Question-Answer Means for Collaborative Development of Software Intensive Systems

Peter Sosnin[a,1]

[a]Head of Computer Department, Ulianovsk State Technical University (Ulianovsk) Russia.

Abstract. The key problem of successful development of software intensive system is adequate conceptual interactions of stakeholders at the early stages of designing. Success of development can be increased with using of AI means including means for modeling of reasoning. In this paper a number of question-answer means for conceptual design is suggested. The base of such means is a question-answer method for conceptual decision of a software project task. All question-answer means are organized as workflows "Interactions with Experience" supported conceptual interactions in corporate network.

Keywords. Question-answer model, conceptual decision, software development

1 Introduction

There is a problem of successful designing of the Software Intensive Systems (SIS). The facts of the low success (about 30 %) in this area [2] means that till now developers of SYS have not got very important technological tools. The role of such tools can play the means of Artificial Intelligence, first of all, means supported interaction with Knowledge and Experience, modeling of reasoning, decision-making and problem solving.

The practice of the SIS development shows that the negative influence of the mentioned reasons can be lowered by applying effective question-answer reasoning for interaction with experience (and models of experience) involved in the process of development. As the number of such reasoning, for example, we can mention reasoning in the "inquiry cycle" [5] and "inquiry wheel" [6]. Similar ideas are used in the special question-answer system which supports development of the SIS [8]. In more general context the place and role of reasoning are presented in [1] from , ,. in [7] where reasoning is presented at seven levels of application together with knowledge and in [4] as model-based reasoning.

[1] Head of Computer Department, Ulianovsk State Technical Unuversity (Ulianovsk), UlSTU, 32, Severny Venetc, 432027, Russia; Tel: +7 8422 4531556; Fax: +7 8422 431556; Email: sosnin@ulstu.ru; http://www.ulstu.ru/SOSNIN

Software development activity is usually represented in the form of workflows, each of which connects with a corresponding system of tasks. The part of such workflows provides creation of the SIS conceptual project in the form of the adequate system of conceptual models including both visual diagrams, and documents.

This paper presents the special method of conceptual designing and workflows called “Interaction with experience” that are based on Question-Answer modeling of human reasoning used in design process. The method has received the name “question-answer method for conceptual decision of the project tasks”. In the name of this method the attribute “conceptual” indicates that base actions of decision process are “conceptual actions” of stakeholders, first of all question-answer reasoning used in a design work. Such conceptual actions are needed to build an adequate conceptual representation of the SIS. Method of conceptual decision is realized in corporate environment of the question-answer processor NetWIQA (Net Working In Questions and Answers). Workflows “Interaction with Experience” is developed with orientation on Rational Unified Process [3].

2 Question-Answer Models

Different types of conceptual models are developed for tasks with certain decisions presented during development of a software intensive system and in its results. Such types include, for example, UML-diagrams, Data Flows Diagrams (DFD) and Entity Relation Diagrams (ER-diagrams). Nowadays, the visualized graphic models consisting of components and connectors between them play an important helpful role. Visual models help the stakeholders to include their skills of work with the figurative information to development processes.

Adequacy of the applied conceptual models essentially depends on how they are constructed. Guidelines are often used to support conceptual modeling. But any guideline describes typical scheme of actions and the typical scheme of reasoning applied to the certain subject domain. Such guidelines function properly, but they are not useful for coordination of various conceptual human schemes.

Historically, questions and answers were the basic means to coordinate conceptual schemes of individuals who try to find the mutual understanding in the definite task and work. Such activity is put in a basis of question-answer modeling of the task.

Question-answer model of a task $QA(Z_i)$ is formed and used on a step-by-step process of the conceptual decision of the task. Such decision usually includes “Conception”, ”Architecture” and ”Project” form of SIS representations. Usage of QA-model of any task is aimed at the coordination of human conceptual schemes.

Construction of QA-model is completed when the set of conceptual models $\{M^C_k\}$, chosen for sufficient understanding of task Z_i, is created. Usage of QA-model in any state on its life cycle represents the specific kind of modeling named “question-answer modeling”.

Thus, the conceptual decision of task Z_i includes decisions of a set of tasks $\{Z^C_k\}$, each of which is aimed at construction of corresponding model from the set

$\{M^C_k\}$. Methods and means of QA-modeling represented below are applied not only to the task of SIS design, but also to any "service task?" Z^C_k.

