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The Activity Taxonomy [ATx] as an Evaluation Framework for Modeling Elements in HCI

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Abstract. This paper focuses on presenting the use of an Activity Taxonomy as an Evaluation Framework of modeling elements that are recently used to capture activity specifications in the context of the HCI. The aims of the evaluation are: to validate the categories of an Activity Taxonomy for Interactive Systems and to analyze the level of understanding of engineers and students, who practice the development of interactive systems, about the modeling elements evaluated. The results of the evaluation are aimed to show which of the notational elements under evaluation have the features to properly represent the activity in the specification of interactive systems. Some of the conclusions of the study reveal that most of the notations do not differentiate the representation of the activity for the business and system levels of abstraction. There is also evidence that is necessary the incorporation of HCI topics, such as task modeling, in training of computer engineering, in order to reinforce the knowledge that students have in these subjects.

Keywords: human-computer interaction modeling, activity modeling, activity taxonomy, evaluation.

1. Introduction

Interactive Systems are designed to support complex interactions. The development of this type of systems involves the capture of large volumes of information. The captured information contains features and attributes related to several aspects, such as security, collaboration, communication, functionality, etc., and several abstraction levels, such as organization and interactive system levels. This is because not only the interactions between system and user must be considered, but also the interactions between people (Guerrero, 2010), (Limbourg, 2004). In previous works an Activity Taxonomy (ATx) is proposed (Villegas et al, 2014), (Giraldo et al, 2014), (Villegas et al, 2015). The ATx allows the designers to disaggregate, decompose, or even add the information related to activity from an interactive system specification, to be understood according to the interest in a view and a point of view.

The ATx definition is based on an extension of the conceptual framework of CIAF proposal (Giraldo, 2010). This framework defines a set of activity classifiers related to aspects (*Software Engineering, Ethnography, Cognitive psychology, etc*), abstraction levels (*Business and System*), activity types (*Core, Support, and Management*), and granularity levels (*High and Low*). We think that the modeling of interactive systems must be understood in a holistic way. Activity Modeling should be related to other models that represent fully the interactive system, Organizational Models, Data Models, Location Models, and so on. In addition, the levels of abstraction in which it takes place must be differentiated: the interaction between people and the interaction of the user with the interactive system. For these reasons, the ATx consider not only the classification of Activity (*How*) but other views used for modeling interactive systems are also added, namely Data (*What*), People (*Who*), Location (*Where*), Time (*When*) and Motivation (*Why*) modeling (Sowa,1992).

The aim of this work is to present the use of the ATx as an evaluation framework of modeling elements capturing activity information in the HCI context. The evaluation method involves measuring the degree to which those elements represent the categories comprising the ATx. It is also intended to measure the level at which students and related Software Development engineers interpret, understand, and use the notations become evaluated.

In the following sections, the state of the art is presented followed by the work context. Then, the methodology is described in addition to the results and discussion. Finally, the conclusions and future work are presented.

2. State of the art

The literature related to the evaluation of modeling elements or notations used to model interactive systems in the area of HCI (Human-Computer Interaction) is greatly reduced. In works such as (Haan et al, 1991), modeling languages focused on HCI are analyzed and compared. The concrete syntax defined for these languages is specified in text form, which does not add much to this work where the focus is on notations specified graphically. There are also works like (Molina et al, 2009), where notations for conceptual modeling of collaborative interactive systems are analyzed and compared. Such study was performed to demonstrate the need to incorporate the aspect of collaboration in the modeling of collaborative interactive systems. The list of attributes includes for example if each approach distinguishes between the cooperative and the collaborative, or whether or not it has an associated methodology.

On the other hand, the works of (Guerrero et al, 2012) and (Limbourg, 2004) show a comparison between a set of notations for task modeling. The attributes used for comparison have to do with concurrency, sequence, system response, operational level, and so on.

