Classifying Groupware Tools to Improve Communication in Geographically Distributed Elicitation

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Abstract. In a scene where stakeholders are geographically distributed, communication presents new challenges for research areas. Considering the characteristics of interpersonal communication and the virtual area where it is carried out, the importance of applying interdisciplinary approaches, such as Cognitive Engineering, is currently increasing. Particularly, our proposal aims at improving the interaction between stakeholders by applying learning models when eliciting distributed software requirements. These models might help characterise the way people interact with distributed environment abstracting information or procedures. Identifying a type of interaction a stakeholder is more suitable for, would led to the use of specific groupware tools as a way of improving communication during a requirements elicitation process.

Keywords. Software Requirements Elicitation, Groupware, Distributed Cooperative Work, Distributed Requirements Elicitation, Cognitive Informatics.

1 Introduction

It is a fact that eliciting, the process of acquiring all relevant knowledge needed to produce a requirements model, is the first key issue for the development of good software systems. Although researchers have noted the importance of effective communication among stakeholders, it continues to be a challenge for distributed requirements elicitation. Communication facilitates commitment by avoiding defining confronting goals, and it also contributes to make organisation's processes more flexible.

There are a number of traditional pitfalls in trying to make effective use of communication channels during an elicitation process. Some of the dangers are that people interpret things in the light of their own background assumptions, uncertainty generates useless information, and selecting appropriate experts is in general an ad-hoc task [14].

Additionally, it is common that participants involved in a software development project must elicit requirements in a scene where stakeholders are geographically distributed. Thus, the distance between members of a development group is an important issue added to the traditional problems of a requirements elicitation process [2,13]. Eliciting requirements with geographically distributed stakeholders must face four major problems [4]:

1. *Inadequate communication*. Distance introduces barriers to informal and face-to-face communication, and stakeholders' communication depends on the quality of the communication tools.
2. *Knowledge management*. The sheer quantity of information about requirements from multiple sources at remote customer sites is not appropriately shared with the developers.

3. *Cultural diversity*. Differences in stakeholders' language and national culture affect global collaboration.
4. *Time difference*. The large distribution of stakeholders across five continents introduces large time-zone differences and allows little overlap available for synchronous collaboration.

Some approaches may help to minimise the impact of these problems. One of them, the CSCW (*Computer-Supported Cooperative Work*), is the area that takes into account human behaviour as well as the technical support that people may need to work as a group in a more productive way. The software used for communication and collaboration in workgroups is called *GroupWare,* however it is not easy to find a consensus on this definition. In [6], a groupware tool is defined as a computer-based system that supports a group of people to achieve a common task (or goal) providing a shared interface. Another work [9], describes a groupware tool as a simple communication technology such as Internet workgroups, although the most commonly referred definition assumes that only more sophisticated communication software systems can be included into the groupware tool category.

Generally speaking, a groupware tool is software for enabling communications between co-operating people working on a common task, and it may include different communication technologies, from simple plain-text chat to advanced videoconferencing [9]. In this paper, we will refer to every simple communication technology as a *groupware tool, function* or *application,* and to the systems that combine them as *groupware packages*.

Groupware tools are widely used for eliciting requirements in collaborative environments. For example, in [16] a method for analysing requirements for complex socio-technical systems is described. The method builds on the I* family of models by explicitly modelling communication between agents. System (i*) models and use cases are developed to describe the dependencies between human and computer agents in terms of a set of discourse acts, which characterise the obligations on agents to respond and act.

On the other hand, as another approach to face the problems of a distributed requirements elicitation process, the use of cognitive informatics is increasingly commonplace. Cognitive Informatics is a profound interdisciplinary research area that tackles the common root problems of modern informatics, computation, software engineering, artificial intelligence (AI), neural psychology, and cognitive science. One of the most interesting things found in cognitive informatics is that embodies many science and engineering disciplines, such as informatics, computing, software engineering, and cognitive sciences, sharing a common root problem – how the natural intelligence processes information.

