Expert-Sided Workflow Data Acquisition by Means of an Interactive Interview System

Daniel Ley

Fraunhofer Institute for Communication, Information Processing and Ergonomics FKIE
Neuenahrer Straße 20, 53343 Wachtberg, Germany
daniel.ley@fkie.fraunhofer.de

Abstract. This paper outlines an approach for gathering workflow data via an interactive interview system. By means of this approach, data acquisition for a subsequent task and/or process analysis is conducted by a process expert instead of a process analyst as customary in application of conventional data acquisition methods. Beside other problems concerning existing techniques, this may solve the dilemma of a lacking common basis between expert and analyst in terms of process knowledge and process thinking.

A classification method is described which allows a definition of processes acquirable by the system. Furthermore, a procedure for decomposing processes is used to gather workflow data in a systematic way. During system application, feedback by sub-process models directs experts to process thinking while system records impart process knowledge for the analyst. The applicability of this approach is shown by results of a first system evaluation. Advantages and disadvantages in relation to common data acquisition methods are stated.

Keywords: Data Acquisition Method, Process Analysis, Task Analysis, Interview System, Process Thinking, Process Knowledge.

1 Introduction and Purpose

Process and task analyses are important and essential ways for improving workflows in various domains. Therefore, different semi-standardized procedures are described in literature, especially for the domain of business processes [1], [2]. These procedures mostly include a generation of workflow models and their analyses via simulations. Consequent optimization recommendations are developed among numerous aspects like processing time, costs or/and workload of involved operators. An essential requirement for building valid process models is the acquisition of complete relevant process data on the basis of expert process knowledge. Methods like questionnaires, interviews or observations are regularly used by process analysts for data acquisition.

There are two main challenges in application of conventional methods, which are considered in the current approach. First, analyses of workflows are mostly conducted by external analysts, which do not have any experience or specific knowledge about the work domain. Their expertise is limited to their knowledge about model notations and the analysis of process models. In contrast, operators are experts with respect to their field of work, but mostly do not know anything about process model notations.

M. Kurosu (Ed.): Human Centered Design, HCII 2011, LNCS 6776, pp. 91–100, 2011.

Consequently, a dilemma exists between analyst and expert: an analyst possesses process thinking and an expert possesses process knowledge – without any or only limited overlap.

Secondly, analysts have to prepare questionnaires and/or interviews and probably have to apply them repetitively in order to capture all relevant data. In case of interview situations it is improbable that analysts adapt their questions during an interrogation in order to capture any unexpected and unconsidered relevant data at the first attempt. Hence, conventional data acquisition methods mostly require time-consuming preparations and have to be iteratively applied. Furthermore, after data acquisition an enormous effort must be made to edit the data and to transfer them into process models for further analyses.

This contribution describes the development of a system called "Process Interviewer" (hereinafter "PI") which allows workflow data acquisition by process experts by a dynamic interview procedure. In this way, no effort of a process analyst is required. Data acquisition can be conducted by experts autonomously by the use of intuitive graphical user interfaces. Periodically depicted graphical sub-process models enable the expert to reflect own workflows and to learn thinking in processes. Apart from that, data and models serve the analyst as information input to understand the conduction of workflows and thus impart process knowledge. Recorded data can be used in process modelling and simulation tools – so there is a minimal effort for data transformation.

Initially, methodical aspects concerning system design are described in the paper. For this purpose, common data acquisition methods are delimited, processes are classified and systematized as well as a method for process decomposition is introduced. Subsequently, the generation of interview steps and an exemplary representation in a user-friendly graphical interface are described. Furthermore, considerations in terms of initiating process thinking via graphical models are appointed. Finally, results of a system evaluation are discussed and the paper is accomplished by a summary and a description of future work.

2 Methodical Aspects for Acquiring Workflow Data by Experts

2.1 Dissociation of Common Data Acquisition Methods

There are several commonly deployed data acquisition methods described in literature [3], [4], [5], [6], usually varying in kind of execution in a wide range, whereby a similar approach like here described has not been found. Summarized, there are six main methods to gather data for task and process analyses: interviews, questionnaires, observations, workshops, document analyses and protocols. In the current work advantages and disadvantages have been collected and compared with expected advantages and disadvantages of the new data acquisition approach.

