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Validating Design Patterns for Mobile Groupware Applications by Expert Users: a USAER Case

Huizilopoztli Luna-García¹, Ricardo Mendoza-González², Miguel Vargas Martín³,
Jaime Muñoz-Arteaga⁴, Francisco J. Álvarez-Rodríguez⁴, Laura C. Rodríguez-Martínez²

¹ Universidad Autónoma de Zacatecas (Campus Jalpa),
Mexico

² Instituto Tecnológico de Aguascalientes,
Mexico

³ University of Ontario, Institute of Technology,
Canada

⁴ Universidad Autónoma de Aguascalientes,
Mexico

hlugar@uaz.edu.mx, {mendozagric, lrodriguez}@mail.ita.mx, miguel.vargasmartin@uoit.ca,
{jmauaa, fjalvar.uaa}@gmail.com

Abstract. The objective of this research work was to analyze the pertinence of a set of design patterns for mobile groupware applications. The pertinence of said contribution was supported by 11 participant members of an educational support group (USAER). The perception of expert users is commonly used in Human-Computer Interaction to improve and validate design strategies such as the proposed one. In this case the feedback provided by the participants helped to ensure that the knowledge offered by the set of patterns is adequate and accurate. A distilled feedback would lead to well-designed user interfaces for mobile groupware applications.

Keywords. User interface, design patterns, mobile devices, groupware systems.

1 Introduction

In recent years we have witnessed advances in wireless technologies and mobile computing, these portable devices and smartphones with increasing processing, storage and communication capabilities open new possibilities in the areas of communication, social interaction, and learning [20, 4]. These technological changes have created a new network environment enabling the development of applications with a wide range of interaction and communication possibilities, and

consequently, new design and usability requirements essential in achieving designs able to help users through their daily activities and tasks. These advances and diversity of mobile devices have introduced a variety of new challenges to the process of user interface design [9].

Currently, the use of applications that allow collaboration between multiple users is a common need. *Groupware systems* represent a good example; they may help groups to coordinate, collaborate, and communicate effectively. Groups from a variety of contexts use this kind of technology, e.g., Educational Support Groups. Particularly, the USAER group (Units Support Services for Regular Education) in Mexico promotes the integration of children with special educational needs into classrooms, early educational schools, and basic educational institutions [35].

The term groupware was first defined by Johnson-Lenz [10] to refer to *a computer based system plus the social group process*. There are several definitions of groupware; however, for the purposes of this research, groupware is defined as *a specific set of technologies that allow working groups to achieve a common task using a shared environment*. The purpose of all groupware systems is to provide the required functionality to

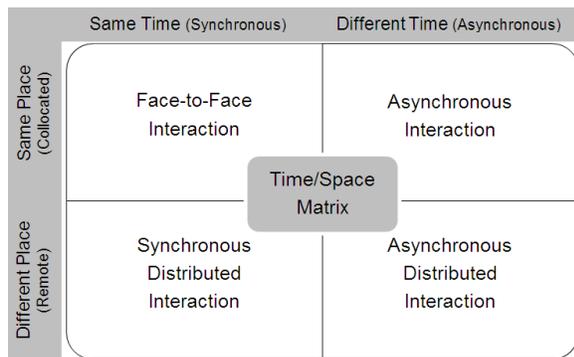


Fig. 1. Groupware matrix, adapted from [13]

allow *user to user* interactions, unlike the *user-system* interaction supported by most conventional software systems [25]. The groupware systems can be classified in several ways, however, maybe the most popular taxonomy in literature is based on Johansen's [13] notions of *time and space*, which is based on a 2x2 matrix where *time-space* considerations suggest four work categories as shown in Figure 1.

As Figure 1 illustrates, if we consider time as the base, the applications are classified into synchronous and asynchronous, if we take a space base, applications can be in the same place or in a different place. Therefore, the matrix includes four different types of interactions, i.e. face-to-face, distributed synchronous, asynchronous, and distributed asynchronous, these are important concepts considered for designing groupware interfaces. It is important to note that a complete groupware system considers the needs of all quadrants of the matrix in Figure 1 [10].

In addition, groupware must provide three specific functions within a group to increase its efficiency, these functions are known as the 3C's or the three pillars on which a groupware system rest: *communication, coordination, and collaboration* [26]. Communication and coordination are necessary to support collaboration. Communication refers to information exchange between group members, coordination refers to group work coordination [21], and finally, collaboration can be defined as the experience of integrating people, processes, and technology [17].

