Transformation of a Use Case Main Success Scenario into Business Object Relation Modeling (BORM) workflow diagram for effective business process requirement analysis – the Greenhouse Integrated Pest Management case study

Vojtech Merunka[1], Athanasios Podaras[2]

[1]Department of Information Engineering, Czech University of Life Sciences, Prague, Czech
e-mail: vmerunka@gmail.com
[2]IT Project Management Division, Alpha Bank, Athens
e-mail: thanasis98@gmail.com

Abstract. The basic part of an innovative and modern approach to business process requirement analysis which is based on the simultaneous utilization of UML Use Case approach and the Business Object Relation Modelling approach is analyzed in the present paper. Precisely the transition rules by which the Use Case Main Success Scenario steps for a computer based process are converted into to a BORM workflow diagram, entitled as the Use Case To BORM Transformation Algorithm (UCBTA) transition rules, are presented as a pattern based method which leads to the effective and efficient business process requirement analysis. The rules are introduced in order to support the UCBTA algorithmic concept. A Greenhouse Integrated Pest Management case study is analyzed as a brief delineation of the algorithm's implementation in a specified agricultural computer based process.

Keywords: Business process requirement Analysis, UCBTA Algorithm, UCBTA Transition Rules, Use Case Main Success Scenario Steps, BORM Diagrams, Integrated Pest Management (IPM)

1 Introduction

The most common technique utilized worldwide for detailed requirement analysis is the UML Use Case model. Use Cases are often the foundation of most Object – Oriented development methods [3]. However, it has been stated by IT experts, who strongly recommend UML tools such as Use Case diagrams followed by the Sequence, Collaboration and State Transition Diagrams for the integration of efficient and effective requirement analysis, that the above mentioned tools are mainly oriented at the programming concepts and are regarded as weak [2] in terms of business logic and business process modeling. Provided that stakeholders are not

In: M. Salampasis, A. Matopoulos (eds.): Proceedings of the International Conference on Information and Communication Technologies
for Sustainable Agri-production and Environment (HAICTA 2011), Skiathos, 8-11 September, 2011.

familiar with computer – oriented concepts, communication between IT experts and stakeholders cannot be achieved at the early stages of system development and throughout requirement analysis phase. *BORM* methodology [4] on the other hand can be successfully utilized in this circumstance while it is business oriented, and it can be consequently absorbed by stakeholders and end users. In BORM diagrams the business process flow is depicted; consequently it can be viewed, controlled and absorbed at a satisfactory level, even by end – users and stakeholders who have no computer orientation. The author's proposal for the derivation of a complete business process requirement analysis is the transformation of the Use Case requirement analysis to the BORM approach with the introduction of a pattern based algorithmic method ***(Fig.1)***; the *Use Case to BORM Transformation Algorithm (UCBTA)* [5] is constructed to cover all possible weaknesses that emerge from the Use Case model and the BORM method when they are utilized solely and not simultaneously for defining and analyzing end – user requirements during the requirement analysis of a business process. The mathematical theory behind UCBTA algorithm is the *Non – Deterministic Finite Automaton* [1]. The UCBTA algorithm is comprised of several steps [5]. Throughout the current document the algorithmic phase analyzed is the transition of the Use Case main success scenario to a BORM diagram which aims at the workflow demonstration to the end users of a system or application. A practical implementation of the UCBTA approach within the area of Agriculture is delineated as a tool for ameliorating automated Greenhouse processes.

Fig. 1 General Schema of the UCBTA Algorithm

2 Objectives and methodology

Primary objectives of the current paper are:

- the justification of the construction of indispensible specified transition rules according to which the Use Case requirement analysis model is transformed to the BORM approach to business process requirement analysis without data loss
- demonstration of the way according to which Use Case main success scenario steps are demonstrated via BORM Diagrams after the transition is completed
- practical proof via the Agricultural Case Study that the UCBTA transition rules are the most important part of the UCBTA transformation, due to the fact that end users with no IT background from any business process area are able to absorb the business process functionality.

The root methodologies from which the Use Case To BORM Transformation algorithm stems are the Use Case analysis and the BORM business process requirement analysis.