Similarly, (Meixner et al, 2011) and (Balbo et al, 2004) proposed taxonomies to assess a set of notations for task modeling in order to select the best, according to the features of the system to be modeled. Among the criteria defining these proposals: Degree of Formality, Integrability, Communicability, Editability, Usability, and Adaptability. Particularly, Balbo proposes the evaluation criterion "*expressive power*", which relates the amplitude of what the evaluated notation can express. This criterion is interesting for this work because one of the attributes that are taken into account in notation assessment is "*expressiveness*".

In the Collaborative Interactive Application Framework (CIAF), Giraldo (Giraldo, 2010) makes a classification and comparison of methodological proposals in relation to the notation, the process, and the tools support. Each notation is classified taking into account, "*Ontological Rigor*", "*Mapping*", and "*Aspect*". It is emphasized that the comparison includes proposals not only for task modeling but also software systems modeling in general.

Many of these proposals define a set of attributes to evaluate notations used to model interactive systems. In most cases, the attributes are related to the quality of notations. It is important to note that few proposals use taxonomies to evaluate how complete is the information captured by its modeling elements. The information should be presented in the specification of an interactive system.

3. Work context

This section describes the core concepts that support the context of this work. It begins with a brief definition of the Activity Taxonomic Structure; and then, a previous evaluation about a set of modeling elements using the CIAF conceptual framework is described.

3.1 Activity Taxonomy for Interactive Systems

The definition of a particular Taxonomy involves the definition of: a set of classifiers, a taxonomic structure, a classification process, and a set of rules (Unterkalmsteiner et al, 2014), (Giraldo, 2010).

Table 1. Activity Taxonomic Structure

Activity Taxonomy Structure – Classifiers of ATx													
Business		**Function**					**Data**	**Goal**		**People**		**Time**	**Location**
		Base		**Support**		**Manage-ment**							
		C	*I-A*	*C*	*I-A*	*W*		*A*	*R*	*Cl*	*Wo*		
	LG												
	HG												
System		**Function**					**Data**	**Goal**		**People**		**Time**	**Location**
		Base		**Support**		**Manage-ment**							
		U	*I*	*U*	*I*	*S*		*A*	*R*	*Us*	*Sy*		
	LG												
	HG												

LG: Low Granularity; HG: High Granularity
C: Client Task; *I-A*: Inter-Action; *W*: Worker Task
A: Aim; *R*: Rule; *Cl*: Client
Wo: Worker; *U*: User Task; *I*: Interaction
S: System Task; *Us*: User; *Sy*: System

More precisely, the set of classifiers captures all the information related to the activity in an organized and separate way, the classification process and the set of rules are defined to control the integrity, uniqueness, consistency, and recursion of the information classified in the taxonomy. All the elements that conform the ATx are described in detail in previous work (Villegas et al, 2016).

The purpose of this section is to show the Taxonomic Structure of the ATx. Such structure expresses the distribution and relationships between the set of classifiers defined for the taxonomy (Table 1). It is important to observe the structure because, in order to perform the evaluation of modeling elements, it was necessary to classify them previously according to the classification process defined for the ATx.

3.2 Previous Work

In previous work, a classification of notational elements from existing proposals, according to the CIAF conceptual framework was performed (Villegas et al, 2014). The results and conclusions are listed in order to have a little more context about the present work and to show the continuity of the research.

- None of the proposals analyzed to make a syntactic distinction to support separately the classification of the Type of Activity in the *Base*, *Support*, and *Management* categories; that is to say, the same modeling elements would be used for any type of activity. Although it is possible to classify the activities performed by a computer system in those categories, this lack of modeling elements for each proposal generates a low level of expressiveness and semantics for modeling any aspect or facet different to each proposal models.
- The proposals analyzed provide few activity modeling elements on the *Business* Abstraction Level, both at the high as well as the low level of granularity.
- At the *System* Abstraction Level, a greater number of modeling elements than those appearing on the *Business* Abstraction Level are observed, which means that the set of proposals focuses more on detailing the information of the interactive systems in this level.
- A methodology or development process that promises fully functional software products should include models that describe the labor, regardless of the quality of its notations.

