Task Descriptions Using Academic Oriented Modelling Languages: A Survey of Actual Practices across the SIGCHI Community

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Abstract. There is an extensive literature on task modelling related to the design of computer systems. Task analysis and task modelling have been widely recognized as central components in human-centred approaches. The aim of this paper is to report on some results of a worldwide survey about actual practices of task descriptions languages (TDL) in SIGCHI community. Results suggest that academic TDL are not well known and not used by participants. They prefer using "home-made" TDL. This may be explained by the fact that formal TDL are not adapted to tasks analysts needs and that task modelling is an expert activity, mainly used by skilled analysts. Indeed, this study shows that task models are not only used in a productive way, *i.e.* to derive useful inputs to the design of man-machine systems. Thus, it seems that formal TDL failed to take this into account.

1 Introduction

There is an extensive literature on task modelling related to the design of computer systems. Task analysis and task modelling have been widely recognized as central components in human-centred approaches [1] to design more useful and usable interactive systems [2], as well as a main piece to develop vocational training [*e.g.*, 3, 4].

In the field of Human-Computer Interaction, task modelling (TM) can be defined as the subset of techniques employed by work analysts (ergonomists, usability specialists, etc) to analyse and to describe users' or workers' tasks in a formal way. TM relates to the phase of collecting data on work and activities during a task analysis (*e.g.* by direct observations, interviews, etc.) as well as the phase of expressing these data through one or several task models. Task models are thus the analyst's representations of the analysed task. These models are usually expressed into a graphical or a textual form. Subsequently, task description languages (TDL) can be seen as specific sets of linguistic and semantic rules used to elicit task models.

Since seminal work on Hierarchical Task Analysis (HTA) by Annett & Duncan in 1967, numerous methods and languages have been consequently proposed to support part of the modelling process (*e.g.* see the review by [2]). Surprisingly, very little literature has been devoted to the work of task analysts performing task analysis as well as specifically task modelling [5]. On the one hand, there are anecdotal reports and subsequent guidelines about the practices. For example, [6] describes the construction of task models from collected verbal report as an iterative process that involves (1) incremental definition of task items and (2) their hierarchical re-organization along the construction process as well as the collection of new data. The author also reports on some difficulties and/or specific properties of this activity, based on her experience. On the other hand, there are few empirical studies about the process of building task models with formal TDL [7, 8, 9, 10].

Finally, it is worth noting that not much is known about actual TM practices, *i.e.* what Task Description Languages are actually used, how they are used, for what intent, when during the design process, by whom, etc. Indeed, recent papers and/or workshops dedicated to task modelling (*e.g.* TAMODIA) generally focused on task description languages rather than on task modelling *per se*. These works have mainly concentrated on discussing linguistic or semantic features (proposed as desirable) for TDL, on proposing tools or articulation of approaches [11] to better support the task modelling part of the design process, on extending TDL to apply for other area like safety prevention, *e.g.* accident investigation and prevention [12], organizational development through work cultural assessment [13], cooperation and cooperative work situations [14], test case generation [15] and finally – the practical (supposed) or theoretical superiority of the specific language they are advocating. Quite no evidence has been published about the way these TDL are actually used across the task analysts' community.

This paper reports on some results of an international survey about actual practices of task descriptions using modelling languages in HCI. The purpose of the survey was to obtain a clear and situated picture of task modelling practices and task description languages actually used in the field of HCI and software ergonomics. We were interested in gathering insights about task analysis/modelling methods and task description languages produced by academics actually used across the international SIGCHI. We investigate the use of the following academic TDL : HTA (Hierarchical Task Analysis, [3]), SGT (Sub-Goal Templates, [8]), MAD (Méthode Analytique de Description, [16]), GTA (Groupware Task Analysis, [17]), CTT (ConcurTaskTrees, [18]), Diane+ [19], GOMS (Goals, Operators, Methods and Selection rules, [20]), Procope [21], TKS (Task Knowledge Structure, [22], TAG (Task-action Grammars, [23]), UAN (User Action Notation, [24]), KLM (Keystroke Level Model, [25]), TMMT (Task Method modelling Tool [26]).

