Collaboration Engineering: Supporting the Collaborative Processes Design for the Accessible and Usable Interactive Systems Design

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Keywords: Usability, Collaboration, Thinklet, Usability and Accessibility Engineering Process Model, Moodle.

Abstract: From the Collaboration Engineering approach it is possible to design collaborative processes that could ensure a collaborative effective work among participants of a working group integrating the available resources and skills. This paper describes the use of Collaboration Engineering for the design of processes that support collaborative activities raised by the Usability and Accessibility Engineering Process Model (MPIu+a) for Requirements Analysis Phase in developing usable and accessible interactive systems.

1 INTRODUCTION

Software development is not an easy task and involves different aspects that require expertise of people of different backgrounds and with different skills. One of the most valuable aspects that are being considered is related with usability and accessibility. The User Centered perspective is a model that involves these aspects taking into account the user perspective during the development process.

In order to involve collaborative aspects in the software development, is very convenient to offer members of the work group, some strategies that allow them to work in a collaborative manner, using resources, time and skills of the participants in an effective and efficient way. The generation of processes that involve collaborative aspects, could be done through Collaboration Engineering proposal, where "collaborative and repetitive processes are designed, which could be transferred to the groups using techniques and collaboration technology" (De Vreede and Briggs, 2005).

There are many development software methodologies whose objective is the design of usable and accessible interactive systems. In this paper the Usability and Accessibility Engineering Process Model (MPIu+a) (Granollers, 2004) has been selected since it raises a suitable integration between the basic foundations of Software Engineering and the principles of the User Centered Design, additionally this Model proposes techniques of requirements analyses, which are centered in the user. The research presented in this paper support the collaborative aspect, which is present in the group dynamics of the activities raised by the MPIu+a in the Requirements Analysis Phase, through design collaborative processes, which can be applied in an independent way of the geographic location of the development team and system potential users.

Collaborative processes generated have been obtained through the design methodology for Collaboration Engineering (Kolfschoten and Vreede, 2007). The next section presents background information on aspects that support this research. Section 3 depicts a case study in order to validate the collaborative process, and finally, some conclusions and further work will be presented.

2 BACKGROUND

2.1 Usability and Accessibility Engineering Process Model (MPIu+a)

MPIu+a is the name of a methodology for the development of usable and accessible interactive systems based on User Center Design (UCD) principles and Software Engineering. One of the central keys of this methodology is the necessity and

Collazos, C., Solano, A. and Fardoun, H.
Collaboration Engineering: Supporting the Collaborative Processes Design for the Accessible and Usable Interactive Systems Design.
DOI: 10.5220/0006941407860793
In *Proceedings of the 13th International Conference on Software Technologies (ICSOFT 2018)*, pages 786-793
ISBN: 978-989-758-320-9

importance that the development software be immersed in the work group perspective, where be possible to include mechanisms that support groups dynamics in an appropriate way, including people of different knowledge disciplines and where the user participation be the central point of the design oriented actions (Granollers, 2004). In a multidisciplinary team with diverse mental models and working ways, it is possible to find difficulties associated with communication and information sharing among these persons (Sutcliffe, 2002), MPIu+a brings some guidelines in order to support the sharing information and therefore try to reach an effective work.

In the Requirements Analysis Phase proposed in MPIu+a the necessity of participation as team members as system representative users is evident, phase in which is high-priority to identify suitably who will be the users and system stakeholders, as well as to establish an effective communication with them with the purpose of determining their real necessities. For this paper we have selected the activities Stakeholders Identification, Stakeholders Meeting and Users Classification of the Requirements Analysis Phase, designing collaborative processes, because they are activities that require a work team and contribution of different people in order to reach the final goal.

Stakeholders identification: the objective of this activity is to determine all the stakeholders of the interactive system development. From base line, all the "stakeholders network" is generated (Sharp et al., 1999).