Sophisticated graphical user interfaces have become so common in everyday life that the

research community dedicated to investigating user interface design has developed multiple collections of development guidelines and patterns (e.g., [8, 18, 29, 31]), which help users to follow a process while trying to ensure an optimal level of quality based on standards such as those specified in the W3C (World Wide Web Consortium). Likewise, companies such as Android [2], Microsoft [16], and Apple [3] have developed principles, guidelines, and specific design patterns for their platforms, as well as on the "desktop" Web where collections and libraries of patterns such as Welie can be found [32]. Consequently, in recent decades hundreds of patterns for interface development have been proposed; however, there are still several issues that the scientific community needs to solidify.

Contribution of this work is the following. As such, in this paper we propose a design pattern classification based on the Johansen's taxonomy [13, 10], the three dimensions of groupware systems [11], and the principles of mobile usability proposed by Nielsen [22]. Subsequently, a group of expert users (USAER) validated the set of the design patterns with the design of a paper prototype. The results were corroborated through the application of recognized techniques in the area of Human-Computer Interaction to get the perception of expert users including audience definition, process flows, wireframes, user testing, among others. Likewise, these patterns are oriented to provide guidance to designers and developers that allow achieving well-designed user interfaces and model specific interactions that allow members of a group improve communication, coordination, and collaboration and effectively comply with the activities and objectives of the working group, which impacts the life cycle stages of software development having a correct direction from the primary stages thereby allowing saving time and money.

2 Problem Outline

The problem that we attempt to tackle derives from the pursuit of good designs for user interfaces in groupware applications. For this approach we realize three principal activities: (1) identifying common patterns related to those collaborative

activities, tasks, and processes in working groups, which should be reflected in groupware user interfaces to encourage the essential groupware functions (*communication, coordination, and collaboration*); (2) encapsulating this knowledge into a strategy oriented to facilitate designers to model those specific interactions that take place in group and collaborative work spaces, and (3) investigating the validity of the patterns' collection on a paper prototype designed for a group of expert users.

We believe that design patterns could represent a good alternative to structure this proposal since we were inspired by previous research whose efforts are oriented in the same way. Some of these research works are discussed in the following section.

3 Related Work

The existing literature identifies several approaches to minimize the efforts on developing user interfaces and groupware systems, that is, several collections of design patterns have been proposed, including those that emphasize providing communication and coordination services, which include some requirements that have influence in the collaboration of mobile scenarios (e.g., [15, 19, 20, 21]). There are also proposed architectures [30] that support specific interactions of the face-to-face quadrant in the matrix of Ellis et al. [10] through a set of tools that support consistency, network communication, group awareness, or pattern languages [27], or pattern collections that include similar features in mobile devices [24]; likewise, frameworks have been developed where the main factors were identified in collaboration features, e.g., interaction process and support [12], notion of context of use [14], and studies for designing and evaluation of system distributed user interfaces to enhance the collaboration, integration, and communication [37].

Therefore, in recent decades various patterns that consider several aspects to solve technological problems and problems that emphasize specific functions of groupware have been proposed. However, most of the contemplated pattern criteria identified in literature are general and have no specific descriptions of

