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ABSTRACT

Interorganizational telecommunications-mediated messages are nearly always expressed either in natural language (via telephone, telex, electronic mail, etc) or through specific protocols developed for the application at hand. Natural language expression is powerful, flexible, equivocal, and not generally machine readable. Specific protocols have a limited expressive power, are inflexible, can be unequivocal, and are machine readable. This paper commences an exploration of the possibility of using a formal language for interorganizational messaging. Such a strategy promises to combine the virtues of natural language and of specific protocols for communication. Formal logic is a natural basis for such a language. Recent developments in illocutionary logic (an extension of predicate logic) bid fair to provide a sound basis for a formal language for business communications. The paper discusses these concepts and how they might be implemented.

INTRODUCTION

There is a considerable excitement about telecommunications and about what can be done with the new technologies that have recently become available (e.g., packet switching networks, voice messaging, etc.) or are anticipated to be available in the near-term (e.g., various ISDN services). Not only are these new technologies promising to provide cheaper or more efficient services (e.g., as in using fiber optic media to lower the cost of basic transmission), but there are many who believe that communications technologies can be and are being used to provide firms with strategic advantage (See Clemons, *et al.*, 1984; Ives and Learmonth, 1984; Clemons and McFarlan, 1985; Wiseman, 1985; Rackoff, *et al.*, 1985).

In the face of what can be fairly characterized as a spectacular array of new communication technologies and services, and of high hopes for sweeping changes in the way organizations do business, it should be kept in mind that there are, and have long been, two worldwide, integrated, working and successful communications networks: telephone and telex. If the new technologies and services are merely faster and cheaper, that is interesting, perhaps even exciting. But what would be genuinely interesting is the prospect of being able, with these new technologies and services, to do something radically new or different. For example, what is exciting about the advent of personal computers is not that they are more powerful than minis and maxis (they are not), or merely that they are cheaper, for hardware is always getting cheaper. What is significant is that microcomputers are so cheap that they can be very widely dispersed; that microcomputers have a very fast communications link with the terminals they support, thereby permitting extensive use of graphics (as in spreadsheet programs, at the very least); that the base of people actively working to develop applications for these machines has become quite large; and so on. With microcomputers, as with telecommunications, it is the prospect of

what can be done with the technology rather than the technology by itself that can generate excitement.

With respect to new telecommunications offerings, perhaps the most commonly cited new and different activities are telecommuting (working at home instead of at the office) and teleconferencing. We note, however, that the examples of strategic employment of telecommunications (most prominently, American Airlines (AA) and American Hospital Supply (AHS)) do not, in any obvious way, rely on advanced communications technologies or services. Rather, they rely on proven technologies creatively applied.

In both these cases, and we think in many others, it is plausible to hypothesize that there are two main characteristics for the success of these applications. The first is that the computer and communications systems are being used to replace a paper-based system (AHS, ordering of hospital supplies) or a paper-telephone-based system (AA, ordering airline tickets). The systems were designed not merely to pass information, but to use the passed information to perform some action (invoicing, ordering, etc.). Of course, the telephone and telex networks have long been used for such purposes, but unlike the AHS and AA applications, the receiving terminal devices in these networks (telephone handset, telex printer) cannot process or manipulate the messages they are given. In both the AA and AHS applications the action-taking was delegated to a machine that can read and process information coming in from a network. Ordering and invoicing are done in machine-readable fashion.

The second characteristic of these applications is that they can be described as interorganizational (Barrett and Konsynski, 1982; Rosenberg and Barrett, 1985). In the AHS case, the value-determining communication takes place between AHS and various hospitals. The essential communications for airline reservation occurs between a travel agent and the airline database.[1]

[1]The ideas presented here were conceived for inter-organizational communications. Nevertheless, we believe they can usefully be applied for intraorganizational communications, e.g., as add-on features for an office automation environment, perhaps as an adjunct to electronic mail. We will explore this notion in future papers.

