Goal Elicitation Heuristics Anchored on a Thinking Frame

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***Abstract*—. Eliciting goals, a non-trivial task, is a challenge to Goal Modeling. Central to our concept of goal is the understanding that a goal is about the future. It is a point, in the timeline, at which actors are motivated to reach. This paper uses qualitative argumentation to justify how a thinking frame helps goal elicitation towards modeling. We present the roadblocks of goal elicitation, the usual strategies for goal elicitation, the IRES Thinking Frame, and an example of goal elicitation heuristics.**

Keywords — goals elicitation, GORE, intentionality, iStar framework, IRES, model-driven requirements

I. INTRODUCTION

It is not a surprise that the concept of abstraction is fundamental to modeling. However, Kramer [1] noticed that "*The ability to perform abstract thinking and exhibit abstraction skills*." is the determining factor to distinguish among those computer science students who perform better in designing from those who do not. We agree with Kramer and notice this difficulty from our experience in teaching conceptual modeling to undergraduates and graduate students, especially in the case of goal modeling.

Modeling goals require that we have goals. However, goals are seldom explicit in the Universe of Discourse[1] (UofD). As such, how would modelers get knowledge about goals? A straight answer: they are told which are the desired goals. Well, the problem is that not only that the answer assumes that goals are given, but also with the ability of humans to deal with the goal concept.

Although, in Requirements Engineering (RE), there is a clear distinction between modeling and elicitation; modeling and elicitation are **intertwined**. Notwithstanding, methods, techniques, and tools for elicitation are distinct from methods, techniques, and tools used for modeling. Modeling is anchored in artificial languages, while elicitation is anchored in natural language. The literature also recognizes that elicitation is more akin to social sciences while modeling is more akin to computer science. The intertwine of elicitation and modeling is characterized by the analysis (Verification & Validation) feedback, which helps the **elaboration** of the resulting models.

Regarding elicitation, it is important to keep in mind that information sources [3] are not limited to people. Information may be gathered, for instance: from texts, from locale, and from the software ecology. Consequently, requirements elicitation uses a myriad of techniques beyond interviews or meetings.

As such, when building models, modelers must have knowledge of the desired goals, and be familiar with the modeling of goals. The paper aims to supply heuristics to help both goal elicitors as well as goal modelers. Heuristics are qualitative by nature and have been helpful to social workers [4] and software designers [5]. Although heuristics help, they pose a threat, since they are not guaranteed to work in all situations.

Our focus is presenting a thinking frame that supports goal elicitation in relation to other high-level concepts. Using the concepts and their relations as a basis, the frame helps reasoning about goals and supports heuristics creation.

Independent of who performs it, elicitation is needed to find which are the desired goals. However, goal elicitation is not trivial, which is derived from the fact that dealing with abstraction is far from being a general characteristic of people that populate the Universe of Discourse.

As mentioned in the first paragraph of this Section, dealing with abstraction is also a problem for some computer science students. We add that this is also a case for software practitioners since we understand that goal modeling is a paradigm shift, similar to the one observed in the introduction of object orientation.

This paper is organized as follows: we deepen into the obstacles of goal elicitation in Section II. Section III reviews

[1] "The overall context in which software will be develop and operated. The UofD includes all the sources of information and all the people related to the software. It is the reality trimmed by the set of objectives established by those demanding a software solution." [2].

related literature. Section IV gives a description of the IRES method and of the Thinking Frame. Section V uses a new set of heuristics for dealing with goals. Section VI discusses the practical effects of these heuristics and their limitations. Section VII concludes, stressing the contributions.

II. RELATED WORK

Distinct approaches have been taken to deal with goal elicitation on different areas of computer sciences [7], [8], as well as in other areas [9].

It is important to consider the fact that some proposals are grounded on representation languages, where there is a close intertwining between elicitation and modeling, while others focus on elicitation of concepts, without relying on a particular representation language. As such, the literature proposes independent elicitation heuristics, modeling dependent heuristics, or a combination of the two.

Usually, the independent elicitation proposals are focused on the general concept of a goal, which is related to higher abstractions in contrast to dealing with a goal in relation to actions (operationalizations). We will use the term High-Level Goals to address these higher abstractions.