The paper is organized as follows. After describing the web survey used to collect data, we will focus on the profiles on respondents, the TDL they use, and the reasons they do or do not do TM.

2 A Survey on Task Modelling Practices and Associated Task Description Languages

The questionnaire was made of 27 questions provided on a website in both French and English to have a wide access to task analysts/modellers within the international ergonomics and human-factors community.

The questions were initially organised into three main themes: (1) respondent's area, education and activity; (2) opinion, description and level of expertise related to task modelling; (3) use of task models. These questions were inspired from a pilot study [7] based on interviews with 5 professional ergonomists and on the content analysis of real task models provided by them. The initial version of the questionnaire was pre-tested with six experts in human factors and ergonomics, in terms of consistency, relevance and ease of understanding. Overall, the experts indicated that the questionnaire was relatively clear and easy to complete. A number of suggestions were made concerning the wording of several items and the overall structure of the questionnaire. These suggestions were incorporated into the revised version.

Participants' Recruitment and Survey Announcement

A call for participation was sent in January 2008 to several professional mailing lists around the world. As we were interested in the use of TDL in the academic community of SIGCHI, the call for participation was mainly sent to academic listserves. CHI-announcement[1] (international), CHI-web[2] (international), Ergoliste[3] (France), ErgoIHM[4] (France), Ergonomics[5] (United Kingdom), SIGIA-L[6] (United States), CHISIGMAIL[7] (Australia), and HCIIDC[8] (India).

Statistical Analysis

Uni- and bi-variate exploratory analyses have been performed. Bi-variate analyses were mostly based on calculating the Cramer's V2[9], a global measure of the strength of association between two variables [27], and calculating the Relative Deviations[10]

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1 http://sigchi.org/listserv
2 http://sigchi.org/listserv
3 https://listes.cru.fr/sympa/info/ergoliste
4 https://listes.cru.fr/sympa/info/ergoihm
5 https://www.jiscmail.ac.uk/lists/ergonomics.html
6 http://www.info-arch.org/lists/sigia-l/index.php
7 http://www.chisig.org/resources/lists.html
8 http://tech.groups.yahoo.com/group/hdiidc
9 V2 or Cramer's V measures the magnitude of the association between two nominal variables. Cramer's V lies between 0 and 1. It is conventionally considered to be small when $V2<0.04$, to be intermediate when $0.04<V2<0.16$, and to be strong when $V2>0.16$.
10 RDs measures the association between two nominal variables. They are calculated on the basis of a comparison between observed and expected frequencies.

(RDs) that measure local associations between specific modalities[11] of the variables [27]. We used Cramer's V and RD's as they are the equivalent of correlations for nominal variable. We did not use any reliability measure for our survey as, up to our knowledge, there is no equivalent of Cronbach's Alpha for nominal variables.

Representativeness and Limits of the Sample

Up to our knowledge, no data are currently available about the profiles of ergonomists and task/work analysts across the world. Thus, it is difficult to assess how representative is our sample. A perspective is to extend this work by confronting these results to optional data originated from national ergonomics societies. Furthermore, the fact that some countries were not represented in our sample might simply mean that we failed in finding the appropriate mean to get in touch with the concerned national community during the time of the survey. It should by no mean be interpreted as an indication that no people are interested and/or doing any activity on ergonomics and in particular regarding the topics of TM.

Consequently, the following analysis will put much emphasis on qualitative interpretation of responses and emerging relationships between analysts' profiles, type of activity than on the quantified ratio of profiles and responses to be generalized to the population of ergonomic and human factors specialists.

3 Results

A total of 201 responses from all around the world were collected on the website. Respondents are professional ergonomists, interaction designers or researchers. They have various educational background (*e.g.*, psychology, engineering), are specialized in various areas (*e.g.* HCI) and have various experiences regarding task modelling. In this section, we detail all these results.