What we find exciting in the current telecommunications environment is the prospect that advancing technology will make interorganizational communications both more extensive and more committed to machine processing, with a concommittant increase in speed and efficiency. The main goals of this paper are to explore a different sort of technical strategy for inter-organizational, machine-based telecommunications, and to begin to investigate how this idea might be implemented.

PROTOCOLS AND LANGUAGES

There are, at present, two ways by which firms communicate with each other using telecommunications systems: through natural language (telephone, telex, voice messaging, electronic mail, fax) and through record passing (electronic funds transfer, airline reservations, newly developed factory and office automation protocols). Under a record passing scheme, communicating firms agree on the field structure of the record (e.g., the first field is N bits long, holds character data, and contains the name of the originating firm) and on various arrangements needed to make a special telecommunications network function properly (i.e., special protocols are developed).

Natural language and record passing are largely complimentary in that the advantages of one tend to be the weaknesses of the other. Thus, for example, natural language is powerful, flexible, very widely available, but subject to equivocation and not generally machine readable, while record passing is limited in its expressive power to explicit conventions, is inflexible, is not nearly as available as the voice (telephone) network, but is precise and machine readable.

Ideally, organizations should have a way of communicating with one another that combines the virtues of both natural language and record passing (or development of special protocols). One way this might be achieved would be to develop technology that would make communicated natural language machine readable, and some success has been met with on this score (Young and Hays, 1985).

We should like to suggest and discuss the development of a different approach: com-

municating by sending messages expressed in a machine readable formal language that can also be understood by people. Such a scheme promises to combine the best features of record passing and natural language.

Application-level protocols for computer communications via record passing have been in place for some time and new protocols are constantly being invented and implemented. Examples are EFT protocols and airline reservation protocols. Usually, these protocols are specified by determining a sequence of fields in a message and the allowable bit patterns within the fields. While it is always possible and frequently useful to specify high-level protocols in this fashion, there are certain advantages in moving from rigidly-defined protocols to languages for communication.

To illustrate, if we wished to have a system for communicating certain facts, say stock prices, we might use a language for doing so, saying price(Stock,Time,Bid), where "Stock" stands for a particular stock, "Time" for a particular time, and "Bid" for the price of that stock at that time. Clearly, we could send an entirely equivalent message by specifying a format or record structure. This approach, however, has disadvantages: rigidity, lack of extendibility, no natural support for inferencing -- all of which we get with a predicate or statement. (The statement, "price(Stock,Time,Bid)," has the form of a Prolog expression. Exploitation of this fact lies at the heart of our proposal to use a formal language for communications.)

So, by using a formal language and sending sentences, we can hope to support inferencing easily, and with it easy extension of the range of expressions. But how far can we go? Predicate logic has its limits, and Prolog (use of which we shall assume in the sequel because it is the most available programming language for representing statements in logic) cannot (directly) support all proper inferencing in predicate logic. Extensions to predicate logic will need to be made. In an earlier paper (Kimbrough, Lee and Ness, 1984) we distinguished informative, performative, and emotive communications: where information communications (e.g., "The umpire called him out") seem to have truth values; performative communications (e.g., (from an umpire) "You're out!") do not seem to have truth values, but are uttered for the purpose of doing something;[2] and emotive communications (e.g., "Throw the bum out!" or "Boo!") which merely express a feeling. As discussed at length in that paper, performatives and other expressions that are not purely informative play a large and central role in business communications. Examples include orders, invoices, receipts, contracts, licenses and payments.

Performative and emotive communications (and other not purely informative communications) cannot adequately be captured in predicate logic, but require some sort of extension to that (formal) language. A main purpose of this paper is to argue for the plausibility of our suggestion (that interorganizational communications be carried out, at least sometimes, using sentences expressed in a formal language) by developing an initial analysis of the rudiments of such a language that is sufficiently powerful to handle transactions and other types of communications commonly encountered in business.