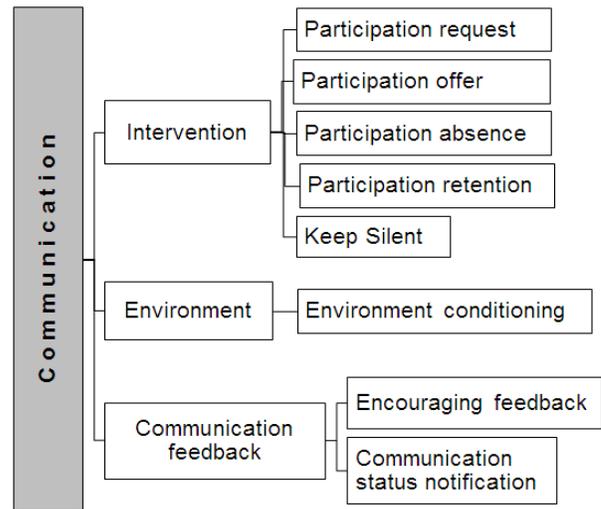


Fig. 2. Patterns in the communication dimension

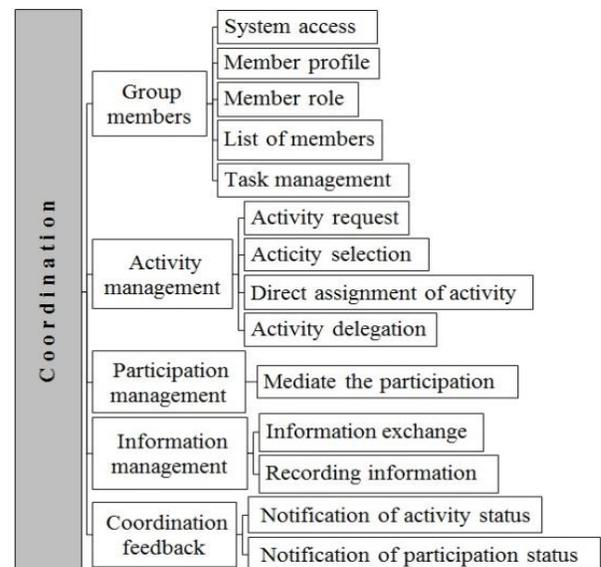


Fig. 3. Patterns in the coordination dimension

their implementation in user interface development for groupware applications for mobile devices. In addition, some studies focus on solving technological troubleshooting in mobile devices, consider separately the specific functions of groupware and ignore basic aspects of design and usability. Berkenbrock [38] noted that little

research has been aimed at supporting the work of system design in a mobile group and help developers to improve the systems' usability. Similarly, Breiner and Seissler [39] notes that despite intensive research in recent years, the development of standards aimed at improving the interaction between humans and computers still lacks a standardized description and organization. This aspect represents an important issue for developers when they try to identify relevant patterns to solve a problem, and also to apply them accordingly in the context of the problem.

On the other hand, we believe that studying groupware dimensions from another perspective can improve the experience of group members in the aspects of communication, coordination, and collaboration. It is important to mention that although some related studies are not recent, they represent a solid foundation since their contributions share (from particular angles) the aims of this research.

4 Design Pattern Classification

The proposed pattern classification is based on the notion of groupware systems proposed by Johansen [13] in his two-dimensional matrix as well as the three groupware system dimensions: *communication, coordination, and collaboration* [10]. We also consider the principles [23] and mobile usability aspects proposed by Nielsen [22]. In the next section, a brief description of the pattern classification for each groupware dimension is described.

4.1 Communication Dimension

The dimension for communication is the most important function of groupware since it is the medium through which messages are exchanged and information is shared [11]. It is possible to identify elements that can characterize this process, such as *participants, information transmitted, and used medium*. In a groupware system, the computer or mobile device is the device that acts as a medium for information transmission [25]. One of the most important challenges regarding communication between people through the use of technology is *how to*

make distributed interactions as effective as face-to-face interactions [10].

It is important to mention that both Johansen's taxonomy [13, 10] and the principles of mobile usability by Nielsen [22] are embedded in the description of the patterns as shown in section 4.4.

Figure 2 shows the proposed classification for the communication dimension.

As it is shown in Figure 2, the communication dimension includes patterns related to 1) recurrent intervention practices and actions during a conversation, 2) environment conditioning according to the type of communication based on the matrix of Ellis et al. [10], where any group or subgroup shares a space-time existence and a simple structure interaction [7], and 3) appropriate notifications to establish an effective communication.

Over 80 common problems organized in 32 categories (*not described in this paper*) that occur in small working groups are described in [34]. It is important to consider these and other recognized problems as the starting point for the development of the design patterns proposed in this work.

In order to provide an example, Tables 1, 2, and 3 describe one pattern from each category (see Figures 2, 3, and 4), which were matched to specific problems and categories from [34].

Table 1 shows the relationship between communication categories, communication issues, and the related proposed patterns.

4.2 Coordination Dimension

Coordination is the act of ensuring that the group is working cooperatively and efficiently to achieve a goal, this includes the distribution of tasks and review of their implementation [11]. Coordination is a necessary activity when several people take part in the same task. The effectiveness of communication and collaboration depends on coordination, that is, on the organization, planning, and synchronization of group activities [25].

Figure 3 shows the proposed classification for the coordination dimension.

The coordination dimension includes related patterns that allow (1) coordination of group members, their activities, and work products, (2) management of participation and planning of group activities, and (3) providing the necessary

Table 1. Category and problems in small groups and related patterns with the communication dimension

Category	Problem	Pattern
Communication between leader and members	Usually a group member interrupts: <i>What is wrong?</i> <i>What can I do?</i>	Participation request
Group Participation	How can a member of a group request to speak during a conversation?	
Technology	I am going to lead a committee meeting: <i>How should I arrange the room?</i>	Environment conditioning
Climate	How to make the user interface represent an appropriate channel that allows proper interaction and communication and at the same time does not result in information overload that hinders group productivity?	
Relationship problems	I would like to develop closer relationships with some group members: <i>How do I start?</i>	Encouraging feedback
Attention	What can I do to help my group members better understand what is said?	
Communication between leader and members	What elements should the interface provide so that group members contribute appropriate feedback to the group?	

feedback to establish a coherent link between the dimensions of communication and collaboration (see Figure 3). Table 2 shows the identified issues and patterns for each problem.