In order to understand better the conclusions listed above, the reference taxonomy, with a broad set of activity classifiers, allows the designers to analyze the nature of activity from different views and points of view. In this way, each one of the roles interested on analyzing a specification will be able to evaluate several aspects from that specification, i.e., organization, HCI, communication, security, collaboration, etc.

For example, an expert at organization level is focused on analyzing interactions between people, more than analyzing interactions between users and the interactive system. Then, the specification of the system must be classified at different levels of abstraction, business and system separately.

In the same way, an expert at the level of the interactive system could be focused on analyzing interactive tasks (*Base*, *Support*), separately from system tasks (*Management*). For example, CTT notation (Paternò, 2004) makes this distinction between types of tasks, although it does not make any task definition or distinction at the business level. This would not be very attractive to a business level interaction expert.

According to the aforementioned, the methodology section presents the way the ATx has been applied to evaluate a set of modeling elements selected from notations used to represent the specification of interactive systems. Previously, the classification of such modeling elements within the taxonomic structure of the ATx was analyzed.

4. Methodology

This section presents how the ATx is used as an Evaluation Framework for modeling elements in the specification of interactive systems. The evaluation process carried out in this work starts with evaluation planning, followed by the information capture; and finally, the analysis of results.

4.1 Evaluation planning

Firstly, the evaluation planning comprises the definition of the main interest of the evaluation, which is making a selection of the most appropriate notational elements for interactive systems modeling taking into account all the classifiers defined in the ATx. It should be noted that this selection is subject to the subjectivity of the surveyed population. In addition, it is necessary to inquire about the level of knowledge and understanding that students and experts in the field of HCI have about notations evaluated.

Finally, it is required to identify whether the notational elements capture information in all dimensions defined in the ATx.

Once defined the main focus of the evaluation, we proceed with the generation of the list of selected notations for evaluation (see Table 2). The list consists of the most important proposals that are currently in the literature related to software development, user interface development, and interactive systems development in general. Each proposal is distinguished by the aspects in which it focuses on specifying the labor; in particular, the Functionality, Collaboration, and User Interface.

Then, the profile of people surveyed is defined:

- Fourth-year students of Informatics Engineering and related.
- Experts in the area of HCI who work in the academic field and/or software development companies.

Then the necessary instruments to drive the assessment process are designed depending on the role of interest. The evaluation instruments are structured as follows:

Evaluation instrument designed for students

- Description of a process to open a bank account.
- List of some activities associated with the process. Activities are classified by level of abstraction, client task, and worker task.
- Description of the tasks: it is intended that the participants analyze a set of modeling elements and select the most appropriate to model or represent the classifiers defined in the ATx.

Table 2. Selected Notations for the Evaluation

#	**Notation**
1	Unified Modeling Language (UML) (OMG, 2008)
2	ConcurrTaskTree (CTT) (Paternò, 2004)
3	Collaborative Interactive Applications Notation (CIAN) (Molina, 2006)
4	Notation defined in Task-Oriented and User-Centered Process Model for Developing Interfaces" (TOUCHE) (Penichet et al, 2009)
5	Notation defined for Communicative Events Diagram in "Methodological Integration of Communication Analysis into a Model-Driven Software Development Framework" (Cubillo, 2011)
6	Notation for Activity Modeling (Constantine, 2009)
7	TaskMODL, DiaMODL(Trætteberg, 2002)
8	Notation defined in "Methodology for Developing User Interfaces to Workflow Information Systems" (Guerrero, 2010)

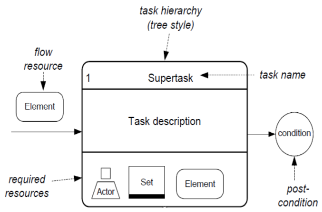
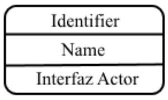
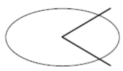
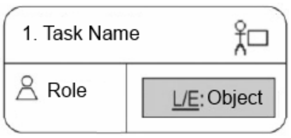
9	Notation defined in "Whitewater Interactive System Development with Object Models" (Nunes, 2001)
10	Notation used in "Process Model of Usability Engineering and Accessibility (MPIu+a)" (Granollers, 2004)
11	Human-centered Assessment and Modeling to Support Task Engineering for Resilient Systems (HAMSTERS) (Barboni et al, 2010)