THE LOGIC OF ILLOCUTIONARY ACTS

The purpose of this section is to present the basic structure of the illocutionary logic proposed by Searle and Vanderveken (1985). (The literature on this subject also refers to the topic as speech act theory.) Their work is imperfect and incomplete, but it is a very nice start and well deserves the sort of testing that implementing our suggestion will lead to. The work is, in any case, the most advanced formal (logical) treatment of speech act theory. They introduce their central concepts as follows:

> In general, an illocutionary act consists of an illocutionary force F and a propositional content P. For example, the two utterances "You will leave the room" and "Leave the room!" have the same propositional content, namely that you will leave the room; but characteristically the first of these has the illocutionary force of a prediction and the second has the illocutionary force of an or-

[2]With performatives, saying so makes it so. The umpire's calling you out makes you out. Similarly, writing VOID on a check actually voids the check.

> der. Similarly, the two utterances "Are you going to the movies?" and "When will you see John?" both characteristically have the illocutionary force of questions, but have different propositional contents. Illocutionary logic is the logical theory of illocutionary acts. Its main objective is to formalize the logical properties of illocutionary forces (Searle and Vanderveken, 1985, p. 1).

Illocutionary acts include: making an assertion of fact, asking a question, uttering a performative, making a promise, expressing emotion, among other things. Promising and issuing performatives, along with stating facts, are the most interesting concepts from speech act theory for business and management applications. If a logic of these utterances were available, then it would be possible to come to a public agreement on the logic, to implement it on local machines, and to have a precise, flexible, available communications (formal) language for business that was machine readable.

A successful system for business communication requires a number of elements, including security privacy and authentication. We believe these problems are well on their way towards satisfactory solution (Even, *et al.*, 1985; Chaum, 1985). In what follows we assume that these issues, particularly the authentication and receipt verification issues, have been favorably resolved. Let us now see, in outline, the basics of the formal theory of illocutionary acts.

In the formal theory of Searle and Vanderveken, an illocutionary act is represented as a triple, consisting of a propositional content, an illocutionary force, and the context of utterance. Thus in Prolog we might have the form:[3]

ill act(<context>,<force>,<content>).

This, at the highest level, will be the structure of the messages (utterances) to be passed between parties. The propositional content can be any expression (seen as either true or false) in predicate logic, modal logic, or any of their standard extensions. The essential feature of the content is that it be machine readable and is to be interpreted as having a truth value. At a minimum, then, expressions in Prolog (facts and rules) could be collected as a propositional content in a speech act representation such as this. For present purposes, the content will be represented by the Prolog predicate:

Content(<structure>).

where <structure> is a collection of Prolog expressions that are to be interpreted declaratively. For example, we might represent the content "all fathers are males. Steve is a father." as:

content((father(Steve),(male(X) :- father(X)))).

The context of an illocutionary act is seen as a 5-tuple, consisting of: a speaker, a hearer, a time, a place, and the world of utterance. The first four elements are easily understood, so we will not discuss them further. The last element, the "world of utterance" is needed for technical reasons, and explaining them is beyond the purposes of this paper.[4] For present purposes, think of the world of utterance as, in the expression of Searle and Vanderveken, "those various other features of the speaker, hearer, time, and place that are relevant to the performance of the speech acts" (Searle and Vanderveken, 1985, p. 27). The context will be represented by the Prolog predicate:

context(<speaker>,<hearer>,<time>,<place>,<world>)

where each element is a Prolog term.

Finally, an illocutionary force is uniquely identified as a seven-tuple, consisting of[5]:

1. the illocutionary point (pi) of which there are five only: assertive, commissive, directive, declarative, and expressive.

[3] We use the angle bracket convention as a metalanguage expression to indicate that something must be filled in here.

[4] The world of utterance would need to be identified in an illocutionary act analog of a possible worlds semantics. The semantics for illocutionary logic have yet to be worked out fully.

[5] The notations in parentheses (pi, degree, mode, prop, sigma, psi, and eta) are that of Searle and Vanderveken.