4.3 Collaboration Dimension

The collaboration dimension refers to the possibility that multiple people can work together on the same task to achieve a common goal [25], that is, it is the deliberate and coordinated participation of group members in order to achieve a specific goal [26].

Figure 4 shows the proposed classification for the collaboration dimension.

The patterns related to the collaboration dimension (see Figure 4) include aspects that

allow group members to have the tools necessary to help them to complete tasks and group goals.

Table 3 shows the identified issue and pattern for each problem.

4.4 Design Patterns for Mobile Groupware Systems

The main purpose for the emergence of patterns is the ability to express knowledge by documenting good and proven practices through different ways of representing patterns [28]. Diverse types of formal formats have been used in the documentation of patterns; the used structure to describe the patterns includes sections such as *pattern name, problem, usability principle, context, solution, example, gesture, and related-pattern* [33].

Table 2. Category and problems in small groups and related patterns with the coordination dimension

Category	Problem	Pattern
Task dimension	How can group members manage their tasks and coordinate with other members of the group?	Task management
	Many of our meetings are not very productive: <i>Is there anything I can do?</i>	
Decision making	How to make the interface display to the group the assigned tasks and allow the members to request a task to work on?	Activity request
	How to allow a group member request and select an activity or task through the user interface?	
Analysis time	How can my group better manage time?	Mediate the participation
	You realize that some group members talk too much and others too little: <i>How to make sure a group member does not monopolize/ dominates the interaction?</i>	
Information	The boss assigned me to investigate a problem: <i>What are some ways to gather background information?</i>	Recording information
Communication between members	I often ask my fellow group members to complete tasks and activities, but they fail to respond to my request or complete the task/activities.	Notification of status activity
	Group members and administrators need to check the status and progress of activities and tasks.	

This section describes only three design patterns to deal with some challenges occurring in small working groups, these patterns are part of an initial collection of 24 patterns and the full pattern list can be found at <http://www.usableinteraction.mx/sections/DesignPatterns.htm/>.

a. Pattern 1. Communication Dimension

Pattern name: Participation request.

Problem:

How to deal with group-members' speak requests during a synchronous communication process?

Usability principle:

Match between the system and real world.

Context:

Interaction is one of the most important factors to consider in the communication process. Group members can intervene in a conversation by

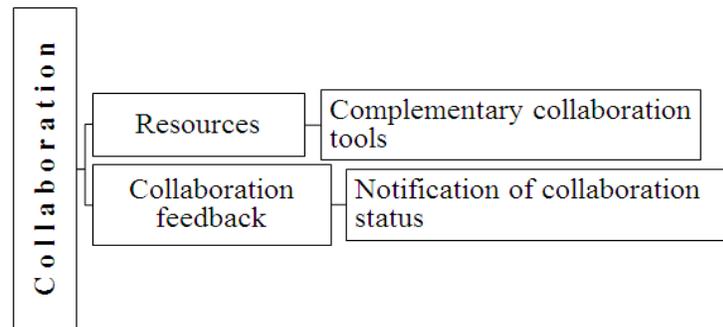


Fig. 4. Patterns in the collaboration dimension

Table 3. Category and problems in small groups and related patterns with collaboration dimension

Category	Problem	Pattern
Technology	I have read little about how technology can help the individual: <i>Is it also useful for groups?</i>	Complementary collaboration tools
	A member can choose how to interact with other group members, choosing the appropriate tool to use. This may be the key to a successful interpersonal communication.	
Task dimension	You think that some members feel excluded.	Notification of collaboration status
	My group has trouble finishing the job: <i>Could this be a problem on assigned roles?</i> <i>What are some essential roles?</i>	

raising their hand when interested in speaking. Such interventions encourage participation among members of a group, a defined characteristic for a group to be effective. Campos [5] defines this type of intervention as a bodily gesture—*kinetic gesture, interaction regulator*—used to regulate interventions in a conversation.

