An Exploratory Study on the Communication Between Producers and Consumers of Use Cases

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ABSTRACT

This technical presents part of the analysis from an exploratory study on the communication between producers and consumers of a software model from the Semiotic Engineering perspective. We chose to investigate UML use cases, as they help in communicating different roles in the software development team, such as designers and developers. We carried out the analysis of the communication of the producers and consumers in this study and we present below the perspectives from the analysis of the participants' conversation when developing the mockups from the use case.

1. INTRODUCTION

According to Reed and Knight [1], effective communication is one of the most critical components of working in software teams. In software development, the communication is carried out through face-to-face discussions in co-located or distributed teams [2], besides the support offered by tools [3]. Software models are also used as means of communication in software development teams [4].

Communication failures from software models can come from information that is not clearly expressed by their producers (people who created the models). Thus, other members of the development team (i.e. consumers, who comprehend the models for the creation of other artifacts) may have different interpretations of the ones intended by the producers. Different interpretations can introduce incorrect information into other artifacts and generate various defects during the production of software; such as the omission of some necessary information or the vague definition of information, thus allowing multiple interpretations [5].

In the exploratory study, we analyzed the use cases (UC) as a means of communication from the Semiotic Engineering perspective [6][7]. We investigated the problems of communicability in this UC, i.e., problems that affect the quality of the transmission of the solution conceived by producers to consumers. We carried out this investigation through the observation of the participants of this study when they performed the development of mockups from the UC. We presents only part of the analysis from this exploratory study.

2. ANALYSIS OF THE CONVERSATION BETWEEN PRODUCERS AND CONSUMERS OF UC

Regarding the participants' conversations when developing the mockups from the UC, we analyzed the inferences obtained by six pairs that produced the mockups. In this paper, not to be extensive, we will present only the analysis of the conversation of the pairs that produced the first two and the last two mockups in the ranking of the designers' evaluation from the UC. We analyzed these inferences from the conversation between the pairs, in which we looked for to analyze the doubts that have arisen when consuming the information of the diagram and specification of the UC. Table 1 presents the pairs with the respective participants who produced the top three and last three sets of mockups.

Pairs	Classification According to UC Producers
[P1, P2] [P3, P4] [P5, P6]	Top three sets of mockups.
[P7, P8] [P9, P10] [P11, P12]	Last three sets of mockups.

Table 1. Ranking of classification according to UC producers.

The analysis of the participants' conversation when developing the mockups was supported with the concepts of conventional implicature and conversational implicature. In addition to the concept of implicatures, we adopted the four maxims of the Grice's Cooperative Principle [8] to analyze the communication between UC producers and consumers. This principle assists in the expression of essential characteristics of an effective and efficient communication. We have adapted and combined maxims in the form of questions to be answered in the analysis.

Table 2 shows the adaptation of the maxims that made sense in the analysis of diagram and specification of UC. In cases where we perceived interruptions in the participants' conversation, we analyzed the cause of these failures in the UC from the answers to the questions described in Table 2.

Grice's Maxims	Grice's Maxims Adapted for UC Analysis
Quantity	- Is the necessary information described? - Is there excess of information described?
Relation	- Is relevant information described?
Quality	- Is there information that is not true about the software?
Manner	- Is there information that could be described more objectively? - Is information organized? - Is there any obscure information?
Quantity and Manner	- Does lack of information cause ambiguity? - Does excess of information cause ambiguity?
Quantity and Relation	- Is the necessary and relevant information described? - If there is too much information, is it relevant?
Quantity and Quality	- Does the necessary information contain statements that are not true?

Table 2. Grice's maxims adapted for UC analysis.

