Methodology for Conceptualization of Customizable Virtual Workspaces

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Abstract. The improvement on evolution of quality of communications based on Internet technology is the base of the trend of development of free Virtual Workspaces. As an emerging family of applications to be developed, needs tools for conceptualizing process as input of design processes. This paper introduces a conceptualization process of virtual workspaces oriented to strictly cover specific interaction needs, and proposes a set of techniques where each of these techniques is associated to development of each conceptualization task of presented process.

Keywords. Virtual workspace, conceptualization process, formalisms for modeling human interactions, techniques to develop formalisms.

1. Introduction

Virtual spaces dedicated to collaborative work (VSCW) are intended to facilitate mediation inside teams whose members are not physically contiguous, and have to develop a conceptual object (for example: research, project development, software, technical articles, reports, documentation of building design, business plans, corporative investment plans, among others). The VSCW must satisfy the requirement of keeping and documenting the different versions of the conceptual object that is being developed by the collaborative working team; leaving a record of the evolution from the agreement among the members of the working group since initial specifications of the conceptual object until its final stage of development.

There are some proposals for conceptual modelling notations of aspects of group work [1-2]. Recently, there has been proposed [3] a set of interaction modeling formalisms among group members within a virtual collaborative work space that may be briefly describe as follows: [a] *Table Concept-Category-Definition*: Its function is to represent the factual knowledge of the conceptual model of group dynamics; [b] *Cases of Interaction*: are used to modelize the interactions between two actors, [c] *Diagrams of Group Interaction*: are used to modelize, in an integrated way, interactions among all actors considered in the modeling process; [d] *Interaction Procedures*: are used to describe the composition of interactions among the actors made for the development of an object; [e] *Sequence Diagram of Group Dynamics*:

are used to express the group dynamics among the actors in the timeline imposed by the procedures of interaction; [e] *Diagram of Conceptual Object Development*: are digraphs with two types of nodes: the "conceptual objects" and the "transformations" which represent the action that must to be performed to make evolve the "conceptual object" from a level of development into another.

This paper is structured as follows, in section 2 is defined the problem of conceptualization of virtual workspaces, in section 3 is proposed a conceptualization methodology (the process, the tasks and the conceptualization techniques for each task of the process), in section 4 is presented a concept proof, and in section 5 is summarized preliminary conclusions and future research.

2. Definition of the Problem

Several authors [4-8] from a wide range of fields (users and developers) have pointed out in different ways that state of conceptual modeling of virtual work group is characterized by the following limitations: [a] lack of techniques to derive conceptual models (and absence of corresponding formalisms) of interaction among group members and among them and objects; from the description of the workspace and developed tasks within it; and [b] lack of processes that allow deriving the architecture of the virtual space designed for the particular needs of a workgroup, from conceptual models which describe the interactions among its members and objects. Regarding these limitations, we introduce a conceptualization process of virtual workspaces, and propose a set of techniques where each of these techniques is associated to development of each conceptualization task of presented process.

3. Proposed Conceptualization Methodology

The conceptualization methodology of virtual space oriented to collaborative work (VSCW) proposed in this paper is structured by a process with three phases: Phase of Static Conceptualization of VSCW, whose objective is focused on the characterization of the concepts related to Virtual Workspace and its categorization in: Actors, Objects and Interactions; Phase of Dynamic Conceptualization of VSCW, whose objective is focused on the characterization of the interactions between actors and between actors and objects, giving a comprehensive view of the interactions streaming along timeline; Phase of Modeling of VSCW, whose objective is to identify the features that should have the virtual workspace to support the interactions among actors, and among actors and objects, identifying which components should give support to each type of interaction. Each phase consists of tasks with an associated technique to develop each one; and a set of products that can act as elements of input and / or output of a given task [9]. Each task defines a set of products as insumes, and generates a set of products as output of its development. The products are partial conceptualizations of the description of workspace and interactions among persons in it. The partial conceptualizations are based on formalisms introduced in [3]. Figure 1 presents the interaction among phases, tasks and products, and shows the flow of

products supplied to tasks and the products that are the result of the different accomplished tasks. A summary of tasks, the techniques that develop them, and products used as input or output for each task (technique) is shown in Table 1.