Evaluation instrument designed for HCI experts

- Context questions: participants were asked whether they work in the business environment and /or academic. They were also asked about the level of familiarity/knowledge in each of the various notations selected to evaluate.
- Description of a process to open a bank account.
- List of some activities associated with the process. Activities are classified by level of abstraction, client task, and worker task.
- Description of the tasks: It is intended that the participants analyze a set of modeling elements and select the most appropriate to model or represent the classifiers defined in the ATx. This time assigning to each notational element a rating according to a scale of 1 to 5, being 1 "not appropriate" and 5 "very appropriate".

Below it is described how the notational elements are presented to participants and the options of response, depending on the role of interest. For reasons of space, only a fragment of the information presented to the experts to evaluate the notational elements, classified previously by the authors, in the "*How*" column and levels of abstraction "*Business and System*" (Tables 3 and 4) are shown. In this case, the notational elements are accompanied by a rating scale of 1 to 5. Participants should have marked with an "X" for the value of the scale they considered corresponding with each statement "*Appropriate for ...*".

Table 3. Modeling Elements classified in "*How*" column according to ATx, Business Level

Modeling Elements for Function on Business Level						
 Super Task	Appropriate for model Client Task	5	4	3	2	1
	Appropriate for model Business Worker Task	5	4	3	2	1
	Appropriate to model the interaction that takes place between the Client and the Business Worker	5	4	3	2	1
 Communicative Event	Appropriate for model Client Task	5	4	3	2	1
	Appropriate for model Business Worker Task	5	4	3	2	1
	Appropriate to model the interaction that takes place between the Client and the Business Worker	5	4	3	2	1
 Essential Use Case	Appropriate for model Client Task	5	4	3	2	1
	Appropriate for model Business Worker Task	5	4	3	2	1
	Appropriate to model the interaction that takes place between the Client and the Business Worker	5	4	3	2	1
 Individual Task	Appropriate for model Client Task	5	4	3	2	1
	Appropriate for model Business Worker Task	5	4	3	2	1
	Appropriate to model the interaction that takes place between the Client and the Business Worker	5	4	3	2	1
 Interaction Space	Appropriate for model Client Task	5	4	3	2	1
	Appropriate for model Business Worker Task	5	4	3	2	1
	Appropriate to model the interaction that takes place between the Client and the Business Worker	5	4	3	2	1

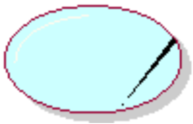
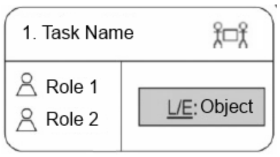
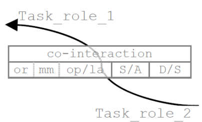
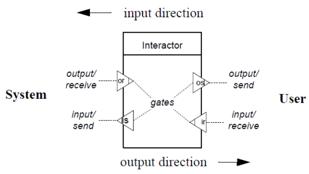
 Business Use Case	Appropriate for model Client Task	5	4	3	2	1
	Appropriate for model Business Worker Task	5	4	3	2	1
	Appropriate to model the interaction that takes place between the Client and the Business Worker	5	4	3	2	1
 Collaborative Task	Appropriate for model Client Task	5	4	3	2	1
	Appropriate for model Business Worker Task	5	4	3	2	1
	Appropriate to model the interaction that takes place between the Client and the Business Worker	5	4	3	2	1

Table 4. Modeling Elements classified in "*How*" column according to ATx", System Level