The feedback by process models is an expected advantage of the system PI in comparison to common methods, directing the expert to process thinking and the analyst to process knowledge with minimal effort. Beside this, analysts do not need previous knowledge concerning the considered work domain: a system application can be conducted without any preparatory work – on condition that an expert with appropriate verbalization skills is using the system. A possible acquisition of cognitive processes, as opposed to e.g. common observations, provides a further advantage. Data acquisition can be interrupted and continued at any point of time via a system application. In addition, the dynamic interview procedure ensures a capture of complete workflows which is problematic in a human expert/analyst situation, e.g. in case of conducting an interview. Due to autonomous system usage, no social-psychological effects like social desirability and investigator bias are expected, too. This involves the problem of no immediate requests during data acquisition. Disadvantageously, data are not acquired in real working situations but only on the basis of the expert's memory. A possible remedy is a system application at the expert's workplace – so she/he can put oneself in the own labor situation. A further disadvantage may that a trained human analyst cannot intervene in order to increase the expert's motivation and to react to his/her needs.

2.2 Classification and Systematization of Processes

Processes are analyzed in a wide range of work domains. Therefore, numerous kinds of process denotations exist, e.g. business processes, cognitive processes, knowledge processes or security processes. A classification scheme is needed for determining process classes ascertainable by PI. A literature and online research on properties of different process entities resulted in the following eight differentiating process characteristics:

- structuredness (structured – unstructured),
- state transition (stochastic – deterministic),
- flow (continuous – discrete),
- action (inter-individual – intra-individual),
- object of transformation (physical – immaterial),
- specificity (specific – unspecific),
- level of abstraction (leading – operational) and
- regularity (regular – irregular).

According to this classification scheme, PI gathers data of discrete workflows with deterministic state transitions of single experts (intra-individual), which are either structured or unstructured. Workflows in question are conducted regular on an operational abstraction level and can be specific or unspecific. They can transform physical as well as immaterial objects. The eight classification characteristics enable an analyst to decide, if data of a specific process or class of processes are ascertainable by PI. Thereby, acquisition is basically domain independent.

Figure 1 shows the placement of several ascertainable processes in a structure model of a three-dimensional working system. It is assumed that there are domain experts E_i (i = 1..n) working in an organization. These experts conduct several activities A_j (j = 1..n) to fulfill their tasks in processes P_k (k = 1..n) within a specific duration $D_{i,l}$ (l = 1..n). It is supposed that an expert E conducts several activities A in different processes P and that she/he is working together with other experts E, which is shown by the overlapping control flows of experts in process P_1.

According to the process classification scheme above we are considering only intra-individual actions for now. We acquire sub-processes of one expert with interfaces (information or material input/output) to other experts. By means of individual interviews of all experts involved in the whole process, hereinafter the data should be connectable to this whole process.

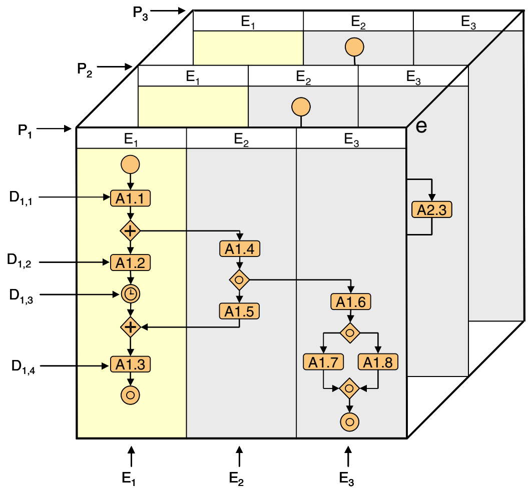

Fig. 1. Structure model of a working system

Therefore, we extract the tasks and actions of only one expert from the working system in one PI application. In Figure 1, these process fragments of expert E_1 within the three processes P_1 to P_3 are marked. Purpose of the interview system for acquiring workflow data of an expert E is to capture these process fragments up to a particular granularity dependent on the purpose of a subsequent analysis. The single process steps (activities A) and their relationships among each other – the process flow (e.g. activity order, alternative activities, random structures and iterations) – are required data. In addition it is necessary to gather activity data like activity durations, interfaces to other experts in a superior process scenery, means of labor and the place of accomplishment. It might not be easy for an expert to communicate the process flow and therewith the activities on the required level of detail, immediately. Therefore, it is essential to choose a step by step procedure, which is outlined in the following section.