Wang [17] defines *Cognitive informatics (CI)* as an emerging discipline that "studies the internal information processing mechanisms of the brain and their engineering applications, via an interdisciplinary approach". As a part of cognitive informatics, some *learning style models* classify people according to a set of behavioural characteristics. This classification is used to improve the way people learn a given task. Hence, in this context it is possible to consider an analogy between stakeholders participating in requirements elicitation and roles (student-instructor) of learning models: during the elicitation process everybody must "learn" from others (for instance, developers must "learn" what a user wants the system to do).

Our main goal is to analyse some aspects founded in interpersonal communication by applying both concepts – Cognitive Informatics (particularly learning style models) and Groupware, aiming at improving the requirements elicitation process. In section 2, we describe some groupware tools in terms of their relevance to distributed requirements elicitation. Then, Section 3 introduces some

learning style models used to classify people according to a set of behavioural characteristics. In section 4, we propose a categorisation of groupware tools that might be used to improve communication when eliciting on distributed environments. Conclusions and future work are discussed in the final section of this paper.

2 Groupware tools in distributed requirements elicitation

Common tools for communication in virtual environments are e-mail, mailing lists, newsgroups, discussion groups or forums, electronic notice boards, document sharing, instant messaging, shared whiteboard, chat, videoconference, etc. Distributed development teams usually choose a combination of two or three of these tools, according to their possibilities and the kind of task they are trying to carry on. They may choose between using a groupware package that offers a combination of tools or they may use individual tools in an ad-hoc way. It is common that groupware packages have the advantage of providing some extra tools for group decision support, group co-ordination for time management, workflow, planning, etc.

Groupware tools can be categorised as *synchronous* or *asynchronous*, as Table 1 shows. Through *asynchronous collaboration* "team members can construct requirements individually and contribute to the collective activity of the group for later discussion" [10]. This type of collaboration plays a very important role when groups are distributed across time zones because of the difficulty to schedule real time meetings. Since real time collaboration and discussions are necessary components of group Requirements Elicitation (RE) sessions, there is an agreement on that completely asynchronous systems are inadequate [10,12]. Then, *synchronous tools* let geographically distributed people work together at the same time, giving them the chance of having instant feedback.

Asynchronous	Synchronous
• E-mail, • Mailing lists, • Newsgroup, • Discussion groups or forums, • Electronic notice boards, • Document sharing, • Asynchronous shared whiteboard	• Instant messaging, • Synchronous shared whiteboard, • Plain-text chat, • Graphical (3D or 2D) chat, • Video conference,

Table 1: A categorization of groupware tools

Following, we present the main characteristics of each tool providing some insights on their purpose and possible uses during the requirement elicitation process.

Asynchronous collaboration:

- *E-mail*: It is the dominant asynchronous tool, especially because of time difference, and because it has an important role in exchanging documents. Some advantages of e-mail in requirements management are: (1) it is a good media to explain details, (2) it provides a written record about requirements and their history, and (3) since it does not require an instant answer, it improves communication between speakers with different native languages. An e-mail has some disadvantages too. For instance, its lack of interactivity makes it difficult to deal with ambiguity,

e-mails can get lost or forgotten, and there is no indication about when a reply will be received [4].

- *Newsgroups and mailing lists:* They have the same characteristics that an e-mail, but they are intended for messages among large groups of people instead of 1-to-1 communications. The main difference between newsgroups and mailing lists is that the former only shows messages to a user when they are explicitly requested, while mailing lists deliver messages as they become available [1].
- *Electronic discussion or Forums*: Electronic forums are public spaces where people can discuss about a particular topic. As it is an asynchronous tool, participants do not need to be present at the same time. It is similar to e-mail except that messages are visible for everybody who enters to the forum, so that people have no control on who can read their contributions or comments.
- *Electronic notice or bulletin board*: It is basically a public space where people can post news, announcements of events, and comments or answers to previous messages. Similarly to forums, messages are available to everybody who enters. Bulletin board and Forum are usually used as synonyms but the bulletin board's goals are wider than forum's. A bulletin board is not only about discussion, but also an entrance to different forums grouped by categories or topics.
- *Document sharing:* It can be made via e-mail or a common shared workspace where documents can be stored and retrieved by people working on the same task. Document sharing has a very important role in elicitation processes, since during RE sessions it is necessary to share a lot of information about requirements (graphical representations, results of brainstorming, list of decisions, etc.).
- *Asynchronous Shared Whiteboard:* It is a technology used in permanent shared electronic spaces. Similarly to forums, it allows members of a group access and leave their comments about previous contributions and new suggestions, but while forums do it in a verbal way, shared whiteboard do it visually [10].