Modeling Elements for Function on System Level						
 System Use Case	Appropriate to model User Task	5	4	3	2	1
	Appropriate to model System Task	5	4	3	2	1
	Appropriate to model the interaction that takes place between the User and the System	5	4	3	2	1
Co-Interacción 	Appropriate to model User Task	5	4	3	2	1
	Appropriate to model System Task	5	4	3	2	1
	Appropriate to model the interaction that takes place between the User and the System	5	4	3	2	1
 Interactive Group Task	Appropriate to model User Task	5	4	3	2	1
	Appropriate to model System Task	5	4	3	2	1
	Appropriate to model the interaction that takes place between the User and the System	5	4	3	2	1
 CTT Interaction Task	Appropriate to model User Task	5	4	3	2	1
	Appropriate to model System Task	5	4	3	2	1
	Appropriate to model the interaction that takes place between the User and the System	5	4	3	2	1

 Task (1)	Appropriate to model User Task	5	4	3	2	1
	Appropriate to model System Task	5	4	3	2	1
	Appropriate to model the interaction that takes place between the User and the System	5	4	3	2	1
 Task (2)	Appropriate to model User Task	5	4	3	2	1
	Appropriate to model System Task	5	4	3	2	1
	Appropriate to model the interaction that takes place between the User and the System	5	4	3	2	1
 Super-Interactor	Appropriate to model User Task	5	4	3	2	1
	Appropriate to model System Task	5	4	3	2	1
	Appropriate to model the interaction that takes place between the User and the System	5	4	3	2	1
CTT User Task 	Appropriate to model User Task	5	4	3	2	1
	Appropriate to model System Task	5	4	3	2	1
	Appropriate to model the interaction that takes place between the User and the System	5	4	3	2	1
 Individual User Processing Task	Appropriate to model User Task	5	4	3	2	1
	Appropriate to model System Task	5	4	3	2	1
	Appropriate to model the interaction that takes place between the User and the System	5	4	3	2	1
 System Input Task	Appropriate to model User Task	5	4	3	2	1
	Appropriate to model System Task	5	4	3	2	1
	Appropriate to model the interaction that takes place between the User and the System	5	4	3	2	1

 System Processing Task	Appropriate to model User Task	5	4	3	2	1
	Appropriate to model System Task	5	4	3	2	1
	Appropriate to model the interaction that takes place between the User and the System	5	4	3	2	1

4.2 Information capture

For the capture of the information, the collaboration of 30 students from the Benemerita University Autonomous of Puebla in Mexico and the University of Cauca in Colombia was requested. Students were in the fourth year of Information Technology Engineering and Systems Engineering respectively. 6 experts in HCI from Colombia, Spain, and Mexico also collaborated in this study.

Participants were asked to assess the notational elements considering the following features:

- *Expressiveness*: The modeling element does express what it represents. (Selic, 2012) defines the expressiveness as the ability to specify concisely yet precisely a system or desired property.
- *Easy diagramming* (if not having a software tool): That is, considering that an icon is more difficult to diagram or outline than a simple geometric shape.
- *Level of granularity or appropriate detail*: Keeping in mind that an Activity can be broken into Actions and turn into Operations.

Finally, the sessions where participants filled out the evaluations were coordinated and the results were tabulated in order to establish the study conclusions.

Both assessment instruments and the complete survey results are available at the following link:

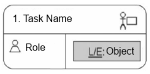
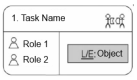
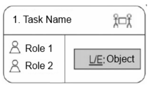
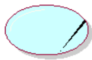
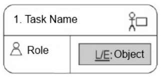
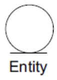
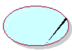
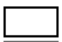
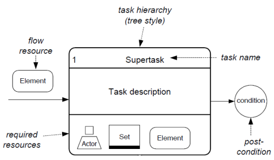
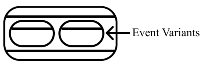
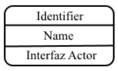
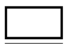
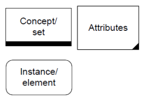
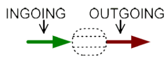
https://drive.google.com/open?id=0B2b_Bc_ft66eSDFveUMtbEZUWFE.