2. the degree of strength of the illocutionary point (degree)

3. the mode of achievement (mode)

4. the propositional content conditions (prop)

5. the prepatory conditions (sigma)

6. the sincerity conditions (psi)

7. the degree of strength of the sincerity conditions (eta)

For present purposes, we will represent an illocutionary force by the Prolog predicate:

force(<pi>,<degree>,<mode>,<prop>,<sigma>,<psi>,<eta>)

where each element is a Prolog term.[6]

Searle and Vanderveken use this scheme to define five basic illocutionary forces, one for each of the five points. They then argue that every illocutionary force can be recursively defined in terms of these five basic forces. In fact, they give plausible definitions of more than 100 illocutionary-force-indicating English verbs. For example, a promise is a commitment with the additional features that the speaker believes that what is promised is to the good of the hearer and that the speaker in promising undertakes an obligation that might not be present in the case of a commitment (Searle and Vanderveken, 1985, p. 192).

Without examining the details of this proposed logic for speech acts, what can we say about its value? First, the basic logical move made by Searle and Vanderveken is to decompose a speech act into a propositional content, an illocutionary force, and a context of utterance. The usefulness of this move is best tested by attempting to apply it (and for that matter the rest of the logical apparatus) in specific cases, such as the one under consideration. We are convinced, however, that this basic move is indeed quite useful.[7] Second, while there are important issues having to do with representing the content and the context of an illocutionary act, the paramount question for Searle and Vanderveken's proposed logic is whether the representation of illocutionary forces is adequate, and in particular, whether the hypothesis of constructability is correct, namely that:

> ...all...illocutionary forces are obtainable from the few primitive illocutionary forces by applying operations affecting the mode of achievement, the degrees of strength, the propositional content conditions, the prepatory conditions, or the sincerity conditions of these primitive illocutionary forces (Searle and Vanderveken, 1985, p. 51).

Like the decomposition move, the hypothesis of constructability is best tested in the fire by the sort of application proposed here. We believe, however, that Searle and Vanderveken have made a plausible, workable first try and that something close to their theory will prove adequate.

The claims being made (by Searle and Vanderveken) are intriguingly bold. While it is clear that the logic of predicates cannot begin to handle all the sorts of uses of language that we have (stating facts, asking questions, issuing commands, etc.), it is not obvious that there are exactly five kinds of linguistic utterance. Searle and Vanderveken claim that there are fundamentally just five. If this is correct, and if the hypothesis of constructability is correct[8] then it should be possible to implement a remarkably stable and powerful formal language, based on the framework of illocutionary logic. The following passage illustrates the idea.

> If we adopt illocutionary point as the basic notion on which to classify uses of language, then there are a rather limited number of basic things we do with language: we tell people how things are, we try to get them to do things, we commit ourselves to do-

[6]The basic move being made here may be described as follows. Whereas a modal operator (e.g., it is necessary that, it is possible that) is a scaler operator on a sentence, an illocutionary force is a vector operator on a (declarative, truth-value holding) sentence.

[7]There is a forthcoming paper by Kimbrough and Lee in which we present results of our initial investigations on this score. Results are quite favorable.

[8]In both cases, correct means true or close enough for practical purposes.

> ing things, we express our feelings and attitudes, and we bring about changes through our utterances. Often, we do more than one of these at once in the same utterance (Searle, 1975).

Although changes to the formal language for speech acts would occur by, for example, adding more precise tools for expressing assertions, we could be confident that the framework behind the logic would not change, there being no sort of thing we might ever say that could not be defined in terms of the five primitive illocutionary forces.[9]

Envisioned Setups

The promise of a logic of speech acts is that with such a formal language it will be possible to capture adequately the central concepts used in business communications (e.g., receipts, invoices, etc.) and to do so in a way that is flexible and extendable and that supports (correct, truth preserving) inferencing. Were this available it would be possible for different organizations to buy, sell, negotiate, and canvas for goods and services, all by computer. Messages, expressed in the formal language, would be sent on a public network that supported authentication, receipt verification, and the various conventions and definitions associated with the language. Individual firms would program their machines to participate on the network in a way that would work to the benefit of the firm. For example, buyers would program their machines to seek and negotiate the best bargain available, given the firm's particular preference structure (e.g., for cost vs. reliability). Sellers would similarly program their machines to monitor the market and to sell for the best available price and delivery terms. Once set in motion, an automated market would take effect. (For further elaboration, see Lee and Widmeyer, 1986.)