Question-answer models are the systematized representation of the reasoning used during the decision of the task Z(t) and kept in special QA-database. Any QA-model is a set of interactive objects such as "question", "answer" and "task" with the certain attributes and operations. The structure and content of QA-model are defined according to the following views:

- Logic view, fixing representation of QA(Z(t)) within the frame of logic of questions and answers (visual representation includes a tree of the tasks where each task is presented by corresponding QA-tree).
- Conceptual view, opening ontology of the task Z(t) and process of its creation.
- Communicative view, opening question-answer processes as communicative interactions of the stakeholders concerned in conceptual decision of the task Z (t).
- Activity view, registering "questions" and "answers" as objects of activity.
- View from positions of experience, fixing experience involved to the decision process.

Each of the presented views (step by step) is formed and registered in QA-base of the project. The certain set of "concern", models, documents and functions providing construction and usage of views are connected with each view. The logic view is a primary base of all these conceptual units, which are produced by developers with special means of analysis, transformation, representation and visualization (Figure 1).

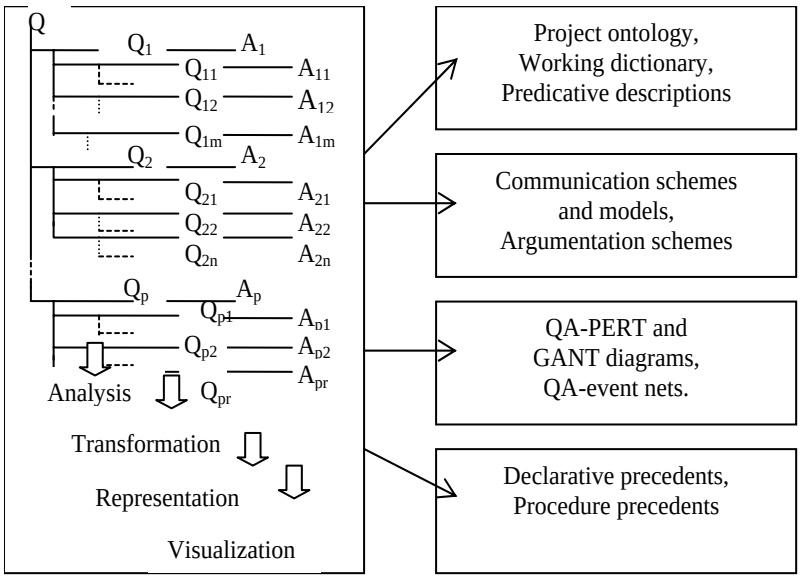

Figure 1.Environment and content of QA-model

Such set of views is used for construction of QA-models of project and service tasks. The general case of QA-model of task Z(t) is defined as an integrated set of "views" on the task, which is realized as a special structure of data registering a logic view, variants of its transformation and representation, including visual representation through results of the analysis.

Let us pass to specifications of QA-models. QA-model QA(Z (t)) of the task Z(t) is created as a system S of dynamic interactive objects QA(Z(t)) = S({XI)}), each of which has an unique index name XI definite type X. Names of types (X=..) reflect types of questions and answers. Indexes of names are assigned automatically.

Each object XI(T_i, Sb^1_j , Sb^2_k, t, G_n)} uses the following attributes: T_i - the description of "object"; Sb^1_j - the identifier of the subject responsible for "object"; Sb^2_k - the identifier of the subject (generally the compound subject), concerned in "object"; t - the moment of time in which the current state of "object" has fixed; G_n – the set of other attributes of "object" XI representing it in the base of the project.

3 Essence of QA-Modeling

Question-answer models, as well as any other models, are created "for extraction of answers to the questions enclosed in model". Moreover, the model is a very important form of representation of questions, answers on which are generated while interaction. Questions are fixed in QA-models obviously in the form of "objects-questions" and implicitly in forms of ambiguities used in textual QA-units.

The essence of QA-modeling is an interaction of stakeholders with artifacts of process and its current results and it helps them:

- To enrich model QA(Z(t) by adding its structure by the new question or/and answer.
- To realize a number of variants of the analysis, interactive (+ collective) inspection and/or validation of state QA(Z(t)) or its fragments, directed on revealing of mistakes and defects of design decisions,and also their conformity to norms and samples.
- To perform predicative analysis aimed at an establishment of adequacy of model.
- To use results of the analysis for establishing of understanding and mutual understanding in group of the stakeholders.
- To extract of requirements and restrictions for the SIS.
- To manage of changes in the project.
- To view the results of monitoring states of designing process.