Synchronous collaboration:

- *Synchronous Shared Whiteboard*: It is a technology that lets people see what is on someone else's computer while sitting at their own computer [9]. Hence, people can talk about what they are seeing and they can use their mouse to highlight parts of the screen or write on it.
- *Chat*: It allows people to type messages on their keyboard and the message instantly appears on someone else's computer. While this kind of communication is not useful for complicated discussions, it can be very good for quick conversations [9]. It can be used in 1-to-1 communications as well as in groups. Different "chat rooms" may be created according to different topics of discussion.
- *Instant Messaging*: Similarly to chat, instant messaging allows synchronous communication between people by typing messages on their keyboard. Depending on the software it would also be possible to attach files. Even when it allows communication between groups of people, it is mainly used in 1-to-1 communications and, like chat, it is recommended for quick conversations instead of complicated discussions.
- *Videoconferencing*: It is a more sophisticated workgroup application, which requires that everyone uses hardware and software that allow computers to send and receive voice and sound [9]. Its main advantage is that people can see each other and speak as they were in a face-to-face interview.

3 Learning style models

Learning style models (LSM) classify people according to a set of behavioural characteristics. This classification is used to improve the way people learn a given task. The models presented in this section have been discussed in the context of analysing relationships between instructors and students.

Our intent is to take advantage of these models and discussions adapting their application in order to improve communication during a distributed elicitation process. To do so, it is possible to consider an analogy between stakeholders and roles in the models, as Figure 1 shows. During the elicitation process everybody must "learn" from others, so stakeholders may play the role of student or instructor alternately, depending on the moment or the task they are trying to carry on.

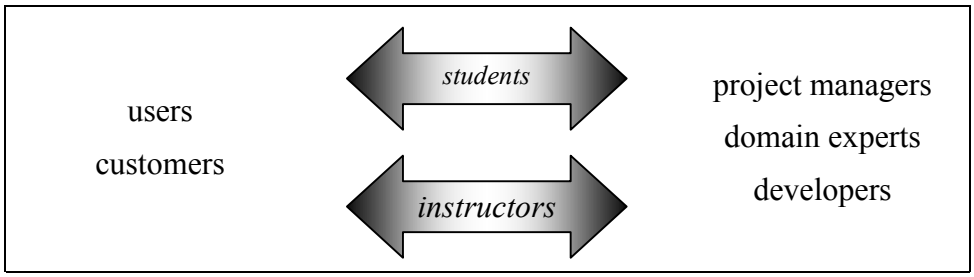

Figure 1: Analogy between stakeholders and roles in learning models

Five LSM, which use different points of view to classify people, are presented in [5,7,8] as follows:

The Myers-Briggs Type Indicator (MBTI) Model. It classifies people according to their preferences on scales derived from the psychologist Carl Jung's theory of psychological types:

- *Extraverts* (try things out, focus on the outer world of people) or *Introverts* (think things through, focus on the inner world of ideas);
- *Sensors* (practical, detail-oriented, focus on facts and procedures) or *Intuitors* (imaginative, concept-oriented, focus on meanings and possibilities);
- *Thinkers* (sceptical, tend to make decisions based on logic and rules) or *Feelers* (appreciative, tend to make decisions based on personal and humanistic considerations);
- *Judgers* (set and follow agendas, seek closure even with incomplete data) or *Perceivers* (adapt to changing circumstances, resist closure to obtain more data).