Although the underlying logic would remain constant, the language used for communication could change by adding (or deleting) definitions of illocutionary forces. By the hypothesis of constructability, all possible illocutionary forces can be defined recursively in terms of the five primitive forces. Thus, for example, buyers and sellers might want to extend their langauge of offer by adding the force, "exploding_offer," which is a regular offer that is only good for 10 minutes after it is made. If the 10 minutes elapse without acceptance of the offer, the offerer is committed not to make another offer on the transaction at hand. The definition of "exploding_offer" would be given in terms of a standard offer plus prepatory conditions (sigma). Standard offers would have been defined in terms of the primitive illocutionary force, the commissive. By means such as these, the offerer could send an explicit message indicating an exploding offer and the receiver of the message could use the (publicly available) definition to deduce the full meaning.

TOWARDS AN IMPLEMENTATION OF THE LOGIC OF SPEECH ACTS

In this section we present some initial results in analyzing important business concepts in terms of the illocutionary logic of Searle and Vanderveken. Our purposes here are limited to analyzing, in a rough and largely informal manner, the illocutionary point (i.e., category of illocutionary force) and the propositional content of the following business concepts: inquiry, offer, order, invoice, receipt, payment, and license. The illocutionary point of an inquiry ("How much do widgets cost?") is a directive (in the terminology of Searle and Vanderveken). The speaker is directing (telling, requesting, ordering, commanding, etc.) the hearer to tell him something. What that something is is the propositional content. Using the Prolog convention of placing an uninstantiated variable (beginning with an upper case letter) in a slot to indicate that the variable is to be matched, we might represent the propositional content of a query about the price of widgets as: price(widget,Price)

Thus in a query regarding the price of widgets, the illocutionary point would be directive and the propositional content would be expressed using the price predicate. Notice that in responding to such a query, the respondent's utterance would have the assertive illocutionary

[9] This is not to claim, of course, that additions to the language to include tense, logic deontic logic, conditional logic, intentional logic, etc., would be obviated. It is to claim, rather, that any such additions would be expansions of the range of expressions permitted as propositional content and thus would fit easily into the overall framework for illocutionary logic.

point and would also use the price predicate to express the propositional content of that utterance.

It is worth noting that this structure (illocutionary force & propositional content) is displayed transparently in Prolog commands. The prompt, ?-, indicates illocutionary force (the point is a directive) and the term or terms following the prompt are the propositional content part of the expression.

An offer is a conditional commissive.

> An offer is a promise that is conditional on the hearer's acceptance. An offer becomes binding only on acceptance. Roughly speaking, the logical form of an offer is: this speech act commits me to perform a certain course of action if it is accepted by the hearer. Consequently, offer and accept are reciprocal verbs. One's offer becomes binding only if it is accepted, and one can accept an offer only if it has been made and has not been withdrawn. These features, by the way, are reflected exactly in the English and American law of contract (Searle and Vanderveken, 1985, pp. 195-196).

An order is a species of directive. The propositional content describes the goods or services ordered (e.g., you send me 100 widgets). The illocutionary force indicator indicates a request (or directive) that the fact described in the propositional content be brought into existence by the hearer. A receipt is an assertive to the effect that the propositional content of the order has, in fact, been made true. An invoice is a directive whose propositional content is that the hearer pay the speaker. The prepatory conditions for an invoice (sigma) include the propositional content of the receipt (and order).

A payment (e.g., a check) is a directive (an order) to a third party for that party to pay the hearer from the speaker's account. The prepatory conditions for the payment (sigma) include the assumption that the third party has the appropriate level of authority over the speaker's account (e.g., that the speaker in fact has his account at the third party's bank) and that the speaker has sufficient funds in the account to cover the requested payment. Notice that because the message directing payment has been tokenized it would be possible, as in the case of paper-based checks, for the hearer to pass along the electronic check and use it directly for payments the hearer desires to make. (This, of course, assumes that the authentication and receipt verification problems have been adequately solved.)