If communication failure occurs between the participants and the UC producers, we use the classification of communication failures adapted from the concepts of Semiotic Engineering, which are: "Complete" (when the consumer does not understand the information in the UC due to lack of conversational context), "Partial" (when the consumer partially understands the information of the UC) and "Temporary" (when the interruption occurs in the interpretation of the UC consumer on the conventional meaning of the content used, which is understood later). Figure 1 shows an example of how we analyzed the participants' conversation when developing mockups.
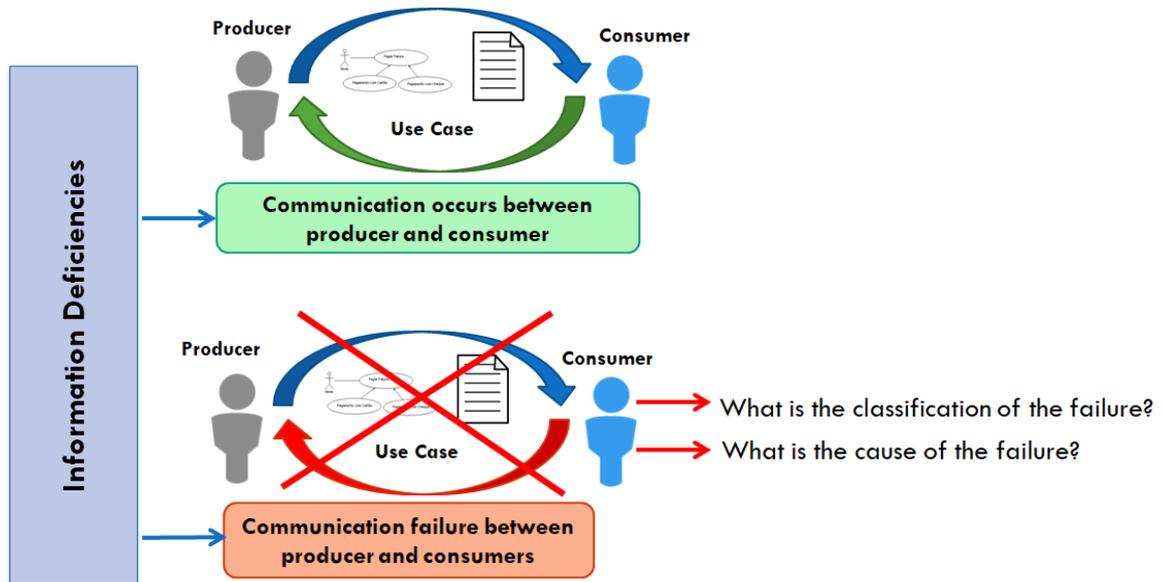
Figure 1. Example of analysis of communicability problems in use cases.

We mapped the activities performed by the participants during the development of the mockups to better analyze the participants' conversation. This mapping of activities refers to the record of the steps taken by the participants, including our observations on the practices adopted by them in carrying out the activity, during the consumption of the UC and the development of the mockups.

Figure 2 and Figure 3 present the mapping of the activities performed by the participants who produced the best mockups. Figure 5 and Figure 6 present the mapping of activities performed by the participants who produced the worst mockups. We will present these four figures later in the text. Table 3 shows the symbols used to record such mapping.

Symbols' Category	Symbols' Description
UC Diagram and Specification	(**A**) Description of Functionality related to the UC; (**B**) Actors, (**C**) Relationships, (**D**) Pre-conditions, (**E**) Main flow, (**F**) Alternative flow, (**G**) Business rules, (**H**) Exception flow.
Construction of Mockups with Balsamiq	(**J**) Analysis of elements in Balsamiq to be inserted into the mockups.
Practices Performed in the Activity	(**I**) Comprehending elements of the mockups described in the use case, (**L**) Comparison between the use case and the created mockups, (**M**) Correction to verify the consistency of the mockups with the use cases, (**N**) Verification of the finalization of the construction of the mockups according to the use case, (**X**) Analysis of elements inserted in mockups, (*****) Discussions about doubts, (#) Report of doubt for a researcher, (+) Use of paper and pen

Table 3. Symbols used in the mapping of participants' activities in Figures 5, 6, 7 and 8.