5. Experimental results and analysis

The analysis of results is oriented to conclude what would be the notational elements that better potentially represent the classifiers defined for ATx.

The results obtained in the selection of the modeling elements which correspond with ATx classifiers are shown in Tables 5 to 8. What can be noticeable at first sight in the obtained results is that most of the participants selected the modeling elements of the UML language, which reflects that the level of acknowledgment and familiarity greatly influence at the time of selection. It is observed that in the cases where the UML was not selected for the <*inter-action*> classifier where the CIAN (Molina, 2006) proposal was selected, it was possible that the UML language did not provide the modeling elements to represent that classifier.

Table 5. Selected Modeling Elements for Function and Data. Business Level

	Function			Data
	Client Task	**Inter-action**	**Worker Task**	
Low Granularity	Storyboard, *(Students)*  Individual Task *(Experts)*	 Cooperative Task *(Students and Experts)*  Collaborative Task *(Students and Experts)*	 Business Use Case *(Students)*  Individual Task Storyboard *(Experts)*	 Entity *(Students and Experts)*
High Granularity	 Business Use Case *(Students)*  Sub-Task *(Experts)*	 Super Task *(Students and Experts)*  Specialized Communicative Event *(Students)*	 Communicative Event *(Students)*  Sub-Task *(Experts)*	 Concept/Set *(Students)*  Communicative Interaction *(Students and Experts)*

The analysis of the results also allows us to conclude the following:

- The acknowledgment and acceptation of the defined notation by the UML language are high. Additionally, the experts refer knowledge about the CTT notation.

- Most students present difficulty in distinguishing the granularity levels, and they are not familiarized with the notations employed to model HCI tasks.

Table 6. Selected Modeling Elements for People, Location, Time and Motivation, by Students and Experts. Business Level

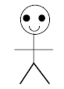
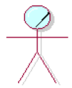
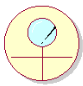
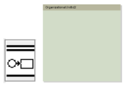
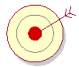
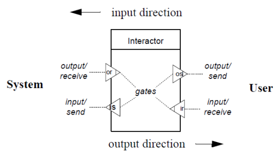
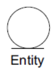
	People		Location	Time	Motivation	
	Client	**Worker**			**Goal-Aim**	**Rule**
Low Granularity	 Human Actor	 Business Actor	Not provide Modeling Elements	Not provide Modeling Elements	Not provide Modeling Elements	Not provide Modeling Elements
High Granularity	 Primary Actor / Receiver	 Business Worker	 Organizational Unit	Not provide Modeling Elements	 Business Goal	Not provide Modeling Elements

Table 7. Selected Modeling Elements for Function and Data. System Level

	Function			Data
	User Task	**Interaction**	**System Task**	
Low Granularity	 System UC *(Students)*  Abstract Individual User Task *(Experts)*	 Super-Interactor *(Students and Experts)*	 System Processing *(Experts)*  System Use Case *(Students)*	 Entry  Notification *(Students and Experts)*

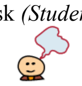
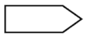
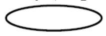
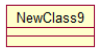
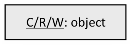
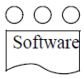
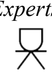
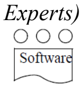
High Granularity	 Task *(Students)*  Individual User Processing *(Experts)*	 CTT Interaction Task *(Experts)*  Task *(Experts)* *Students didn´t answer*	 Activity *(Experts)*  Task *(Experts)* *Students didn´t answer*	 Class  C: Creation R: Reading W: Writing Object *(Students and Experts)*

Table 8. Selected Modeling Elements for People, Location, Time and Motivation. System Level

	People		**Location**	**Time**	**Motivation**	
	User	**System**			**Goal-Aim**	**Rule**
			Students and Experts			
Low Granularity	 Actor *(Students and Experts)*	 System Actor *(Students)*  System *(Experts)*	Not provide Modeling Elements	Not provide Modeling Elements	Not provide Modeling Elements	Not provide Modeling Elements
			Students and Experts			
High Granularity	User Rol *(Students and Experts)* 	System *(Students and Experts)* 	Not provide Modeling Elements	 Concurrency, Sequence between Taks	Not provide Modeling Elements	Not provide Modeling Elements

- For the “Location”, “Time”, and “Motivation” categories, the most recurrent answers are: “Text” and “modeling elements are not provided”.
- Most notations analyzed do not provide notational elements for modeling classifiers in the *“Location”*, *“Time”*, and *“Motivation”* categories.

