Guidelines for Training Functional Task Analysis

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EXECUTIVE SUMMARY

The goal of this report is to provide guidelines for training task analysis, based on two specific research studies (Adams, 2010) as well as on the general literature. A summary of the objectives and guidelines for training functional task analysis is as follows:

	Objective	Guideline
1.	Determine task goal	Spend time discussing activities at the onset of the task analysis: main goal (task) and the purpose of the task analysis.
2.	Determine plan	Prepare for a variety of task analysis formats
3.	Create hierarchy	Emphasize that developing a hierarchy is an active process that involves creating and expanding a task space, and negotiating the placement of a subgoal.
4.	Determine task boundaries	Be prepared to provide definitions, as depth and breadth of task analyses may be influenced by definitions or other factors.
5.	Identify subgoals	Employ a variety of methods to identify subgoals, and be aware that factors other than the task to be analyzed may be important.
6.	Create versatility	Purposefully consider task variations to make a task analysis more general, and state your assumptions when you choose specific instances.
7.	Determine satisfaction criteria	Emphasize satisfaction criteria so they are not overlooked.
8.	Assess performance	Tie analysis to performance. Task analysis involves more than just representing the subgoal structure of a task. Task performance is important at the starting and ending point of task analysis.

INTRODUCTION

Task analysis refers to a collection of methods that are used to understand and represent a task for the purpose of the design or redesign of tasks, systems, instructions, environments, and ensuring usability, efficiency, and safety. There are many task analysis methods (see overview in Stanton et al., 2005), which may be organized into three groups, depending on the level of analysis they aim at (Adams, Rogers, & Fisk, in press): computational level (goal level), algorithmic level (methods used to accomplish the goal), and implementational level (underlying physical instantiation). The focus of this reports lies on analyzing a task on the computational level, that is, understanding and representing a task in terms of a hierarchy of goals and subgoals. Hierarchical Task Analysis (HTA) is a task analysis method that re-describes goals into subgoals, and thus an example of a functional task analysis.

Systematic training of task analysis is important as studies indicated that novices do not spontaneously develop the procedural knowledge necessary to conduct a task analysis. Novices' HTAs of simple tasks were problematic after brief introductions of 15 minutes and subsequent practice, either with feedback (Patrick et al., 2000) or without feedback (Adams, 2010; Felipe, Adams, Rogers, & Fisk, 2010). Because a task analysis provides the basis for the next steps in system design and evaluation, it is important that training is successful.

Currently, literature does not offer much help for developing training for task analysis. Articles and book chapters exist that introduce one specific task analysis method, maybe including a stepwise procedure (e.g., Ormerod & Shepherd, 2004). Sometimes a whole book is devoted to one method (e.g., Shepherd, 2001). Some books review a range of methods, covering

individual methods briefly and generally (e.g., Jonassen, Hannum, & Tessmer, 1989; Kirwan & Ainsworth, 1992; Stanton, Hedge, Brookhuis, Salas, & Hendrik, 2005) and emphasizing the diversity of methods rather than their common features and how to acquire the requisite skills. Although examples are provided, these are often abridged to illustrate a particular point, limited in scope, and may require specific domain knowledge to understand a point's significance. Task analysis workshops are available, but workshop materials are typically only available to participants. Training of task analysis also occurs in university courses or within organizations, but instructions differ between instructors and again, training materials are typically restricted to the attendees. Finally, the few studies describing training of task analysis refer to material that is not publicly available (Patrick, Gregov, & Halliday, 2000; Stanton & Young, 1999). In sum, training material available to the public exists in the form of general descriptions and a set of examples for which the learner may or may not have the specific domain knowledge.