Stakeholders meeting: once the stakeholders have been identified, it is necessary to know their influence in the development project, for which a meeting must be planned, the key points to be treated are identified previously (they are related with objectives, possible users, technological restrictions, usability objectives, etc.).

User classification: the objective of this activity is to classify to the users in user profiles and roles, and to make an association between these profiles and roles, with the purpose to identify clearly their characteristics and their roles within the system.

2.1.1 Collaboration Engineering

Collaboration Engineering is defined as "*an approach to designing collaborative work practices for high-value recurring tasks, and transferring those designs to practitioners to execute for themselves without the ongoing intervention of a professional facilitator*" (Kolfschoten et al., 2006). Researchers over Collaboration Engineering have determined some similar behaviors in the way participants work in order to achieve group goals, these behaviors have been called: collaboration patterns, which are defined as "moving a group from some initial state to some end state" (De Vreede and Briggs, 2005). The collaboration patterns are (Kolfschoten and Vreede, 2006): generate, reduce, clarify, organize, evaluate, build consensus.

Once obtained the collaboration patterns, it is necessary to identify the way to perform them. In that way, the thinklets may be used to create repeatable, predictable patterns of thinking among people making an effort toward a goal (Briggs et al., 2003, De Vreede et al., 2006). A thinklet is the smallest unit of intellectual capital to create a known pattern of collaboration her in order to achieve a goal (De Vreede and Briggs, 2005).

2.1.2 Collaborative Processes Design

The collaborative process design was made based on the design methodology for collaboration engineering proposed by Kolfschoten et al. in the HICSS-39 Workshop on Collaboration Engineering (Kolfschoten and Vreede, 2007). The task Stakeholders Identification has been selected as example to show the application of the propose methodology for the collaborative processes design, next the results obtained in each phase are presented.

Step Task Diagnosis

In this step it is necessary to identify the objectives, deliverables and requirements of the task from which the respective collaborative process is designed. The identification would be made with the

Table 1: Task diagnosis of the stakeholders identification.

Stakeholders Identification:
Objective: identify all the project stakeholders (even those that could influence negatively) (Granollers, 2004).
Deliverables:
List of Categories from which the stakeholders will be identified.
Stakeholders classified in the identified categories.
Role Description of every identified stakeholder.
Requirements:
Knowledge on the Stakeholder concept.
General Description of the system to develop.
Information about the proposals to classify stakeholders of an interactive system (Newman et al., 1995).
Information about the methodology for the classification of users, propose by authors of *Center HCI Design and Computer Science Department* (Sharp et al., 1999).

continuous support of expert people in the grasp of task application (Kolfschoten and Vreede, 2007). Table 1 presents the result of this activity.

Step Task Assessment

The activities of the task are identified and evaluated. The evaluation basically consists of determining if a predefined way to execute the task exist, in this case, will have to be evaluated if it can be carried out of collaborative way (Kolfschoten and Vreede, 2007). Table 2 presents the information related to the activities identified for the task.

Table 2: Task assessment of the stakeholders identification.

No	Activities	Collaborative
1	To generate a list of categories from which the stakeholders will be grouped.	Yes
2	To identify the system stakeholders in the categories previously generated.	Yes
3	To describe the stakeholder role in the system	Yes

It is possible that some activities are identified like non collaborative ones, the criterion in which we have been based to define them of this way is that the execution of these activities don't require consensus on the matter or that different points of view are considered. The non-collaborative activities can be executed by a single person or they don't imply a work in equipment.

The criterion that was considered to determine if an activity is collaborative is that this activity can imply a group work for its execution. In the Stakeholders Identification task, it has been considered that all the activities that conform it can make of collaborative way.

Step Activity Decomposition

In this step the form in which the group would make the collaborative activity is analyzed and this behavior of work is associated with the identified *Collaboration Patterns* in the Collaboration Engineering. Result for one of the collaborative activities of the Stakeholder Identification Task is shown in Table 3.

