility and about tool or material availability. TT mainly manages communication with suppliers. Within the DT, communication is widespread even if information should always be forwarded to the group supervisor. The only way in this team to mediate this asynchronous written communication is email. Emails are used as comments coming with a document as in these following descriptions:

- A member creates a first draft with computer-aided design tools, each member then discusses this draft, asking for complement or verifying calculus. To do so, team members write down their ideas and questions as comments anchored to the draft(s). Each member puts his/her annotation on any documents, but a subtle micro-organization structure within the team involves some ethical rules. After the revision and the updating process, detailed plans are then communicated to the TT in order to begin production phases. TT receives drawing plans and their comments, which explain how the DT made a decision.
- These annotations are often merged as new documents following an explaining purpose (for example by listing and explaining in an email, all the modifications which are visible in the document).
- Annotations are identified as elements of solutions, of negotiations and of discussions, helping the design process retrieval. As our teams share and manage an important number of documents, an adapted classification should be set up, based on several pieces

of information: author, date, content, aim, recipient, which part of the document/plan it comments, etc. Since it is an innovative project, they can only partly define an a priori classification for documents to be produced. Their classification is possibly extended as work progresses. They try to organize documents and annotations by storing their mail by date, title and author. Thus, they need a tool to support their classification and share their storage.

This situation shows us that indexation and communication functionalities are crucial to understand on which basis a solution has been adopted. It is also crucial for experience building. Annotation is used for communication, indexation and is a part of the experience elaborated during the project. We are now going to describe a scenario representing how our annotation tool can be used to support collaborative work.

### B. Indexation scenario

During the project, team members can upload documents they want to share and they can annotate them. To retrieve these documents, they should classify them. But as they should all be able to retrieve their documents, the classification that they are going to use has to be common. As shown previously in section III, the classification should be based on a shared

vocabulary. Members should then be able to select appropriate indexes to classify their documents.

To build a shared classification, team members have two options. The first one is to exchange orally to find which concept will be a priori pertinent during the project. The classification is then set until the end of the project. The other option is to build their classification continuously. It could be done by two ways: manually (highly time-consuming) or supported by Natural Language Processing tools. If they choose to do it manually, they are able to link their document to an existing index (figure 1). If they choose an NLP support, the tool is automatically parsing the body of the annotation and the annotation anchor (context of the annotation) and proposes them a list of possible indexes. When building or updating the classification, team members might choose the appropriate indexes among the results proposed by NLP modules and they are able to see straight the last modifications through the visualization frame (see Figure 1).

In the next section, we present an example of classification build and updated for the project. The classification is done semi-automatically by means of our NLP tool.