- At the business and system level, answers of Experts and Students are very similar in the columns *"People", "Location", "Time"* and "*Motivation"*.
- The level of familiarity/knowledge of students with each of the various notations selected has not been taking into account. Despite this, it is not surprising that most participants selected UML, as it is one of the most known notations.
- It is necessary to incorporate HCI subjects, task modeling, in training of computer engineering, in order to reinforce the knowledge that students have in these subjects.

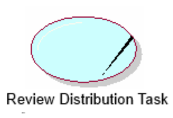
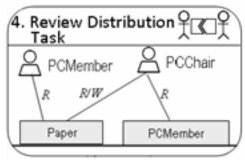
6. Discussion

A deeper analysis on the way the evaluation was applied reveals that the assessment of the notational elements was not enough in order to achieve the objectives proposed. In some cases, it is clearly observed that diverse modeling elements have a disadvantage regarding others due to the way that the evaluation instrument is presented; and additionally, to the subjectivity of the participants.

For example, if two modeling elements are confronted, in this case the ones that represent a business task in the UML language as well as the CIAN notation (Table 9) and *expressivity* of every element is evaluated having in mind attributes like "Visualization of the relation between Business Actor and Worker", "Visualization of the relation between Worker and Data", the notation of the UML language is evaluated in disadvantage regarding the CIAN notation. While in CIAN it is required only one notational element to express information related to the aforementioned attributes, a diagram is required for the UML. That is to say, it can be concluded that its modeling elements hide information. Thus, they are less expressive.

The detailed analysis allows glimpsing that the evaluation done has some gaps both in context as well as content. In the first place, the context lacks indicating if the notational elements to evaluate have or have not relations or connections. In the second place, some notational elements that look highly detailed are not taken into account as long as they are presented in a great size. But, this level of detail decreases as its size reduces or it is laid out according to the size that the diagrams are presented in the design of interactive systems. And in the third place, the evaluation should have been designed not only from the notational elements point of view but also from the diagrams point of view. This is because, from the perspective of design, the information is captured through diagrams.

Table 9. Modeling Elements Representing a Task in UML(OMG, 2008) and CIAN (Molina et al, 2008)

UML Task Representation	CIAN Task Representation
	

It is then understood that the design of interactive systems is affected by variables that must be measured in the concrete syntax of the modeling languages such as Focal Point, Continuity, Balance, and Equilibrium. These variables make a design more expressive, easy to understand, and easy to communicate with engineers.

For this evaluation, in particular, it is observed that some notational elements are presented in a bigger size than the normally used by an engineer in a diagram. That is how when presenting every modeling element separate from the diagram, different information to the one expressed when presenting a complete diagram is expressed.

The following example illustrates the necessity to elaborate an analysis not only at modeling elements level but also at diagrams level.

In the icon that represents and Interactive Task in CTT notation (Paternò, 2004), a person in front of a computer can be clearly appreciated. (Figure 2). From this perspective, the answer to the question: *Do you believe that this icon is appropriate to model the interaction between a person and a computer?* A positive answer will be very possible.

Figure 2. Interactive Task representation in CTT (Paternò, 2004)

Now, let us suppose that the same icon that represents an Interactive

Task is presented for its evaluation, but this time it is a Task Diagram where it is not easy to appreciate in detail a person in front of a computer (Figure 3). It is possible to find a negative answer in front of the question: do you believe that the icon that represents an interactive task is appropriate to model the interaction between a person and a computer? It is not so evident to appreciate in detail what the "Interactive Task" symbol represents if it is located in the same diagram with other tasks, with dependence and hierarchy relationships.

