Considerations for Building a Common Platform for Cooperative and Collaborative Authoring Environments

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Abstract
This paper reports on considerations about the common basic functions and components for building a collaborative authoring environment. We aim to specify and systematize the technological issues towards the future standardization [5, 16] of such environments, based on our previous research experiences. Standardization includes many difficult aspects, however it will extend and widen the field of applications possible within the collaborative and cooperative authoring paradigm, and will enable the usage of the fruits of years of research and individual implementations of the concept of collaborative, but mostly, cooperative authoring. In this paper, we try to set a systematic basis of a common platform for collaborative authoring.

Keywords: Collaborative Authoring; Authoring Environment; Common Platform; Computer Supported Collaborative Authoring

1. COOPERATIVE & COLLABORATIVE AUTHORING SUPPORT

Cooperative and collaborative authoring (C^2A) are fundamental authoring forms that become more important with the paradigm shift towards re-usage and cooperation in the current authoring technology. The objects of C^2A are the *collaborative mutual interdependence* relations and the *group-implying activities* [11, 13].
Simply put, in pure *collaborative authoring*, each author takes over (an) authoring sub-task(s). When each author accomplishes the sub-task(s), the group goal is reached and collaborative mutual interdependent authoring is achieved.
In the wider spread *cooperative authoring*, authors just re-use each otherís materials, style, learning goal settings, dictionaries, linking and sequencing, etc.
Distributed C^2A is a type of collaborative authoring that can take place in the network environment, etc., with multiple authors virtually far from one another (comparable to the situation in [9]). A virtually distanced setting can mean remote physically (geographically), but also covers cases where direct interaction and dialogue among participants is not possible due to other reasons. Distributed C^2A support is a pioneering research domain that tries to find out ways to support the cooperation and collaboration (C^2) of multiple authors on the network.
Computer Supported C^2A (CSC^2A) is directly connected to distributed collaborative learning (CSCL - Computer Supported Collaborative Learning) [6], in cooperative curriculum-related activities, according to the used Learning Technology [5], on one hand, and to CSCW (Computer Supported Cooperative Work) [1,8,17] on the other. Compared to CSCW, CSC^2A has the same direct goal, i.e., *working efficiency*, in the sense of authoring achievement efficiency combined with the recognition or meta-recognition of the subject field. At the same time, CSC^2A has as a final goal *the student learning achievement efficiency*, borrowed from CSCL [4,13].
The regular CSC^2A-management software implementation should provide therefore two types of activity space: a *private working space* and a *collaborative working space*. The first is, unlike in collaborative learning [13], just a space for processing the material into a final form, to be copied into the collaborative space. In pure collaboration this private space practically disappears, as authoring becomes an iterative, peer-feedback dependent process. Here, authors can exchange information in a synchronous, but mostly, asynchronous manner. Many researches are studying these two types of activity spaces for learning environments [10,11,15], but not enough studies focus on authoring purposes. We now propose to analyse the case of the C^2A Environment (C^2AE) [2], by mapping it over the previously proposed collaborative learning environment case [11] and extracting analogies.

2. PRIMITIVE ACTIVITIES AND REQUIRED RESOURCES IN C^2A

In this section, we describe the primitive interaction activities among participants in C^2A, from a macro-granulation perspective. From a

technological viewpoint, every CSC^{2}A should provide at least all appropriate tools for these activities. Here we list them in their order of priorities: *Planning/ Execution/ Creation; Coordination / Control; Initiative/ Supervision; Observation / Suggestion; Data / Idea sharing; Dialogue (with Interaction).*

Surprisingly, compared to collaborative learning [11], only *Turn Taking* doesnít appear as a primitive activity, and supplementary to pure Execution, *Creation*, as a higher level execution form, is added. To carry out these activities, the following resources are required in C^{2}A environments: *Personal Workplace; Shared Workplace (shared object space); Dialogue Channel (implicit or explicit); Technologically mediated remote communication (audio, visual)* ñ latter optional for cooperative environment. Furthermore, more refined cognitive tools are desirable for facilitating group collaborative authoring, such as, e.g., concept mapping tools [2], etc. Therefore, we consider that an essential condition for CSC^{2}A systems is that the common platform/ infrastructure should have at least the above-mentioned resources built-in.

