ELECTRONIC WORKSHOPS IN COMPUTING

Series edited by Professor C.J. van Rijsbergen

Frank Dignum, Jan Dietz, Egon Verharen and Hans Weigand, (Eds)

Communication Modeling - The Language/Action Perspective

Proceedings of the First International Workshop on Communication Modeling, Tilburg, The Netherlands, 1-2 July 1996

Modeling the Dynamics of Transferable Obligations in Business Procedures

Yao-Hua Tan and Walter Thoen

Published in collaboration with the
British Computer Society

©Copyright in this paper belongs to the author(s)

Modeling the Dynamics of Transferable Obligations in Business Procedures

Yao-Hua Tan and Walter Thoen

EURIDIS
Erasmus University Rotterdam
P.O. Box 1738
3000 DR Rotterdam
ytan@fac.fbk.eur.nl

Abstract

In this paper we present a first sketch of a formal framework for representing deontic deep structure models for business procedures. These models can be used in redesign of such procedures. The framework is based on a combination of deontic logic and action logic. To illustrate its usefulness we illustrate how transferable obligations, i.e. obligations that can be transferred from one agent to another, can be analysed in this framework. In particular, we analyse the difference between transfer of agency and transfer of liability of an obligation.

1. Introduction

In international trade transfer of obligations and rights is very important. An example of such a transfer of rights is the negotiable Bill of Lading. The owner of this document can claim goods from a transport company. Ownership of this document might change several times during the transport of the goods. For several applications it is important to be able to formally reason about such transfer of rights and obligations. In this paper we will present a formal analysis of these transfers. In particular, we show in this analysis that in the transfer of obligations it is important to distinguish between a transfer of agency and a transfer of liability.

In this paper we present a first sketch of a formal framework to represent and analyze the dynamics of transferable obligations. This framework is a combination of different modal logics, of which deontic logic is the most prominent one. Although there are currently techniques available to implement most modal logics (see e.g. [4]), it is not the primary objective of our research to make the framework itself computer executable. Rather the framework should provide concepts that are adequate to model the deontic deep structure behind the procedures¹. This deontic deep structure plays an important role in the (re)design of procedures.

In the case of (re)design of procedures it is essential to understand the underlying functionality of the procedure. For what purpose was the procedure introduced? Why were certain documents introduced? And, more specifically for redesign, is the procedure still needed, or can the underlying functionality be implemented by a more efficient procedure. This last question is in particular interesting in the case of the 'electronification' of a procedure; i.e. adapting procedures to make them applicable in electronic networks environments. Currently, the usual redesign approach is simply to replace paper-based documents one-to-one by electronic data interchange (EDI) documents, but this approach does not make the best use of the potential of electronification. In particular, electronifying every document in a procedure does not address the issue whether parts of or even the whole procedure is still needed in an electronic environment. One could describe the currently dominant approach to electronify documents one-to-one into their electronic counterparts as a type of superficial redesign. In contrast

¹The notion deontic deep structure was introduced by Ron Lee

with a type of redesign, which one could call deep redesign, that is based on first modeling the underlying functionality of the whole procedure.

What should such a model of the underlying functionality look like? In many procedures documents play a crucial role. For example, passport for identification, import or export clearance documents, bills of lading in international sea transport. The purpose of most of these documents is fraud prevention or detection. In general, one could say that fraud means that somebody violated his obligation to do action p , while he pretends to have done p . Fraud is easy, when it is hard for the victim to detect it. For example, in international trade the big problem is distance and time. The buyer B in Rotterdam is obliged to pay for the goods when the seller S has shipped them in Singapore. How can B be sure that S did what he promised to do, namely shipping the goods? S should send B documents that are sufficient evidence for B to believe that S fulfilled his obligation. This is precisely one of the functions of the bill of lading. Since obligations are essential for fraud analysis, it is an obvious choice that the underlying functionality of procedures should be represented in a deontic model. If we want to have computer-supported redesign, then the functionality of a procedure must be encoded in a model that can be processed by a computer. Hence, the deontic model should be represented in some sort of deontic logic. The framework presented in this paper should provide the concepts for this deontic deep structure model of a procedure.