Table 3: Activity decomposition of the stakeholders identification.

Related activities: identification of system stakeholders in the categories previously generated (Activity 2). ***Description***: for each one of the defined categories, the members identify the system stakeholders that consider belong to this category. ***Inputs:*** list of categories. ***Results*:** list of system stakeholders, below to each one of the categories. ***Observations:*** this activity is due to carry out for each one of the categories that previously have been generated that corresponds to some proposal of classification. ***Group:*** group of people in charge of the Phase of Analysis of Requirements.	
Patterns	***Justification***
Generate	To generate a list of system stakeholders that belongs to each one of the categories.
Evaluate	The team members verify that the stakeholder belong to the categories in which they were assigned.

Step Thinklet Match

Once associated the Collaboration Patterns to the different activities, each one of them is related with the thinklet that is considered can support the

Table 4: Thinklet match of the stakeholders identification.

Description: the categories defined previously are presented to the participants in different pages, so that they identify in each one of them the project stakeholders pertaining to this category. Later, the team members must identify if there is some stakeholder that it does not belong to the category in which is classified, in this case the participant would have to propose the category where considers that it must be classified and a discussion is generated (other participants express their commentaries).		
Pattern	**Thinklet**	**Reasons of selection of the Thinklet**
Generate	LeafHopper	The team members can list system stakeholders on the categories in which they have the most interest or the most expertise.
Evaluate	BucketWalk	It's pertinent to generate discussion with respect to the location of the stakeholders. It's necessary to validate that each one of the stakeholders corresponds to the assigned category.

execution of the activity. The thinklets identified for the different activities, must be adapted to the resources, the group and to the abilities of the people involved in the execution of the collaborative processes (Kolfschoten and Vreede, 2006). Result of applying this step in the activity described in Table 3 is displayed in Table 4.

Step Design Documentation

From information obtained in the previous steps, some documents defined in Collaboration Engineering are generated, which are: *Process Description, Detailed Agenda and Facilitation Process Model (Kolfschoten and Vreede, 2007)*. *Process Description* is a document that presents general information related to the collaborative process design. Table 5 shows the *Process Description* for the *Stakeholder Identification.*

Detail Agenda: The detailed agenda is a document that contains parameters to define the activities that comprise of the designed process, the agenda should specify all information related to the thinklet, which were identified in the designed process. The Detailed Agenda of the *Stakeholders Identification* is displayed in the Table 6.

Facilitation Process Model (FPM) is used to display the process flow, and critical elements in this flow. For each one of the activities that conform the designed Collaborative Process, the number of sequence (corresponding with the detailed agenda), pattern of collaboration, thinklet name, description of the activity and the suggested time to each activity are presented (Kolfschoten and Vreede, 2007). A FPM of the Stakeholders Identification task is displayed in Figure 1.

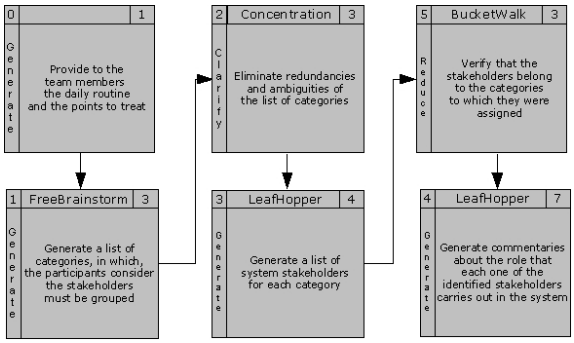

Figure. 1: FMP of the Stakeholders Identification Task.

Step Design Validation

There are four forms to validate the design: pilot testing, walk-through, simulate and reviewing (Kolfschoten and Vreede, 2007). The validation of the designed collaborative process for the Requirements Analysis Phase was made through the test pilot, which is an implementation of the collaborative process in order to evaluate the effectiveness of the process. This validation will reveal whether the process can be done with the considered time and with the given group and resources (Kolfschoten and Vreede, 2007).

