Towards Modelling Strategic Actor Relationships for Information Systems Development – with Examples from Business Process Reengineering*

Eric S. K. Yu and John Mylopoulos
Department of Computer Science, University of Toronto
Toronto, Ontario, Canada M5S 1A4

1 Introduction

As business environments continue to undergo rapid change, it is becoming increasingly important for information system developers to have a good understanding of the business environment for which their systems are being developed. Formal models that capture and organize knowledge about a business environment can facilitate understanding, and associated tools can support the rapid translation of formally expressed requirements to design specifications and to implemented systems [Jarke92].

The importance of being able to clearly link information technologies and systems to business goals and objectives is highlighted by the recent concept of business reengineering (e.g., [Hammer90] [Davenport93]). In response to competitive pressures, customer demands and changing regulatory conditions, many companies are fundamentally rethinking the way they do business. Information systems are expected to contribute towards innovative solutions to specific business problems, and not merely to implement well-known solutions.

For example, in the area of claims processing, insurance companies are no longer content with information systems that simply automate well-established process steps. Instead, information systems are called upon to contribute to the overall redesign of the claims handling process. The questions that drive the process redesign effort might include:

- Why does it take so long to have a claim settled after an automobile accident?
- Why does the company hire appraisers to assess damages?
- How else can claims be settled?
- What other concerns would arise if these new ways for handling claims are to be adopted?

Traditional system analysis techniques such as structured analysis and entity-relationship modelling focus on the modelling of activities and entities. While these are important for systems development, they offer little help in the search for innovative alternative solutions to business problems, and what enabling roles information systems can play in these new business configurations. Existing models have been designed for describing *what* a business process is like, but they cannot express *why* the process is the way it is. The motivations and intents and rationales behind

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the activities and entities are missing from these models. Most business processes involve many participants or players, with complex relationships among them. These relationships are strategic in the sense that each party is concerned about opportunities and vulnerabilities, and seek to protect or further their interests in an attempt to redesign the process.

In the insurance example, the insurance company wants to minimize the payout to claimants, that is why appraisers are hired to keep repairs to the necessary minimum. At the same time, the insurance company wants to keep customers happy so that they continue to renew their policies. Car owners want repair damages to be assessed fairly, and are likely to get body shops to give repair estimates that maximize the insurance payout. What information is collected and used by the claims representative (accident particulars, witness statements) and the appraiser (e.g., photographs of damage, multiple repair estimates) reflects the strategic interests of the various parties.

Since information systems increasingly are used to alter strategic relationships, analysts need to be able to describe these relationships, and to propose and argue about solutions from strategic perspectives. Currently there is little formal support for this kind of reasoning. Business process reasoning is usually done informally, and are hard to relate to technical system alternatives.

The i^* framework has been developed to help support process modelling and reengineering [Yu94d]. Processes are taken to involve social actors who depend on each other for goals to be achieved, tasks to be performed, and resources to be furnished. The framework includes a Strategic Dependency model – for describing the network of relationships among actors, and a Strategic Rationale model – for describing and supporting the reasoning that each actor has about its relationships with other actors. The models are formally represented in the conceptual modelling language Telos [Mylopoulos91] and their semantics are based on intentional concepts such as goal, belief, ability, and commitment (e.g., [Cohen90]).

The framework has been presented earlier in the context of information systems requirements engineering [Yu93b], business process reengineering [Yu93a] [Yu94a] [Yu94c], and software processes [Yu94b]. In this paper, we emphasize the need for analysts to link information system decisions to strategic business reasoning, using an example from business reengineering.

2 The Strategic Dependency Model

A Strategic Dependency model is a graph, where each node represents an *actor*, and each link between two actors indicates that one actor depends on the other for something in order that the former may attain some goal. We call the depending actor the **depender**, and the actor who is depended upon the **dependee**. The object around which the dependency relationship centres is called the **dependum**. By depending on another actor for a dependum, an actor is *able* to achieve goals that it is otherwise unable to achieve, or not as easily or as well. At the same time, the depender becomes *vulnerable*. If the dependee fails to deliver the dependum, the depender would be adversely affected in its ability to achieve its goals.