3 Discussion

UCBTA Algorithmic Steps and Transition Rules. The transition path, through which the Use Case Analysis model is transformed into a BORM Business Process workflow diagram and through which the desired *process result* is reached, is comprised of the following steps:

a) UCBTA Input – Process Definition

b) UCBTA 1st Part – Defining the Use Case:

If U_c = Use Case and P=Process it is considered that $U_c \subseteq P$

c) UCBTA 2nd Part – BORM general function definition (Transformation Initiation)

If B_F = BORM Function and P=Process it is considered that $U \subseteq B_F$ and $P \subseteq B_F$

d) UCBTA 3rd Part – Considering Use Case Actors

e) UCBTA 4th Part – BORM Participant determination

If U_A = Use Case Actor and B_P = BORM Participant it is considered that $U_A = B_P$

f) UCBTA 5th Part – Use Case Main Success Scenario Statement – Initial step

U_{MSS} = Use Case Main Success Scenario; the relation to the BORM General Function will be the following: $U_{MSS} \subseteq B_F$

g) UCBTA 6th Part – BORM Initiation Statement

The BORM Initiation is equivalent to the Use Case Main Success Scenario initial step.

h) UCBTA 7th Part – Defining Use Case Steps

The Use Case Steps are symbolized as $u_1, u_2, u_3 \ldots\ldots u_n$ and the corresponding sub steps as $u_{1A}, u_{1B}, u_{2A}, u_{2B}, \ldots\ldots u_{nA}, u_{nB}$, $n \in N^*$

i) UCBTA 8th Part – BORM Action specification

If BORM Action is symbolized as B_A, then the relation which involves the BORM Action and the Use Case Steps will be the following:

$B_A = \{u_1, u_2, u_3 \ldots\ldots u_n\}$

and

$u_1 = \{ u_{1A}, u_{1B}, \ldots\}$,

$u_2 = \{ u_{2A}, u_{2B} \ldots\}$,

$u_n = \{ u_{nA}, u_{nB} \ldots\}$, $n \in N^*$

j) UCBTA 9th Part – Design the Use Case Diagram

k) UCBTA 10th Part – Define BORM Data Flows

l) BORM Diagram Construction (Object Relation Diagram)

m) UCBTA Output: BORM Result

UCBTA Transition Rules. Transformation models are inadequate in the case that part of data is lost during the execution of the transition from the one model to the other. For the precise comprehension of how data loss is eliminated during the transformation of the Use Case Model to the BORM business process requirement analysis approach, the author's concept is based on the creation of specific regulations that cover all the cases according to which the Use Case Main Success Scenario comprised of steps and sub steps is converted to BORM data flows, states and activities. Throughout the sections that follow the above mentioned regulations called UCBTA Transition Rules are analyzed in detail.

3.1 Basic UCBTA Transition Rule

The basic type of the UCBTA transition rules comprises of the core transition from the Use Case Model to the BORM Business Process model. Throughout the core UCBTA transition, it is depicted how precisely a basic Use Case step of the main success scenario is diagrammatically adjusted to the BORM approach and represented by the BORM Process – Participant interaction model. The Process – Participant interaction model is also entitled as BORM Diagram. In the case that the above mentioned basic main success scenario Use Case step is divided into several

sub steps the constructed BORM Diagram includes the aforementioned sub steps as well as they are described throughout the BORM method.
Let us assume a delineated *Process A* and its corresponding *Use Case A*. The Use Case analysis also involves *Actors* who take part in the process and are defined as *Actor A* and *Actor B* who are expressed as participants in BORM. Moreover, the Use Case step of the main success scenario is defined in the following way:

1. Actor A sends message to Actor B

The aforementioned step is supposed to be comprised of the following *sub steps* as well:

1a) Actor A expects reply
1b) Actor B receives message
1c) Message received by Actor B

The main goal is the transformation of the above written step and its subs steps to BORM activities flows and states, without any loss of data.

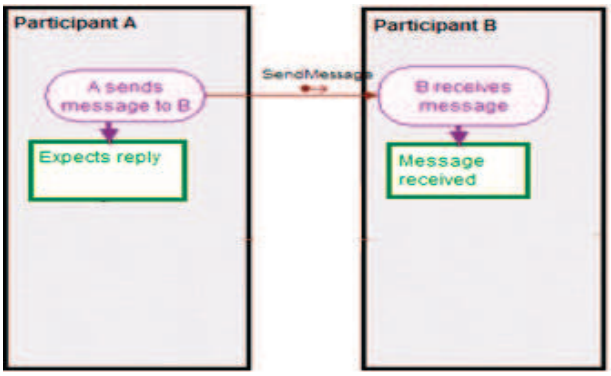

Fig. 2 BORM Diagram of Process A after Basic UCBTA Transition

3.2 Primary or Initial Step UCBTA Transition rule

The second type of the analyzed rules of the Use Case transition to BORM is the Primary UCBTA Transition. Throughout the primary transition it is explained by the author how the Initial and the second step of the main success scenario are transformed to BORM activities, states and data flows.
The delineation of the primary transition is initiated with the assumption that UCBTA requirement analysis has to be performed for Process A. It is also assumed that the corresponding Use Case which is related to the aforementioned process is Use Case A.
The Use Case analysis also involves actors who take part in the process and are defined as Actor A and Actor B who are expressed as participants in BORM.