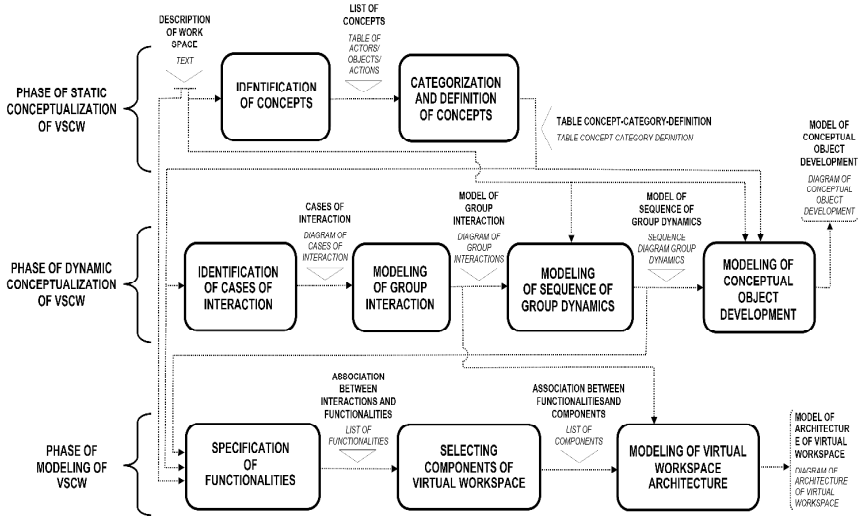

Fig. 1. Interaction among phases, tasks and products

Table 1. Summary Table of Tasks, Techniques and Products (Input or Output)

	FASE	TASK	TECHNIQUE	MODELING FORMALISM(S) FOR INPUT PRODUCT(S)	MODELING FORMALISM FOR OUTPUT PRODUCT
PHASES OF PROPOSED PROCESS	STATIC CONCEPTUAL-IZATION OF VSCW	Identification of Concepts	Technique for Identification of Concepts in Text (see Table 2)	Description of Work Space	List of Concepts
		Categorization and Definition of Concepts	Technique to Build Table Concept-Category-Definition (see Table 3)	List of Concepts	Table Concept-Category-Definition
	DYNAMIC CONCEPTUALIZATION OF VSCW	Identification of Cases of Interaction	Technique to Build Diagram of Cases of Interaction (see Table 4)	Table Concept-Category-Definition	Diagram of Cases of Interaction
		Modeling of Group Interaction	Technique to Build Diagram of Group Interactions (see Table 5)	Diagrams of Cases of Interaction	Diagram of Group Interactions
		Modeling of Sequence of Group Dynamics	Technique to Build Sequence Diagram Group Dynamics (see Table 6)	Description of Work Space Diagram of Group Interaction	Sequence Diagram Group Dynamics
		Modeling of Conceptual Object Development	Technique to Build Diagram of Conceptual Object Development (see Table 7)	Description of Work Space Table Concept-Category-Definition Sequence Diagram Group Dynamics	Diagram of Conceptual Object Development
	MODELING OF VSCW	Specification of Functionalities	Technique for Association between Interactions and Functionalities (see Table 8)	Description of Work Space Table Concept-Category-Definition Diagram of Group Interaction	Table of Association between Interactions and Functionalities
		Selecting Components of Virtual Workspace	Technique for Association between Functionalities and Components (see Table 9)	Table of Association between Interactions and Functionalities	Table of Association between Functionalities and Components
		Modeling of Virtual Workspace Architecture	Technique to build Diagram of Architecture of Virtual Workspace (see Table 10)	Table of Association between Functionalities and Components	Diagram of Architecture of Virtual Workspace

Table 2. Technique for Identification of Concepts in Text

Input:	Description of Work Space (DWS)
Output:	List of Concepts
Step 1.	Identify persons in DWS
Step 2.	Identify objects in DWS
Step 3.	Identify actions in DWS
Step 4.	Build a discriminated list of concepts classifying them in: actors, objects and actions

Table 3. Technique to Build Table Concept-Category-Definition

Input:	Description of Work Space
Output:	List of Concepts
Step 1.	Categorize Concepts in Actors(persons), Objects and Interactions (Actions)
Step 2.	Define each Concept
Step 3.	Integrate results on a Table

Table 4. Technique to Build Diagram of Cases of Interaction

Input:	Table Concept-Category-Definition
Output:	Diagram of Cases of Interaction
Step 1.	Identify pairs of actors interacting
Step 2.	For each pair of actors: generate a list of objects and interactions
Step 3.	For each pair of actors: Build the Case of Interaction
Step 4.	For each Case of Interaction: Give a graphic description in terms of Actors, Interactions and Objects