For example, a car owner can have his car repaired by a body shop, even if he does not have the ability to do the repairs himself. However, he is vulnerable to the car not being repaired.

The model distinguishes among four types of dependencies – goal-, task-, resource-, and softgoal-dependency – based on the type of freedom that is allowed in the relationship between depender

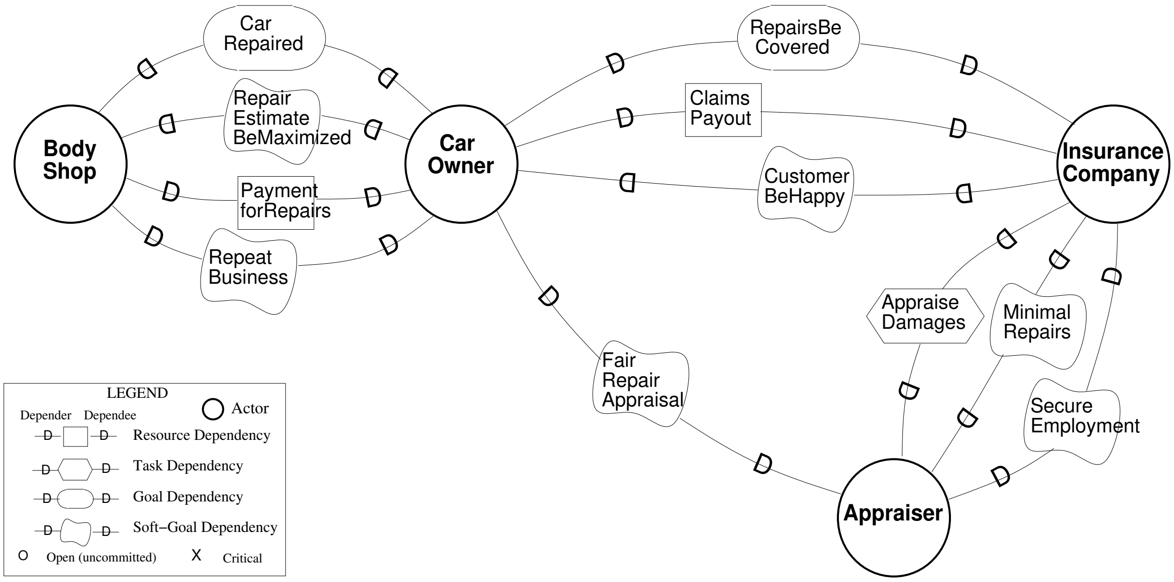

Figure 1: *Strategic Dependency model of traditional auto insurance (the "as-is" arrangement)*

and dependee. Three levels of dependency strengths are distinguished based on the degree of vulnerability [Yu93a].

Figure 1 shows a Strategic Dependency model for a traditional automobile insurance business configuration. The car owner depends on the insurance company to reimburse for the repairs from an accident (ClaimsPayout). For this, car owner pays insurance premium in order to have coverage (RepairsBeCovered). The insurance company wants to offer good service to the customer in order to keep the business (CustomerBeHappy). To maintain profitability, the company depends on appraisers to appraise damages so that only the minimal necessary repairs are approved.

The car owner depends on the claims appraiser for a fair appraisal. However, the appraiser can be expected to act in the interests of the insurance company because of his dependence on the latter for continued employment. The car owner, in turn, can depend on the body shop to give an estimate that maximizes the car owner's interests, since the body shop depends on the car owner for repeat business. An analysis of strategic dependencies at a more detailed level would reveal the role of information and information systems in these relationships [Yu93b].

Information systems that support the claims process have this kind of understanding entrenched as implicit assumptions. These assumptions are seldom made explicit during IS development because existing modelling techniques do not encourage or support the modelling of relationships that involve intentional concepts. Without this deeper understanding, it is difficult to evolve information systems to meet changing needs, as evidenced by the problem of "legacy systems". With rapid changes in business environments, and recent management concepts such as business reengineering, well-entrenched relationships are being re-examined and radically reconfigured. Traditional business patterns and assumptions can no longer be taken for granted.