Table 5: Process description for stakeholders identification.

Process description
The person in charge of the activity invites to each one of the participants to write in different pages the categories in which they consider the system stakeholders must be grouped. Later, it is requested to the team members that make commentaries on each category, whether or not they think is pertinent that this category be part of the final categories list. • Taking the propose categories list and the respective commentaries, the person in charge of the evaluation presents to participants a categories list, from which they must identify. • Similar categories. The participants are invited to present the similar categories to the rest of the group and explain the reason for which they consider that these categories are similar, the group must decide if the categories are combined or any of them is eliminated. • Categories that present ambiguity, so that these are clarified by some other team member or alternating categories names are suggested. • Categories that must be eliminated of the list. The categories defined previously are presented in different pages; the participants identify in each one the project stakeholders. Later, it is requested to the team members to identify if some stakeholder does not belong to the category in which is classified, in this case the participant would have to propose the category where he considers that the stakeholder must be classified and a discussion is generated so that the other participants express their commentaries. Finally, in different pages the stakeholders are displayed so that the members identify in each one of them the role that carries out in the project.

Table 6: Detailed Agenda for stakeholders identification.

#	Task	Deliverable	Question/Assignment	Thinklet	Time
0	To provide to the team members the daily routine and the points to treat.	Knowledge of the participants about the activity.			1 day
1	To generate a list of categories, in which, the participants consider the stakeholders must be grouped.	List of Categories to group the stakeholders.	Please, write the categories in which you consider the system stakeholders must be grouped.	Free-Brainstorm (Generate)	3 days
2	To eliminate redundancies and ambiguities of the list of categories.	List of categories, neither redundancies nor ambiguities.	Please, identify from list of categories those that are similar, present ambiguity or must be eliminated.	Concen-tration (Clarify)	3 days
3	To generate a list of system stakeholders for each category	List of Stakeholders.	Make your contributions with respect to the system stakeholders that you consider belong to the categories. Start working on the topics in which you have the most interest or the most expertise.	LeafHopper (Generate)	4 days
4	To verify that the stakeholders belong to the categories to which they were assigned.	Set of stakeholders in the respective category.	Is there some stakeholder in the category that does not belong to this?	BucketWalk (Reduce)	3 days
5	To generate commentaries about the role that each one of the identified stakeholders carries out in the system.	Role Description that each one of the stakeholders in the system.	Make your contributions with respect to the role that this stakeholder carries out in the system. Start working on the stakeholders in whom you have the most interest or the most expertise.	Leaf-Hopper (Generate)	7 days

3 CASE OF STUDY

The validation of collaborative process for Requirements Analysis Phase, was made through project "Virtual Learning Objects Repository - LOR", which consists of making an analysis and design of Virtual Learning Objects Repository, to support pedagogical process for the virtual education in Universidad Abierta y a Distancia (UNAD), Colombia.

General information about the project

The principal objective of the validation for the Requirements Analysis Phase is to know system users and their necessities. For which it is necessary:

- To identify all the LOR project stakeholders (even those that could influence negatively).
- To determine the influence of each one of the stakeholders in the development of the project.
- To identify user roles and profiles and to determine the relations between these profiles and roles.

Stakeholders information:

In the team for execution of *Stakeholders Identification*, we have identified the stakeholders and their respective roles (see Table 7).

Table 7: LOR Project Stakeholders and Roles.

Member	Role	Geographic location
Cauca University Teacher	Evaluator	Popayán, Colombia
Systems Engineering Students	Evaluators	Popayán. Colombia
UNAD Teacher	LOR Project Management	Popayán, Colombia
UNAD Teacher	LOR Project adviser	Popayán, Colombia
Three Systems Engineering Students, UNAD	People in charge of Requirements Analysis and Developers	Popayán, Colombia
Doctoral Program in Computer Science Student, Lleida University.	Person in charge of Requirements Analysis	Lleida, Spain
Systems Engineering Students, Cauca University.	People in charge of the activity	Bogotá, Colombia

The initial criterion for the selection of the members was to have interested people in to develop of interactive systems supported under the methodology proposed by the MPIu+a, as well as of the initiative to motivate effective practices of collaborative work within the team members. Additionally, we looked for to involve people who were dispersed geographically.