Profiles of Survey's Participants

Represented Countries
Europe was the most represented region (71%, n = 148), followed by Northern America (13%, n = 27), Asia (7%, n = 14) and Oceania (5%, n = 11). Africa and Southern America were not represented. See figure 1.

The French respondents were quite a bit more represented (57%, n = 115)[12] than those from other world's areas (43%). Among the latter, represented countries were by order of magnitude the US (10%, n = 21), the UK (8%, n = 16), India (6%, n = 12), Australia (5%, n = 10), Canada (3%, n = 6), the Netherlands (2%, n = 4), Germany

[11] There is attraction when the RD is positive and repulsion when it is negative. See [28] for details.

[12] One missing response.

(2%, n = 3), Italy (2%, n = 3) and Luxemburg (1%, n = 2). Finally, eight countries were represented by only one respondent: Belgium, China, Ireland, Israel, Monaco, New Zealand, Poland and Portugal.

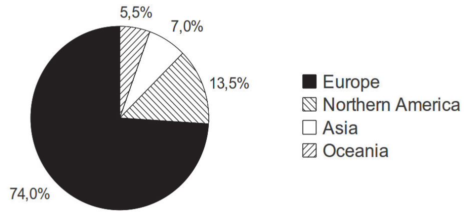

Fig. 1. Participants' geographical localisation.

Most Participants Have a Significant Experience in Ergonomics as Well as in Work or Task Analysis/Modelling

Globally most participants reported to be experienced in the domain of ergonomics and human factors (figure 2). They were 86% with 1 to 15 years or more of experience whereas 14% (n = 28) reported from 0 to 1 year of experience. . Participants having between 1 and 5 years of vocational experience (30%, n = 61) and between 5 and 10 years of experience (28%, n = 56) were the most represented in the sample. Participants having 15 years or more of experience were also well represented (19%, n = 38). The less represented group of participants were analysts with an experience between 10 and 15 years (8.5%, n = 17).

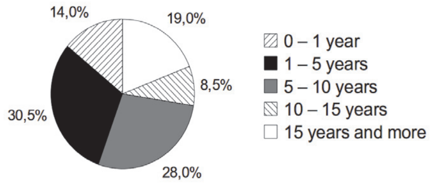

Fig. 2. Participants' number of years of experience.

Among the participants, 24% (n = 49) have never done TM at the time of the survey. Actually, most of the respondents reported having a previous experience in task modelling (76%, n = 152) during their career. Among those that have an experience, most still do it in their daily activity (86%, n = 130), whereas 14% (n = 22) did not anymore (figure 3).

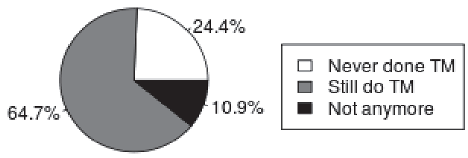

Fig. 3. Percentage of respondents having already done task modeling or not.

Participants' Educational Background: Mainly Ergonomics, Followed by Psychology and Computer Sciences

The main proportion of respondents (59%, n = 119) had studied ergonomics (fig. 4), even if ergonomics was rarely their initial background. The remaining participants reported no formal education in ergonomics. 13% (n = 27) had a whole education in the Psychology domain, sometime with specialization close to the domain of ergonomics (*e.g.* vocational psychology); 10% (n = 22) reported having an educational background in Computer Sciences, mostly in the area of HCI or cognitive engineering; 6% (n = 13) in design or other engineering area than Computer Science, namely: aeronautics, industrial design, optometry, technical documentation. Finally, 3% (n = 6) of our respondents were from the physiology, medical or therapy domain, and 6% (n = 13) corresponded to "other profiles" with education in sociology, health & safety, communication, business, etc.

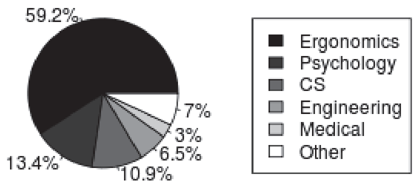

Fig. 4. Educational background of respondents. CS = computer science.