Regev and Wegmann [10] is representative of elicitation of High-Level Goals, and lists the following techniques, based on earlier literature: a) "*Understanding stakeholders' problems and negating them; b)* Extracting *intentional statements from interview transcripts, enterprise policies, enterprise mission statements, enterprise goals, workflow diagrams, scenarios written with stakeholders.; c) Asking "How" and "Why" questions about these initially identified goals in order to go up and down the goal hierarchy.; d) Asking "How else" questions to identify alternative goals."* [10]. Note that [10] uses previously available knowledge to gather high-level goals, while [7] targets mining towards modeling with the KAOS language.

Collete and Salinesi [11] make explicit the close intertwining of modeling and elicitation. They say: "goal modeling proved to be an effective way to elicit requirements". Leiter [12] provides a series of detailed techniques/heuristics to elaborate "requirements constructively from high-level goals", within the context of the KAOS language. Other examples of intertwining are the works of Casagrande et al. [7], which use a bottom-up strategy (text mining available documents), and Oshiro et al. [8], which use a top-down strategy based on idea generation and a goal graph refinement.

It is interesting to note that goal elicitation in other areas; in medicine, Mertz et al. [9] say: *"Goal elicitation is challenging for physicians as previous research has shown that patients do not bring up their goals on their own."* However, they [9] proposed a new method for dealing with eliciting goals from patients, but do not give details.

In [13], the authors use an open questionnaire (qualitative) asking "*…patients to write down what they wanted to achieve in their daily life, the priority of each goal, and the extent to which asthma made it difficult to achieve those goals*.".

Given the literature that we revised, we could not find a structure of thought that could help stakeholders (elicitors, informants, and modelers) better understand the nature of the goal concept, without relying on goal taxonomies. We also observed that there is a lack of detailed heuristics to elicit High-Level Goals.

III. DIFFICULTIES IN DEALING WITH GOALS

We will tackle the difficulties in dealing with goals, by addressing different classes related to these difficulties.

A. Abstraction

First, as we have argued, abstract thinking is a skill that is not widespread. On top of that, goals are abstract by nature and per se do not change anything, that is it is not an action. This aspect makes it hard to apply any observational anchoring toward goals.

Their lack of materialization makes it difficult for people to link it to the real world.

Notwithstanding, it is possible to educate people on abstract thinking. First, it is necessary that the concept be understood. Second, there are methods, techniques, and tools that help the familiarization with the concept. Third, educators must check the comprehension of the concept by analyzing the use of methods, tools, and techniques in reference to the goal concept.

B. Function/Data Orientation

There is a tradition in computer science education and in real-world practice to understand computing as a way of changing data. That is, the focus is on capturing the actions in the real world and the data that is related to these actions. Contrary to the notion of goal, actions and data are anchored in the real world. Things change in the world since a function (action) is applied to those things. So, verbs reflect the functions, and we may observe the effects of enacting verbs.

On the other hand, it is easier to connect data with objects in the real world. So, because an object usually has a life cycle, it is easier to anchor the data with reality: an object is created, an object is changed, and an object is discarded. The culture of data and function may also be considered a hindrance to the perception of goals since it is easier to rely on those concepts.

Naturally, the law of less effort also contributes to the problem. It is easier to think about actions than about goals. In some goal models, it is common to see verbs naming goals. It is a collective understanding, that this roadblock leads to systems being reformulated again and again until it reaches a point that is satisfactory to clients.

C. The Limits of Why

In the requirements literature, we often see the reference to the 5W1H for helping elicitation. Information sources are queried based on these questions to better understand the Universe of Discourse. Different authors have relied on the Why question to get to goals. However, the Why question is not straightforward, since it requires a shift in reasoning about something, and sometimes poses a challenge for humans as information sources, who may understand the Why as a personal

inquiry [4]. Becker [4] argues that it may be better to get to the Why by asking How in this kind of situation. Another aspect of the Why question is that it relies on operationalizations, so may hinder abstraction. On top of that, direct questioning for gathering information requirements is prompt to problems. This was observed by Wetherbe [14], who proposed an indirect way of questioning, using conceptual frames.