The goal of this report is to provide guidelines for training of functional task analysis, that is, task analysis methods that focus on understanding the goals of a task. As mentioned earlier, Hierarchical Task Analysis (HTA) is one example of a functional task analysis. The recommendations in this report are meant to aid the design, delivery, and evaluation of task analysis training. Guidelines and recommendations are primarily based on two studies (Adams, 2010), but are also informed by the general literature on this topic. The guidelines are intended for training of individuals who have to apply task analysis in their jobs and have limited background knowledge of task analysis. An underlying assumption is that the trainers themselves are familiar with the task analysis concepts expressed in this report.

This report is organized by objectives and guidelines. An objective describes the goal for a training unit and is followed by a general guideline for that objective. Each guideline is briefly

elaborated with a description, supporting evidence regarding why the issue is important to consider, and more specific recommendations for training. A summary of methods for accomplishing the objective completes each section.

OBJECTIVES AND GUIDELINES

Objective 1: Determine task goal.

Guideline 1. Spend time discussing activities at the onset of the task analysis: main goal (task) and the purpose of the task analysis.

Description

- Activities at the onset of the task analysis include determining the main goal (the task) and the purpose of conducting the task analysis. The main goal is the task being analyzed, for example to *operate a tractor*. The purpose of the task analysis is the reason why the task is being analyzed, for example to improve safety or guide redesign of a system. The distinction between goal and purpose are important for novices to understand.

Supporting Evidence

- After brief instructions, the majority of novices learning to conduct HTA demonstrated that they understood the importance of the goal and purpose both in their task analyses (procedural knowledge) as well as in a recall test (declarative knowledge; Adams, 2010).

- However, assessment of declarative knowledge showed that novices confused the goal of the task and the purpose of the task analysis (Adams, 2010).

- Also, procedural knowledge assessment showed that novices adjusted the main goal that was given to them (Adams, 2010), which may influence the resulting task analysis and its interpretation.

- Think-aloud data from professionals indicated that they asked questions during the task analysis. Furthermore, data indicated that 'why' questions can be useful to ascertain the main goal and verify that the task to be analyzed is the proper one given the purpose of the task analysis (Adams, 2010).

Recommendations

- Define and discuss the main goal (the task).

- Be prepared to discuss the implications of adjusting the main goal.

- Define and discuss the purpose of conducting the task analysis.

- Delineate the main goal of the task from the purpose of conducting the task analysis.

- Use WHY question to verify the main goal of the task.

- In task analysis products, check that main goal has been stated and not adjusted. You can expect that most trainees will have stated it and some will have adjusted it.

Summary of Methods for Successfully Meeting the Objective of 'Determine Task Goal

- determine purpose of the task analysis
- set scope of analysis
- state assumptions
- differentiate purpose and goal
- delineate task to be analyzed (main goal) from the task of conducting the task analysis
- identify goal
- define goal of the task
- question the given goal
- determine super-ordinate goal
- delineate task goal from other (similar) task goals
- ask question

Objective 2: Determine plan.

Guideline 2. Be prepared for a variety of task analysis formats.

Description

- Task analyses can be displayed or represented in many different formats, for example a bulleted list or flowchart. Specific task analysis methods differ in their requirements for a specific format. Formats differ in the extent to which they differentiate between the content of a task element and its sequence, that is, the plan in HTA terminology. Although there is a tendency to use a list-style format, novices initially start with a variety of formats and explore different formats.

Supporting Evidence

- Without instructions as to the format of task analysis, novices tended to use a variety of formats and also adjusted their format over the course of different task analyses (Adams, 2010).

- Without specific format instructions, novices used mostly a list-style format, but also included pictures, flowcharts, hierarchies, text, and a combination of them (Adams, 2010).

- Even with explicit instructions to use one of two HTA formats (a hierarchy or tabular format) not all novices complied. Other formats used included algorithm and flowchart (Patrick et al., 2000).

Recommendations

- Be prepared to discuss the advantages and disadvantages of different formats, including pictures, unnumbered list, numbered list, flowchart, text, hierarchy, and combinations thereof.