Table 5. Technique to Build Diagram of Group Interactions

Input:	Diagram of Cases of Interaction
Output:	Diagram of Group Interactions
Step 1.	Identify the same Actor (if exists) in different Cases of Interaction
Step 2.	Initialize Diagram of Group Interactions with one of Cases of Interaction identified in 1
Step 3.	For each Cases of Interaction not integrated into the Diagram of Group Interactions with an Actor in common with this: integrate the Case of Interaction with the common Actor to the Diagram of Group Interaction
Step 4.	IF: Still Exists Cases of Interaction with a common Actor but not integrable to the Diagram of Group Interactions: Initialize a new Diagram of Group Interactions with one of the Cases of Interaction identified. Go to Step 3. OTHERWISE: Finish technique execution.
Step 5.	For each Diagram of Group Interactions: Give a graphic description in terms of Actors, Interactions and Objects

Table 6. Technique to Build Sequence Diagram Group Dynamics

Input:	Description of Work Space (DWS) Diagram of Group Interaction
Output:	Diagram of Group Interactions
Step 1.	Deploy the timeline of each Actor present in Diagram of Group Interactions
Step 2.	Identify in the DWS, the sequence of interactions present in the Diagram of Group Interactions.
Step 3.	For each Interaction in the Sequence of Interactions constructed in Step 2, identify in the DWS: Object present in the interaction, Actor who starts Interaction and Actor who completes Interaction
Step 4.	In the Sequence order of Interactions constructed in Step 2, deploy interact-tions with mention to associated objects identified in Step 3, between timelines of Actors constructed in Step 1.
Step 5.	Identify in the DWS, cycles of group of interactions and note them on the constructed diagram.

Table 8. Technique for Association between Interactions and Functionalities

Input:	Description of Work Space Table Concept-Category-Definition Diagram of Group Interaction
Output:	Table of Association between Interactions and Functionalities
Step 1.	Build a table of Interactions present in the Sequence Diagram of Group Dynamics, distinguishing the type of interaction.
Step 2.	From the Description of Work Space extend the table developed in Step 1, mentioning the functionality which has to be satisfied by componente that will support the associated Interaction.
Step 3.	Build a table of Interaction and Component Functionality that will support the Interaction

Table 7. Technique to Build Diagram of Conceptual Object Development

Input:	Description of Work Space Table Concept-Category-Definition Sequence Diagram Group Dynamics
Output:	Diagram of Conceptual Object Development
Step 1.	From Table Concept-Category-Defining, build a table of Interactions and Objects presents in Diagram of Group Interaction
Step 2.	From the Description of Work Space and table generated in Step 1: build a table in which Objects and Derived Objects are distinguished. It has to be mentioned the object from which the derived object derives, the Interaction which generates the derived object and the vinculation of derivation.
Step 3.	From the Description of Work Space, Table Concept-Category-Definition, Sequence Diagram Group Dynamics and the table generated in Step 1: build a table following the order that describes the Sequence Diagram of Group Dynamics, identify: interactions, transformations associated with the interactions which object or objects are inputs of transformation, objects generated by each transformation, and cycles of transformation associated cycles of interaction.
Step 4.	From tuples (ASSOCIATED TRANSFORMATION / INPUT OBJECT / GENERATED OBJECT) described in table generated in Step 3: deploy the Elemental Components of Diagram of Object Conceptual Development.
Step 5.	Build Diagram of Conceptual Object Development by coupling Elemental Components built in 4.

Table 9. Technique for Association between Functionalities and Components

Input:	Table of Association between Interactions and Functionalities
Output:	Table of Association between Functionalities and Components
Step 1.	Build a table of Interactions present in the Sequence Diagram of Group Dynamics, distinguishing the type of interaction.
Step 2.	From the Description of Work Space extend the table developed in Step 1, mentioning the functionality which has to be satisfied by componente that will support the associated Interaction.
Step 3.	Build a table of Interaction and Component Functionality that will support the Interaction

Table 10. Technique to build Diagram of Architecture of Virtual Workspace

Input:	Table of Association between Functionalities and Components Diagram of Group Interactions
Output:	Diagram of Architecture of Virtual Workspace
Step 1.	Deploy Actors present in the Diagram of Group Interactions
Step 2.	Deploy Components present in the Table of Association between Functionalities and Components
Step 3.	Link the Actors and Components through the Components Integration System

4. Concept Proof

To illustrate the proposed techniques applied to the development of each task is provided a proof of concept based on a case brought in [3]. The descriptions of the interactions among persons in virtual space that will be designed are presented in the following paragraph:

> *"...Master's degree student sends the PhD degree student, his master's thesis plan developed previously. PhD degree student reviews the plan and made the corrections and comments that he considers relevant and then send them to master´s degree student. He appropriates the corrections and comments to continue working on his master's thesis plan. Once the PhD degree student believes that the version of the master's thesis plan has not problems, forward it to senior researcher asking for his overseeing of the final version of master´s thesis plan. Senior researcher oversees the corrections made by the PhD degree student. As a result of overseeing, he can send comments which may include observations about the correction made and/or to make further corrections to be introduced in master´s thesis plan. Upon receiving these comments, the PhD degree student appropriates these and forwards them to master's degree student for his appropriating also, allowing in this way the generation of new versions of the document ...".*

The Technique for Identification of Concepts in Text is applied to develop the task of Identification of Concepts, which produces partial conceptualization model (hereinafter PCM) shown in Table 2. The Technique to Build Table Concept-Category-Definition is applied to develop the task of Categorization and Definition of Concepts, which produces PCM shown in Table 3. The Technique to Build Diagram of Cases of Interaction is applied to develop the task of Identification of Cases of Interaction, which produces PCM shown in Figure 2. The Technique to Build Diagram of Group Interactions is applied to develop the task of Modelling of Group Interaction, which produces PCM shown in Figure 3. The Technique to Build Sequence Diagram Group Dynamics is applied to develop the task of Modelling of Sequence of Group Dynamics, which produces PCM shown in Figure 4. The Technique to Build Diagram of Conceptual Object Development is applied to develop the task of Modeling of Conceptual Object Development, which produces PCM shown in Figure 5.

Table 2. List of Concepts of case "Review of Master's Thesis Plan"

Concept	Category
INCORPORATE	ACTION
PhD STUDENT	PERSON
SEND	ACTION
SEND COMMENTS	ACTION
SEND CORRECTION	ACTION
SENIOR RESEARCHER	PERSON
MASTER STUDENT	PERSON
THESIS PLAN	OBJECT
REVIEW	ACTION
REVIEW AND CORRECT	ACTION
REQUEST OVERSEE	ACTION
OVERSEE	ACTION

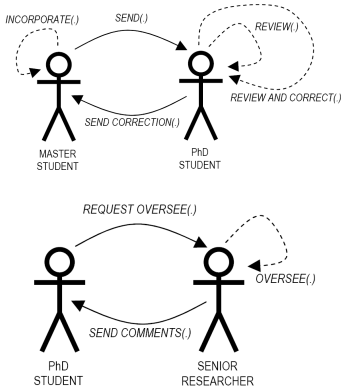

Fig. 2. Interaction cases of concept proof case

Table 3. Table Concept-Category-Definition of case "Review of Master's Thesis Plan"

Concept	Category	Definition
INCORPORATE	INTERACTION	Actor "A" incorporates the received information in the document and / or comments in it.
PhD STUDENT	ACTOR	Professional who has a master degree or academic equivalent and is making a career of doctoral degree
SEND	INTERACTION	Actor "A" sends to actor "B" a document or information.
SEND COMMENTS	INTERACTION	Actor "A" sends Actor "B" the comments on the results of overseeing carried out, this may include observations about the correction made and/or further corrections to make.
SEND CORRECTION	INTERACTION	Actor" A" sends to actor "B" the result of the review and correction of the document with its observations.
SENIOR RESEARCHER	ACTOR	Professional with a PhD degree or academic equivalent, with background in human resources training at the doctoral level and master degree.
MASTER STUDENT	ACTOR	Professional with grade title and who is making a master degree
THESIS PLAN	OBJECT	Document referred to student´s research project who is carrying out to earn a PhD, master's, specialty or grade degree.
REVIEW	INTERACTION	The actor reviews the document and states his comments (in case needed) but without doing any correction.
REVIEW AND CORRECT	INTERACTION	The actor revises and corrects the document with indication of his comments and corrections
REQUEST OVERSEE	INTERACTION	Actor "A" asks oversee of review / corrections on a document generated by a third actor. Overseeing will be made by actor "B".
OVERSEE	INTERACTION	Actor "A" oversees the reviews or corrections made by an actor "B" on a document that has been sent previously to him by a third actor.