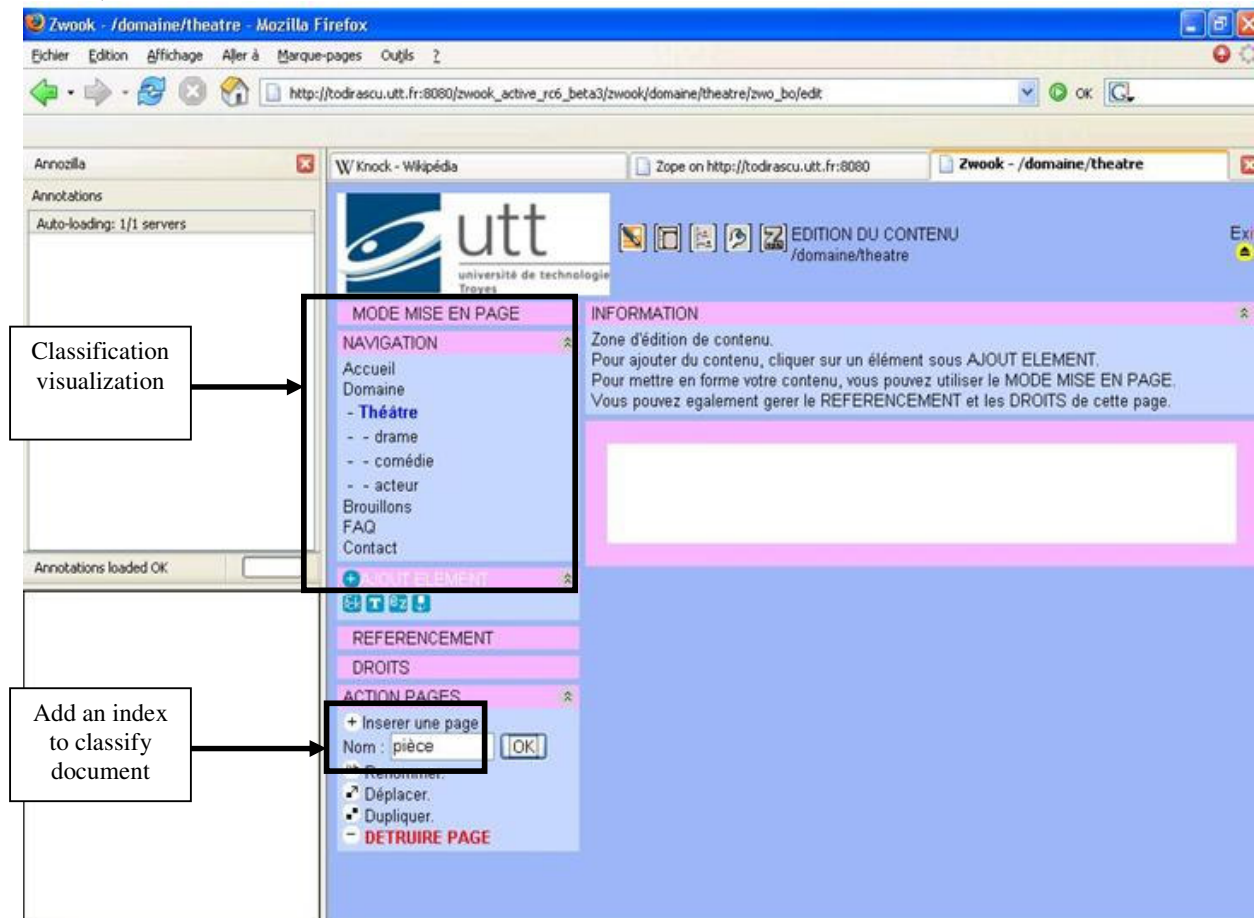


Figure 1. Screenshot of the classification visualization in AnT&CoW

## VI. A CLASSIFICATION SCHEME FOR OUR TEAM

Sharing a common classification enables project members to understand the context and organization of their project. But building such classification is time-costly. Our NLP embedded tool offers users to automatically parse all the documents and proposes only the most frequent terms of these documents and those matching with specific patterns. From our project, we chose a corpus of 27 e-mails (2 200 words) linked to documents, and a set of working documents (89 000 words). We extracted automatically 1 280 frequent terms. We studied these terms following [27]. They assume that annotations during a project are divided in three main viewpoints: domain, micro-organization and argumentation. It results on a list of 960 phrases classified in the 3 main viewpoints (Figure 2) and we add a planning viewpoint subdivided in several sub-viewpoints (Figure 3).