D. *Viewpoints*

Another roadblock to be considered is that there are different viewpoints [15] in a given Universe of Discourse. Elicitation from diverse sources is a way of finding conflicts early on, which may be beneficial from multiple sources of knowledge. However, there is a cost associated with managing these conflicts.

In goal elicitation, the challenges are similar, but there is an inverse opportunity. The lack of conflict is positive since there is agreement over an abstract concept, and the chances of it being a goal are improved. We must consider that, usually, disagreement happens, more often, on the way of doing something.

IV. IRES

The Intentional Requirements Engineering Strategy (IRES) treats the main conceptual parts of building an iStar-based goal model, which are: elicitation (elicit goals, identify SDsituations), modeling (model dependencies, model rationale, specify requirements), analysis, and management (based on an active Baseline). It is important to stress that IRES has an evolving circle centered on a Baseline, so steps are mentioned for the sake of separation of parts. That is not to be confused with a process that is stepwise. Elicitation evolves together with modeling in constant interaction.

The emphasis of this paper is not on the IRES process, but on how to deal with the goal concept, from a high level of abstraction. We understand the goal concept as stated by Yu:

> "*A goal is a condition or state of affairs in the world that an actor would like to achieve*". [16].

As such, we understand a goal as a vision for the future.

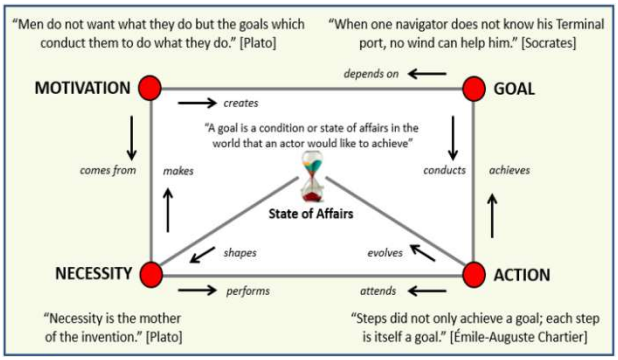

Figure 1 -The IRES Thinking Frame [17]

The IRES Thinking Frame (Figure 1) is grounded on a philosophical frame [17] based on insights from Émile-Auguste Chartier, Socrates, and Plato. It helps humans to reason on the connection of less abstract concepts with a goal. The reasoning is supported by straight relations (common sense) between the concepts. By opposing the concept of a need to a solution to the need, an action, is yet another justification for the relations **attends** and **performs** in the bottom of the thinking frame. Similarly, "A goal is a condition or state of affairs in the world that an actor would like to achieve" [16] justifies the relations **creates** and **depends on,** since "would like to achieve" is a motivation, which leads to goal.

The Frame is centered on the State of Affairs and uses four corners (concepts) that interact mutually: 1) Motivation, 2) Goal, 3) Action, and 4) Necessity. It is important to **note the difference** between the concepts State of Affairs and Goal. A Goal is the desired future state, whilst the State of Affairs refers to the present state. The Frame is a "Multi-loop, Multi-level Feedback", meaning it is in constant evolution. It is used to better explain the mechanism of intentionality and its impact in the Universe of Discourse from the point of view of Goal Oriented Requirements Engineering (GORE). The Frame allows the thinking process to go ahead in different directions. The Frame can be used clockwise or counterclockwise. It can depart from any node (concept).

For instance, departing from Motivation, clockwise, the frame posits that Motivation **creates** a goal. The Goal **conducts**[2] to one or more Actions. An Action **attends** a necessity, as well as **evolves** a State of Affairs. A State of Affairs **shapes** Necessity. Necessity **makes** Motivation. If departing from Necessity, counterclockwise, the frame posits that a Necessity **performs** Actions to **achieve** a goal. The goal **depends on** motivation, which **comes from** necessity. Different actions may achieve a goal. There is a circular reasoning in the Frame that follows the reasoning used in the chasing diagrams of Category Theory [18], which will be explored in future work.

V. Elicitation Heuristics

We used the IRES Thinking Frame as the argument for the creation of elicitation heuristics that help the elicitation of goals. We will exemplify some of these heuristics for a Conference Management System. The heuristics are organized in three classes. One that elicits high level goals, other centered on the vocabulary of the Universe of the Discourse, and another that deals with the feedback from the application of the first two.