The ultimate objective of the research at Euridis is to develop a computer-supported methodology for procedure redesign that consists of the following three phases. First, we develop a deontic deep structure model of the existing procedure. Secondly, to this model we apply a library of heuristics that can be used to reduce the risk of fraud related to this specific deontic deep structure model. The input for these heuristics is the deontic model, and the output is a proposal for a procedure that include paper or EDI documents which give optimal protection against potential fraud. The third phase is that these proposals are modelled as Petri nets, which are generated with the modelling tool Case/EDI that was developed at Euridis (e.g. see[1]). The heuristics for an electronic environment might be different from a paper-based environment. For example, in an appropriately secured electronic environment the EDI version of a passport might be no longer needed, because the communication protocol is defined in such a way that nobody can present himself on the network as another person.

The outline of this paper is as follows. In section 2 we will present several logics that are incorporated in the formal framework in order to make it suitable for representation of obligations in procedures. In section 3 we will informally discuss some examples which point out the differences between a transfer of agency and a transfer of obligation. In section 4 we will show how the formal framework is applied to provide a deontic deep structure model of the examples. In section 5 we will discuss the shortcomings of the current representation and propose some further refinements.

2. Logics for representing transferable obligations

2.1. The logic of Directed Obligations

In many business situations it is important to model the obligations between different agents (e.g. in trade: buyer, seller, transporter, stevedore, customs offices etc.). Most of these obligations can be viewed as relations between two agents. For example, the obligation to pay for delivered goods is directed, so to say, from the buyer to the seller. In order to model this aspect of obligations, we need a notion of directed obligations in our framework. A suitable notion of *directed obligations* is provided by the logic of Herrestad and Krogh [5,6]. They give the following example to illustrate the notion of directed obligation. Suppose i and j have a contract which states that: ‘ i ought to pay j 1000 ECU’. This contract implies a directed obligation from i to j that i brings about that j receives 1000 ECU. They argue that this contract implies a combination of a bearer-relativised ought-to-do obligation on i to bring about that j receives 1000 ECU, and a counterparty-relativised ought-to-be statement relative to j that i brings about that j receives 1000 ECU. Hence, they propose to define a directed obligation as a conjunction of a bearer-relativised ought-to-do obligation for i (O_i) that i brings about that A and an ought-to-be statement relativised to a counterparty j (O_j) that i brings about that A :

$${}_iO_j(iEA) =_{\text{def}} {}_iO(iEA) \wedge O_j(iEA)$$

This definition may be read as: “i is obliged towards j that i sees to it that A, if and only if, it is obligatory for i that i sees to it that A, and for j is ought-to-be that i brings about that A.” In O_j the j is not to be regarded as an agent, but rather as a patient for whom something ought to be the case. From a legal point of view one could consider j as the claimant that can bring a violation of the obligation to court.

Each operator $_iO$ is regarded as a relativised SDL operator; i.e. as having a normal modal logic of type KD. The semantics are given by a model-structure: $M = \langle W, R, I, P \rangle$. W is interpreted as a set of worlds $\{\alpha, \beta, \gamma, \dots\}$ P is a (standard) valuation function which assigns the values true or false to a sentence at a world in W. I is a set of individuals $\{i_1, i_2, \dots, i_n\}$, and R is a set of functions $\{R_1, R_2, \dots, R_n\}$ for each individual $i_1, i_2, \dots, i_n \in I$. Each member of R takes a member of W and returns a subset of W; i.e. $R_i : W \rightarrow \text{Pow}(W)$. The intuition behind the functions in R is that each individual has a function which returns the deontically ideal worlds (for that individual) given a world. The semantic notion of *ideality* is interpreted as a preference for worlds where all obligations holding in α , the world of evaluation, are fulfilled. For the bearer-relativised obligation operator the following truth conditions suffice:

($\| A \|$ denotes the set of worlds in which the formula A is true)

$$M, \alpha \models _iOA \text{ iff } R_i(\alpha) \subseteq \| A \|$$

reading: “ $_iOA$ is true at a world α in the model M, if and only if, A is true at all worlds that are ideal relative to α .”