Two Main Orientations in Participants' Activity: Interface Design vs. Health and Disabilities Issues

Usual domains of activity linked to task analysis and task modelling were found in our sample, although not in similar frequencies. The activities found more frequently in the sample were Interface design/specification and Interface evaluation. They were respectively performed often or most often by about 52% and about 50% of the participants. Slightly less frequent but still important, we found system's function design/specification that was sometime or often performed by 52% of respondent. On the other hand, the following activities were performed from never to rarely by more than half of the subjects: design of physical devices, health/occupational issues, system reliability, evaluation of physical devices, training program design and disability-related issues.

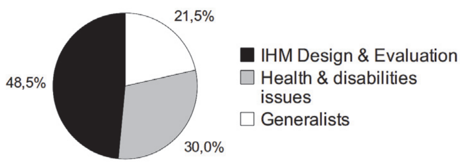

Fig. 5. Orientations in participants' activity.

A hierarchical cluster analysis leads us to distinguish between three groups depending on the patterns of activity (figure 5):

- Participants specialized in interface design, specification and evaluation (49%, n = 97)

– Participants specialized in health and disabilities issues (30%, n = 60)
– Participants that have no dominant domain of activity (22%, n = 43)

Mostly Practitioners and a Few Researchers from Public and Private Areas

Practitioners represented about 71% (n = 142) of the participants while researchers were about 20% (n = 41). Most represented groups were threefold. 31% (n = 63) of respondents were "consultant ergonomist in a consultancy firm", 25% (n = 51) "ergonomist in a private or public company", and 15% (n = 31) "researcher in a public institution". The remaining participants were distributed across "ergonomist in freelance" (7%, n = 14), interface designer and/or analyst (7%, n = 14) and "researcher in a private or public company" (5%, n = 10) and other (7%, n = 14).

What Profile(s) For Participants that Reported To Do Task Modelling?

Analysis of Relative Deviations between participants profile variables and their experience in TM shows that participants currently concerned by the activity of TM are characterized as follows. They are more often researchers in a public institution (*e.g.* university, NASA), or interface designers and evaluators. They have an engineering or a psychological science background and hold a PhD. They have more than 5 years of experience in their job, and work preferentially on the design, specification or evaluation of human machine interface.

Participants Know Essentially the Three Following TDL: GOMS, MAD and HTA

Globally[13], three task modelling languages and methods (considering also their extensions and/or various idioms) are clearly emerging as dominating in our sample:

– GOMS -Goals, Operators, Methods and Selection rules [2]; this TDL is based on a cognitive architecture, GOMS provides task analysts with a tool to predict performance associated with the use of one particular interface. Thus, its main use is in interface evaluation.
– MAD (Méthode Analytique de Description, analytical method of description, [2]); MAD has been designed to analyse and to formalize worker's representation of their goals structure. It is mainly used to extract interface requirements.
– HTA's purpose (Hierarchical Task Analysis, [3]) is to represent how worker actually perform their tasks. It was initially intended to derive training program, but it has been adapted to derive software requirements by [8].

These TDL are respectively known by 31% (63/201), 25% (51/201) and 24% (49/201) of the respondents in the sample (table 1). Other languages are far less known: CTT, TAG, KLM, DIANE+, ETIT, TKS (see [2] for description of these TDL).

The geographical distribution differs according to the known TDL. HTA appeared to be probably the most widely known since it was present in 13 of the 18 countries represented within our sample.

[13] Results are based on the total number of respondents.

GOMS is probably the second worldwide large language of description. It is quoted across 11 countries. MAD showed a specific effect since it appears to be only known in France, in Canada and in Australia in our sample.

Knowing a Task Description Language Does Not Mean It Is Still Used

Although widely known, the 3 methods and languages are not used as often as expected (table 1). In this view, HTA is the most TDL used since 40 respondents declare that they have already used it. Respectively, 31 and 26 respondents declare that they have already used MAD and GOMS. It's worth noting that, despite GOMS is the most widely known TDL, it's one of the less used TDL since only 41% of respondent that know it have actually used it.