Kolb's Learning Style (Kolb) Model. It classifies people as having a preference for: (1) how they take information (in concrete experience or abstract conceptualisation), and (2) how they internalise information (active experimentation or reflective observation). People is categorised into four different types:

- *Type 1* (concrete, reflective) *"Why?"* These people prefer explanations of how information relates to their experience, their interests. Guidelines should act as a motivator.
- *Type 2* (abstract, reflective) *"What?"* People in this group prefer information presented in an organised, logical fashion and benefit if they have time for reflection. Guidelines should function as an expert.

- *Type 3* (abstract, active) *"How?"* These people prefer having opportunities to work actively on well-defined tasks and to learn by trial-and-error in an environment that allows them to fail safely. Guidelines should function as a coach, providing guided practice and feedback.
- *Type 4* (concrete, active) *"What if?"* People in this group prefer applying information on new situations to solve real problems. Guidelines should stay out of the way, maximising opportunities to discover things for themselves.

Herrmann Brain Dominance Instrument (HBDI) Model. This method classifies preferences of thinking into four different modes, based on the task-specialised functioning of the physical brain:

- *Quadrant A* (left brain, cerebral): logical, analytical, quantitative, factual, critical;
- *Quadrant B* (left brain, limbic): sequential, organised, planned, detailed, structured;
- *Quadrant C* (right brain, limbic): emotional, interpersonal, sensory, kinesthetic, symbolic;
- *Quadrant D* (right brain, cerebral): visual, holistic, innovative.

Cognition (Eicher) Model. This model shows individual preferences about (1) how people receive information, regarding learning and attending; (2) how an individual might organise or process initial information; and (3) how an individual prefers to communicate and express to others. These preferences are further analysed as follows:

Learning and Receiving / Communicating and Expressing

- *Verbal*: the best way of learning is through verbal explanations, questions and answers, and real time conversations.
- *Visual*: the best way of learning is through watching the images, text and icons on the screen. The act of looking stimulates both comprehension and retention.
- *Tactile*: the best way of learning is through doing "hands on" work. A person must be sited at the keyboard, practising and "feeling" how a program works.

Organising and Thinking

- *Vertical*: these people prefer conducting tasks in a "step by step" manner, paying attention to details. They are concerned about completing tasks in sets fixing time intervals. They need to know the precise logic behind a job task.
- *Lateral*: these people prefer conducting many tasks at once, attending to "the big picture/bottom line" complete tasks at inconsistent intervals. They need to know the broad theme or general reasoning behind a job task.

Felder-Silverman (F-S) Model. Briefly, this model classifies people into four categories, each of them further decomposed into two subcategories as follows:

- *Sensing* (concrete, practical, oriented toward facts and procedures) or *Intuitive* (conceptual, innovative, oriented toward theories and meanings);
- *Visual* (visual representations of presented material – pictures, diagrams, flow charts) or *Verbal* (written and spoken explanations);
- *Active* (working by trying things out, working with others) or *Reflective* (thinking things through, working alone);
- *Sequential* (linear, orderly, learn in small incremental steps) or *Global* (holistic, systems thinkers, learn in large leaps).

3.1 Setting a basement for characterisation

Generally speaking, each learning model reflects its authors' views on what a characterisation should be or should be able to provide as a support for the learning process. However, a closer study of their characterisations shows that there is a common set of issues that all of them try to address. These issues are critical for characterising people and constitute the basis of our proposal. We found out that every item of the models is included in the Felder-Silverman Model (for example the *sensing* attribute refers to people with characteristics of *sensors* in the MBTI Model), so we might build a complete reference framework choosing the F-S model as a foundation, i.e. any other learning style model might be inferred from it. Table 2 shows the relationship between the categories of the F-S model and the categories of the models presented in the previous section.