A. *High Level Goals*

High-level goals are a generic term that refers to abstract goals, usually associated with the macro-system, which are goals that are either established in the Universe of Discourse, by some system that will encompass the software system, then the term macro-system, or that exists in the Universe of Discourse but were not systematized as macro-systems goals.

We propose two sets of examples of heuristics for high-level goals. The first one is based on the Frame. The second is based

[2] We choose the verb conduct with the context of classic music: an orchestra conductor directs an ensemble of musicians, selecting which instruments will be played at a given time. In our case this is to reflect that case that a goal may have different **choices of actions** to achieve it. In goal modeling this is achieved by the OR operator of a goal graph.

on reusing earlier catalogued quality goals, which is the NFR catalogues [19]. In the first case, we use either Motivation, Necessity, or Action as a start point in the Frame, as to find Goal. and proposed heuristics combining the frame with general interrogative questions [20]. In the second case we reuse available NFR catalogues.

B. Vocabulary (Lexicon)

IRES mandates the construction of an application lexicon, which aims to register the vocabulary of the Universe of Discourse. The lexicon [21] is composed of symbols of four types: subject, verb, object, and state. Since they must be achieved, the heuristics target states, connecting to a goal to be achieved. Softgoals identification is centered on finding quality (adjectives) used in describing verbs that relate to a state or in the description of states.

C. Feedback Heuristics (Checking the Elicited Goals)

The last class is composed of heuristics that combine the earlier ones and use them for elaboration, refinement, of an existing model. This is akin to the advice of Bostrom [22] with his Precision model, a feedback strategy to check mutual understanding in communication among stakeholders. As mentioned in the Introduction, an analysis (V&V) process is grounded on feedback. It also reuses the concept of iStar diagnosis checklist [23].

D. Conference Management Example

Figure 2 shows a first SR model [16] for part of a Conference Management System. It was built with the help of the first type of heuristics. In the case of Goal *Article be Reviewed* we use the following heuristics with stakeholder Conference Chair: **a**) "From Necessity, Question stakeholders to make an association from their top needs with the reason (motivation) for these needs.". This led to the Motivation*: Having a Conference Program*. ; **b**) "From Motivation, Ask stakeholders what the evolution/development of the product will create in terms of future achievements (it may be a goal)." This led to the Goal *Article be Reviewed,* which will be executed by a Reviewer. From this goal we used the Frame relation **conducts**, which led to the task (Action) *Review Article.* We confirm this Action by applying the relation **performs**.

As for the case of the Softgoals, we used the second type of heuristics with stakeholder Reviewer: "Bring up qualities in the list and ask about their relevance to the evolution/construction of the product.". We may also have used the first set, to gather quality goals (Softgoals). The linking of these Softgoals to the task (Action) *Review Article*, follows the same rationale of using the Frame relations **conducts** and **performs**. The contribution link (hurt) is reused from the catalog.

It is interesting to note that the task *Review Article* is abstract. As such, we use the Frame to find out that there is a Necessity to *Have the Article,* which **makes** the Motivation *Obtain the Article* which **creates** the Goal *Article be Received*.

The entity resource in i* reflects part of the State of Affairs, since it is static, so in Figure 1 *Review* is a resource. The task (Action) *Review Article* **evolves** the State of Affairs.

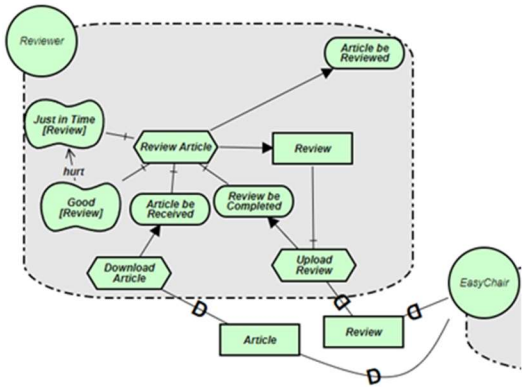

Figure 2 -The Partial Model

Figure 3 shows a revised SR model, which was enhanced by the third type of heuristics in combination with the first type. In this case we applied two heuristics with the stakeholder Reviewer: a) "From Goal: Examine if there is something that can improve or give an advantage to the goal.", and b) "From Action: Consider if alternative actions may be executed for achieving the goal.". Applying a) we got a Reviewer Necessity: *Someone to Help,* and a Motivation: *Support Productivity*, which led to the Goal (Softgoal) *Save Time*. Applying b) the Reviewer brought up the opportunity of a sub-reviewer, leading to the Action: *Invite Sub-Reviewer*, as an alternative to the Goal *Article be Reviewed*.