Regarding the current use of the most known academic TDL, the number of people that still use one of the 3 widely known method is very low (table 1). Only 16 respondents still use HTA, whereas only 11 and 10 respondents still use MAD and GOMS.

Table 1. Number of responses related to knowing, having already used and still using GOMS, MAD or HTA.

TDL	Known	Already used	Still used
GOMS	63	23	10
MAD	51	31	11
HTA	49	40	16

There is a weak relationship between knowing a TDL and its actual use by participants (Cramer's V2 = 0.01). Looking at Relative Deviations suggested however that some languages differ. Indeed, participants that quote GOMS tended to have actually used it less than for other languages (RD = -.20). Inversely, participants that quoted HTA still use it more than other languages (RD = +.22).

Academic Methods Do Not Seem Adapted to the Participants Needs

Only 23.5% (n = 38) of respondents are currently using some of the formal methods without any modification (figure 6). Most of the respondents that continue to make TM are currently using some adaptations of academic methods (39.5%, n = 64) or are using their own home-made method (37%, n = 60). Results concerning participants who stopped to perform TM are similar.

The main reason reported by participants is that academic methods are not actually adapted to their needs (39.5%, n = 51), either because their use is highly time consuming (13.2%, n = 17), too complex (10.8%, n = 14), or not well adapted to be shown to partners, users/operators (12.4%, n = 16) or generally speaking (3.1%, n = 4). Another reason reported is a lack of training (27%, n = 35) in these methods. It is worth noting that most of the respondents (55.87%, n = 72) didn't find any appropriate response among the suggested ones.

Participants that use an adapted method reported that their main source of inspiration was HTA followed by MAD and GOMS in terms of number of evocation. Moreover, 12 respondents reported several sources of inspirations ranging from two to three academics TDL.

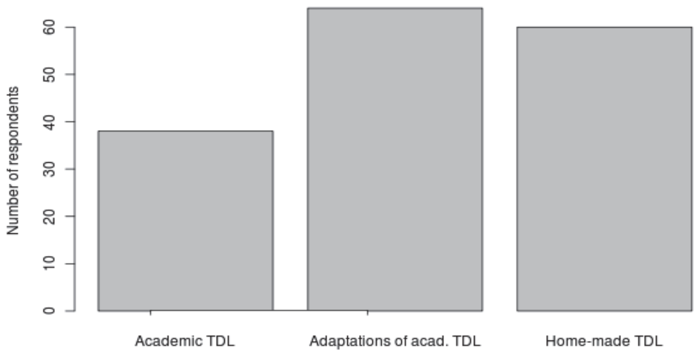

Fig. 6. Type of TDL used by respondents still performing task modelling.

What Is the Profile and Arguments of Participants that Have Never Done Task Modelling and Analysis?

Experience as a Crucial Factor for Doing TM

In our sample, 49 participants have never done TM. These participants are over-represented among the less experienced, *i.e.* those that have less than 5 years of experience (RD = +.40). Inversely, the more experienced ones are less represented (RD = -.30). Participants that have never done TM are thus not skilled task analysts.

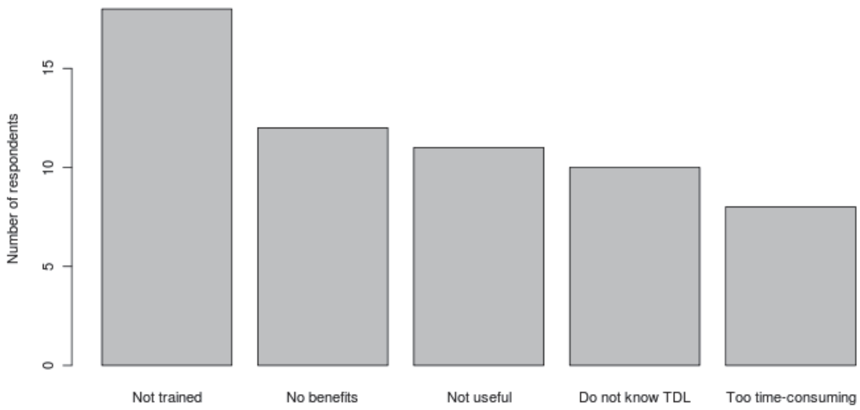

Fig. 7. Reasons for not doing task modelling.