Moreover, the initial and the second step of the main success scenario are defined in the following way:

1. Actor A sends message to Actor B
2. Actor B sends reply message to Actor A

Considering the initial step of the main success scenario the sub steps involved are:

1a) Actor A expects reply
1b) Actor B receives message
1c) Message received by Actor B
2a) Actor B expects new info message
2b) Actor A receives reply
2c) Reply message is received by Actor A

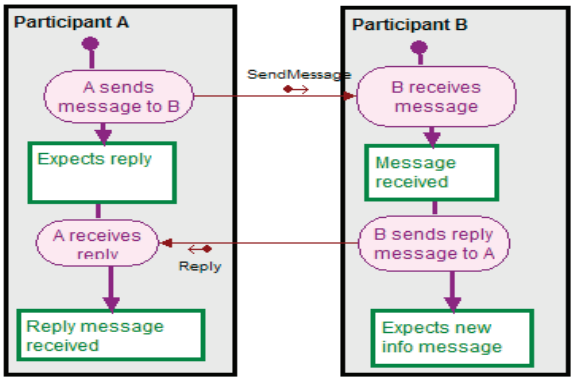

Fig.3 BORM aspect of Process A after Primary UCBTA transition

3.3 Middle Step UCBTA transition

The second type regarding the UCBTA Transition rules is the Middle Step UCBTA transition. The specific type follows exactly the same transformation path as the Primary UCBTA transition type; the main difference due to which the two types are distinguished is the fact that the Middle transition type refers to middle Use Case steps.

Provided that the UCBTA requirement analysis is implemented for a defined Process B, the corresponding Use Case B is defined as well. An additive assumption is that the Use Case Steps of which the analyzed Use Case main success scenario is comprised is n, where $n \in N^*$.

The Middle UCBTA Transition rule is applied for steps k and $k+1$, where $2<k<n$, $k+1 < n$ and $k, n \in N^*$. The steps and sub steps of the main success scenario will be defined in the same way as in the primary UCBTA transition rule, and the BORM aspect is depicted (Fig.4) the BORM Diagram. It can be noticed that the difference with the first rule is that the middle step transition in BORM is without starting or ending points.

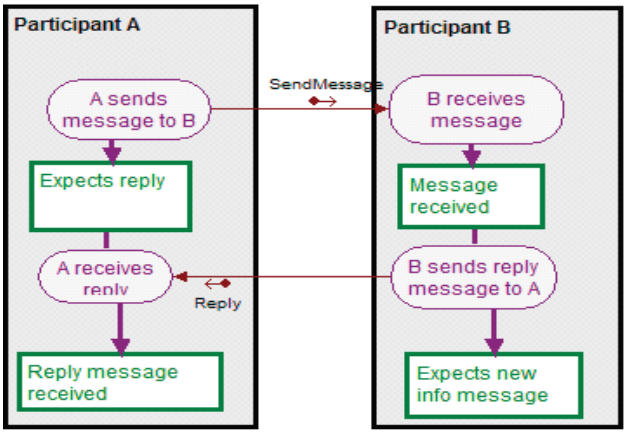

Fig. 4 BORM aspect of Process B after Middle Step UCBTA transition

3.4 Conditional UCBTA Transition Rule

The final type of the analyzed rules of the Use Case transition to BORM is the Conditional UCBTA Transition. The specified UCBTA transition rule is based on the fact that one or more steps of the Use Case main success scenario could lead the process in many different states.