2.3 Decomposition of Processes

A particular challenge consists in the generation of a systematic procedure to gather process data by an expert who has no experience in terms of process thinking. For this purpose, a dynamic interrogation procedure with appropriate graphical user interfaces is developed. On this basis a process is captured in user-friendly single interview steps. At first the procedure inquires data of superior process structures, which are then refined step by step until the final level of single activities is reached, similar to common task analyses [4], [6], [7]. This approach is based on a procedure mentioned in investigations to process model abstraction [8], [9], [10]. The authors use 'single entry single exit fragments' (SESE fragments) to abstract an existing process model step by step. Thereby, SESE fragments are process elements which have exactly one incoming and one outgoing edge. Thus, all activities contained in a SESE fragment can be synthesized into one superordinated activity by which means the process is abstracted gradually.

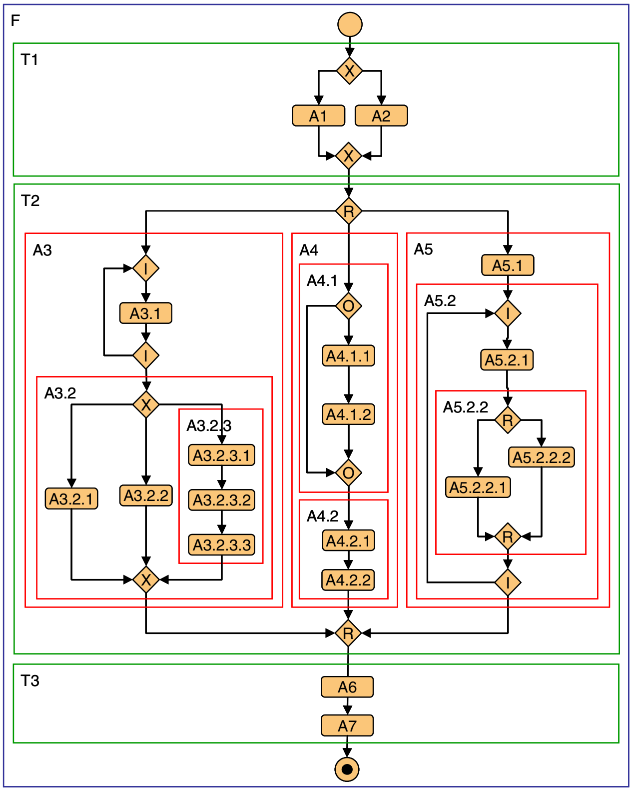

Fig. 2. Exemplary process labeled with SESE fragments

In Figure 2 an exemplary process model is shown in which SESE fragments are labeled on different abstraction levels. The process notation consists of activity elements (small rounded rectangles), gateways (diamonds) and their connections for labeling chronological orders (arrows). Gateways are distinguished in X-Gateways (XOR – labeling alternative flows), I-Gateways (ITERATION – labeling the repetition of activities or fragments), A-Gateways (ARBITRARY – labeling activities or fragments conduct in arbitrary order) and O-Gateways (OPTIONAL – labeling activities or fragments which are not necessarily conducted). This gateway-based process notation supports an easy identification of SESE fragments, since gateways join incoming or outgoing edges and therefore determine boundaries of SESE fragments. SESE fragments on the lowest level are single activities, e.g. A4.1.2.

As already mentioned above, the present work exploits this concept of SESE fragments. However, it is a process decomposition rather than a process abstraction. So we choose the opposite way and begin with inquiring the function F of an expert, e.g. his profession or job, which encompasses the sum of her/his workflows (note ‘F’ in Figure 2). Next step is the acquisition of her/his work tasks T, which represent SESE fragments on the highest level (note the single entry edge and the single exit edge at the border lines in each case – enabled through the gateway concept). These tasks match the process oriented activity sequences suggested in Figure 1. All further steps deal with the decomposition of activity sequences on different levels. In doing so, it is important that every fragment satisfies the SESE requirement: only one ingoing and one outgoing edge may occur. Principally, every process transformable in SESE notation can be acquired by PI.