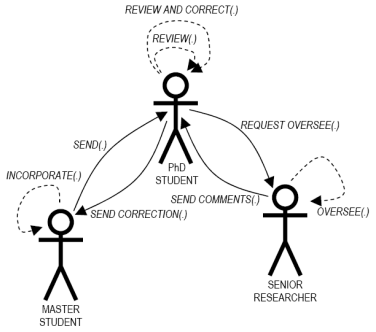

Fig. 3. Group interaction diagram among Actors

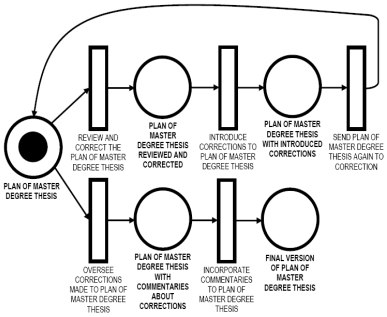

Fig. 5. Diagram of Conceptual Object Development for case "Review of Master's Thesis Plan

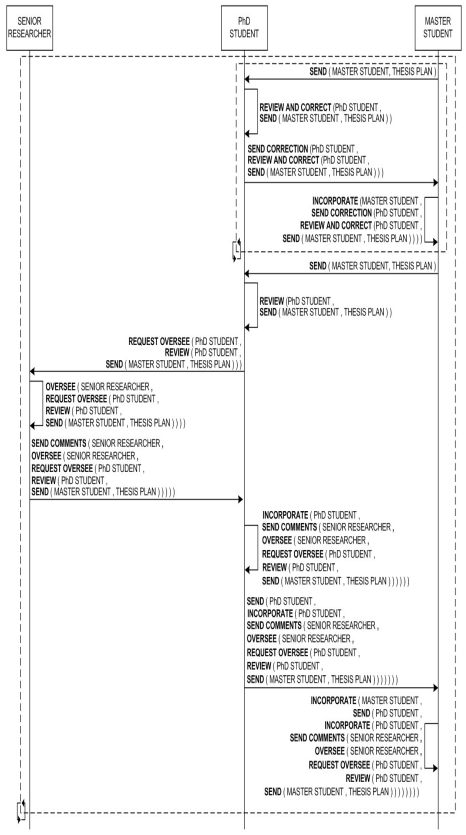

Fig. 4. Sequence Diagram of Group Dynamics of case "Review of Master's Thesis Plan

The Technique for Association between Interactions and Functionalities is applied to develop the task of Specification of Functionalities which produces PCM shown in Table 4. The Technique for Association between Functionalities and Components is applied to develop the task of Selecting Components of Virtual Workspace which produces PCM shown in Table 5. The Technique to build Diagram of Architecture of Virtual Workspace is applied to develop the task of Modelling of Virtual Workspace Architecture which produces PCM shown in Figure 6.

5. Conclusions

Work in groups is one of the usual labour strategies that may be mediated by Internet technology. Virtual workspaces arise as a possibility to establish working groups in which persons are not physically contiguous or have difficulty to share the same real space. Our work focuses on conceptualization process for customizable virtual

working spaces that require to be strictly adjusted to the needs defined by the nature of task developed by the work group. The proposed process is a step towards formal design of the virtual space architecture in which the virtual work will take place.

Table 4. Table of Association between Interactions and Functionalities

INTERACTION	FUNCTION-ALITY
INCORPORATE	No component required
REVIEW AND CORRECT	
REVIEW	
SEND	Ability to transmit documents in real time
SEND COMMENTS	
SEND CORRECTION	
REQUEST OVERSEE	Carry video conferences 1-1
OVERSEE	

Table 5. Table of Association between Functionalities and Components

COMPONENT FUNCTION-ALITY	COMPONENT
Ability to transmit documents in real time	EMAIL MODULE
Carry video conferences 1-1	WEB-CONFERENCE MODULE PERSON TO PERSON

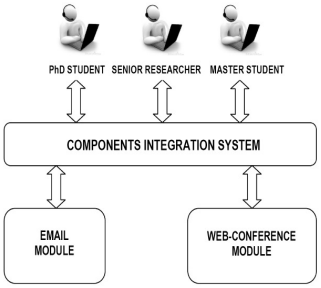

Fig. 6. Diagram of Architecture of Virtual Workspace

To consolidate the results presented in this paper, the following research works have been started up: [a] the development of a prototype configuration of VSCW component-based and a prototype tool to support the process of formalizing interactions, and [b] explore the validity of the proposed conceptualization process in the following cases: (i) VSCW for Architects team working in building design, and (ii) VSCW for Software Engineers team working in software development.

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