1. Actor A sends message to Actor B
2. Actor B replies to Actor A, if the message is recognized
3. Actor B rejects message, if message is not recognized, and procedure terminates

Considering the initial step of the main success scenario the sub steps involved are:

1a) Actor A expects reply
1b) Actor B receives message
1c) Message received by Actor B

In the same way the second step includes the following sub steps:

2a) Actor B expects new info message
2b) Actor A receives reply
2c) Reply message is received by Actor

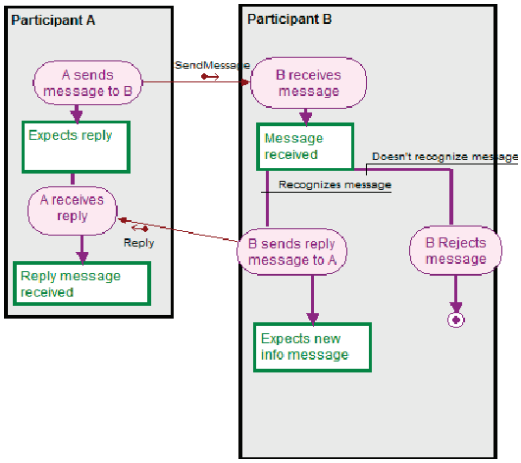

Fig. 5 BORM aspect of Process C after Conditional UCBTA transition

3.5 UCBTA Case Study – Greenhouse Integrated Pest Management Business Process Requirement Analysis

Integrated Pest Management (IPM) is defined by many experts as a sustainable approach to managing pests that combines biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks. It is a proven approach that balances economic, environmental, and health objectives [12], [15], [3].
Throughout the current research, the *Evaluation of Pesticide Effectiveness* Business Process is analyzed via the UCBTA approach to requirement analysis at a business level as a demonstrative Case Study.

Input Part – Process Definition: *"Evaluation of pesticide effectiveness through monthly record keeping"*

Use Case Definition: *"Evaluate pesticide effectiveness through monthly record keeping"*

BORM General Function: *"Economic IPM Administration"* According to the mathematical model of the UCBTA algorithm, the Use Case To BORM transition can be continued since *evaluation of pesticide effectiveness through monthly record keeping* is also part of a general *Economic IPM administration*.

Defining Actors: The Actors involved in the current Use Case are the following:
IPM Management System (Computer System, Database Derver)
Grower

BORM Participants: BORM participants are the same as the Use Case Actors:

IPM Management System (Computer System, Database Derver)
Grower

Use Case Main Success Scenario Initial Step: *"Grower selects monthly report task with regard to the amount of pesticide consumed".*

BORM Initiation: *"Grower selects monthly report task with regard to the amount of pesticide consumed"*

Use Case Steps definition:

A) Main Success Scenario
1) Grower selects pesticide monthly report task
2) Computer System demands time period
3) Grower stores time period data
4) Computer System demands registration number of the pesticide
5) Grower stores pesticide data
6) Computer System sends pesticide information to the Database Server
7) Database Server produces monthly pesticide data report and message about its effectiveness
8) Computer System displays message to the grower for the pesticide effectiveness

B) Sub steps
1a) Computer System receives pesticide monthly report command
1b) Selection is obtained by the Computer System
1c) Grower awaits response
2a) Grower receives time period demand by the system
2b) Computer System awaits data
2c) Demand (for time period data) is received by the user
3a) Grower expects registration number request
3b) Computer System receives expected time period data
3c) Time period data is obtained by the Computer System
4a) Grower receives pesticide registration number request
4b) Computer System expects registration number
4c) Pesticide registration number is obtained by the Grower
5a) Grower expects system's pesticide report
5b) Computer System receives registration number
6a) Database Server receives monthly data of the used pesticide
6b) Computer System expects server report
6c) 4 week pesticide information is obtained by the DB Server
7a) Computer System receives monthly pesticide report
8a) Grower obtains monthly pesticide effectiveness report and corresponding action message

Main success scenario, as a subset of the BORM General Function: It should be mentioned once more that the main success scenario must be a subset of the BORM function; the aforementioned Use Case scenario comprises of a standard subset of the

BORM General Function; consequently the model transformation algorithmic procedure can be normally continued.

Use Case Diagram: The Use Case Diagram which is related to the business process requirement analysis of the Pesticide effectiveness evaluation through monthly record keeping process will be designed according to Fig. 5

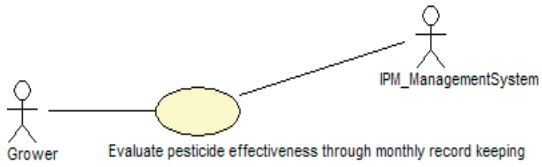

Fig. 5 Use Case Diagram of the Analyzed IPM Business Process

Defining the BORM Data flows: The BORM Data flows are related to the analyzed throughout the previous section concepts of the Business Process Diagram. Communication between participants, states, and transitions are defined in terms of ORD (Object Relation Diagram or Business Process Diagram) construction.