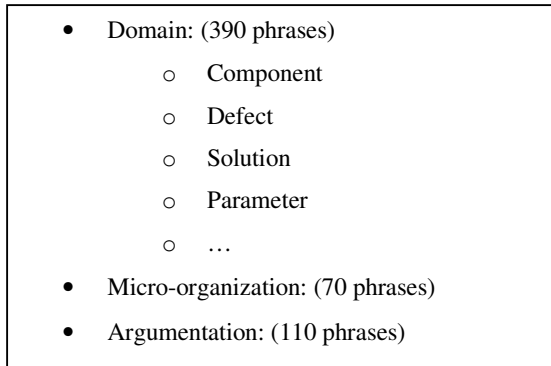


Figure 2. Domain, Micro-organization and Argumentation viewpoint

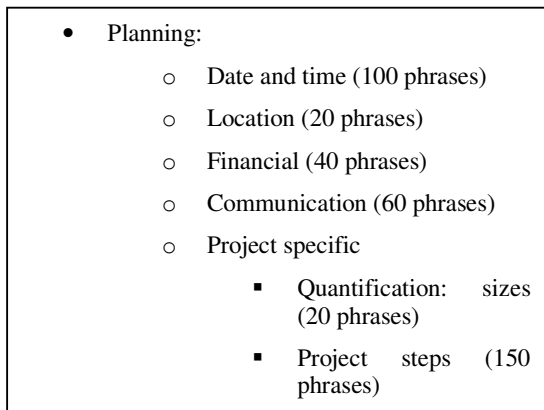


Figure 3. Planning viewpoint

To build and to update this classification, team members need to use a tool supporting these activities, helping them to easily browse the shared knowledge map. Due to our indexation and visualization requirements, we chose the Topic Maps (TM) formalism [29] in order to represent each viewpoint containing concepts or sub-viewpoints. The TM formalism enables users to structure their concepts under scopes (viewpoints), but also to define concepts from textual

fragment contextualising the concept. They can also easily browse the resulting TM.

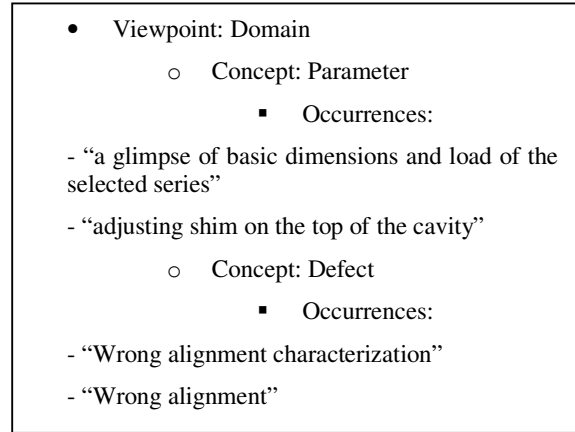


Figure 4. Detail of a part of the domain viewpoint

The classification building and updating from the project documents and exchanges shows that the classification is detailed and composed of several granularity levels. For example, the "planning" viewpoint contains general terms related to project management (in the broad sense of planning with project milestones). But, from the "domain" viewpoint example (Figure 4), we can see that the terms found in documents i.e. the occurrence "dimension" do not match directly a concept as domain. User should add another granularity level by the concept "parameter" containing the term "dimension". The NLP tool might retrieve similarities but cannot by itself classify the text. Thus, the user has a central role in the process of classification.

## VII. THE TOOL

AnT&CoW [26], an annotation plug-in which is still under development, roughly implements annotation and indexation functionalities. We are now focusing on the aspects of visualization of the classification and of draft creation. AnT&CoW re-uses Annozilla [30], an open-source annotation plug-in for Mozilla-Firefox browser, which follows W3C Annotea protocol [31]. When the user launches Annozilla, the plug-in appears as a frame on the left hand side of the screen. We improved Annozilla in order to facilitate communication. Annotations posted by several members are stored on a server and can be classified according to several viewpoints defined by community members. Annotations can be anchored by a user on a document. The user creates links between two or several fragments of document(s). The sense of the link between the original text and the annotation is explained by the comment written by the annotation's author in the annotation body. This body could also be annotated and then anchor an annotation. Multi-anchoring and replying is part of the genesis of a new document. Actually, our tool enables multi-anchoring only on one document at a time, but we will go beyond technical limits in order to enable multi-anchoring among several documents.

From the note paraphrasing an external document, new ideas are brought out and form a discursive comment. The cooperative structuring of a discursive comment during discussion around a document can be merged into a new document (Figure 5): AnT&CoW allows the composition of a document representing a collective interpretation by gathering all the annotations related to the same topic. Gathering these fragments is done manually by choosing fragments or automatically after a keyword selection. This new document is

chronologically arranged and enables visualization of argumentation by showing annotations, their indexes, and their links.

AnT&CoW is still under development but already implements basic collaborative functionalities allowing collective activity awareness [32] and collective knowledge creation through communication and indexation means.

