# Interactive Analysis of Agent-Goal Models in Enterprise Modeling

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## ABSTRACT

*Understanding and analyzing the needs of an enterprise in the early stages of a project requires knowledge about stakeholders, their goals, interactions, and alternative actions. Agent-goal models offer a way to systematically and graphically capture this information, even as it evolves through continued elicitation. However, the complexity of resulting models makes it difficult to evaluate the achievement of key stakeholder goals within a model without applying systematic analysis procedures. Existing approaches to agent-goal model evaluation focus on automated procedures, without explicitly promoting model iteration and domain elicitation. In this paper, the authors argue that "Early" Enterprise modeling requires analysis procedures that account for the incompleteness and informality of early agent-goal models, facilitating iteration, elicitation, and user participation. A qualitative, interactive evaluation procedure for agent-goal models is introduced, using the i* Framework illustrated. Case study experience and results of an exploratory experiment show the applicability of the procedure to early enterprise analysis.*

*Keywords:* *Agent Oriented Models, Enterprise Modeling, Information Systems Modeling, Goal Modeling, Goal Oriented Models, Model Analysis, Requirements Modeling*

## INTRODUCTION

The success of an enterprise is often affected by intangible, abstract goals which play a role in achieving customer, colleague, and employee satisfaction, and which typically depend on the actions of other parties. Goal- and Agent-Oriented Modeling frameworks, such as i* (Yu, 1997), have been introduced in order to model and explore socio-technical domains including actors or stakeholders, their goals and responsibilities, dependencies and alternatives. This approach was initially aimed as a first step in a system development process, as part of "Early" Requirements Engineering (RE), but it is also applicable to the early stages of modeling and understanding an enterprise, including its internal operations and relationships to the external environment. Such "Early" Enterprise Modeling (EM) can be used to understand the objectives of stakeholders, explore alternative courses of action, analyze their impacts, assess whether stakeholder objectives are met, make

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tradeoffs among competing goals, and facilitate organizational decision making.

Consider an example enterprise: a not-for-profit organization that provides counseling for youth over the phone, but must now also offer counseling via the Internet. Online counseling could be viewed by multiple individuals, and may provide a comforting distance which would encourage youth to ask for help. However, in providing counseling online, counselors lose cues involved in personal contact, such as body language or tone. Furthermore, there are concerns with confidentiality, protection from predators, public scrutiny over advice, and liability over misinterpreted guidance. How can such an organization explore and evaluate options for online counseling, balancing the needs of multiple parties?

Goal- and Agent-Oriented Models (agent-goal models) which capture such socio-technical situations often form a complex web of relationships, with alternatives in the model contributing positively or negatively to certain goals, which themselves contribute to other goals. It is useful to assess the level of achievement of a goal in the model when a particular alternative is selected by considering the positive or negative evidence a goal has received via relationships with other goals. However, when a model contains multiple, multi-step relationship links, it can be difficult to trace the effect of a particular alternative on the satisfaction of one or more goals. There is a need for systematic analysis procedures which consider the effects of alternatives throughout the goal network, providing a consistent way to assign goal achievement levels via propagation along the links.

Models developed to consider enterprises at the goal level are often informal and incomplete, focusing on "soft" goals, such as customer satisfaction, which are difficult to precisely define. Such models are intended to be used as sketches, interactive recordings of an ongoing discovery process involving stakeholders and analysts. As the stakeholders express their viewpoints, as discussions occur, and as analysts learn more about the domain, such models undergo continuous change.

A number of analysis procedures for analyzing goal models have been introduced (e.g., Giorgini et al., 2004; Amyot et al., in press; Letier & van Lamsweerde, 2004; Franch, 2006). However, these procedures have focused on automated reasoning, placing more value in the results of the analysis than in the interactive process of analyzing and exploring the model. An ideal analysis procedure for Early RE or EM agent-goal models would consider the informal and incomplete nature of such models, would facilitate iteration and domain exploration, and would be simple to apply. Our experience has shown that interactive, qualitative evaluation allows for the use of domain-specific knowledge to compensate for model incompleteness, and encourages an interactive process of inquiry over the domain.

In this work we introduce a qualitative, interactive evaluation procedure for goal- and agent-oriented models, allowing the user to compare alternatives in the domain, asking "what if?" type questions. Alternatives can include alternative system or process design choices, or alternative courses of actions, capabilities, and commitments. We present the procedure informally, using prose, to facilitate easy understanding and optional manual application. We introduce a sample methodology using this procedure to guide users through the process of modeling and evaluation. Although the procedure has now been implemented in the open-source, Eclipse-based OpenOME tool (OpenOME, 2009), past case studies involved manual application of the procedure. The procedure is presented in terms of the i* Framework; however, the procedure could be applied to other agent-goal models, such as those created using the NFR Framework (Chung et al., 2000) or GRL (Amyot et al., in press).

The procedure and variations of the sample methodology have been tested in case studies, including an analysis of the intentions behind controversial new technology (Horkoff et al., 2006) and a long-term project involving a large social service application (Easterbrook et al., 2005; Strohmaier et al., 2007; Strohmaier et al., 2008). Case study experience shows that the pro-