Technology

The tool selected for the validation of the designed Collaborative Processes is Moodle, which is a software package for the creation and handling of courses in Internet. This tool presents some advantages that are described next (Moodle, 2018):

- It is designed under the foundations of social constructive pedagogy.
- It allows establishing access keys.
- The participants can create their own profile.
- The user can choose the language of Moodle Graphic User Interface (Moodle is available in more than 70 language).
- Moodle has a variety of resources and activities for courses.
- The home page presents the changes since the last user's income, which contributes to a sense of community.
- The resources can be configured so that whether or not visible to the participants.

Moodle was selected by the benefits mentioned above, on the other side the resources offered by the platform could be employed to implement the collaborative processes designed. In addition, the tool provides an opportunity for participants to generate discussions, make contributions, analysis and reflection on the contributions of other members of the group, contributing to the construction of shared knowledge and decision-making. The Table 8 presents the information related to the adequacy of one of the Moodle forums (according to the options available in the tool for configuring forums), to run one of the activities of the task Stakeholders Identification, which is to apply the thinklet Concentration in order to deleting redundancies and ambiguities in the proposed list of categories.

Results achieved

The results for the case study from the validation of the collaborative processes designed is as follows:

The categories to group stakeholders and stakeholders in each one of them were determined, as well as their description and relationship with the Project. Below the categories and their stakeholders are presented:

End Users: In this category are all people who interact directly with the system, the stakeholders of this category are: External Visitor, Administrator, Student, Assessor, Tutors and Teachers.

Table 8. Information Forum "Categories not redundant nor ambiguous".

Type Forum: Forum for general use.
Procedure: The list of categories that have been identified, as follows: • End Users: This category comprising students, teachers, special users (those who will use the resources and activities available on the website). • Developers: it includes all people related to the design and development of website. • Sponsors: This category includes people or entities that might sponsor or support with resources to the development site. Some categories may be similar, ambiguous or must be removed from the list. Please identify them and select them. ***Suggestion*** It is recommended to write each of the categories that are similar or ambiguous in a new item, with the category name in the subject. You can use the body of the message the write the identified characteristics and contributions (depending on the property identified) with respect to: (a) the reason that you think that the categories are similar, (b) aspect that is not understood in that category and (c) the reason that you think that the category must be removed. For each of the categories proposed by the other team members, you can make: (a) proposing the combination of the categories or eliminating any of them, if you have noticed similarities between them, (b) explain a category where information is not sufficiently clear and (c) arguments against or in favor of eliminating the category. **Allowing any participant opens new issues:** allowing new topics and answers.

Developers: refers to the people who are involved with the system in its development stage, such as: Project Manager, User Developer, Experts Evaluators, Instructional designers, graphic designers, responsible for Requirements Analysis, Programmers, advisers Development.

Sponsors: these are involved in influencing the development of the project in terms of financial support and other resources, in this category are: Managers UNAD, Semillero de Investigación en Ambientes Virtuales de Aprendizaje SIUNAD, System Research Unadista (Sistema de Investigación Unadista).

The roles, user profiles, and the relationship between them were determined, obtained the following results:

Designing a Method of Collection of Information for the purpose of obtaining information from users of the system.

List of User Profiles System, which identified: External Visitors, Students, Tutors, Teachers. List of User Roles, the roles refer to the function that could be played by users to interact with the system. The roles are identified: Consultant (who will be searched and downloaded of Virtual Objects), Builder (who designs and builds Virtual Objects), Evaluator (authorizing the issuance of Virtual Object), Administrator (manages users and privileges).