Design the BORM Diagram (Process – Participant Interaction Model or Object Relation Diagram (ORD)) (FIG. 6)

UCBTA Output – BORM Result: BORM Result is equivalent to the final step or sub – step of the Use Case Main success scenario.
"Grower obtains monthly pesticide effectiveness report and corresponding action message".

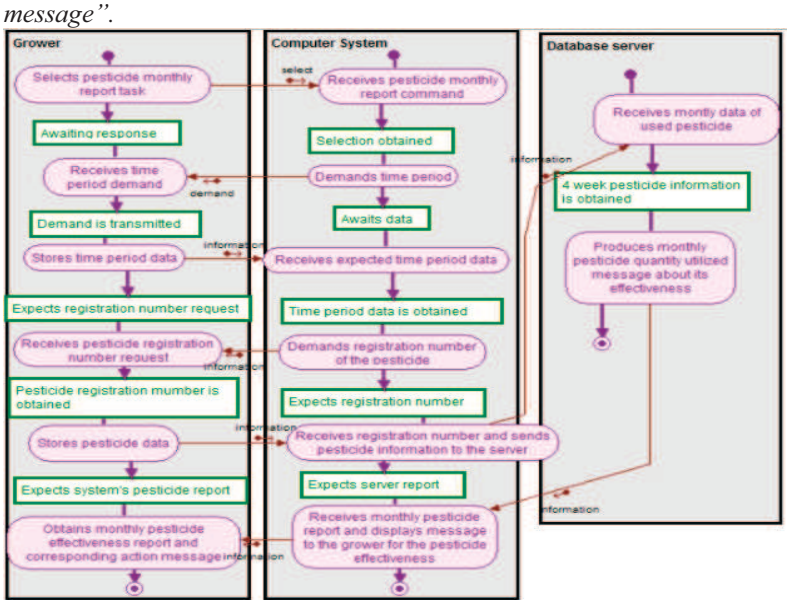

Fig. 6 BORM Diagram of the IPM Process

4 Conclusion

The most critical phase of the application or system development is the requirement analysis phase. Throughout the concrete phase the business needs of the end users are defined and analyzed by the IT experts. The most significant of the Object – Oriented methodologies to requirement analysis, named as Use Case analysis, is not adequate for that purpose if it is not followed by an equally tested and pure Object – Oriented approach; the concrete approach is the Business Object Relation Modeling (BORM). For the above stated reason the Use Case to BORM Transformation Algorithm (UCBTA) is introduced as a complete solution for implementing efficient business process requirement analysis. The most important part of the transition from the Use Case model to the BORM approach to requirement analysis is the creation of specific rules that cover all the cases according to which the Use Case Main Success Scenario comprised of steps and sub steps is converted to BORM data flows, states and activities and as a result data loss is eliminated and end users utterly comprehend the business process functionality. The UCBTA methodology can be successfully implemented on complicated Greenhouse Integrated Pest Management computer based business processes, throughout the initial phase of a Greenhouse Information System Integration.

References

1. Stiglitz, J. (2002) Globalisation and its discontents. London: Allen Lane.
2. Aggleton, P. and Chalmers, H. (2000) Nursing models and nursing practice. 2nd ed. Basingstoke: Macmillan.
3. Taruskin, R. (1988) The pastness of the present and the present of the past. In Authenticity and Early Music, ed. N. Kenyon, p.137-207. Oxford: Oxford University Press.
4. Colley, A., Banton, L., Down, J and Pither, A. (1992) An expert-novice comparison in musical composition. Psychology of music, 20, p.124-34.
5. Cuperus G. W., Mulder P. G., and Royer T. A., Insect Pest Management Techniques for Environmental Protection, Chapter 6, CRC Press LLC, 2000, ISBN 1-56670-478-2
6. Flint M.L., Daar S., Moinar R., Establishing Integrated Pest Management Policies and Programs: A guide for public agencies, University of California, Division of Agriculture and Natural Resources, 2003, ISBN 978-1-60107-267-2

7. ATTRA (Appropriate Technology Transfers for Rural Areas), Integrated Pest Management for Greenhouse Crops, Pest Management Systems Guide, ISBN 800-346-9140)
8. Knott, R. P., Merunka, V., Polak, J.: The BORM methodology: a third-generation fully object-oriented methodology, in: Knowledge-Based Systems Elsevier Science International New York, ISSN 0950-7051 (2003)