For the counterparty-relativised ought-to-be statements we need some notion of *preference*. The idea is that when the law expresses something like “for j it ought to be the case that A”, then a legal authority expresses a preference on behalf of j that A is the case. When expressing such a preference, the legal authority regards A to be a *benefit* for j (and j to be the *beneficiary* of A). Herrestad and Krogh assume the O_j operator to have its semantics defined in a similar way as the $_iO$ operator. The logic of $_jE$ is regarded to be a minimal logic of type ET.

2.2 The logic of (in)direct action

In many business situations an agent has the obligation to do something, but he is delegating the execution of this action to another agent. The boss in an organization can delegate the tasks he is obliged to do to a subordinate. A seller of goods can hire a transporter to deliver the goods at the place of the buyer, if it was stipulated in the contract that the seller was obliged to do so. Delegating the execution of a task to another agent is sometimes called indirect action.

In their logic Herrestad and Krogh use the action operator $_iE$, representing “i brings it about” or “i sees to it that”. In their definition of this operator no distinction is made between direct and indirect action. In other words, in $_iEA$ it is not clear whether agent I himself is bringing about A, or some other person is doing it for him. In [7] Santos and Carmo argue that it is of vital importance for modelling in organizational analysis to make this distinction. They even suggest to introduce two different operators to represent this distinction formally, namely $_iE$ and $_iG$. They start with the following axioms for the $_iE$ operator

$$\begin{aligned} [T] \quad & | _iEA \rightarrow A \\ [C] \quad & | (_iEA \wedge _iEB) \rightarrow _iE(A \wedge B) \\ [RE] \quad & \text{If } | A \leftrightarrow B \text{ then } | _iEA \leftrightarrow _iEB \end{aligned}$$

The [T] schema captures the intuition that if agent i brings it about that A, then A is indeed the case ($_iE$ is a ‘success’ operator). The [C] schema presupposes co-temporality. The [RE] schema is just closure under logical equivalence. In the above axioms there is only one agent. However, interaction between the agency of different agents is also possible. Santos and Carmo discuss which of the following properties should be accepted:

$$\begin{aligned} [EEE] \quad & \neg E_j EA \rightarrow \neg E_i EA \\ [EE\neg E] \quad & \neg E_j EA \rightarrow \neg E_i EA \end{aligned}$$

Accepting [EEE] leads to the conclusion that an agent may “bring about” indirectly (by using another agent). Accepting [EE¬E] is a way of insisting that $\neg E_j EA$ means that agent i must bring it about that A is the case by itself (directly). The claim of Santos and Carmo is that we need both notions. Therefore they introduce a new operator $\neg E_i G$, read as “agent i ensures that”. We will accept [EE¬E] and the $\neg E_i G$ operator. This means that we will read $\neg E_j EA$ as “agent i executes A (with his own hands)”. The operator $\neg E_i G$ has the following formal properties:

$$\begin{aligned} [T] \quad & \neg E_i GA \rightarrow A \\ [C] \quad & (\neg E_i GA \wedge \neg E_j GB) \rightarrow \neg E_i G(A \wedge B) \\ [No] \quad & \neg \neg E_i G \text{True} \\ [GGG] \quad & \neg E_j GA \rightarrow \neg E_i GA \end{aligned}$$

With schema [GGG] having the following reading: “whenever agent i ensures that agent j ensures that A , agent i also ensures that A ”. With respect to the relationships between the different agency operators (the direct and indirect), we should accept (at least) the following reasonable principles:

$$\begin{aligned} [EG] \quad & \neg E_j EA \rightarrow \neg E_i GA \\ [GEGG] \quad & \neg E_j GA \rightarrow \neg E_i G_j GA \\ [EEEG] \quad & \neg E_j EA \rightarrow \neg E_i E_j GA \\ [EGE] \quad & \neg E_j EA \rightarrow \neg E_i G \neg E_j EA \end{aligned}$$

The first principle is fundamental and states that “whenever agent i brings it about that A , agent i also ensures that A ” (bringing about is a particular case of ensuring). The other two state respectively that “whenever i ensures that j brings it about A , i also ensures that j ensures that A ” and “whenever i brings it about that j brings it about A , i also brings it about that j ensures A ”. The last one states that “whenever agent i brings it about that A , i ensures that i brings it about A ”.