3. C^{2}AE STRUCTURAL MODEL

Figure 1 displays the C^{2}A concept from the point of view of the author behavior and the resource usage. We can differentiate between *author-to-author dialogue* (communication) and *other activities* (curriculum creation, etc.). Note that we include the coordination activities in the latter category. The figure shows the layers for the C^{2}A goal and C^2 work, as well as the layer containing the various authoring resources to consult during C^{2}A. These include all possible resources to which the author has access during authoring in an Internet environment (e.g., authoring materials, all-purpose tools,

specialized tools, authoring applications, various authoring data, etc.).
In C^{2}A an author can face an authoring task that s/he doesnít have the time or personal resources to fulfill, and, by interactions with other authoring companion(s), or by consulting other materials, s/he can exchange meaningful information, and notice other ways of perception and teaching. As the authoring efficiency has been shown to increase in such C^{2}A situations, many systems try to positively encourage collaboration and especially re-usage with the help of computer implementations.

4. C^{2}AE STRUCTURAL COMPONENTS

4.1. Collaborative authoring model elements
Figure 2 shows the details and various essential elements of the conceptual image of the C^{2}A model, where workplace and working subjects are brought together. Authors can belong to one or more groups, or none at all (pure re-usage, i.e., cooperation) and can be involved in curriculum creation projects or parts of projects together, therefore sharing that particular space (collaboration: pure or partial), and work privately for the rest.
The C^{2}A shared (collaborative) workplace contains the *dialogue support objects* for dialogue and information exchange support, the *collaborative working objects* for authoring activity related support, and the *collaborative memory*, for reference and information and end-product (course, etc.) accumulation (Fig. 2).
The private workplace contains the *working repository* of the private working objects, and the *private memory* for consultation and accumulation of information on private activities. Moreover, the figure also details the information referencing layer that is shown to

Dialogue Layer

Collaborative Workspace (CWS)

Individual Workspace (IWS)

Performance Layer

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Individual Workspace (IWS)

Information Reference Layer
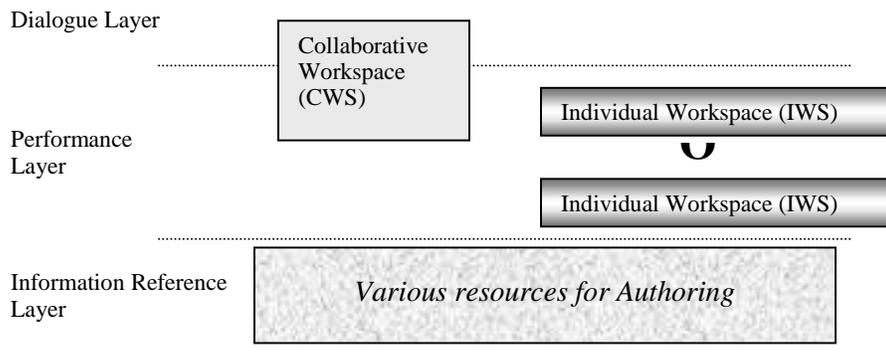
Various resources for Authoring

Figure 1: The Global Structural Model of the Cooperative and Collaborative Authoring Environment

contain information oriented towards individual and collaborative authoring goals, authoring materials, various educational data, libraries, educational applications, all-purpose tools, market applications, etc.

4.2. C^2AE structural elements

There are six essential structural/basic elements (objects) for building the C^2A environment. Due to lack of space, only the first hierarchical layer of definitions will be presented in this article.

1. C^2AE representation: Many systems have already used the collaborative learning paradigm [11], and helped towards extrapolating the important structural points of a C^2AE (Fig. 1,2). To define the C^2AE, we need to define the following six concepts: *General structural model of the C^2AE; Essential structural elements of the C^2AE and their Attribute(s) and Relation(s); Dynamical model of the C^2AE (data transmission model);Dynamical mechanism of the C^2AE (data exchange mechanism).*

2. Collaborative workspace representation: The collaborative workspace is an essential structural element of the collaborative part of the C^2AE that establishes a virtual space for collaborative activities for authoring groups and collaborating individuals, and ensures the continuity of these collaborative activities within that space (by

activity related information recording, etc.). Moreover, this space also provides functionalities for the cooperative activities. The workspace definition requires the definition of the following terms below: *Structure of C^2A space*, its *Essential elements* and their *Attribute(s)* and *Relation(s).*