- If HTA is to be trained, emphasize that a hierarchy format supports the separation of task content (subgoals) from their sequence because novices will rarely choose this format spontaneously and divert even with explicit instructions.

Summary of Methods for Successfully Meeting the Objective of 'Determine Plan'

  - separate sequence from content
  - determine sequence
  - choose format
  - follow format
  - adjust format

Objective 3: Create hierarchy.

Guideline 3. Emphasize that developing a hierarchy is an active process that involves creating and expanding a task space, and negotiating the placement of a subgoal.

Description

- Novices' initial understanding of task analysis will lead them to create a task analysis that is only a few subgoals broad on the highest level of analysis and rarely involves breaking down a subgoal into more depth. That is, novices start off by having a constrained task space. Creating a hierarchy requires novices to expand this task space that they originally had in mind. Creating a hierarchy also involves reasoning about whether to include or exclude a subgoal and where in the hierarchy a subgoal is to be placed, including revising its position.

Supporting Evidence

- Task analyses that novices conducted after having received instructions were significantly deeper than task analyses that novices conducted before having received instructions (Adams, 2010).

- Novices' task analysis breadth did not change after training. However, novices' task analyses included breadths that were too narrow and too broad compared to breadth recommendations of 3 to 8 subgoals broad (Adams, 2010).

- Experienced task analysts moved individual subgoals between and within levels of the hierarchy, occasionally revising the positions as the analysis progressed (Adams, 2010).

- Experienced task analysts pondered and explicitly decided to include or exclude subgoals based on the assumptions they made, rather than include all the subgoals that came to mind (Adams, 2010).

- A task analysis conducted breadth-first was associated with narrower and deeper task analyses compared to a task analysis conducted depth-first approach, which was associated with broader and flatter task analyses (Adams, 2010). The breadth-first approach constrains the number of subgoals on the highest level of analysis before breaking them down, whereas the depth-first approach takes the first high-level subgoal and breaks it down into sub-sub goals and sub-sub-sub goals before returning to the next high-level subgoal and breaking it down.

Recommendations

- Brief training and practice will aid novices' understanding that depth greater than one is associated with a hierarchy. However, ensure that novices to HTA understand the concept of depth and hierarchy and that they recognize it is an important part of HTA.

- Encourage discussion about the placement of a subgoal and about whether a subgoal should be included in the task analysis.

- A breadth-first approach may help keeping task analyses narrow and minimize loss of resources if the project scope is being adjusted and a subgoal subsequently no longer needs to be broken down further.

Summary of Methods for Successfully Meeting the Objective of 'Create Hierarchy'

  - expand breadth
  - reduce breadth
  - expand depth
  - reduce depth
  - adjust subgoal placement
  - decide explicitly whether to include or exclude a subgoal
  - determine location of subgoal
  - set task structure dimensions
  - evaluate subgoal placement
  - move element within same level
  - place subgoal in hierarchy
  - move element to another level

Objective 4: Determine task boundaries

Guideline 4. Be prepared to provide definitions, as depth and breadth of task analyses may be influenced by definitions or other factors.

Description

- When analyzing a task, it is important to include a task's prerequisite and concluding aspects which affect the breadth of the task analysis (Patrick et al., 2000). It is also important to understand to which level to analyze, that is, the depth of the analysis. Decisions about breadth and depth may be influenced by novices' definitions of breadth and depth or by other factors such as person factors (e.g., prior knowledge), task factors (e.g., task complexity), or general actions (e.g., trying to be detailed or the simplest way to do a task).

Supporting Evidence

- Literature provides various recommendations about the breadth of a task analysis, which can be condense to the range between 3 and 8 subgoals (see Adams, 2010).

- Novices produced task analyses with too narrow or broad breadth boundaries (Adams, 2010; Patrick et al., 2000). Novices also reported that their decision about the breadth of the analysis, that is, where to begin and end the analysis, was influenced both by a definition (starting and ending point) as well as person and task factors (Adams).