For example, the pair with participants P1 and P2, in Figure 2, started the activity comprising the UC diagram, discussing the actors (symbol B) and relationships (symbol C) of the use cases. Notice that the symbol C has '*', indicating the participants' questions about the relationship. Then the pair read the UC specification, having doubts about the actors (symbol B with the '*', which indicates doubt about the symbol B, i.e., doubt about the actors). For this, the pair queries the UC diagram again and comprises the description of the actors related to the UC (a sequence of symbols B* and B indicate the clarification of the doubt with the other artifact). Otherwise, as a sequence of A* and D in Figure 2, the

doubt is maintained. We present the analysis of the understanding of the information from consumers of UC models for the development of mockups below.

2.1 Analysis of the Conversation between the Pairs that Produced the Top Set of Mockups

- **P1 and P2**

Figure 2 shows the mapping of the activities performed by participants P1 and P2 during the understanding of the diagram and specification of UC for developing the mockups (considered as the first set of mockups in the ranking of Elderly Care software designers). Regarding the **consumption of the UC diagram** by P1 and P2, i.e., the understanding of the information for developing the mockups, we noticed that one of the participants had difficulty with the understanding of the relationships between the use cases (use of C* in Figure 5). The following is part of the participants' dialogue on this question:

"I did not understand this 'extend' here (P1); It is because this use case is monitoring this other use case (P2)

ACTIVITIES	MAPPING OF PARTICIPANTS' ACTIVITIES
Understanding the Use Case Diagram (Astah Tool)	B | C* | C | | B | | | D
Understanding the Use Case Specification (PDF reader)	B* | B | A* | A | D | E | F* | G | E | H | B | F | E | FG | F | FG | G | L | M | H F | E F | F G | E F* | F
Construction of Prototypes (Balsamiq Tool)	FG | H F | I | G | L | M | FG* | I | FG | E H | L G | E F | F

A. Functionalities. B. Actors. C. Relationships (include and extend). D. Preconditions. E. Flow of events. F. Alternative flow. G. Business rules. H. Exception flow. I. Understanding interface elements described in the use case. J. Analysis of elements from the balsamiq tool to be inserted in the interface. L. Comparison between the use case and the created prototypes. M. Corrections to verify the consistency of the prototypes with the use cases. *. Doubt regarding the element. #. Report of doubt for a researcher, and + Use of paper and pen.

Figure 2. Mapping of participants' activities in the construction of mockups from Use Cases - P1 and P2.

This communication failure was classified as "Temporary", because P2 was able to understand the information through conversational implicature (from the context of the domain of the problem). This was due to the non-observance of the producers of UC regarding the maxim of Quantity, since the information needed to understand the relationships of the diagram was not described (responding to the question "*Is the necessary information described?*").

Regarding the **consumption of the UC specification** by P1 and P2, we observed that there were doubts regarding the main flow and associated alternative flow (use of EF* in Figure 2). The following is part of the participants' dialogue:

"I've already gotten lost (P2); It is here (P1); Ok! This business of going back and forth in the use-case specification is annoying (P2)".

This communication failure was classified as "Temporary" because there was an interruption in the interpretation of the consumer in relation to the conventional meaning of the content used in the UC specification. This was due to the <u>non-observance of the producers of UC regarding the maxim of Quantity and Manner,</u> because too much information in the UC specification can cause misunderstandings in the interpretation (responding to the question "*Does the excess of information cause ambiguity?*"). P2 had interruptions in the consumption of the main flow and associated alternative flow due to deficiencies of excess of information. At the conclusion of the activity, we noticed that participants P1 and P2 were careful with the construction of the mockups, e.g., correcting the screens constructed from the UC (use of M in Figure 2). As the participants were careful about communicating the information expressed, perhaps this is also one of the reasons for the development of one of the best mockups.

- **P3 and P4**

Figure 3 shows the mapping of the activities performed by participants P3 and P4 during the consumption of UC for the development of mockups (considered as the second set of mockups in the ranking of Elderly Care software designers). Concerning the **consumption of the UC diagram**, participants P3 and P4 had no doubts in interpreting the information reported by the use case producers.