3 Realization and Evaluation of the Interview System PI

3.1 Questions and Appropriate User Interfaces

Additional data are necessary for a further analysis of workflows, affecting properties of activities beside the acquisition of single process steps (activities) and their relationships. In order to determine relevant properties, different modeling languages like the Business Process Modeling Notation (BPMN, [11]) were taken into account. Finally, properties of activities relevant for standard process and task analyses were fixed, like activity duration, interfaces to other experts in a superior process scenery (resource input, output) and means of labor. Contrary to most other approaches, the place of accomplishment of activities is additionally considered – by this means a subsequent analysis of spatial conditions is possible.

All necessary data for a workflow analysis are allocated to different interview steps. In each step only limited data can be acquired in order to prevent an overload of experts. Another requirement for system design concerns the unique application of PI by an expert without the help of an analyst. This circumstance requires an easy respectively intuitive usage of the system by inexperienced users. Anyway, the allocation of questions to a single step took place dependent on related content and structure of workflow components. After allocation the development of a dynamic interview procedure has been the next step, whereas steps concerning the structure of workflow determined the fundamental flow. For each interview step a human-machine interface has been designed. As an example, the acquisition of structured and unstructured activity orders is presented below.

Figure 3 shows the user interface for acquiring the order of activities. At the beginning activities of a partial process structure are presented in the upper area of the interface. According to the number of activities fields are displayed, among which the activities can be moved. In Figure 3 there are three fields and the corresponding three activities are already allocated to these fields – two activities to the left field and one activity to the middle field. Allocating activities to different fields constitute a specified order of activity execution (from left to right – indicated through arrows between the fields), whereas the allocation of more than one activity to one field represents an arbitrary execution order of these activities. Thus, the two activities in the left field in Figure 3 are conducted in any order during the workflow and only after their completion the activity in the middle field will be executed. This example shows a ‘drag and drop’ question. There are other question types like multiple choice or fill-in-the-blank text. The example shows an interview step repeated for every partial structure of a workflow. An interlacing of structured and unstructured partial flows is possible by the iterative and dynamic interview procedure. According to this, structured, unstructured as well as semi-structured processes can be gathered.

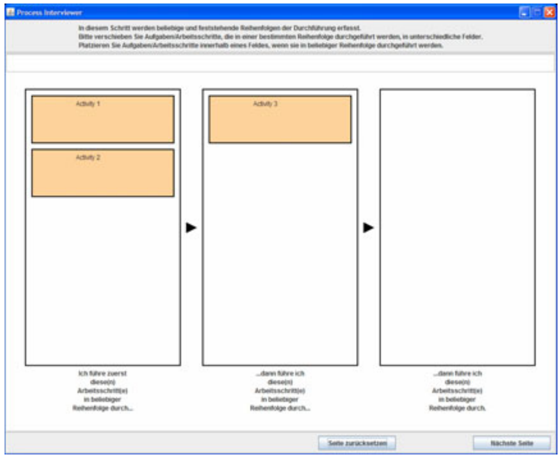

Fig. 3. Interview step of PI for the acquisition of the order of activities

3.2 Initiating Process Thinking: Feedback via Graphical Sub-process Models

The dilemma of a missing common knowledge base of analysts and experts has already been mentioned above: in the majority of cases an analyst does not know anything about the process she/he has to analyze. But by applying PI she/he receives information by means of data logging. By contrast, the expert mostly does not know anything about process modeling, thereby a subsequent participative validation of analyst's process models is quite difficult. As a countermeasure, the expert should be introduced to a simple process model notation in the course of an interrogation. For this purpose the system provides a feedback for every acquired SESE fragment in form of a partial graphical model representation. This allows the expert to check her/his entered data whereby a thinking in processes is initiated. In order to restrict the complexity of process models, activity generation is limited up to ten for each partial workflow.