The main reason advocated by participants is that they (figure 7):

– are not trained to use them (49%, n = 18)
– see no benefits of using them in their work (24%, n = 12)
– don't think it's useful for their work (22%, n = 11)
– don't know any TDL (20%, n = 10)
– think it's a too time-consuming activity (16%, n = 8)

Training As a Central Determinant for Doing TM
There is an intermediate link between the fact of knowing formal methods for TM (*i.e.* HTA, MAD, GOMS) and having already performed task models (table 2), V2 = 0.05).

Table 2. Relationships between having already done TM and having reported knowing formal methods.

Knowledge of formal methods	Already done TM	Never done TM	Total
Yes	88	16	104
No	64	33	97
Total	152	49	201

Participants that have never done TM tend to be highly represented among those that have no formal knowledge of formal methods (RD = +.40) whereas knowing formal methods tends to minor the fact of not having done TM (RD = -.37). These participants mention a lack of knowledge or training in TM (57%, n = 28) for not doing so. In fact, only 25% (n = 52) of respondents report to have been trained in TM. Additionally, training reported by respondents appear to vary widely in terms of duration, ranging from 2 hours to 120 hours (mean = 24h, sd = 25, median = 16h), which is quite short for training task modelling techniques.

Participants Who Reported To Have Done Task Modelling: To What Extend and for What Purpose

The advantages of doing TM were rated as follows. Globally, two assertions were rated the highest and in the same proportion (96%, n = 146, agreement vs. 4%, n = 6, disagreement). These are that TM (1) enable the modeller to better understand what operators/users are doing and (2) is a good mean of supporting the discovery of lacking information, fuzziness and uncertainties while analyzing the activity. Slightly less although still highly rated, we found the assertion that task model is a good support to communication with operators/users as well as to with other design participants (91%, n = 138, agreement vs. 9%, n = 14 disagreement). Finally, they were 77% (n = 117) vs. 33% (35/152) of participants agreeing that TM may act as a sort of external memory to store data collected in the field. Although still highly rated, the latter result shows however that such an external memory is not considered as obvious by a third of the respondent, suggesting that it could be the case only in certain conditions.

Starting Point for the Modelling Process
Most of the respondents begin TM before the end of the analysis on the field (78.3%, n = 119), either after the first contact with the field (38.2%, n = 58), or during systematic analysis (40.1%, n = 61). Example of "other" item is "depending on the context" or "during all the stages".

Validation of the Model

Globally, most of the respondents that have already done TM reported to validate the model with operators/users (80%, n = 121). This validation was mostly done by showing the model to the operators/users and correcting it with their assistance (74%, n = 89). Validation was also carried out by comparing what the model "predicts" with what operators/users actually do (52%, n = 63) or what they do in a simulated work environment (40%, n = 49). Almost half of the respondents use only one validation method (47%, n = 57), while 35% (n = 42) use two of them and 17% (n = 20) use the three mentioned. One respondent reported not to use one of the three alternatives.

They are 47% (n = 57) to use a single method. A third of them (31%, n = 37) only interviews users or operators, 9% (n = 11) use only observation, and 8% (n = 10) use only simulation. The remaining 52% (n = 62) used between two or even three methods:

- Interviews and field observations (24%, n = 32)
- Interviews, field observations and simulation (17%, n = 20)
- Field observations and simulation (8%, n = 10)

Model's validation doesn't systematically leads to new field investigations but 38 (31%) respondents report that it's frequently the case and 57 (47%) consider that it is neither frequent nor rare. Only 2 respondents reported to never do further analysis after having carried out a validation.