ACTIVITIES	MAPPING OF PARTICIPANTS' ACTIVITIES
Understanding the Use Case Diagram (Astah Tool)	A C B
Understanding the Use Case Specification (PDF reader)	B# P A D B E B E F G H + D G+ E+ G# G G G E G
Construction of Prototypes (Balsamiq Tool)	I G I M I G I G B G G G I L G

A. Functionalities. B. Actors. C. Relationships (include and extend). D. Preconditions. E. Flow of events. F. Alternative flow. G. Business rules. H. Exception flow. I. Understanding interface elements described in the use case. J. Analysis of elements from the balsamiq tool to be inserted in the interface. L. Comparison between the use case and the created prototypes. M. Corrections to verify the consistency of the prototypes with the use cases. *. Doubt regarding the element. #. Report of doubt for a researcher, and + Use of paper and pen.

Figure 3. Mapping of participants' activities in the construction of mockups from Use Cases - P3 and P4.

With regards to the **consumption of the UC specification**, we observed that there were doubts about the actors and business rules, which were asked to the researchers during the study (use of B# and G# in Figure 3 – doubts regarding actors and business rules, respectively). We report below some of the questions asked by the participants to one of the researchers during the study:

"Reallocate to the new responsible actor. So, we have to make a screen for it? (P3)" and "For this business rule here, can I use two screens?? (P4)".

The researcher informed the participants that they could make the decisions they considered appropriate for the development of the mockups. This communication failure was classified as "Temporary", because it was only an interruption in the decision to represent the information. This was

due to the <u>non-observance of the producers of UC regarding the maxim of Quantity</u>, because the lack of information for the representation of the system can impact the adequate number of screens needed (responding to the question "*Is the necessary information described?*"). At the conclusion of the activity, we noticed that participants P3 and P4 were also careful with the construction of the mockups, such as correcting the screens constructed from the diagram and specification of UC (use of M in Figure 3). Thus, the participants made corrections and verifications of the information that should be in the mockups correctly. Such practices, i.e., verifications of the UC information in mockups, can be seen as adequate for the communication between producers and consumers.

- **P5 and P6**

Figure 4 shows the mapping of the activities performed by participants P5 and P6 during the consumption of UC for the development of mockups (considered as the third set of mockups in the ranking of Elderly Care software designers). Concerning the **consumption of the UC diagram and UC specification**, participants P5 and P6 had no doubts in interpreting the information reported by the use case producers. We observed that there were doubts regarding the elements from the balsamiq tool to be inserted in the interface (use of J* in Figure 4). We do not consider this as a communication failure.

ACTIVITIES	MAPPING OF PARTICIPANTS' ACTIVITIES																												
Understanding the Use Case Diagram (Astah Tool)	P																												
Understanding the Use Case Specification (PDF reader)	P		E	B	F	I	X				G				X		G		E	G	X	F	G			I		G	X	N
Construction of Prototypes (Balsamiq Tool)						E	J	J*	J		G	J	L	E		J		G					G	L	J	I*	I		G	N

A. Functionalities. B. Actors. C. Relationships (include and extend). D. Preconditions. E. Flow of events. F. Alternative flow. G. Business rules. H. Exception flow. I. Understanding interface elements described in the use case. J. Analysis of elements from the balsamiq tool to be inserted in the interface. L. Comparison between the use case and the created prototypes. M. Corrections to verify the consistency of the prototypes with the use cases. *. Doubt regarding the element. #. Report of doubt for a researcher, and + Use of paper and pen.

Figure 4. Mapping of participants' activities in the construction of mockups from Use Cases – P5 and P6.

2.2 Analysis of the Conversation between the Pairs that Produced the Last Set of Mockups

- **P7 and P8**

Figure 7 shows the mapping of the activities carried out by participants P7 and P8 (considered as the penultimate set of mockups in the ranking of the Elderly Care software designers). Concerning the **consumption of the UC** (diagram and specification), participants P7 and P8 had doubts on interpreting the information about the actors (use of B* in Figure 5). The following dialogue was reported on this:

"I was in doubt if GPS warns everyone involved (P7); This Smartphone actor does what? (P8)".