- Person and task factors most often influenced novices' decision on the depth of the analysis (Adams, 2010).

- Experienced task analysts also produced some task analyses that were too broad or narrow. Overly broad task analyses conducted by professionals were more likely associated with a depth-first approach (Adams, 2010).

Recommendations

- Discuss definitions of the breadth of the task analysis, that is, where a task may begin and end.

- Review trainees' definitions of breadth when their task analyses are too broad (i.e., above 8 subgoals on one level).

- Observe trainees as to whether they employ a breadth-first or depth-first approach as a possible reason for a task analysis being too broad.

- Discuss the relative benefits of a breadth-first approach over a depth-first approach, that is, more control over breadth, minimal loss of money and effort if a deeply analyzed branch is removed from the project.

- Illustrate the relationship between the breadth and depth of a task analysis.

Summary of Methods for Successfully Meeting the Objective of 'Determine Task Boundaries'

- state assumptions
- define breadth of task analysis
- determine breadth of task analysis
- determine if breadth is appropriate
- recall minimum breadth
- recall maximum breadth
- define depth of task analysis
- determine depth of task analysis

Objective 5: Identify subgoals.

Guideline 5. Employ a variety of methods to identify subgoals, and be aware that factors other than the task to be analyzed may be important.

Description

- The process of breaking down goals into subgoals is essential for functional task analyses, but how subgoals are identified is not well-described. Providing a definition of what a subgoal is (e.g., a verb-noun pair) can guide trainees regarding what to look for. A definition can then be complemented by other strategies (or methods) that can help identifying a subgoal.

Supporting Evidence

- Most experienced task analysts stated assumptions at the onset or in the course of the task analysis (Adams, 2010).

- Experienced task analysts asked most often questions about "what". These questions aimed at understanding the task space, its objects, the procedure, specific requirements, and aspects of a task (Adams, 2010).

- Novices used definitions of a subgoal, but these definitions were not uniform, spanning from "each step was a subgoal" to "things needed to meet those goals" and "elements necessary to get the goal, however not broken down into steps like the plan" and "open to my interpretation" (Adams, 2010).

- Most of the subgoals identified by both novices and experienced task analysts were lower level (Adams, 2010; Patrick et al., 2000).

- Task symmetries may serve as cues to identify other subgoals (Adams, 2010). For example, the subgoal "open lid" may cue the symmetrical subgoal "close lid".

Recommendations

- Define what a subgoal is, and practice identifying it. This includes delineating one subgoal from another. Use the task analysis format as a cue. For example, a paragraph format is likely to have subgoals embedded and closely tied to other subgoals.

- Questions about "what" and "how" are most beneficial when creating the initial task structure.

- Use identified subgoals as a cue to check for pre-requisite or concluding subgoals.

Summary of Methods for Successfully Meeting the Objective of 'Identify Subgoals'

- ask questions
- consider prior knowledge
- consider task factors
- consider time constraints
- check symmetrical subgoals
- check task aspects
- refer to task constraints
- search task space
- specify requirements
- state assumptions
- understand task space
- determine procedure
- identify objects
- select level of analysis
- define subgoal
- identify subgoal
- delineate subgoal from other subgoals
- determine exact wording
- notice if subgoal is outside boundaries

Objective 6: Create versatility.

Guideline 6. Purposefully consider task variations to make a task analysis more general, and state your assumptions when you choose specific instances.

Description

- Task analyses that focus on goals have the benefit of being applicable over a range of technological implementations. Such a task analysis is described as being versatile or general. However, task familiarity may impede creating a versatile task analysis. Habits of accomplishing tasks may direct a task analyst's focus to a specific procedure or technology and underlying assumptions may remain unattended.

Supporting Evidence

- Novices' task analyses were not all versatile, and some task analyses were specific even when participants were unfamiliar with a task (Adams, 2010).