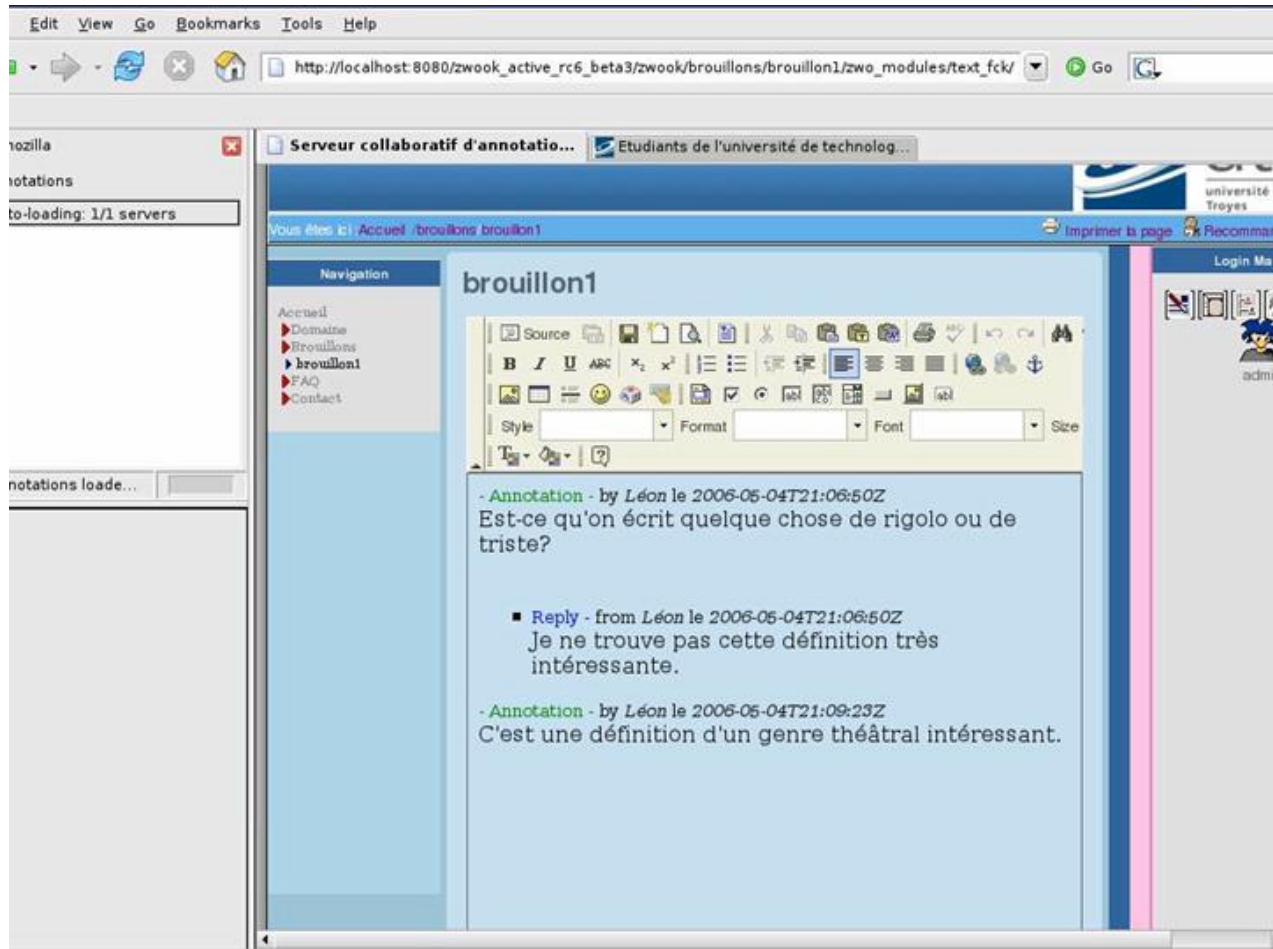


Figure 5. Screenshot of a new draft edited in AnT&CoW

## VIII. CONCLUSION

Digital documents require a domain-specific management of documents. Then, it becomes crucial to provide users working in a distributed collaborative project with a tool supporting their editing activities. Managing documents during a project means to be able to elaborate, to share and to classify the documents. Collective activities in the team can be mediated by annotations which enable team members to exchanges, to build fragments of document and also to link a document with another document. As team members share and elaborate new documents through annotations, they need to retrieve them. Then, our tool should support not only annotation but also indexation of documents.