This communication failure was classified as "Complete" because the participants did not understand such information that was implied in the UC. This was due to the <u>non-observance of the producers of UC regarding the maxim of Quantity and Manner</u>, because the lack of information for the clarification of the actors can cause ambiguity in the interpretation of the purpose of the system (answering the question "*Does the excess of information cause ambiguity?*"). The Smartphone actor included different components, such as GPS and Agenda. However, in the UC diagram, only the Smartphone actor was used, and in the UC specification, the producers used only the description of the components.

ACTIVITIES	MAPPING OF PARTICIPANTS' ACTIVITIES
Understanding the Use Case Diagram (Astah Tool)	B B* I O O O
Understanding the Use Case Specification (PDF reader)	I* A B* B D E* E F G O E O O A
Construction of Prototypes (Balsamiq Tool)	I O J G J G J E G E J G J O J G J E O J A M

A. Functionalities. **B.** Actors. **C.** Relationships (include and extend). **D.** Preconditions. **E.** Flow of events. **F.** Alternative flow. **G.** Business rules. **H.** Exception flow. **I.** Understanding interface elements described in the use case. **J.** Analysis of elements from the balsamiq tool to be inserted in the interface. **L.** Comparison between the use case and the created prototypes. **M.** Corrections to verify the consistency of the prototypes with the use cases. ***.** Doubt regarding the element. **#.** Report of doubt for a researcher, and **+** Use of paper and pen.

Figure 5. Mapping of participants' activities in the construction of mockups from Use Cases – P7 and P8.

Regarding the **consumption of the UC specification**, we observed that there were doubts regarding the information for the correct representation of it in the mockups (use of I* in na Figure 5). Here are some of these questions:

> *"In this reminder, you have to have some data. What is the need to place a warning? (P8); I did not understand. In the case of the notification, I think it is when the person will open the phone and there is a message (P7)".*

This communication failure was classified as "Complete" because the participants did not understand the information. This was due to the <u>non-observance of the producers of UC regarding the maxim of Quantity and Relation</u>, because there is a lack of necessary and relevant information to clarify to consumers the reason of different interactions, like reminders and warnings (responding to the question "*Is the necessary and relevant information described?*"). At the end of the activity, we noticed that participants P7 and P8 were also careful with the construction of the mockups. In addition, the participants had doubts about the information described in the main flow (use of E* in Figure 5). We report the following quote from the participant:

> *"Will this list of responsible for the elderly already be available? (P8)".*

This communication failure was classified as "Complete". This was due to the <u>non-observance of the producers of UC regarding the maxim of Quantity and Manner</u>, because the lack of information for

the clarification of business rules causes ambiguity in the interpretation of the system's purpose (answering the question "*Does the excess of information cause ambiguity?*"). At the end of the activity, participants P7 and P8 verified the set of mockups with the UC and concluded that no corrections were necessary (use of M in Figure 5). This verification was not performed adequately with the UC, which can also hamper the development of systems from the intended intention of the UC designers.

- **P9 and P10**

Figure 6 shows the mapping of the performed activities of participants P9 and P10 (considered the last set of mockups in the ranking of mockups of Elderly Care software designers). Concerning the **consumption of the UC diagram**, participants had doubts on interpreting the information about the actors (use of B* in Figure 6). The following dialogue has been reported on this:

> *"Here is the smartphone and the coordinator. I do not quite understand what the smartphone does. What about the coordinator? Does everything the person in charge does? (P10)".*

ACTIVITIES	MAPPING OF PARTICIPANTS' ACTIVITIES
Understanding the Use Case Diagram (Astah Tool)	Q B* … I*
Understanding the Use Case Specification (PDF reader)	I* A D G F E I G H G G F* F G* F G
Construction of Prototypes (Balsamiq Tool)	X X J G E I* I* E F G M F G F G
A. Functionalities. B. Actors. C. Relationships (include and extend). D. Preconditions. E. Flow of events. F. Alternative flow. G. Business rules. H. Exception flow. I. Understanding interface elements described in the use case. J. Analysis of elements from the balsamiq tool to be inserted in the interface. L. Comparison between the use case and the created prototypes. M. Corrections to verify the consistency of the prototypes with the use cases. *. Doubt regarding the element. #. Report of doubt for a researcher, and ✚ Use of paper and pen.