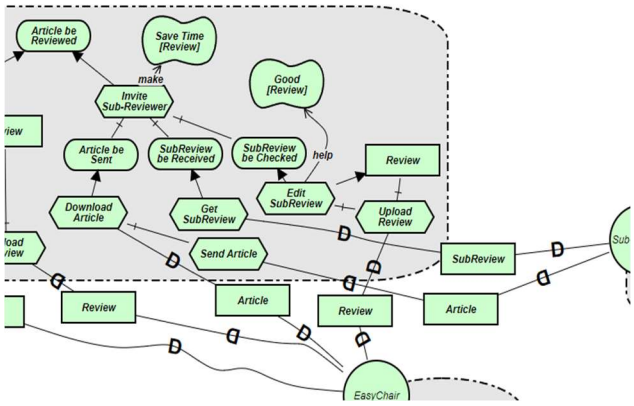

Figure 3 -The Revised Partial Model

Likewise, the rationale shown for Figure 2, we took the abstract task *Invite Sub-Reviewer*, and used the Frame to bring out the Softgoals (Goals): *Article be Sent*, *SubReview be Received* and *SubReview be Checked*.

The Vocabulary heuristics are used in both the initial and the revised model, one example is the heuristic: "Each symbol of the state type is a goal candidate, write it in the table using the passive voice to represent the goal that should be achieved.".

VI. DISCUSSION

Heuristics are, by definition, qualitative practices. As such, there is a challenge in gauging them in terms of efficiency. However, they are considered, in general, to contribute to the efficacy of elicitation. The appropriateness of the heuristics used in this short paper is based on the example of a well-known

application. Future work will bring a more complete set of heuristics, as well as deepen the argumentation for their appropriateness.

The novelty of our contribution is the IRES Thinking Frame (Figure 1). It is based on our lasting experience in researching intentional modeling, as well as our work as educators in both undergraduate and graduate courses. As such, it relies on extensive literature we had the opportunity to learn from. On top of that, the insight that the thinking frame could use similar reasoning practices, as in chasing diagrams, provides a reasonable support for our contribution.

The use of the Frame in the creation of heuristics was based on argumentation, which relied on the Frame's circular reasoning. We are investigating its relation to the reasoning used in the chasing diagrams of Category Theory. Initial results show shows that there is a metaphor among the Frame and the chasing diagrams.

As it is now, the set of example heuristics are general and not guided to specific domains. Of course, that experimental work may be developed to check the extent of positive results in applying a given set of heuristics. However, such type of study is problematic due to its qualitative nature, which depends on who uses it, how it is used, as well as the number of subjects which will be engaged.

VII. CONCLUSION

Goal elicitation is treated by different authors in software engineering/requirements engineering. We have found a lack of depth in the discussion of goal elicitation from the literature, with a preponderance of direct questioning, which is not proper to get to goals

Our paper brings out the challenge and points out the use of heuristics to enable goal discovery based on a thinking frame. It contributes to the discussion of goal elicitation by first explaining why goal elicitation is challenging, and by reviewing different strategies to tackle the problem. Second, we propose top-down (from IRES Frame), bottom-up (Vocabulary), and middle-out (Feedback) strategies.

Our discussion of the goal concept is centered on the interweaving of elicitation and modeling, it is about the elaboration of models. A better understanding of the concept of goal empowers modelers to better use the goal-oriented language of choice.

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REFERENCES

[1] Kramer, J. "Is Abstraction the Key to Computing?" Communications of the ACM, April 2007, Vol. 50 No. 4, Pages 36-4210.1145/1232743.1232745G.