Hammer and Champy ([Hammer93] pp. 136-143) describes a hypothetical but plausible scene in which a process redesign team explores new innovative solutions to revitalize an automobile insurance business. Since it costs as much to process a small claim as a large claim, one way to reduce administrative costs is to reduce insurance company involvement in dealing with small

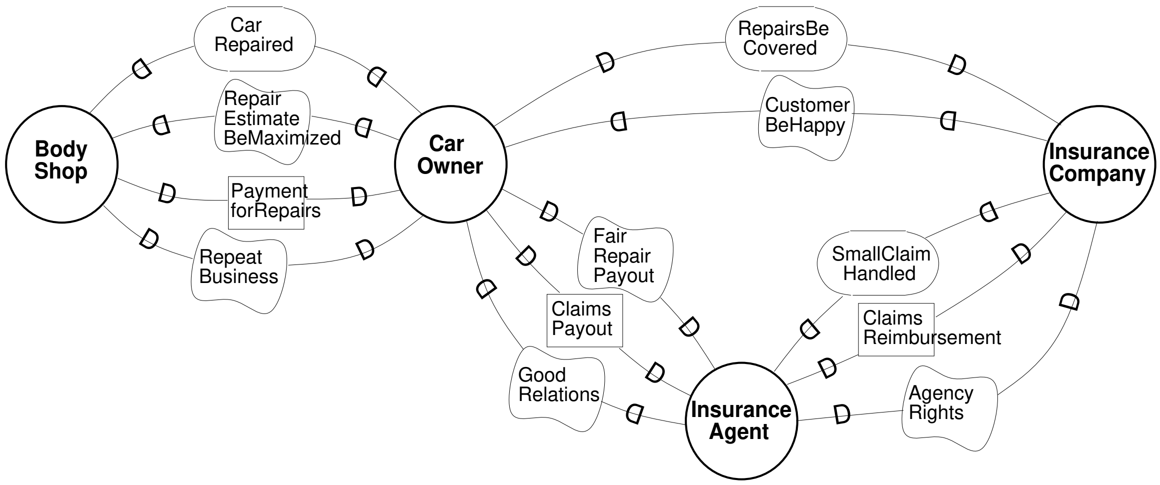

Figure 2: *Strategic Dependency model for alternative 1 – "Let the insurance agent handle it"*

claims. "Why not let the insurance agent handle small claims?", it was suggested. The insurance agent will do all the inquiry and payout, while the insurance company will concentrate on large claims that have more significant impact on profitability. The agent get to cement his relationship with the customer, while the customer is more likely to get a fair hearing from the agent about a fair payout amount. This keeps the customer happy, which is what the insurance company wants.

Figure 2 shows the Strategic Dependency graph for this new business process configuration. Needless to say, shifting the claims handling responsibilities to the insurance agent means that the information needs of the insurance agent are also radically altered. Based on the new configuration of strategic dependencies, one could derive what information needs to be shared or sent among insurance agents and the insurance company, and how accurate and up-to-date they need to be.

Once the traditional wisdom of how an insurance business should be run is no longer regarded