AnT&CoW permits users, (1) to annotate digital documents by anchoring textual fragments, (2) to elaborate documents via annotations gathering and editing, and (3) to build a classification and to index digital documents and fragments of documents by means of the classification. By using AnT&CoW, project members are able to classify collaboratively their shared documents and to visualize an up-to-date classification. As well, newcomers of the project can understand the meaning of indexes inside the project as they have a direct access to the documents through the classification represented in Topic Maps format. NLP Tools support users in their time-costly task but we still need to optimize automatic proposition of indexing terms by refining of patterns.

## ACKNOWLEDGMENT

This research carries a funding from the National Center for Scientific Research /Communication and Information Science and Technology department as part of TCAN and from the European Social Fund and Champagne-Ardenne regional council.

## REFERENCES

- [1] Clark, H. H. & Brennan, S. E. (1991). Grounding in communication. In L. B. Resnick, J. Levine & S. D. Teasley (Eds.), *Perspectives on Socially Shared Cognition*. (pp. 127 - 149). Washington, DC: American Psychological Association
- [2] Buckland M., What is a "document"?, (1998), in Hahn, T. B. & Buckland M. (eds). *Historical Studies in Information Science*. Medford, NJ: Information Today, 1998, pp. 215-220 <http://www.sims.berkeley.edu/~buckland/whatdoc.html>
- [3] Buckland M., What is a "digital document"?, (1998), in *Document Numérique* (Paris) 2, no. 2 (1998): pp. 221-230 <http://www.sims.berkeley.edu/~buckland/digdoc.html>
- [4] Pédaque, R.T., *Document et modernités*, 16 mars 2006 – (Document and modernities) <http://rtp-doc.enssib.fr/IMG/pdf/Pedaque3-V4.pdf>
- [5] De Libera A., (2000), *La philosophie médiévale*, Paris, PUF ( coll. Que sais-je ? 1044), 4e éd.
- [6] Berners-Lee T., Hendler J., and Lassila O., (2001) The Semantic Web, *Scientific American*, 2001
- [7] Handschuh S. and Staab S. (2003) Annotating of the Shallow and the Deep Web, in *Annotation for the semantic Web*, S. Handschuh, S. Staab, IOS Press p.25-45
- [8] Koivunen, M-R, and Swick R.R. (2003) Collaboration through annotations in the Semantic Web in *Annotation for the semantic Web*, S. Handschuh, S. Staab, IOS Press p 46-60.
- [9] Dingli A., (2003) Next Generation Annotation Interfaces for Adaptive Information Extraction. In *6th Annual Computer Linguists UK Colloquium (CLUK 03)*, January, 2003, Edinburgh, UK
- [10] Domingue J.B., Lanzoni M., Motta E., Vargas-Vera M., and Ciravegna F., (2002), Mnm: Ontology driven semi-automatic or automatic support for semantic markup. In *13th International Conference on Knowledge Engineering and Knowledge Management (EKAW02)*, October.
- [11] Dzbor, M., Motta, E. and Domingue, J. B. (2004), Opening Up Magpie via Semantic Services. In *3rd ISWC*, November 2004, Japan
- [12] Handschuh, S., Staab S., and Ciravegna, F., (2002), S-cream - semi-automatic creation of metadata. In *13th International Conference on Knowledge Engineering and Knowledge Management (EKAW02)*, October 2002
- [13] Sumner T., Buckingham Shum S., Wright M., Bonnardel N., Piolat A. and Chevalier A. (2000), Re-designing the peer review process: A developmental theory-in-action. In R. Dieng, A. Giboin, G. De Michelis & L. Karsenty (Eds.), *Designing cooperative systems: The use of theories and models* (pp. 19-34). Amsterdam: I.O.S. Press, 2000.