In Figure 4 a simple process model is represents the order of activities determined in Figure 3. It shows the activities order in control flows and the arbitrary activity order by the concept of blobs [12]. In this case, the concept of blobs does not additionally represent simultaneous actions of experts. Reason for that is the assumption that simultaneous actions are only possible on the level of rules [13], [14]. However, in the current approach we are acquiring activities on rule-based level. By proofing the shown model the expert decides if it represents her/his mental concept of the partial process or not – and gets the opportunity to adjust it. In the next interrogation steps the system asks if activities can be divided in further sub-activities.

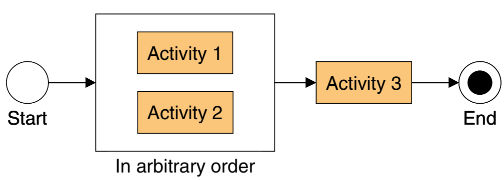

Fig. 4. Expert feedback through a simple partial process model

The knowledge gap between expert and analyst is reduced by such simple partial process model representations: Experts get a simple model-based representation of their workflows and learn process thinking, whereas the analyst can understand the content of experts' workflows by tracing back the survey records. This should build the missing common basis between expert and analyst in terms of process knowledge and process thinking and constitutes a good condition for further process analysis.

3.3 Results of a First Evaluation

Twelve scientists (average age=26.2, x_{median}=28, x_{min}=24, x_{max}=32); six females and six males) out of the field of human-systems engineering have been asked for the workflows of their everyday job for the first expert evaluation of PI. Beside the analysis of logged data (application time, number of activities entered…), the testing of the independent applicability by experts, the identification of improvement suggestions concerning the system usability and the examination of a possible initiation respective improvement of a thinking in processes have been the aims of the evaluation.

The analysis of log files shows an average application time of μ=70.2 minutes (x_{median}=68, x_{min}=34, x_{max}=114), whereby instructions of the investigator provide an application termination in case of a lack of concentration or motivation. During application time every expert generated an average of 20.6 nodes (x_{median}=21.5, x_{min}=10, x_{max}=30) including function, tasks and activities. Hence, the acquisition of one node (including all information like input, output, duration, tools needed, order concerning other nodes, child nodes…) amounts 3.7 minutes (x_{median}=3.1, x_{min}=2.1, x_{max}=7.9). These data have to be compared with applications of standard acquisition methods (like interviews, questionnaires and observations), which will be conducted in a future, more extensive evaluation. Out of this can be proved, if an application of PI is less time-consuming than the application of a standard method. During the development of this approach it has been considered in which way a restriction of interview granularity can be ensured. A feasible solution seemed to be the limitation of an activity duration. According to the following process or task analysis the analyst might define the interview granularity by determining a minimum activity duration. This would enable the system to terminate an interview by averting a splitting of appropriate activities into sub-activities. However, the first evaluation showed that experts defined at most x_{max}=6 hierarchical levels (excluding function and tasks), whereas the mean has been 3.2 levels (x_{median}=3, x_{min}=1). This indicates that the need for a termination criterion does not exist due to an already limited granularity. Otherwise it must be examined, if the existing granularity is sufficient for the purpose of the subsequent analysis – perhaps an activity division must be enforced by the system.

The evaluation revealed a possible independent applicability of the system by experts. Experts have been allowed to talk to the investigator and to ask questions. However, those concerned almost exclusively improvement suggestions instead of system handling. A further structured identification of improvement suggestions related to the system usability has been conducted by surveys after applying the system (NASA-TLX [15] and ISONORM 9241/10 [16]).

In order to test an initiation or improvement of thinking in processes, the test persons have been asked to transform a continuous text into a process model before the application of PI and afterwards. The evaluation of these process models showed that there has been no relevant improvement. This circumstance is ascribed to the already existing experience concerning process and task analysis, inquired in the course of investigation.

Altogether, the evaluation reveals positive assessments by the usability experts concerning the applicability of the system and numerous suggestions for improvement regarding the usability. A potential to use the system in projects for an acquisition of workflows has been confirmed. However, the discussion in terms of the motivation of users was divided. Some experts assessed the system handling as exciting, others expressed that it is boring. So there is a demand for the identification of opportunities to increase the motivation of users while interacting with the system. Finally, it should be mentioned, that consequent process models indeed showed weakly structured processes (i.e. not many activity orders) which probably corresponds to the overall creative work of scientists.