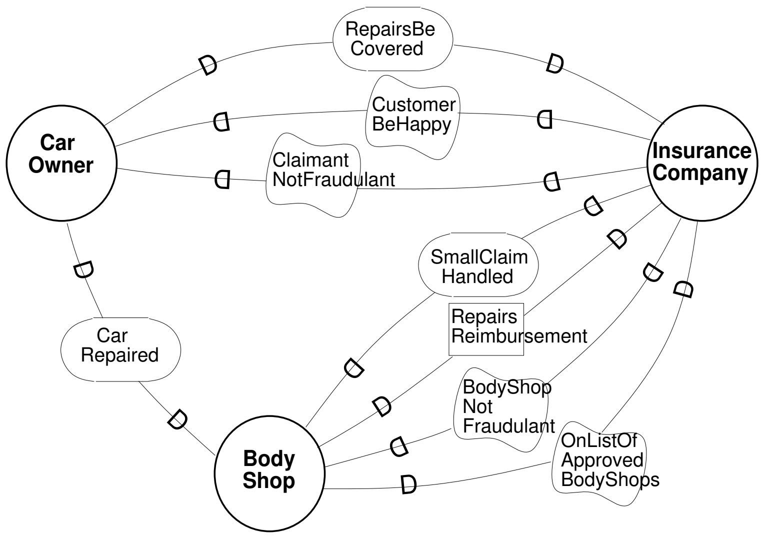

Figure 3: *Strategic Dependency model for alternative 2 – "Let the body shop handle it"*

as sacred, even more radical solutions could emerge. "Why not let the body shop handle the claims?!", someone else suggested. Traditionally, body shops are not likely to be on the side of the insurance company. For example, one would not expect an insurance company to be willing to pay according to a body shop's repair estimates, since the body shop is on the customer's side, as illustrated by the strategic dependencies in Figure 1. However, for small claims, it may not be a bad idea to bypass all the paperwork and help the customer get his car fixed as quickly as possible. This meets the customer's goal to have his car fixed promptly, while reducing costs dramatically for the insurance company. However, this approach raises concerns about possible fraud, which need to be addressed. Figure 3 shows the Strategic Dependency model for this proposal.

The Strategic Dependency model encourages a deeper understanding of a business process by focusing on intentional dependencies among actors, beyond the usual understanding based on activities and entity flows. It helps identify what is at stake, for whom, and what impacts are likely if a dependency fails.

Although a Strategic Dependency model provide hints about why a process is structured in a certain way, it does not sufficiently support the process of suggesting, exploring, and evaluating alternative solutions. That is the role of the Strategic Rationale model.

3 The Strategic Rationale Model

A Strategic Rationales model is a graph with four main types of nodes – **goal**, **task**, **resource**, and **softgoal** – and two main types of links – **means-ends links** and **task decomposition links**. A Strategic Rationale graph describes the reasoning behind each actor's relationships with other actors, thus revealing the internal linkages that connect external strategic dependencies.

A process is often depicted as a collection of activities with entity flows among them (as in a "workflow" analysis). For example, a claims handling process would include such activities as verifying the insurance policy coverage, collecting accident information, determining who is at fault, appraising damages, and making an offer to settle.

In the Strategic Rationale model, we arrange these into a hierarchy of means-ends relationships and task decompositions (Figure 4). When a process element is expressed as a goal, this means that there might be different possible ways of accomplishing it. A task specifies one particular way of doing things (of accomplishing a goal), in terms of a decomposition into subtasks, subgoals, resources, and softgoals. In seeking ways to redesign a business process, goals offer potential places to look for improvement. An ambitious redesign effort needs to discover and rethink high-level goals – by asking "why" questions, rather than be content with solutions for low-level goals. Higher goals are discovered by asking "why" questions. Once sufficiently high-level goals have been identified, alternatives may be sought by asking "how else" the goals can be accomplished.

In the auto insurance example described in [Hammer93], the reengineering team wanted to consider radical solutions, by identifying a high-level goal: that claims be settled. Unencumbered by current business thinking about how this goal should be accomplished, the team arrived at innovative proposals that involve new strategic business relationships with insurance agents and body shops.

Each alternative may have different implications for a number of quality goals, or "softgoals", such as CustomerBeHappy, FastProcessing, and Profitable. A softgoal is one which does not have *a*