We performed an association between roles and user profiles. It is important to mention that a role can be associated with many profiles and vice versa. The association is presented in Table 9.

Table 9: Association between user roles and profiles.

Profile	Role
Extarnal Visitor	Consultant
Student	Consultant
Teacher	Consultant, Builder, Evaluator
Tutor	Consultant, Evaluator
Manager	Manager

Other results were obtained like a description of the user profile, their common needs and the definition of usability and functional objectives.

Summary of results from thinklets

As the selection of each thinklet in the design of collaborative processes was justified, we performed an analysis based on the participation of the team members in these processes to determine whether the issues considered each thinklet met during the execution of activities. Table 10 presents some of the thinklets and comments respective.

Table 10: Results by Thinklet.

Thinklet	Comments
LeafHopper	In each case the complete list of issues were presented for which contributions were generated in each one of them, so that the group could make their contributions on those areas in which they had more experience and knowledge. Members of the group were able to generate insights into various aspects and additionally had the opportunity to make comments regarding the contributions of their partners.
FreeBrainstorm	This technique enabled the group could generate a wide range of ideas and contributions on the various topics of discussion raised. Members of the group had a chance to comment on the contributions of others, which in some cases are allowed to generate discussions and exchange of views among all. Each contribution was argued by the author, this helped to generate shared information within the group.
Concentration	Members of the group had the space available to indicate their concerns and findings when a concept was not clear enough or when some contributions of the other members were redundant; also, could clarify an idea, or make proposals for elimination or combination of ideas some approach redundant. This was made possible thanks to everyone could freely express arguments to support a proposal, as well as express opinions envelopes contributions of others. This thinklet made it possible to generate clear and accurate information, to facilitate the development of subsequent activities.
Bucket-Walk	Members of the group had the opportunity to express their comments respect the opinions of their partners, this allowed generate a discussion and find an appropriate form of classification. The discussion generated among members of the group made possible to reach agreements and shared views.
PopcornSort	This thinklet allowed quickly organize a joint informal comments. The team had a chance to argue and justify their proposals, which made possible to generate discussion with other members of the group, motivating to generate new ideas and contributions.

4 CONCLUSIONS

Collaboration Engineering approach presents fundamental support to the Computer Supported Collaborative Work, since through this approach it is possible to design processes that demonstrate the presence of communication, coordination and collaboration between the group members. The methodology of design for the Collaboration Engineering allows the collaborative processes design in different environments, in a specific way in the development of usable and accessible interactive systems.

Collaboration Engineering approach makes possible the generation of strategies that fortify the collaborative aspects and the guidelines raised in the MPIu+a for the suitable flow of the communication and the information among the members of the multidiscipline equipment, especially in those environments of work where the actors are dispersed geographically.

It is necessary to conform work teams by people of different disciplines, teams should be present spaces in which there is an interchange of communication and information adapted among the teams members. With Collaboration Engineering it is possible design collaborative process that support the implementation of the dynamic in the activities of each one of these phases.

Collaborative processes design, constitute a framework for the multidisciplinary team who try to follow the principles of Design Centered User for the development of interactive systems, which represents a significant contribution to the propose activities in the MPIu+a. The geographic dispersion of the participants in a work group does not have to be considered a weakness to structure, design and handle processes that are carried out in a collaborative way. It is possible to mention some technological tools which can support the synchronous and asynchronous work between the participants through implementation and use of suitable collaborative strategies.

The documentation obtained can be used by the people in charge to make the activities for which the collaborative processes were designed, they are no need to have the continuous aid of the people in charge of the processes design. The collaborative processes design can be used in the development of different interactive systems, since they were designed independently of the Interactive System in which they went away to apply.

The future work includes the design of collaborative processes for the different activities that comprise of the MPIu+a, as well as the validation from all the designed processes in the development of an Interactive System.

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