Figure 6. Mapping of participants' activities in the construction of mockups from Use Cases - P9 and P10.

This communication failure was classified as "Complete" because the participants did not understand such information that was implied in the UC. This was due to the non-observance of the producers of UC regarding the maxim of Quantity and Manner, because the lack of information for the clarification of the actors can cause ambiguity in the interpretation of the system's purpose (answering the question *"Does the lack of information cause ambiguity?"*).

Regarding the **consumption of the UC specification**, we observed that there were several doubts regarding the correct representation of the information in the mockups (use of I* in Figure 6). Here are some of these questions:

> *"Is this notification meant to represent a conflict? (P10); I did not understand this about the updated notification to the new responsible (P9)".*

This communication failure was classified as "Complete" because the participants did not understand the information. This was due to the non-observance of the producers of UC regarding the maxim of Quantity and Relation, because there is a lack of necessary and relevant information to clarify

to consumers the reason of different interactions, like reminders and warnings (responding to the question "*Is the necessary and relevant information described?*"). The participants also had doubts about the information described in the main flow (use of E* in Figure 6) and on understanding the business rules. We report the following quotations from the participants about the main flow:

"*I cannot understand this time of receipt. (P10); What about this user list? (P9)*"; "*I am not understanding anything else. What is this message? (P10)*".

This communication failure was classified as "Complete" because the participants did not understand such information that was implied in the UC. This was due to the <u>non-observance of the producers of UC regarding the maxim of Quantity and Manner,</u> because the lack of information for the clarification of business rules can cause ambiguity in the interpretation of the purpose of the system (answering the question "*Does the lack of information cause ambiguity?*"). At the end of the activity, the participants checked and corrected the mockups in order to improve the description of the alternative flow and the business rules (use of M, followed by FG in Figure 6).

- **P11 and P12**

Figure 7 shows the mapping of the performed activities of participants P11 and P12 (considered the antepenult set of mockups in the ranking of mockups of Elderly Care software designers). Concerning the **consumption of the UC diagram**, participants did not see it.

ACTIVITIES	MAPPING OF PARTICIPANTS' ACTIVITIES																												
Understanding the Use Case Diagram (Astah Tool)																													
Understanding the Use Case Specification (PDF reader)	I	A	B*	D	E	+	#	F	+	F	I	G	F	I				G	M	G		H	I						
Construction of Prototypes (Balsamiq Tool)										F	G	J	E*	Ed			F				J	G	H	G	J	G

A. Functionalities. B. Actors. C. Relationships (include and extend). D. Preconditions. E. Flow of events. F. Alternative flow. G. Business rules. H. Exception flow. I. Understanding interface elements described in the use case. J. Analysis of elements from the balsamiq tool to be inserted in the interface. L. Comparison between the use case and the created prototypes. M. Corrections to verify the consistency of the prototypes with the use cases. *. Doubt regarding the element. #. Report of doubt for a researcher, and + Use of paper and pen.

Figure 7. Mapping of participants' activities in the construction of mockups from Use Cases – P11 and P12.

Regarding the **consumption of the UC specification**, we observed that there were some doubts on interpreting the information about the actors (use of B* in Figure 7). The following dialogue has been reported on this:

" *There is no exist a new responsible (P12); Let's just make the flow of the responsible (P11); In this case of waiting that new responsible confirm the reallocation, is it only a confirmation of the system or new responsible have to confirm? (P12)*".

Regarding the doubts about the actors, the researchers were consulted during the study (use of # in Figure 7). This communication failure was classified as "Complete" because the participants did not

understand such information that was implied in the UC. This was due to the <u>non-observance of the producers of UC regarding the maxim of Quantity and Manner</u>, because the lack of information for the clarification of the actors can cause ambiguity in the interpretation of the purpose of the system (answering the question "*Does the excess of information cause ambiguity?*").

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