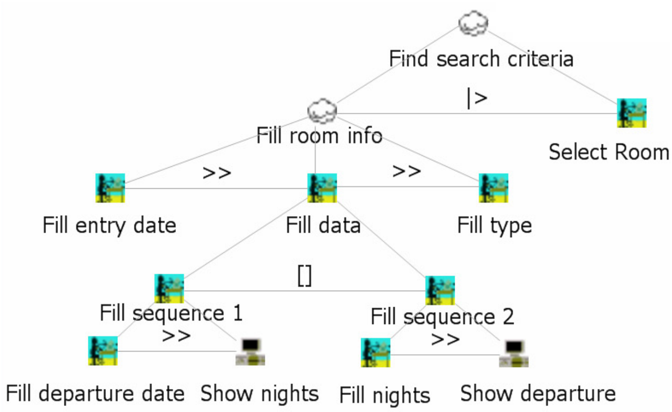


Figure 3. Task diagram representation in CTT (Paternò, 2004)

In this sense, the idea that it is necessary to analyze the elements of modeling holistically begins to prevail. That is to say, the analysis from the diagrams perspective must be done, and not from every notational element separately.

7. Conclusions and Future Work

The development of languages is very important from the perspective of modeling in software engineering because the implementation of functional software requires all the essential properties of the system of interest to be concise and precisely captured. In this way, what is sought with ATx definition is to find what are the modeling and abstract elements that have the greatest potential to become components of an integrator language that allows to express the temporality, synchronization, hierarchy, structure, and other aspects that characterize the interactive systems (and software in general); and likewise, define its expressiveness. In addition, the levels of abstraction in which it takes place must be differentiated: the interaction between people and the interaction of the user with the interactive system. Such differentiation is supported with the definition of new notational elements. For instance, at the business level of abstraction for greater accuracy in modeling the interactive systems and greater traceability between levels of abstraction. This is expected to contribute positively to code generation and quality in the development of interactive systems.

The software engineers employ modeling languages aiming at the understanding the relevant characteristics of the current complex or desired systems. In the same way, software engineers do this in order to communicate its understanding and design intentions toward such systems. In this sense, the components of a modeling language, as its abstract notation, concrete notation must agree with the mental models of the engineers in order to capture the information that it is pretended to be used whether to generate a software application or a language that can execute most types of tasks and types of defined functionalities in the domain of interactive systems.

It is necessary to take into account attributes such as realism and focal point at the time of conducting a modeling elements evaluation. In other words, equilibrium must be maintained between what the participants can see and read and the size of the diagrams presented. Otherwise, some evaluated notations can result in disadvantage regarding the others at the moment of comparing modeling elements that present themselves isolated, with modeling elements that are presented in a diagram altogether. Also, every diagram has a purpose and an objective, and that the context must be associated; and lastly, identifying the key notational elements at the time of evaluation has to be taken into account.

Due to this, it is necessary to propose as future work the design and application of an evaluation that involves no only the modeling elements, but also the diagrams that are used to represent the interactive systems where the results are oriented to simplify the modeling and to employ a minimum quantity of notational elements in the models. The work must contemplate attributes such as Focal Point, Equilibrium, and Realism that contribute to evaluating the level of expressivity in the evaluated notations.

Additionally, it is necessary to provide a higher level of contextualization and information in the evaluation instrument that allows capturing more precisely the mental models of the engineers and analyzing its potential to understand what it is related to the modeling of interactive systems. All of this, oriented toward having tools that allow the definition of a precise modeling language that is expressive and concise.

It would be interesting to add to the evaluation instruments, an open answer section and not only Liker scales, so the participants can justify their selections and/or answers. This way a more thorough perception of the participants' answers could be obtained.

The final purpose of this research is to define a sufficiently generic language to represent the Activity and provide a basis for the definition of executable languages within the interactive systems design.

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