4 QA-Method for Conceptual Decision of the Project Tasks

In most general case application of a method begins with the first step of question-answer modeling initial statement (Figure 2) of a development task $Z^*(t_0)$. In special cases of its application initial statement of a task is included in a task's tree corresponding to the design technology with which it will be used.

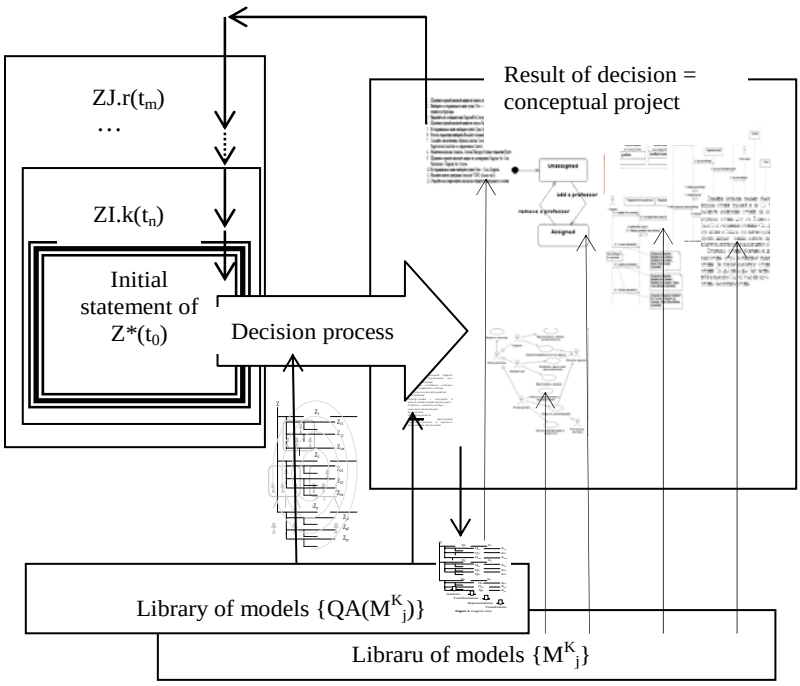

Figure 2. Scheme of method

The essence of a method consists in the following:

- The system of tasks of conceptual designing is formed and solved according to a method of stepwise refinement.
- The initial state of stepwise refinement is defined with system of normative tasks of "life cycle the SIS" which is included the main project task Z*(t0). The base version of normative tasks corresponds to standard ISO/IEC 12207.
- Realization of a method begins with the formulation of the main task statement in the form, allowing to start constructing of the prime conceptual models.
- During detailed elaboration in the system of tasks join not only the project tasks connected with specificity the SIS, but also service tasks, each of

which is aimed at creation of the corresponding conceptual diagram or document.

- For each service task its question-answer model is created on the base of the definite question-answer pattern from the special library.
- During conceptual decision of any task, included in a task tree of the SIS project, additional tasks can be discovered and included to the system of tasks (Figure 3).
- General conceptual decision integrates all conceptual decision of all task included in a task tree of the project.
- Conceptual decision is estimated as completed decision if its state is enough for successful work at the subsequent development stages of the SIS. The degree of sufficiency is obviously and implicitly checked. Useful changes are added to the more adequate conceptual representation of the SIS.