The semantics of $\neg E_i G$ are given by a model structure: $M = \langle W, G, P \rangle$, where W is interpreted as a set of worlds $\{\alpha, \beta, \gamma, \dots\}$ P is a (standard) valuation function which assigns the values true or false to a sentence at a world in W . I is a set of individuals $\{i_1, i_2, \dots, i_n\}$, and G is a set of functions $\{g_1, g_2, \dots, g_n\}$ for each individual $i_1, i_2, \dots, i_n \in I$. Each member of G is a function with signature $\text{Pow}(W) \rightarrow \text{Pow}(W)$, and takes a subset of W representing some state of affairs and returns a subset of this subset for which i has ensured this state of affairs. So $g_i(X)$ means the set of worlds where individual i ensures (the state of affairs described by) X . The truth at a world for expressions of the form $\neg E_i GA$ is defined by:

$$M, \alpha \models \neg E_i GA \text{ iff } \alpha \in g_i(\|A\|)$$

To validate the desired schemata, the following constraints on the model M are imposed: for all X and Y (subsets of W),

$$\begin{aligned} (t_g) \quad & g_i(X) \subseteq X \\ (c_g) \quad & (g_i(X) \cap g_i(Y)) \subseteq g_i(X \cap Y) \\ (no_g) \quad & g_i(W) = \emptyset \\ (ggg) \quad & g_i(g_j(X)) \subseteq g_i(X) \end{aligned}$$

In order to consider the relationships between the operators $\text{,}G$ and $\text{,}E$, the previous model should be extended with functions $(f_i, \dots, f_n)$ with signature $\text{Pow}(W) \rightarrow \text{Pow}(W)$, where $f_i(X)$ means the set of worlds where agent i executes X ; define

$$M, \alpha \models \text{,}EA \text{ iff } \alpha \in f_i(\|A\|)$$

and impose the constraints (to validate the schemata $[T]$, $[C]$, $[No]$ and $[EE \rightarrow E]$ for $\text{,}E$):

$$\begin{aligned} (t_e) \quad & f_i(X) \subseteq X \\ (c_e) \quad & (f_i(X) \cap f_i(Y)) \subseteq f_i(X \cap Y) \\ (no_e) \quad & f_i(W) = \emptyset \\ (ee \rightarrow e) \quad & f_i(f_j(X)) \subseteq \neg f_i(X) \quad (\text{for } i \neq j) \end{aligned}$$

$(\neg f_i(X))$ denotes the complement of $f_i(X)$ in W

Finally, the semantic counterparts of $[EG]$, $[GEGG]$, $[EEEEG]$ and $[EGE]$ are obtained by imposing:

$$\begin{aligned} (eg) \quad & f_i(X) \subseteq g_i(X) \\ (gegg) \quad & g_i(f_i(X)) \subseteq g_i(g_j(X)) \\ (eeeg) \quad & f_i(f_j(X)) \subseteq f_i(g_j(X)) \\ (ege) \quad & f_i(X) \subseteq g_i(f_i(X)) \end{aligned}$$

Santos and Carmo state that their operators $\text{,}E$ and $\text{,}G$ are particularly useful to capture the notion of responsibility in an organization. As we argue in the remainder we believe that these operators are also useful for modelling certain aspects of obligations in inter-organizational situations. The formal framework that we discussed in the introduction contains at least the combination of the two logics from Herrestad and Krogh, and Santos and Carmo. The way we combine these two logics is that within the logic of Herrestad and Krogh we replace the semantics of their operator $\text{,}E$ by the semantics of the operators $\text{,}E$ and $\text{,}G$ of Santos and Carmo. The logic of Herrestad and Krogh is very suitable to model the directedness aspects of obligations, but their notion of 'bringing about' is a bit restrictive, in particular if we want to model certain aspects of the transferability of obligations. The advantage of the logic of Santos and Carmo is that their logic provides a very subtle formal framework for the representation of indirect action. This notion of indirect action plays an important role in the modelling of transferrable obligations in which an agents fulfills his obligation by having another agent that executes the fulfilling action for him.