- [14] Ackerman M. and Halverson C., (2004), Sharing Expertise: The Next Step for Knowledge Management in *Social Capital and Information Technology*, Huysman M. and Wulf V. (ed)
- [15] Laclavik M., Gatial E., Balogh Z., Habala O., Nguyen G., and Hluchy L., (2005), Experience Management Based on Text Notes (EMBT), in *Proc. of eChallenges 2005 Conference, Innovation and the Knowledge Economy*, Volume 2, Part 1: Issues, Applications, Case Studies; Edited by Paul Cunningham and Miriam Cunningham; IOS Press, pp.261-268.
- [16] Jordan K., Hauser J., and Foster S., (2003) The augmented Social Network : Building identity and trust into the next-generation Internet, in *firstmonday* vol.8, N.8, august 4th 2003 [http://www.firstmonday.org/issues/issue8\\_8/jordan/](http://www.firstmonday.org/issues/issue8_8/jordan/)
- [17] Delacroix J., *Les Wikis* M2 éditions, 2005
- [18] Denoue, L., and Vignollet, L., (2000) An annotation tool for Web browsers and its applications to information retrieval, in *proceedings of RIAO 2000*
- [19] Price, M., Schilit, B., and Golovchinsky, G. (1998), XLibris: The active reading machine. In *proceedings of CHI'98 Human factors in computing systems*, Los Angeles, California, USA, vol.2 of Demonstrations: Dynamic Documents, pages 22-23, 1998.
- [20] Ka-Ping Y. (1998), *CritLink : Better hyperlinks for the WWW*. <http://crit.org/ping/ht98.html>, 1998.
- [21] Bentley, R., Horstmann, T., Sikkil, K. and Trevor, J., (1995), Supporting Collaborative Information Sharing with the World Wide Web: The BSCW Shared Workspace System, in *The World Wide Web Journal: Proceedings of the 4th International WWW Conference*, Issue 1, December 1995, pp 63-74. O'Reilly
- [22] Sun C., Jia X., Zhang Y., and Yang Y., (1997), REDUCE: a prototypical cooperative editing system, in *Proceedings of the 7th International Conference on Human-Computer Interaction* , pp.89-92, San Francisco, USA, Aug. 24-30, 1997
- [23] Marcellesi, J.-B. and Gardin B. (1974), *Introduction à la sociolinguistique : la linguistique sociale*, Paris, Larousse, coll. « Langue et langage »
- [24] Simone C. and Sarini M., Adaptability of Classification Schemes in Cooperation: What does it mean?, in *Proceedings of ECSCW 2001*, 19-38, 2001.
- [25] Shirky, C., (2005), *Ontology is Overrated: Categories, Links, and Tags* [http://www.shirky.com/writings/ontology\\_overnated.html](http://www.shirky.com/writings/ontology_overnated.html)
- [26] Lortal G., Lewkowicz M., Todirascu-Courtier A., 2006, Enabling communication rationale via annotations: a document-based cooperation in, Hassanaly P. , Herrmann T. , Kunau G. and Zacklad M. (eds) *Proceedings of COOP'06* (short paper), Carry-le-Rouet, May 9th-12th 2006, pp 75-82.
- [27] Zacklad M., Lewkowicz M., Boujut J-F., Darses F., Et Détienne F. (2003), Formes et gestion des annotations numériques collectives en ingénierie collaborative, *actes des journées Ingénierie des Connaissances 2003*, Laval.
- [28] Hornby, A.S., *Oxford Advanced Learner's Dictionary of Current English Oxford*, England: Oxford University Press, 4th edition, 1989
- [29] Biezunski, M., Bryan, M., and Newcomb, S. R., (1999) *Topic Maps*, spécification ISO/IEC 13250, 3 Décembre 1999.
- [30] Annozilla, (2004) <http://annozilla.mozdev.org/>
- [31] Annotea, (2001) <http://www.w3.org/2001/Annotea/>
- [32] Carroll J., Neale D., Isenhour P., Rosson M, McCrickard D., Notification and awareness: synchronizing task-oriented collaborative activity, in *International Journal of Human-Computer Studies*, v.58 n.5, p.605-632, 2003,