Felder-Silverman (F-S) Model	Other Models
Sensing	Sensor (*MBTI)* Concrete (*Kolb)* Left brain and Cerebral (*HBI*) Thinker *(MBTI)*
Intuitive	Intuitor *(MBTI)* Abstract (*Kolb)* Feeler (*MBTI)* Right brain and Limbic (*HBI)*
Visual	Visual (*Eicher*)
Verbal	Verbal (*Eicher*)
Active	Extravert (*MBTI*) Active (*Kolb*) Tactile (*Eicher*)
Reflective	Introvert (*MBTI*) Reflective (*Kolb*)
Sequential	Judger (*MBTI*) Vertical (*Eicher*)
Global	Perceiver (*MBTI*) Lateral (*Eicher)*

Table 2: Relationships between categories of the F-S model and categories of other LSM

Therefore, since every model has a representation in the Felder-Silverman Model, we choose it as a basis for analysing learning and communication aspects of a stakeholder. The F-S model is depicted by the following characteristics and strategies [7,8], which may help to improve the performance when learning a new task:

- *Sensing and Intuitive people:* Sensors prefer learning facts. They like solving problems by well-established methods and dislike complications and surprises. Sensors tend to be patient with details and good at memorising facts and doing hands-on (laboratory) work. On the other hand, intuitors often prefer discovering possibilities and relationships. They like innovation and dislike repetition. They tend to work faster and to be more innovative than sensors. Intuitors do not like work that involves a lot of memorisation and routine calculations.

- *Visual and Verbal:* Visuals remember best what they see (as pictures, diagrams, flow charts, time lines, films, and demonstrations). They prefer visually presented information. Verbals get more out of words, and written and spoken explanations. They prefer verbally presented information.

- *Active and Reflective people:* Active people tend to retain and understand information by doing something active with it (discussing or applying it or explaining it to others). "Let's try it out and see how it works" is an Active ´s phrase. Reflective people prefer to think about information quietly first. "Let's think it through first" is the Reflective's response.

- *Sequential and Global workers:* Sequential people tend to gain understanding in linear steps, with each step following logically from the previous one. They tend to follow logical stepwise paths in finding solutions. They may not fully understand the material but they can nevertheless do something with it (like solve homework problems or pass a test) since the pieces are logically connected. On the other hand, global people tend to work in large jumps, absorbing material almost randomly without seeing connections, and then suddenly "getting it". They may be able to solve complex problems quickly or put things together in novel ways once they have grasped the big picture, but they may have difficulty explaining how they did it.

In the Felder-Silverman Model, people may fit into one category or the other depending on the circumstances, i.e. people may be "sometimes" active and "sometimes" reflective. The preference for one or the other category may be *strong*, *moderate*, or *mild*. Only when there is a strong preference, people can be catalogued as a member of a certain group.

Classification into the different categories may be made, for instance, by the multiple-choice test proposed by Soloman-Felder [15]. As a result, each person gets a rank for each category that suggests his or her preference. For example, a pair 4-7 for *intuitive*/*sensing* indicates a mild preference to be part of a *sensing* category whereas a pair 12-1 indicates a strong preference for *intuitive*. A *score* on the scale proposed by the Soloman-Felder test is calculated as a difference between both edges of the pair (in the first case, the pair is 4-7 so the score is 3 for the *sensing* subcategory).

Preference	**Strong**	**Moderate**	**Mild**		**Moderate**	**Strong**	
Score	**11-9**	**7-5**	**3-1**	**1-3**	**5-7**	**9-11**	
Sensing		✓					Intuitive
Visual			✓				Verbal
Active				✓			Reflective
Sequential		✓					Global

Figure 2: Scores on the scale Soloman-Felder to characterise people's preferences

Scores should be considered as follows:

- Scores on a scale 1-3: people who are fairly well balanced on two dimensions of the scale (*mild preference*);
- Scores on a scale 5-7: people who have a moderate preference for one dimension of the scale and will learn more easily in a environment which favours that dimension (*moderate preference*);

- Scores on a scale 9-11: people who have a very strong preference for one dimension of the scale; they may find difficulties in a environment which does not support that preference (*strong preference*).

Scores have been organised into a matrix, where each row shows two opposite subcategories at its ending points, as shown in Figure 2.