3. Some Examples

We will now informally discuss some examples which point out the differences between a transfer of agency and a transfer of obligation.

Example 1: Trade situation (Transfer of Agency)

This example describes a simple trade transaction between a buyer-agent (agent B) and a seller-agent (agent S). We start with the situation in which both agents do not have any obligation. The first step in the contract negotiation process is that both agents agree to the terms of a purchase order. This agreement creates an obligation for agent S to deliver certain goods and it creates an obligation for agent B to pay for the goods. The resulting situation is shown by step (1) of figure 1.

We assume that both agents will try to fulfill their obligations. So agent S has to see to it that the goods are delivered to agent B. Agent S has two options, he can either deliver the goods himself or he arranges for someone else to deliver the goods. We call the first option *direct agency* and the second option *indirect agency*. If agent S

chooses the second option and he also succeeds in finding someone else, we call this a *transfer of agency*. Of course, whether both options are available for agent S depends on the terms of the agreement. We assume that agent B does not care who actually delivers the goods (as it is in most trade transactions) so both options are available to agent S.

If agent S chooses the first option, he fulfills his obligation by delivering the goods himself. As is usual agent S makes agent B sign for reception. This act of signing is a performative action by agent B with which agent B states that agent S has fulfilled his obligation. So the effect of this performative action is that agent S's obligation ceases to exist.

The second option is more complex because it introduces a third agent (see step 2 in figure 1). For this option agent S has to come to an agreement with some transportation agent, agent T. Let's assume that agent S agrees with an agent T that agent T will deliver the goods to agent B after agent S has paid the transportation costs. What is the new situation after agent S and T reached their agreement? Has agent T fulfilled his obligation? Agent B does not have the goods yet. In other words, agent B still has a claim towards agent S to deliver the goods, so the obligation for agent S is still existing. The result of the agreement is that some new obligations are created. Two new obligations are (1) the obligation for agent T to deliver the goods to agent B and (2) the obligation for agent S to pay for this service. But is there also a relation between agent T and agent B? In other words, does agent T has some obligation towards agent B? We assume that the agreement between agent S and agent T does not provide agent B with a claim against agent T to deliver the goods, so agent T does not have an obligation towards agent B.

Figure 1 - Trade example (Transfer of Agency)

To summarize, the above example shows two possibilities for an agent to fulfill an obligation. An agent can perform the obliged action himself, we call this direct agency. An agent can arrange for another agent to perform the obliged action, we call this indirect agency and we call the result of the arrangement a transfer of agency. The transfer of agency, however, does not fulfill the obligation for agent S. The claim of agent B against him still exists.

Example 2: Liability insurance (Transfer of Agency + Liability)

Under Dutch law there are actions which, if performed by you, create an obligation for you to pay a compensation to another person (see step (1) in figure 2). If you shoot the ball through your neighbour's window during a street soccer game, you have to pay the damage to the neighbour. This means that every person² has a conditional obligation to pay a compensation. You can insure yourself against this risk. By taking out an insurance policy you redirect a possible claim towards the insurance company (see step (2)) at the cost of paying an insurance premium.

So if agent A takes out an insurance policy the insurance company will pay a future claim. In case of such a future claim, agent B filed a claim on the insurance company. In other words, the insurance company, agent C, has a conditional obligation towards agent B to pay a compensation. The taking out of the insurance policy has resulted in a redirection of the claim from agent A to agent C. This implies that agent C has a obligation towards agent B, and agent A no longer has such an obligation. We will call this a transfer of liability. Hence, in this case agency as well as liability is transferred from A to C, which differs from Example 1 where only agency was transferred.