Solution:

The groupware user interface should help group members by including guidance (e.g. iconography, metaphors, among others) that allows them to generate this kind of interventions. The user interface should represent the users' language, verbal (*oral and written*) and non-verbal (*symbols and signs, which are familiar to users*).

Example:

Figure 5 shows the (*raise-hand*) button on an interface, which allows the group to claim the floor during a conversation.

Gesture:

Touch, tap.

Related patterns:

Activity request, mediate the participation.

b. Pattern 2. Coordination Dimension

Pattern name: Activity request.

Problem:

How to make a team member request an activity through the interface?

Usability principle:



Fig. 5. Button that allows one to speak, courtesy of [6]



Fig. 7. Contextual tools: files and ChardDroid, courtesy of [18]

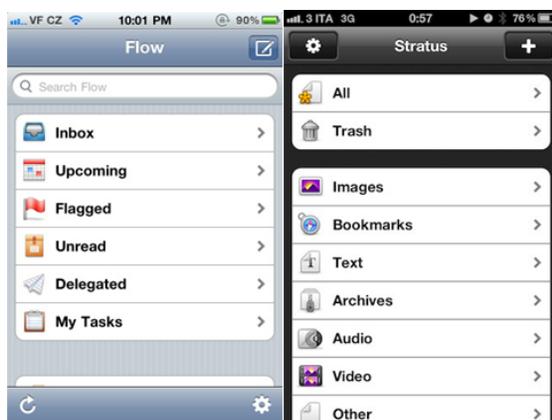


Fig. 6. List menus: Valspar Paint and Kayak, courtesy of [18]



Fig. 8. Validation and prototyping (the USAER team)

Match between the system and real world.

Context:

In the context of a meeting, activities and tasks are an approach of group work, and that work is focused on achieving the group's goal. The activities and tasks can be requested by group members in different ways, e.g. several participants share a list of tasks that they have to work on, and each member takes an activity or task in which he/she will work on.

Solution:

The interface should allow the group members to request and select an activity within the assigned group tasks.

Example:

Figure 6 shows two examples of design patterns that can be used to design the interface.

Gesture:

Vertical swipe, horizontal swipe, touch, tap.

Related patterns:

Participation request, activity select.

c. Pattern 3. Collaboration Dimension

Pattern name: Complementary collaboration tools.

Problem:

A group member cannot carry out his/her activities, collaborate or communicate with other group members because the interface does not allow these actions.

Usability principle:

Match between the system and real world.

Context:

Complementary tools are all materials and technological equipment that allow group members to collaborate. These tools serve to reinforce verbal communication—*stimulation of the left hemisphere of the brain*—and nonverbal—*stimulation of the right hemisphere of the brain*—therefore, both hemispheres are stimulated. This pattern deals with interactions, collaborations, and support among group members.

Solution:

The interface should provide group members with the right tools to allow them to participate and collaborate synchronously or asynchronously, that is, it should provide the needed resources to achieve the goals of the group.

Example:

Figure 7 shows two examples of design patterns that can be used to design the interface.

Gesture:

Touch, tap, vertical swipe, horizontal swipe.

Related patterns:

Participation offer, activity delegation, encouraging feedback.

5 Case Study: USAER

We conducted a case study as a proof of concept for the proposed set of patterns as follows.

(a) Description. This proposal was evaluated from the perspective of “expert users” (USAER) in order to obtain a representative starting point for designers/developers for designing mobile groupware systems.

As a study scenario, we selected the “Unit of Support Services for Regular Education” (USAER) Maria Montessori from the rural community Tlachichila, Nochistlán de Mejía (Zacatecas, Mexico). The aim of this aid group is to provide specific support for children with special educational needs associated with disability in their educational integration process.

(b) Participants. A total of 17 individuals participated in the study, including 6 Research Professors or Technical Experts, internationally recognized for Usability, Human-Computer Interaction, and User Experience (UX) (1 female and 5 males); 11 professionals (USAER members) specialists in Communication, Psychology,

Regular Education, Special Education, and Social Work to validate the set of patterns.

(c) Methodology. The expert users (USAER) were provided with an overview of the study purpose and were given a set of the proposed patterns expressed as important aspects of design in groupware applications. Individually the expert users designed a series of paper prototypes, and then in focus groups the initial interfaces of a mobile groupware application were designed. Figure 8 shows a series of paper prototypes designed by expert users.

The obtained feedback helped to determinate the technical pertinence of the proposed set of design patterns which is related with 1) strengthening communication between group members, 2) automating the process of communication between group members, 3) automating the group's activities and tasks, and 4) strengthening the cooperative and collaborative work among group members through the use of groupware application.