4 A characterisation of groupware tools for distributed elicitation

Once stakeholders are classified using the previous model, it is possible to take advantage of this categorisation to improve communication during the elicitation process. Particularly, it is possible to analyse these categories from two different points of view, according to:

- *The way people interact with the context*: the categories that are involved are visual/verbal and active/reflective, and in this case communication may be improved by choosing an appropriate set of groupware tools according to the stakeholder personal characteristics. We found out that sensing/intuitive and global/sequential categories analyse personal behavioural characteristics that are not relevant when choosing a set of groupware tools, since these categories refer just to the way people process information whereas groupware tools focus on the way people receive and communicate information.
- *The way people think and process information.* This point of view involves all the categories suggested by Felder-Silverman Model, and communication may be improved by choosing an appropriate set of elicitation techniques and supported by different groupware tools.

In this paper, we focus on the first point of view and we propose a suitable set of groupware tools for each subcategory. Document sharing and electronic notice board are not included in our analysis since communication does depend not only on the way files are interchanged or managed but the kind of representation that is used to share information (graphical representations, plain text, combination of them, programs, etc).

Our categorisation of groupware tools is shown in Table 3. We have used the sign "++" to indicate those groupware tools more suitable for a given category. The sign "+" indicates a groupware tool is mild preferred by a stakeholder. Finally, the sign "-" suggests that a particular groupware tool is "not suitable" for communication.

		Visual	Verbal	Active	Reflective
Asynchronous	E-mail	+	++	-	++
	Mailing List, Newsgroup	-	++	-	++
	Async. Shared Whiteboard	++	-	-	++
	Forums	-	++	-	++
Synchronous	Instant Messaging	+	++	++	-
	Sync. Shared Whiteboard	++	-	++	-
	Chat	-	++	++	-
	Video Conference	++	++	++	-

Table 3: Characterisation of groupware tools based on the F-S model

Visual people need to visualise concepts. They learn best by listing key points, enclosing them in boxes or circles, and drawing lines with arrows between them to show connections. They also like using colour-codes, highlighting words so that everything that is related to one topic has the same colour. Hence, visual tools like shared whiteboard are recommended for them. Messages for visual people should be short in order to be effective: instant messaging and e-mails would be more suitable for them than chat.

Verbal people would prefer communicating via written and spoken verbal explanations. E-mail and forums would be ideal for them because they would have the chance to share and discuss their ideas. The synchronous tool they would prefer is chat.

As Felder-Silverman Model strategies suggest, audio-visual media like videoconference, is recommendable for visuals as well as for verbals. For visuals because it is important for them seeing their interlocutor gesture to follow a conversation, and for verbals because they have the chance of listening and expressing them verbally.

Active people tend to retain and understand information best by doing something active with it (discussing or applying it or explaining it to others) that is why they would prefer synchronous tools. Reflective people prefer to think quietly before doing something. That is why they would prefer to work with asynchronous tools.

Then, we propose the following guidelines for supporting communication on distributed elicitation processes:

1. **Identify stakeholders' characteristics.** We should focus on the stakeholders' personal behavioural characteristics, identifying categories from Felder-Silverman Model by applying a multiple-choice test proposed by Soloman-Felder. This step is a crucial activity, because it provides knowledge about people who is going to be involved in the requirements elicitation process.

2. **Classify and assign groupware tools.** We proceed classifying the available groupware tools. The classification is based on the association between the Felder-Silverman Model categories for each stakeholder and the characteristics of the groupware tool set. This step helps in deciding which tool is appropriate for each stakeholder: for example, if a person has a very strong preference for the visual dimension of the category visual/verbal, then the recommendation will be on assigning groupware tools like shared whiteboard and videoconference. It's clear that these people will be more comfortable working with media that let them take advantage of their visual abilities.

4.1 A motivating example

Given a set of stakeholders, it is possible to know their behavioural characteristics by applying the first guideline introduced below, in order to obtain a table similar to Table 2 for each of them.

In spite of we only use the information these tables provide for visual/verbal and reflective/active categories, information obtained for every stakeholder can be combined so that it is possible to know which set of tools is the most suitable for a given subset of stakeholders. The tools are suggested according to the relations shown in Table 3.