Figure 2 - Insurance example (Transfer of Agency + Liability)

4. Formal analysis of the examples

In this section we illustrate how a deontic deep structure model for each of the examples from the previous section, is represented in the formal framework. We will also see from these models that there are still important elements missing from the framework. As we said in the introduction we can only present a first sketch of the framework in this paper. The logics of Krogh and Herrestad, and Santos and Carmo are fundamental parts of the framework, but

² There are some exceptions, like children under 18 for which their parents are liable.

they are not enough. At the end of this paper we describe more specifically the parts that have to be added to the framework. The deontic deep structure model for Example 1 shows that we have to integrate the indirect action operator $\bar{G}$ in the notion of directed obligation. In particular, to make the distinction between these two examples it is important to formally distinguish between direct and indirect agency, i.e. to distinguish between $\bar{G}$ and $\bar{E}$. The deontic deep structure model for Example 2 shows, in contrast with Example 1, a case of transfer of agency as well as liability.

Figure 3 is an example of the deontic deep structure model for Example 1. In the initial state none of the agents has an obligation. The contract between agent S and agent B yields the transition from state 1 to state 2. D represents the delivery action and M represents the payment action. In state 2 we see that both agent S and agent B have an obligation. The contract between agent S and agent T concerning the delivery causes the next transition. In state 3 the agent S and agent T have a new obligation because of their contract. The transfer of agency of delivery of the goods is reflected by the introduction of tGD in state 3. The transfer of agency from agent S to agent T only causes new reciprocal obligations, none of the previous obligations has disappeared. Hence, this example shows that agency transfer does not relieve the bearer of his responsibilities to fulfill his initial obligation to deliver the goods. In particular, the agent S is still liable for non-delivery of the goods by agent T. If T does not deliver the goods, then agent B files the damage claim related to this non-delivery on agent S, not on agent T. This is reflected by the fact that in the obligation $sOb(sGD)$ agent B can still file a claim on agent S. Of course, in case of such a claim from B on S, the latter agent will file a claim on agent T, but these are two different claims. As we explained in section 1 the operator O_j represents who can claim in the case of violation of the obligation. Therefore, we consider that in this example $sOb(sGD)$ is still an obligation that has to be fulfilled by S, hence S only transferred his agency of the delivery of the goods, not his liability. The fact that, in case of a non-delivery claim by B, S can file a claim on T, is reflected in the obligation $tOs(tGD)$, where S is the claimant with respect to T if there is non-delivery of goods.³

Figure 3 - State transition for Trade example

In figure 4 the deontic deep structure for the Insurance example is shown. In the initial state agent A has a conditional obligation towards agent B to pay a compensation for the damage that agent A might do to B's property. Agent A takes out an insurance policy, which yields the transition to state 2. As shown in state 2 of figure 4 the insurance company, agent C, has taken over the conditional obligation to pay the compensation in case agent A damages property of agent B. In this state agent A no longer has an obligation to pay. Any claim by agent B with A is immediately send on by A to C. In case of non-payment C is in fault, and not A! This transfer of liability is reflected by the fact that in the transition from state 1 to 2 the obligation $aOb(aGM)$ is replaced by $cOb(cGM)$. In the latter obligation B sends his claim no longer to A, but to C! The transfer of agency is reflected by the change of agency from aGM to cGM . So, this clearly is a case in which both the agency as well as the liability of the payment is transferred from A to C.

³ In [7] also a so-called influence operator, ilj , is introduced. One of the axioms for his operator is $(ilj\phi \wedge jG\phi) \rightarrow iG\phi$. Hence, if we add sID to State 3, then fulfillment of tGD of agent T also fulfills sGD of agent S.

Figure 4 - State transition for Insurance example

5. Conclusions and Further Research

In this paper we presented a first sketch of a formal framework for representing deontic deep structure models for procedures. This framework contains at least a proper combination of the logics of Herrestad and Krogh and Santos and Carmo. To illustrate its usefulness we illustrated how the difference between transfer of agency and transfer of liability can be analysed in this framework. The examples in this paper also showed that still many elements are missing in the framework. Here we discuss some of them that we will investigate in further research.