Task Models As a Design Media To Communicate Between Other team's Members

Most respondents (81%, n = 123) hand out the task models to other members in the design team (*e.g.* during meeting, in deliverables, in requirements documents, etc.). The arguments to do this are to:

- discuss operators' or users' tasks and the appropriateness of the future tool for these tasks (74%, n = 91)
- document the design/evaluation phase of the project (64%, n = 79)
- assert design evaluation, decisions or specification choices (23%, n = 28)

4 Discussion

Formal TDL Are Not Well Known and Are Not Used

A first surprising result of this survey is that formal TDL found in the scientific literature are not known by the participants as we could have expected. Three TDL seems to be better known, namely GOMS, HTA and MAD. Other TDL (CTT, KLM, TKS, TAKD, TAG, DIANE+) are even barely known by respondents. The (lack of) promotion of TDL to students could explain this result, either because these TDL are not known by academics in charge of the training of future task analysts, or either because academics think that knowing one or two of the most popular TDL is enough for future task analysts.

Nonetheless, the fact of knowing a TDL can be questioned: indeed, it may have been interpreted by participants as “well knowing” and not just having received a short academic presentation.

A second surprising result is that even if participants are aware of one or more TDL, they don’t know them well and don’t use them. In our opinion, lack of training is not the only reason for this. As we have mentioned earlier, few of the people who know the academic methods have used them and fewer people still do. Lack of training or knowledge is thus not the only explanation.

Formal TDL Are Not Adapted to the Analysts' Needs

Participants also claim that the use of formal TDL is not adapted to their needs. Main difficulties quoted are that it takes to much time, it requires a lot of expertise, and it’s not easy to communicate to design team members or operators with formal TDL.

Another interesting result is that although most of the respondents reported the use of only one of the academic method listed, we observed that 9 respondents mentioned the use of two or even three different methods. It suggests that features of one TDL are not completely sufficient and require some complements or “enhancements” with features borrowed from others TDL. These uncovered features are probably seen as equally important or interesting by participants. Two different TDL could provide features worth mixing when describing a single model at the same time using features from both languages and model. TDL features can also be complementary (and thus they can require articulation) in the course of the evolving phases of design.

In fact, barely no study has intended to consider how task analysts or ergonomists, in their daily activity, use task models and why, when and how they use them. This kind of study would give useful insights into the design of new TDL adapted to the needs of professional ergonomists. As already stated by [8] we need to use our user-centred design method to help ourselves design TDL fit for their users, *i.e.* our community.

Our study brings few answers to this question. But, as it’s only a survey, it’s not deep enough to give real inputs for the design of new methods.

Productive Use of Task Models Is Not the Only One Use

Task Models Are Used for a Better Understanding of Analysed Work

Respondents think that the construction of task models help them clarify the task they are analysing. Two hypotheses can be made concerning this. First, analysts need to gather several data from many different sources (*e.g.* interviews, observations, etc.). Thus, it may be difficult for them to maintain these data in working memory. Task models can be considered as an information structure to lighten mental workload associated with understanding how people perform their tasks. External representations have been recognized as one central feature in cognitive mechanism associated with problem-solving activities [30, 31, 32]. Secondly, during task analysis, ergonomists build a mental representation of users’ or workers’ tasks. Modelling these tasks is a way of externalizing their representations. Many researches in cognitive psychology show that externalising the representation of any situation enhances our understanding about it [33, 5, 34].

Responses suggest that task models can also be considered as an external long-term memory storing data collected during the task analysis. First, the task models allow analysts to have a retrospective view on the analysis they led and on the knowledge they acquired. Discussions in the HCI community report some similar use of task models [35, 36]. These authors advocate that task models can be used to store all the knowledge acquired on tasks in order to specify system functions that could not have been developed for the system currently designed. Second, the task model can help analysts to have a prospective view on their analysis and all the gap of knowledge that have to be filled. Construction fo the model can help analysts become aware of all the knowledge they lack about worker's or user's tasks. Thus, constructing task models can lead to a more complete task analysis.