Table 4 shows the result of applying our guidelines to a hypothetical group of stakeholders (Mary, John, Pam, and Tom). On one hand, Pam has a moderate preference for the active

subcategory and a mild preference for the visual. On the contrary, Tom has a mild preference for the active subcategory and a strong preference for the visual. In this case, the subset of tools, recommended for communication between this group of stakeholders is the intersection between (1) shared whiteboard, e-mail, instant messaging and videoconference, and (2) synchronous tools, as we see in Table 4. Then, the resulting subset is composed of synchronous shared whiteboard, instant messaging and videoconference.

In the same group, if Mary needs to interact with John, according to the table below we note that Mary has a moderate preference for the active subcategory and a strong preference for the visual one. On the contrary, John has a mild preference for the visual subcategory and a strong preference for the reflective. The subset of tools recommended for communication between them would be the result of the intersection between asynchronous and visual tools: e-mail and asynchronous shared whiteboard.

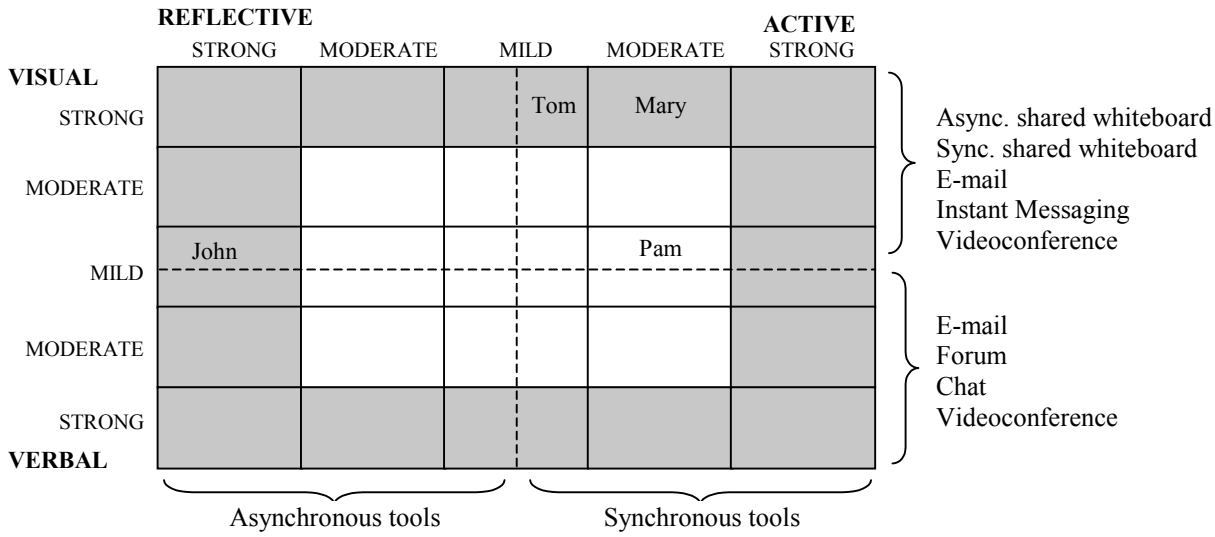

Table 4: Choosing a set of groupware tools according to stakeholders' characteristics

But, what is the recommended subset of tools if we need interactions among any number of members of a group? In this case, it is necessary to take into account which quadrant of the table contains the greatest density of stakeholders. This intersection will highlight preferences and suggest a subset of tools suitable for the majority of the group. It is important to remark that the analysis might be based mainly on strong preferences, since communication with stakeholders with mild or moderate preferences may not be highly affected. This is the reason why we have coloured Table 4 given preponderance to strong preferences.

5 Conclusions and future work

Many organisations have adopted a decentralised, team-based, distributed structure, whose members communicate and coordinate their work through information technology. Groupware tools now permit powerful means of communication, allowing groups to develop distributed software engineering activities. Among them, eliciting requirements specially depends on communication-intensive tasks.

We have proposed a classification of groupware tools that might be used to improve communication when eliciting requirements on distributed environments. The classification is based on cognitive characteristics of the stakeholders, which have been modelled as categories of a learning style. In the next stage of our work, we are including this classification as a technique of a particular elicitation model. The extended model will be empirically validated by defining some use cases aiming at providing more conclusive results.

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