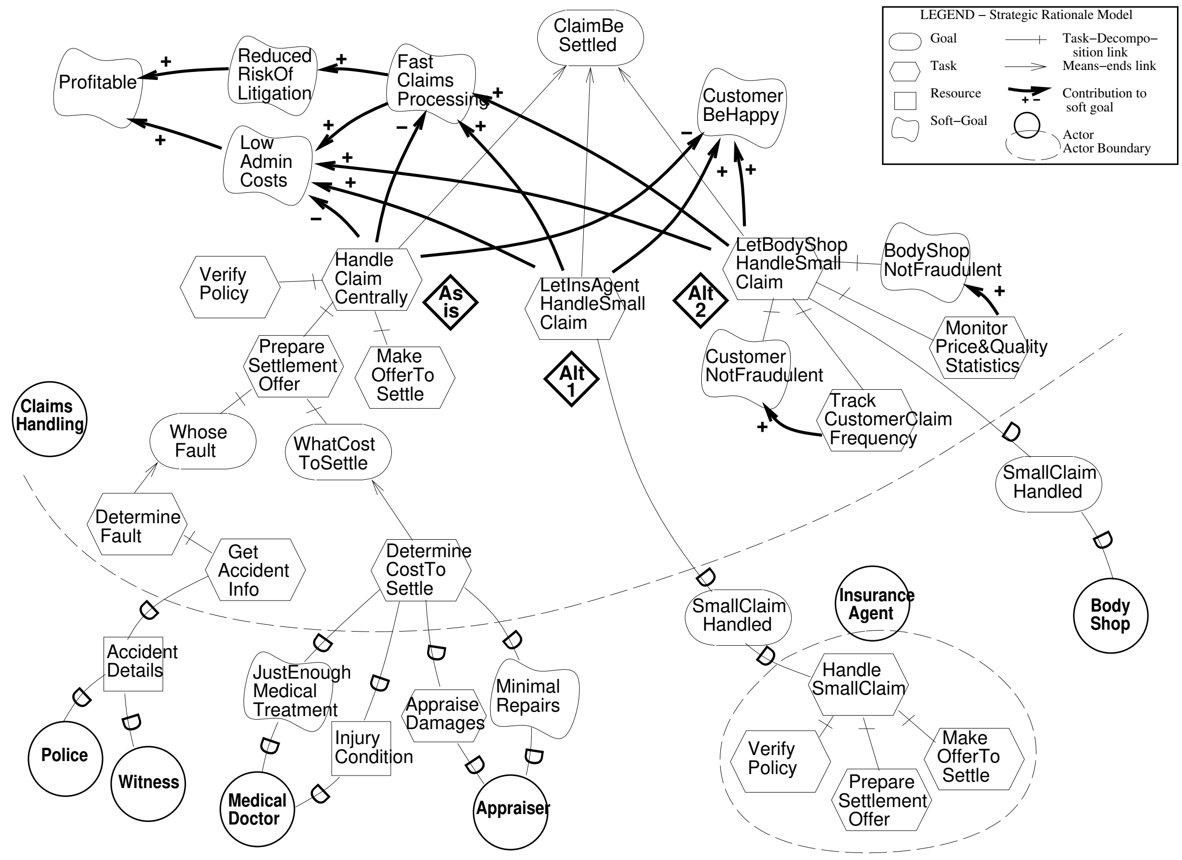

Figure 4: *Strategic Rationale model to support reasoning about reengineering the claims handling process*

priori, clear-cut criteria of satisfaction. Although some of these can be measured and quantified, a qualitative approach can be used at the stage of exploring the space of alternatives. Contributions to softgoals can be positive or negative, and are judged to be adequate or inadequate. The treatment of softgoals is based on a framework developed by Chung for dealing with non-functional requirements in software engineering [Mylopoulos92].

By explicitly representing means-ends relationships, the Strategic Rationale model provides a systematic way for exploring the space of possible new process designs. Generic knowledge in the form of methods and rules can be used to suggest new solutions and to identify related goals [Yu94a]
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4 Conclusion

As information systems are increasingly called upon to help alter the strategic relationships among business work units and external players (such as customers, suppliers, and business partners), models that are capable of describing strategic relationships and to help reason about them are needed. We have proposed one approach which emphasizes that organizations are made up of strategic, intentional actors. The Strategic Dependency model allows the modelling of how strategic actors relate to each other intentionally, while the Strategic Rationales model allows modelling of the means-ends reasoning the actors have about different potential ways of relating to each other for accomplishing work. The adoption of a conceptual modelling approach to process modelling and reengineering facilitates the connection between business process models and information systems development, using a consistent knowledge-based approach to software engineering (e.g. [Jarke92]).