In this paper the state transitions in the figures are described informally. From a formal point of view these state transitions can be analysed as transitions in dynamic logic. We plan to investigate to what extent it is possible to represent this dynamic behaviour of transferable obligations in the illocutionary deontic logic of [2] that is based on dynamic logic.

Another issue is that the interdependency between obligations within one state is not reflected in the formal framework. For the fulfilment of a set of obligations within one state there might exist a constraint on the order in which they can be fulfilled. For example, before the seller can fulfill his obligation to deliver the goods he must pay the transport company. So there is a constraint on the order of the seller's actions. We are currently investigating how to formalise such constraints.

Related to this interdependency issue there is another perhaps even more fundamental issue. The obligation of the seller to deliver goods precedes the obligation of the buyer to pay for them. In international trade situations this interdependency becomes a bit more complicated. The buyer B in Rotterdam is obliged to pay for the goods when the seller S has shipped them in Singapore. In the introduction we already mentioned that this creates an extra problem for the buyer. How can B be sure that S did what he promised to do, namely shipping the goods? The solution is that S should send B documents that are sufficient evidence for B to believe that S fulfilled his obligation. But this implies that the fulfilment of the payment obligation is conditional on the belief that B has about S. To model this aspect of the interdependency we should include in our framework also epistemic logic, the logic of knowledge and belief (for a survey see [3]). Moreover, belief might be changed due to new information. Retracting a belief, and also the results of actions that were caused by this belief, is a typical example of defeasible or non-monotonic reasoning. To model this kind of processes we could also include non-monotonic logic in our framework.

In the trade example we only described a transfer of agency to a transport company. In reality many actions are required to fulfill the obligation to deliver goods. It might, for example, be obliged to take out an insurance or to obtain several customs documents. So, in general the seller has to make a 'plan' describing all required actions. The seller might wish to transfer the agency for several of these actions. So we need to formalize this 'plan' and the way in which it will lead to the fulfillment of an obligation (the plan's goal). For such a plan it is important to decide whether or not to accept the following rule, $(iOj(iGA) \wedge A \Rightarrow B) \rightarrow iOj(iGB))$. This rule states that if i has an obligations towards j that i ensures A , and B is necessary condition for the correct performance of A , then i has an obligation towards j that i ensures B . If we accept this rule then all actions like B should be included in the plan. Not accepting this rule is a way of insisting that an action is only obliged in case this is stated explicitly.

Acknowledgements

We want to thank Roger Bons, Ron Lee and Leon van der Torre for discussions on issues addressed in this paper.

References

1. R. Bons, R.M. Lee, R. Wagenaar and C. Wrigley, Modelling inter-organizational trade procedures using documentary Petri nets, in *Proceedings of the Hawaii International Conference on Systems Sciences* (HICSS'96), 1995.
2. F. Dignum and H. Weigand, Communication and Deontic Logic, *Proceedings of the ISCORE'94 Workshop*, Amsterdam 1994.
3. R. Fagin, J.Y. Halpern, Y. Moses and M.Y. Vardi, *Reasoning About knowledge*, MIT Press, 1995.
4. L. Farinas del Cerro, *Modal deduction with applications in epistemic and temporal logics*, in: D.M. Gabbay, C.J.. Hogger and J.A. Robinson (eds.), *Handbook on Logic in Artificial Intelligence and Logic Programming*, pp 499-594, Oxford University Press, 1995.
5. H. Herrestad and C. Krogh, *Deontic Logic Relativised To Bearers And Counterparties*, in: J. Bing and O. Torvund (eds.), *25 Years Anniversary Anthology NRCCL*, TANO Publishers, CompLex series, Oslo, 1995.
6. H. Herrestad and C. Krogh, *Obligations Directed from Bearers to Counterparties*, Working Paper, Department of Philosophy, 1995.
7. F. Santos and J. Carmo, Indirect action, Influence and Responsibility in Deontic Logic, Agency and Normative systems, *Proceedings of the DEON'96*, Springer Verlag, 1996.