3.Authoring resource(s) representation: C^2A resource(s) have to be guaranteed for private activities, collaboration (screen sharing, operation sharing), and cooperation (repository sharing). Here we need to define: *Essential structural elements of the C^2A resource(s); Fundamental referencing model of resources.*

4. Collaborative workplace representation: The collaborative workplace belongs to the *collaborative workspace*, and is an essential component of the C^2 working environment, used in groups for collaboration, or, with respect to the outer world, in cooperation. Namely, the collaborative workplace is in a "use_of" relation with the group and the private author. This workplace is determined by the *collaborative communication support objects* for distant group members, by C^2 *work objects* and by the *collaborative memory* that uses both previous object types for storage and retrieval. The defining of the collaborative workplace requires the definition of the terms below: *Collaborative*
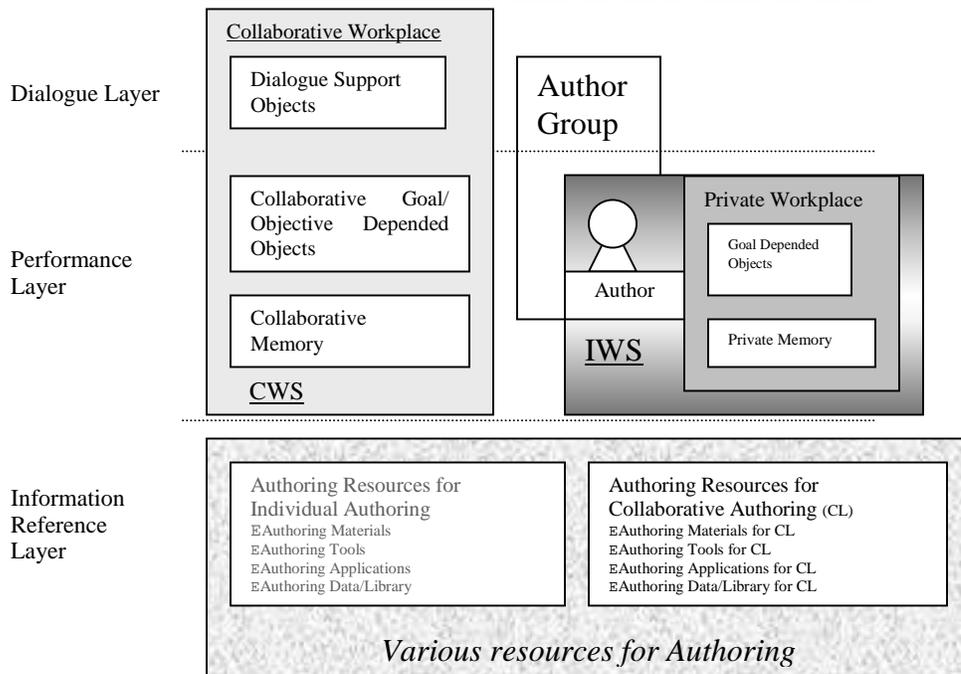

Dialogue Layer	**Collaborative Workplace** — Dialogue Support Objects	**Author Group**
Performance Layer	Collaborative Goal/ Objective Depended Objects; Collaborative Memory; **CWS**	Author — **IWS**; Private Workplace — Goal Depended Objects; Private Memory
Information Reference Layer	*Authoring Resources for Individual Authoring* — EAuthoring Materials, EAuthoring Tools, EAuthoring Applications, EAuthoring Data/Library	Authoring Resources for Collaborative Authoring (CL) — EAuthoring Materials for CL, EAuthoring Tools for CL, EAuthoring Applications for CL, EAuthoring Data/Library for CL
	Various resources for Authoring	

Figure 2: Collaborative Authoring Environment Components

workplace structure, its *Essential* elements and their Attributes and *Relation(s).*

5. Collaborative author group model

The group is defined within the collaborative workspace of the collaborative authoring environment. The group uses the collaborative workplace and pursues the collaborative authoring goal. This goal is defined as a set of individual achievements expected from the multiple members of the group. To define the author group model, the following elements and terms must be defined: *Group model structure*, its *Essential elements* and their *Attribute(s).*