Task Models Are Used To Communicate With Design Teams and Workers

Participants in the survey express loudly that they use task models to communicate the results of their analysis (the task models, not the requirements or specifications derived from their analysis). The model is used as an interface between the analysts and project members. First, the model can be shown to workers or users in order to check the validity of the model. In this case, the model is used to confront the analyst's representation of the task of the worker/user with the worker/user's own representation. Thus, the analyst can detect some mismatch between the two. Second, the model is shown to other design team members. It's used to assert some design or evaluation decision. Analysts also use the model to help other designers to understand the worker/users' tasks. Thus, their representation of it can also be closer to the reality. Nonetheless, using a task model this way implies that other designers and worker/users know how to read it. The model is thus a boundary object [37] used to encourage discussions between task analysts, worker/users and other designers.

These non-productive uses of task models, is, in our opinion, the core of why people use task models. They use them to facilitate their daily activity and to communicate with others.

Task Modelling As an Expert Activity

Generally speaking, task modelling seems to be an activity that requires high "expertise". Indeed, in our sample, only experienced ergonomists or human factors experts use TM in their daily activity.

Few studies have reported difficulties about doing TM using formal TDL [9, 10]. In most TDL, tasks are decomposed hierarchically. Authors found that decomposing a task this way is one of the biggest difficulties encountered by students in ergonomics or human factors. Our own experience in teaching TM confirms this. This may mean that students are not encouraged to do TM because of the difficulty of using formal TDL. This may explain why "home-made" TDL are the most used TDL in our study.

Nonetheless, our study suggests another explanation. As non-productive use of task models are not well documented, these are not taught. Thus only experienced task analysts have discovered them during their practice. And, as they don't know formal TDL, they use "home-made" TDL, which are perfectly tailored to their needs.

From the picture this study draws of the actual use of TDL, we aim to engage in a reflective approach for both researchers and practitioners to shorten the distance between techniques developed by researchers and their actual use by practitioners. In our opinion, shortening this distance will allow both practitioners and researchers to produce TDL well tailored for practice. Nevertheless, our study has a severe limitation. We only explore the use of descriptive task models, *i.e.* task models used to described what users or workers actually perform, either with the actual system or with the new one. However, during design, other kinds of task representations are used: prospective task models, *i.e.* task models describing what the users or workers will perform with the new device. Such TDL include UML (Unified Modelling Language, [38]) and scenarios [39]. Maybe descriptive task models are less used than prospective task models during design. Another severe limitation of our study is the listserves used for the call for participation. We only used listserves mainly devoted to academics or to the general SIGCHI community. At the time of the study we were not aware of listserves primarily devoted to practitioners.

5 Some Implications of Our Study and Recommendations Towards the HCI Community

Despite having no scientific evidence on this, we strongly believe that task modelling enhances the practice of ergonomics in design. Two reasons can be given. First, task modelling improves the understanding of task and the completeness of task descriptions. Task modelling is a more systematic way of describing tasks. Second, task modelling is an efficient way of discussing and making other designers understand the tasks of users and operators.

Based on the results of this study, a previous research [7] and our personal experience regarding task modelling, here are some recommendations to improve adoption and appropriation of task modelling.

First of all, TDL need to be more visual. Task models are used to communicate the results of task analysis. However, in most academic TDL, only tasks, their structure and their sequence are visually represented [7]. Crucial information needed to design or evaluate computer systems like triggering conditions of tasks, information needed by users or operators are hidden. This reduces the utility of academic TDL. Home-made TDL collected in our previous study [7] exhibit information needed by ergonomists to design or evaluate systems.

Most dedicated software applications (*e.g.* Euterpe for GTA) are not tailored to the actual use of task models, they lack some basic functions. Even if this is related to the drawbacks of academic TDL mentioned previously, these software applications need the support of communicating functions like printing and exporting task models.

Nonetheless, enhancement of academic TDL and task modelling software is not sufficient. We need to train students to the use of task modelling. However this training must not only focus on productive use of task models, it should increase student awareness towards their non-productive use discussed previously in the paper.

Acknowledgement

The authors would like to thank all participants. This research has been partially funded by the French National Funding Agency (ANR) in the context of PERF RV2 and V3S projects.

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