As information systems [CoopIS94] as well as human organizations [Rockart91] progress increasingly toward cooperative and distributed, networked configurations, it is becoming ever more important to have models that can help reason how complex, interlinked systems contribute to business and organizational objectives. The "distributed intentionality" perspective taken by the $\boldsymbol{i}^*$ framework offers one approach for modelling and reasoning about the complex interactions among information system components and humans in distributed, evolving business processes.

References

[CoopIS94] *Second International Conference on Cooperative Information Systems (CoopIS-94),* Toronto, Canada, May 17-20, 1994.

[Cohen90] P. R. Cohen and H. J. Levesque, Intention is Choice with Commitment, *Artif. Intell.,* 42 (3), 1990.

[Davenport93] T. H. Davenport, *Process Innovation: Reengineering Work Through Information Technology,* Harvard Business School Press, 1993.

[Greenspan94] S. J. Greenspan, J. Mylopoulos, A. Borgida, On Formal Requirements Modeling Languages: RML Revisited, (invited plenary talk), *Proc. 16th Int. Conf. Software Engineering,* May 16-21 1994, Sorrento, Italy, pp. 135–147.

[Hammer90] M. Hammer, Reengineering Work: Don't Automate, Obliterate, *Harvard Business Review,* July-August 1990, pp. 104-112.

[Hammer93] M. Hammer and J. Champy, *Reengineering the Corporation: A Manifesto for Business Revolution,* HarperBusiness, 1993.

[Jarke92] M. Jarke, J. Mylopoulos, J. W. Schmidt, Y. Vassiliou, DAIDA: An Environment for Evolving Information Systems, *ACM Trans. Information Systems,* vol. 10, no. 1, Jan 1992, pp. 1-50.

[Mylopoulos91] J. Mylopoulos, A. Borgida, M. Jarke, M. Koubarakis, Telos: Representing Knowledge about Information Systems, *ACM Trans. Info. Sys.,* 8 (4), 1991.

[Mylopoulos92] J. Mylopoulos, L. Chung, B. Nixon, Representing and Using Non-Functional Requirements: A Process-Oriented Approach, *IEEE Trans. Soft. Eng.,* 18 (6), June 1992.

[Rockart91] J. F. Rockart and J. E. Short, The Networked Organization and the Management of Interdependence, *The Corporation of the 1990's – Information Technology and Organizational Transformation,* M. Scott Morton, ed., 1991.

[Yu93a] E. Yu, J. Mylopoulos, An Actor Dependency Model of Organizational Work – With Application to Business Process Reengineering, *Proc. Conf. Organizational Computing Systems (COOCS 93),* Milpitas, Calif., Nov. 1-4, 1993, pp. 258-268.

[Yu93b] E. Yu, An Organization Modelling Framework for Information Systems Requirements Engineering, *Proc. 3rd Workshop on Info. Tech. and Systems, (WITS'93),* Orlando, Florida, USA, December 4-5 1993, pp. 172-179.

[Yu94a] E. Yu, J. Mylopoulos, Using Goals, Rules, and Methods To Support Reasoning in Business Process Reengineering, *Proc. 27th Hawaii Int. Conf. System Sciences,* Maui, Hawaii, Jan. 4-7, 1994, vol. IV, pp. 234-243.

[Yu94b] E. Yu, J. Mylopoulos, Understanding "Why" in Software Process Modelling, Analysis, and Design, *Proc. 16th Int. Conf. Software Engineering*, May 16-21 1994, Sorrento, Italy, pp. 159-168.

[Yu94c] E. Yu, J. Mylopoulos, From E-R to "A-R" – Modelling Strategic Actor Relationships for Business Process Reengineering, *Proc. 13th Int. Conf. Entity-Relationship Approach*, December 13-16 1994, Manchester, U.K., to appear.

[Yu94d] E. Yu, *An Framework for Process Modelling and Reengineering*, Ph.D. Thesis, Dept. of Computer Science, Univ. of Toronto, forthcoming.