- Versatility was not a main feature mentioned by novices after a brief period of training (Adams, 2010).

- Novices did not consider many task variations when completing HTAs individually, but improved when conducting task analysis in a group (Patrick et al., 2000).

- When experienced task analysts created specific task analyses, they had an existing technology in mind, stated their assumptions, and created specific scenarios. Another reason for a more or less specific task analysis is that analysts differed in the purpose of their task analysis (Adams, 2010).

Recommendations

- Guide thinking about versatility by asking learners to list and consider different procedures or sequences of accomplishing goals, different users, or different inputs and outputs.

- Engage learners in group discussions to aid elicitation of different perspectives on task completion.

- Brainstorm about variables that are important for a task completion. Then pick one instance of each factor and create the task structure. Pick another instance and check if the task structure is still applicable, adjusting it if necessary.

Summary of Methods for Successfully Meeting the Objective of 'Create Versatility'

  - consider different ways to complete a task
  - consider task variations
  - constrain task space

- create scenario
- determine task variables
- refer to task analysis purpose
- refer to task performance
- select task variables

Objective 7: Determine satisfaction criteria.

Guideline 7. Emphasize satisfaction criteria so they are not overlooked.

Description

- Functional task analysis not only involves an analysis of subgoals but also determining whether the subgoals have been met. Not all learners address this spontaneously.

Supporting Evidence

- Novices rarely mentioned satisfaction criteria spontaneously without instruction, and not all did so even after instructions (Adams, 2010).

- After brief instructions, few novices recalled this to be one main feature of HTA. This feature may be overshadowed by all the other information to be learned (Adams, 2010).

Recommendations

- Ask learners to identify satisfaction criteria.

- Check task analysis products to determine whether satisfaction criteria were explicitly stated, either as a subgoal or a condition.

Summary of Methods for Successfully Meeting the Objective of 'Determine Criteria'

  - identify satisfaction criteria
  - state satisfaction criteria

Objective 8: Assess performance.

Guideline 8. Tie analysis to performance. Task analysis involves more than just representing the subgoal structure of a task. Task performance is important at the starting and ending point of task analysis.

Description

- Observing performance is an integral part of task analysis. Knowledge extracted from experts informs the representation of a task and its subgoal structure. However, using the task structure to guide observation of performance or informing analysis and design are part of task analysis as well, and this ties back into Guideline 1, the purpose of conducting a task analysis.

Supporting Evidence

- Assessing performance is part of task analysis (Shepherd, 2001).

- Assessing performance involves *using* a created task representation that guides the evaluation of a person or system. Comparing expectations and observations helps focus the problem area and direct where to look for specific recommendations (Adams, 2010).

Recommendations

- Once a subgoal structure has been created, use it to assess problem areas of human performance, such as whether an employee with a given set of capabilities and limitations can perform a specific task or job.

- Suggest specific recommendations based on the task analysis and performance assessment to clarify how task analysis can inform the design and evaluation of a system.

Summary of Methods for Successfully Meeting the Objective of 'Assess Performance'

  - determine task performance criteria
  - assess task performance with respect to criteria
  - determine human abilities and limitations
  - determine recommendations
  - suggest recommendations

CONCLUSION

The term *functional task analysis* refers to methods that focus on understanding the goals of a task. One example of a functional task analysis method is Hierarchical Task Analysis (HTA), a commonly used task analysis method. Literature indicates that training of functional task analysis is needed, yet offers little specific guidance for training.

This technical report outlined eight guidelines that correspond and address the following training objectives: determine task goal, determine plan, create hierarchy, determine task boundaries, identify subgoals, create versatility, determine satisfaction criteria, and assess performance. Each guideline to an objective was followed by specific recommendations for training and a summary of methods to successfully meet an objective. Our goal was to provide information to assist trainers of functional task analysis, and HTA in particular, to prepare their instructional materials and anticipate questions and problem areas.

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