6 Conclusions and Future Work

This paper briefly describes a classification of design patterns oriented to achieve well-designed mobile groupware interfaces. The proposed strategy provides guidance for designers to integrate specific interactions in user interfaces for groupware systems. Additionally, their implementation could contribute to improve communication, coordination, and collaboration in working groups.

To achieve this goal, we matched every proposed pattern to the principal issues in group communications analyzed by Wilson [34]. Then, we integrated traditional solutions for these problems into specific interactions bearing in mind basic roles, tasks, and activities in working groups.

A case study was conducted with expert users; in this context the proposed set of patterns could provide a basic but reliable starting point for designers/developers to create well-designed mobile groupware applications.

There are several aspects to explore as future work, such as the implementation of the proposed collection of patterns into a digital mockup, which will then be analyzed by means of a heuristic

evaluation to verify their effectiveness from the users' viewpoint.

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Huizilopoztli Luna-García is a Research Professor at the Department of Electrical Engineering of the Universidad Autónoma de Zacatecas (Campus Jalpa), Mexico. Currently he is a Ph.D. candidate in Computer Science at Instituto Tecnológico de Aguascalientes; he holds a Master's degree in Sciences and Information Systems from Universidad Autónoma de Aguascalientes, and a Bachelor of Computer Science from Instituto Tecnológico de Zacatecas. His research interests are human-computer interaction, user-centered design, UX, design patterns, mobile technology, and educational technology.

Ricardo Mendoza-González is a Research Professor at Instituto Tecnológico de Aguascalientes (Mexico). He obtained a Ph.D. in Computer Science from Universidad Autónoma de Aguascalientes, Mexico, in 2009, a Master's degree in Computer Science from Universidad Autónoma de Aguascalientes, Mexico, in 2007, and a Bachelor of Computer Science from Instituto Tecnológico de Aguascalientes, Mexico, in 2004. Dr. Mendoza-González was a member of the Mexican System of Researchers from 2010 to 2013. He has reported his work in journals such as *Advances in Engineering Software* and prestigious international conferences such as IEEE-CCECE,

CADUI, ICIMP, and IASTED-CNIS. He collaborates with researchers of the University of Ontario Institute of Technology (UOIT, Canada) and Universidad Autónoma de Aguascalientes (Mexico). His current research interests include several topics in human-computer interaction, information security, usability, artificial intelligence, and software engineering.

Miguel Vargas Martín, before joining the University of Ontario Institute of Technology (UOIT), was a Post-Doctoral Researcher at Alcatel Canada and Carleton University in Ottawa, Ontario. He works in the area of providing security mechanisms to protect computer systems; under this umbrella, his major fields include new authentication paradigms and traffic inspection. A second research domain is the optimization of websites and virtual learning environments, where his work led to a freely available web service called Navdriver and a learning platform prototype tested in real classroom settings at UOIT.

Francisco J. Álvarez-Rodríguez is a Professor of Computer Science at Universidad Autónoma de Aguascalientes. He holds a Ph.D. in Engineering from UNAM, Mexico (2004). He has a number of collaborations with very important researches in prestigious universities around the world. Dr. Álvarez-Rodríguez has reported his work in journals, book chapters, conference papers, and technical reports, and so far has supervised almost 40 students at the graduate and undergraduate level. His current research interests include software engineering (methodologies, metrics,

among others) and distance education (educational internet technologies, learning environments, learning objects, among others).

Jaime Muñoz-Arteaga is a Professor of Computer Science at Universidad Autónoma de Aguascalientes. He is a Researcher in human-computer interaction and web technologies. He holds a Ph.D. in Computer Science, Human-Computer Interaction (University Toulouse 1 (UT1), Toulouse, France, 2000). He has a number of collaborations with very important researches in prestigious universities around the world. Dr. Muñoz-Arteaga has reported his work in journals, book chapters, conference papers, and technical reports, and so far has supervised over 45 students at the graduate and undergraduate level. His current research interests include several topics: human-computer interaction, mobile technologies, software engineering, and artificial intelligence.

Laura C. Rodríguez-Martínez is a full Professor at the Systems and Computing Department, Instituto Tecnológico de Aguascalientes, Mexico. She obtained a Ph.D. in Computer Science from Universidad Autónoma de Aguascalientes, Mexico, in 2009. Her research interests include software systems development processes, service-oriented software engineering, and graphical user interfaces development processes.

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Corresponding author is Huizilopoztli Luna-García.*