[2] J. Leite, G. Hadad, J. Doorn, and G. Kaplan. "A Scenario Construction Process.", Requirements Engineering Journal, 5(1):38-61, 2000. Springer-Verlag.

[3] do Prado Leite, Julio Cesar Sampaio, Edson Andrade de Moraes, and Carlos Eduardo Portela Serra de Castro. "A Strategy for Information Source Identification." WER. 2007.

[4] Becker HS (1998) Tricks of the trade: How to think about your research while you're doing it. University of Chicago Press.

[5] Parnas, D. "On the criteria to be used in decomposing systems into modules," Commun. ACM, vol. 15, Dec. 1972.

[6] Van Lamsweerde, Axel, and Emmanuel Letier. "From object orientation to goal orientation: A paradigm shift for requirements engineering." International Workshop on Radical Innovations of Software and Systems Engineering in the Future. Springer, Berlin, Heidelberg, 2002

[7] E. Casagrande, S. Woldeamlak, W. L. Woon, H. H. Zeineldin and D. Svetinovic, "NLP-KAOS for Systems Goal Elicitation: Smart Metering System Case Study," in IEEE TSE, 2014,

[8] K. Oshiro, K. Watahiki and M. Saeki, "Goal-oriented idea generation method for requirements elicitation," Proceedings. 11th RE, 2003, doi: 10.1109/ICRE.2003.1232787.

[9] Mertz K, Shah RF, Eppler SL, et al. A Simple Goal Elicitation Tool Improves Shared Decision Making in Outpatient Orthopedic Surgery: A Randomized Controlled Trial. Med Decis Making. 2020;40(6):766-773. doi:10.1177/0272989X20943520.

[10] Regev, Gil, and Alain Wegmann. "Where do goals come from: the underlying principles of goal-oriented requirements engineering." 13th RE. 2005.

[11] Rolland, Colette, and Camille Salinesi. "Modeling goals and reasoning with them." Engineering and managing software requirements. Springer, Berlin, Heidelberg, 2005. 189-217.

[12] Letier, Emmanuel. Reasoning about agents in goal-oriented requirements engineering. Diss. PhD thesis, Université catholique de Louvain, 2001.

[13] Hoskins, Gaylor, et al. "Achieving Good Outcomes for Asthma Living (GOAL): mixed methods feasibility and pilot cluster randomised controlled trial of a practical intervention for eliciting, setting and achieving goals for adults with asthma." Trials 17 (2016).

[14] Wetherbe, James C. "Executive information requirements: getting it right." Mis Quarterly (1991): 51-65.

[15] Leite, J. C. S. P. "Viewpoints on viewpoints". (Viewpoints '96) on SIGSOFT '96. https://doi.org/10.1145/243327.243682.

[16] Yu, E.; Modelling Strategic Relationships for Process Reengineering. Ph.D. Thesis, Graduate Department of Computer Science, University of Toronto, Toronto, Canada, 1995, pp. 124.

[17] Oliveira, A.P.A, Werneck, V.M.B., Cysneiros, L.M., Leite, J.C.S.P. "The Philosophy Behind IRES, an Intentional Requirements Engineering Strategy", 24th WER, 2021.

[18] Goguen, Joseph A. "A categorical manifesto." Mathematical structures in computer science 1.1 (1991): 49-67.

[19] Cysneiros, L.M. "Evaluating the Effectiveness of Using Catalogues to Elicit Non-Functional Requirements". 10th WER, 2007.

[20] M. Sultan and A. Miranskyy, "Ordering interrogative questions for effective requirements engineering: The W6H pattern," 2015 5th RePa, 2015, pp. 1-8, doi: 10.1109/RePa.2015.7407731.

[21] Antonelli, L, Rossi, G., Leite, JCSP, Oliveros, A. "Deriving requirements specifications from the application domain language captured by Language Extended Lexicon", 12th WER, 2012.

[22] Bostrom, R.B. Successful application of communication techniques to improve the systems development process, Information & Management, 1989 doi.org/10.1016/0378-7206(89)90005-0

[23] Oliveira, Antonio de Padua Albuquerque, Julio Cesar Sampaio do Prado Leite, and Luiz Marcio Cysneiros. "Using i* Meta Modeling for Verifying i* Models." iStar. 2010.