4 Summary and Future Work

In this paper a new approach for workflow data acquisition by the interactive interview system PI has been outlined. Acquirable processes have been structured by SESE fragments for the development of a dynamic interview structure with corresponding questions and user interfaces. During system application, feedback through partial process models should initiate an expert's thinking in processes. A first evaluation showed the functioning of the approach and the favored independent applicability of the system by experts. It gave information concerning application durations, quantity of obtained data and suggestions for improvement in terms of usability.

Investigation issues like a comparison with conventional data acquisition methods and initiation of process thinking will be considered in a future evaluation. Prior to that, the system will be adapted in terms of usability, inclusive the integration of a structure tree indicating the actual interview position for a better orientation. Furthermore, since the current system enables interviews on operational level (see the process classification in section '2.2'), a future version of the system will contain a configuration for data acquisition on management level.

Overall, feedback by simple partial process models intent to initiate an expert's process thinking. System records impart an analyst's process knowledge. This provides a common knowledge basis and therefore a simplification of further analyses of workflows.

References

1. Havey, M.: Essential Business Process Modeling. O'Reilly Media, Inc., Sebastopol (2005)
2. White, S.A., Miers, D.: BPMN Modeling and Reference Guide: Understanding and Using BPMN. Future Strategies Inc. (2008)
3. Burge, J.E.: Knowledge Elicitation for Design Task Sequencing Knowledge, Thesis (1998)

4. Kirwan, B., Ainsworth, L.K.: A Guide to Task Analysis. Taylor & Francis, London (1992)
5. Lindgaard, G.: Usability Testing and System Evaluation. A guide for designing useful computer systems. Chapman & Hall, London (1994)
6. Stanton, N.A., Salmon, P.M., Walker, G.H., Baber, C., Jenkins, D.P.: Human Factors Methods. A Practical Guide for Engineering and Design. Ashgate (2005)
7. Annett, J.: Hierarchical Task Analysis. In: Diaper, D., Stanton, N. (eds.) The Handbook of Task Analysis for Human-Computer Interaction, pp. 67–82. Lawrence Erlbaum Associates, Mahwah (2004)
8. Polyvyanyy, A., Smirnov, S., Weske, M.: Process Model Abstraction: A Slider Approach. In: Proc. International IEEE EDOC 2008. IEEE Computer Society, Los Alamitos (2008)
9. Polyvyanyy, A., Smirnov, S., Weske, M.: On Application of Structural Decomposition for Process Model Abstraction. In: Proc. 2nd International Conference on Business Process and Services Computing (2009)
10. Smirnov, S.: Structural Aspects of Business Process Diagram Abstraction. In: Proc. IEEE Conference on Commerce and Enterprise Computing (2009)
11. OMG Business Process Modeling Notation (BPMN): Specification, Version 1.2, 2009-01-03. OMG (2009)
12. Harel, D.: Statecharts: A visual formalism for complex systems. Science of Computer Programming 3(8), 231–274 (1987)
13. Rasmussen, J.: Skills, Rules, Knowledge, Signals, Signs and Symbols and other Distinctions. Human Performance Models. IEEE Transactions on Man, Systems and Cybernetics SMC-13(3), 257–266 (1983)
14. Rasmussen, J., Pejtersen, A.M., Goodstein, L.P.: Cognitive Systems Engineering. John Wiley & Sons, Inc., U.S (1994)
15. Hart, S.G., Staveland, L.E.: Development of NASA-TLX (Task Load Index): Results of empirical and theoretical research. In: Hancock, P.A., Meshkati, N. (eds.) Human Mental Workload, pp. 139–183. Elsevier, Amsterdam (1988)
16. Prümper, J., Anft, M.: ISONORM 9241/10, Beurteilungsbogen auf Grundlage der Internationalen Ergonomie-Norm ISO 9241/10. Büro für Arbeits- und Organisations psychologie, Berlin (1997)