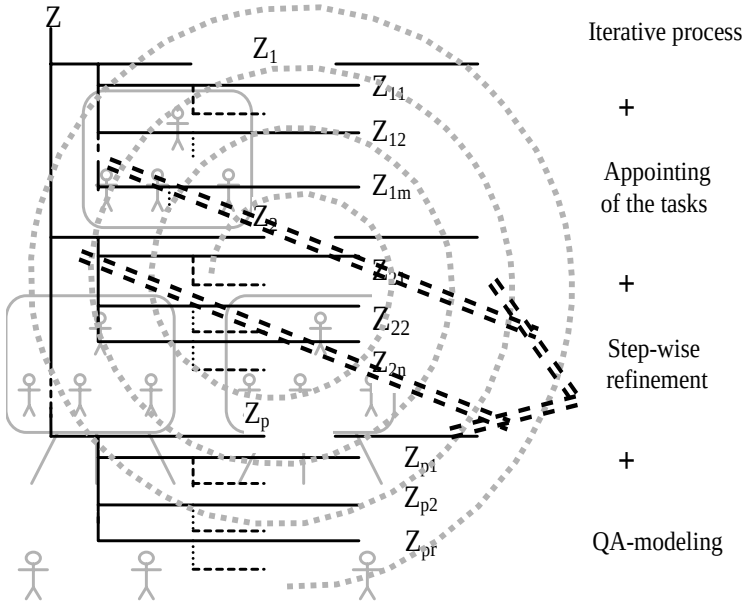

Figure 3. Task's tree of development process

5 Workflows "Interaction with Experience"

The workflows called "Interaction with Experience" is realized as the application of the question-answer processor NetWIQA[8]. QA-processor is an environment for collaborative development of the SIS. It is realized on the base of architectural styles "Client-server", "Repository", "Model-view-controller" and "Translator". All named styles were integrated according to object-oriented and component-

oriented paradigms. The base version of QA-processor can be opened for WEB-access of stakeholders from Internet.

Noted application of the QA-processor is developed as the model of Rational Unified Process (RUP) technology providing creation of the conceptual project. For creation of the conceptual project the workflows “Business modelling”, “Requirements”, “Analysis and design” and also three supported workflows are used. The application is aimed at construction of 16 artefacts, including all architectural artefacts of the RUP.

The basic role in realization of a method is carried out a workflow of question-answer reasoning QAR(t). Therefore we shall present a number of details connected with dynamics of this workflow.

At definite time t_i the reasoning QAR(t) goes to QAR(t_i)-state, which has its causal potential that gives the possibility to move the reasoning forward to the next state QAR(t_{i+1}). In this aspect the “history” of previously made work, represented in QAR(t)-codes, influences the next rational step of reasoning. Next steps both for reasoning and for design can be defined by means of question-answer analysis of QAR(t)-codes.

General statement of each project task should be defined before Question-Answer working with this task. Special definition of the task (as its general statement) uses a special pattern to present a task as 3 structured text blocks.

The first reflects the main purpose of a system under design, which is specified by its potential users. Here we begin the work with the basic Use-Case diagram for the task in UML language.

The second defines the main techniques to perform Use-Case diagram for the task. It provides construction of the basic diagram of business -objects of UML.

The third defines technology of implementation of a system under design. Information of this block is applied in conceptual design as context information.

Analysis of a text T_0 of the general statement of a task and its translation to PROLOG-like language are used for extraction of questions to begin and continue QAR.

More detail it is based on step by step registering of questions and answers in accordance with following technique:

- The set of questions $\{Q_i\}$ is taken from the text $\grave{O}_0$ and coded by adequate texts T (Q_i).
- Actions of item 1 are executed for each text T (Qi, therefore the set of questions $\{Q_{ij}\}$ and their codes $\{T(Q_{ij}\}$ is formed. Actions of item 2 are used to control the correctness of question codes and for the choice of those questions $\{Q_k\}$ which will be used for the next step of detailization from the set $Q = \{Q_i\} \cup \{Q_{ij}\}$. Other questions are recorded for their application in the subsequent steps.
- Set of answers $\{A_k\}$ and their codes $\{T(A_k\}$ is formed and registered in QA database.
- Each text $T(A_k$ is processed as the text $\grave{O}_0$. The cycle 1-4 is repeated until the project comes to the end.

All project tasks $Z^P=\{Z^P_r\}$ are derived from process described above. Any task Z^P_r is a question qualified by stakeholders as a task-question answer which can be

found only through decision process. Any service task Z^C_m has its QA-pattern kept in special library. Such pattern helps to build model $QA(Z^C_s)$ for definite conceptual artifact. The work with questions, answers, QAR and conceptual artifacts are executed with the help of technological tasks $Z^T = \{Z^T_n\}$ generally described below.

6 Conclusion

This paper presents QA-method for conceptual decision of the SIS project tasks. Method is based on a stepwise refinement and QA-modeling. It can help to build the system of conceptual models which represents the SIS on levels of descriptions presented “Conception”, “Architecture” and “Project”. Means of method are organized as a set of workflows called “Interaction with Experience”, and can be used additionally to the RUP as a model of its workflows. Means of QA-modeling are adjusted to support Conceptual Design of Software Intensive Systems, their documenting, and training of a design team in a closed corporate network. Such means can be open for stakeholders in Internet through the defended WEB-access. Proposed means have confirmed the practical usefulness in development of a number of the SIS, including “Automated system for management of distance education” and “Automated system for planning of cargo transportation”.

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