6. Collaborative memory structure representation

The collaborative memory (CM) is included in the collaborative workplace of the collaborative workspace. It serves to store the objects used for dialogue support and objects used and developed in C^2A. Moreover, it has the role to retrieve these objects and stored information at request (later on, the CM or a copy of it will have to respond to requests in relation with learning). To define the collaborative memory structure, the definition of the following terms is necessary: *Collaborative memory structure,* its *Essential elements* and their *Attribute(s)* and *Relation(s).*

5. C^2AE DATA TRANSMISSION MODEL AND INTERFACE OBJECTS

5.1. Data transmission model in the C^2AE

Figure 3 shows the data transmission model in a C^2AE populated with authors and author group(s). The C^2A support system has to be able to send and receive, at the author's request, essential information regarding the C^2 and private workspace elements. Figure 3 illustrates our hypotheses by displaying a minimum of required relations. For example, a function has to be built that is able to fetch C^2 or private work objects requested by the group or privately from various resource(s), here represented by the *load_into* relation.

5.2. Interfaces

Five interfaces for the common objects are defined below.

1. Interface between authoring resource(s) and C^2 work object(s): The group performs collaborative activities by loading the C^2 work object(s) of the collaborative workplace from the authoring resources, for group and personal use.
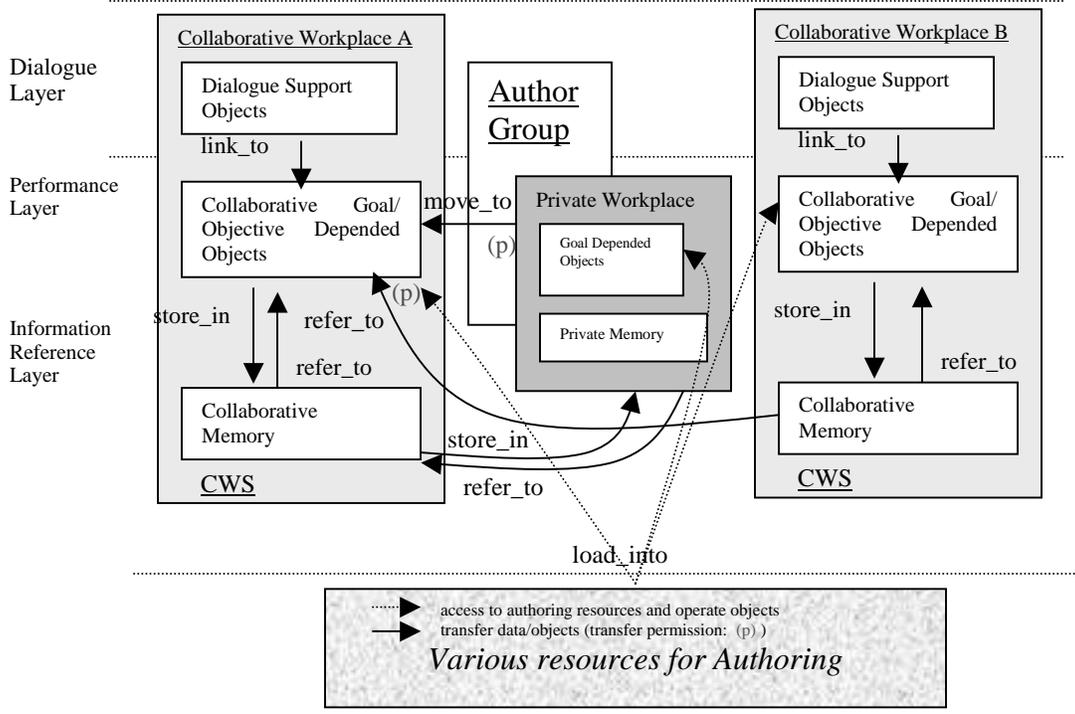

Figure 3: Data transmission model of the Cooperative and Collaborative Authoring Environment

Authoring resource(s) are used by multiple groups or individuals. By activating a group request, a memory image of the requested authoring resource(s) is produced, and therefore the collaborative work object(s) of the group collaborative workplace come into being. For defining this interface and its regulations, the following must be defined: *Authoring resource(s) reference structure,* its *Essential elements* and their *Attribute(s)* and *Relation(s); Protocol between the authoring resource(s) agent and the collaborative work object agent.*

2. Interface between dialogue support object(s) and collaborative work object(s): The dialogue support objects enhance the information exchange between authors and manage the communication activity history. The role of the communication among authors is to support and smoothen the various authoring and work activities managed by collaborative work object(s). Namely, the communication that takes place in order to achieve the group-authoring goal is closely related to communication in collaborative work for problem solving. For the computer to understand the meaning of the communication, it is necessary to link the output of the dialogue support object and the collaborative working object (proper ontological representation). For this purpose, the items below need to be defined: *Dialogue support object and collaborative work object output data structures,* their *Essential elements* and *Attribute(s).*

3. Interface between the private workspace and C^2 work object(s) of the collaborative workplace: C^2A does not always take place in the collaborative workspace. A group member or an independent author can bring in work results from the author's private workplace to the collaborative workplace, or the work result from the collaborative workplace can be copied to the private workplace. Therefore, next to the definition of the C^2 work object input data, the definition of the output data of the private workplace is also necessary, as follows: *Private workplace output data structure,* its *Essential elements* and their *Attribute(s)* and *Relation(s); Protocol between the private workplace agent and the collaborative workplace agent; Protocol between the collaborative workplace agent and the collaborative work object agent.*

4. Interface between *C^2* work object(s) of the collaborative workplace and the collaborative memory: The C^2 work object output data is the authoring log data. The interface uniformity between the C^2 work object(s) and the collaborative memory within the collaborative workplace is ensured by the C^2A log exchange and the C^2 work object addition/deletion. By establishing a uniform representation of the C^2A log, the accumulation in and the reference to the collaborative memory can be implemented in an interoperable form. For this, the items below must be specified: *Relation between the essential elements of the collaborative workplace structure and authoring log structure; Storage request structure of the authoring log into the collaborative memory,* its *Essential elements* and their *Attribute(s)* and *Relation(s); The reference request structure of the authoring log from the collaborative memory,* its *Essential elements* and their *Attribute(s)* and *Relation(s).*

5. collaborative memory - group model Interface
The collaborative memory of the collaborative workplace stores various data developed during the group curriculum activities. This information is the ordered and managed information of the group model. Thereafter, the group model is registered. When some new group activity commences, the previous activity history and results from the group model are referred. Moreover, the collaborative memory stores data developed during public individual authoring activities. Therefore, the collaborative memory maintenance is necessary. For the correct reference of such information, the items below have to be defined: *Relation between the collaborative memory attribute(s) and the group model attribute(s); Relation between the collaborative memory attribute(s) and the (independent, individual) author model attribute(s); Output data structure from the collaborative memory into the group model and individual author model,* its *Essential elements* and their *Attribute(s)* and *Relation(s).*

6. CONCLUSION

The technological concept formation of the basic and common platform for building the cooperative and collaborative authoring environment (C^2AE) needs a collective effort and is an ongoing process. We have started in this paper from some considerations based on our experiences, and have gradually built specification items towards a future standardization. We have not followed the ramifications we have opened due to lack of space. To give just a flavor of next developments necessary, we mention here some further functions required in the C^2AE [13]:

➢ *Coordination* (constrained and mediated by the external environment)

➢ *Reification* (material evidence in the external environment)

➢ *Illustration* (external representation)

➢ *Storage* (in later use, for the purpose of reflection)

Examples of general tools for supporting collaboration are as follows: *Concept Mapping tools; Editors for argumentation network; Work flow* (planning tool); *WYSIWIS* (What You See Is What I See).

So far, we have integrated a few parallel projects with related goals (distance learning, life-long learning, re-usage of educational materials), under the name RAPSODY [10] and RAPSODY-EXT [12].

In this paper, we have systematically elaborated, from an academic point of view, the fundamentals of the common functions and components for building a platform for a C^2AE for the future directions of standardization. However, these considerations and issues are only the first steps towards standardization, and our paper doesnít claim to be exhaustive on the matter. For further research, the presented standardization candidate items have to be refined further on, and their functionalities extended. We havenít mentioned here, for instance, C^2AE exchange mechanism implying C^2A agents, etc. Therefore, we need more investigations and discussions to persuade people about the importance of standardization for collaborative and cooperative authoring.

By using a common architectural, functional and technological basis, and, moreover, by using other common concepts that were not treated in this paper, such as a common ontology for a static representation model, and a common dynamic model (e.g., in Petri net representation), real collaboration and cooperation within authoring environments for learning environment creation can be achieved.

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