Finally, a license is a declarative (aka, peformative). It confers certain rights or privileges on the hearer. This may be done with restrictions. For example, a driver's license might have propositional content: it is permitted that you drive and you obey the state's rules of the road. The permission is granted by an appropriate declaration; you have the permission if the right agent under the right conditions says you have the permission.

Prolog Formulation

We present here a simple (and simplified) example of formalized commercial communications based on the illocutionary logic discussed above. In particular, we will represent a query, an offer, and an acceptance.

Suppose, for the sake of example, that Jones and Smith are communicating about widgets with Jones buying them and Smith selling them. Both Jones and Smith participate on a network run by an agent (another Prolog process) whom we will call the Post Master. Messages pass from the speaker to the Post Master and on to the hearer. The steps to be formalized are, informally, as follows:

1. Jones sends a message on the network inquiring of Smith what the price of widgets is.

2. Smith hears the message, reasons that Jones may be interested in buying widgets since Jones is a frequent customer of Smith, and replies with an offer of widgets at $102.00 each.

3. Jones gets Smith's message, decides that the offer is a good one, and replies to Smith with an acceptance.

Let us see, albeit somewhat incompletely, how this can be formalized.

In step 1, the speaker is Jones, the hearer is Smith, the time is 0, the place is Jone's address. The 'world content' will be here specified as a simple message identifier, 91, as assigned by the Post Master. Thus:

context(jones,smith,time0,address_jones,91).

The illocutionary force is an asking for information (represented by ask) and has been defined in terms of a directive, a primitive illocutionary force. The definition is in a publicly available program maintained by the Post Master. Finally, the propositional content is: price(widget,Value). The interpretation of this predicate ("price(X,Y)" means that the price of an individual X is $Y) is also publicly available and maintained by the Post Master. So, the message that Jones puts out on the network to inquire about the price of widgets is:

```
ill_act(
     context(jones,smith,time0,address_jones,91),
     ask,
     price(widget,Value)
                              ).
```

Next, Smith receives the message, which is put into a module of Smith's Prolog database. That database contains other Prolog facts and rules. In particular, there is a rule saying that if a favored customer asks for the price of something we sell, then reply with an offer, rather than reply, e.g., with a catalog quote. So, Smith's database includes the Prolog statements shown below, in additional to Jone's message.

In this program, time/1 (the predicate time, the arity 1) is a built-in predicate that always succeeds, that cannot be resatisfied, and that returns the current time. The predicate, address/2, sets the address of the individual indicated in its first argument. The predicate, send_to_post_master_the_message(A,B), is also a built-in predicate that is used for writing messages to the network. If this predicate is set as a goal and both A and B are instantiated, then the message A is sent on the network to address B, by forwarding both to the Post Master. The predicate, deal_A_if_B(A,B), would be publicly defined (with the definition held by the Post Master). Its interpretation is: There is an agreement that A and that B.

The "if" in the deal...predicate is present because usually the predicate is used in the context of an offer, which has a conditional commissive illocutionary point. The predicate, deliver(Seller,-Buyer,Item,Each), is interpreted as: The Seller will deliver to the Buyer an Item at price Each. Finally, the predicate, pay(Buyer,Seller,Item,-Each), is interpreted as: The Buyer will pay the Seller the amount Each for an Item. Like deal_A_if_B, deliver and pay would be publicly defined.

In step 3, Jones gets the answer, an offer, from Smith, and determines what to do. Jones, in our example, has a rule that says to accept any offer

---

```
favored_customer(jones).        /*  Jones is a favored customer.
                                    Other favored customers would be
                                    indicated by similar statements.
                                                        */

favored_customer-price(widget,102.00)  /*   The price of a widget for
                                          a favored customer is $102.00.
                                                        */
```

/* Now, reply. Other statements would normally have reply as head and have other tails.

Overall structure:

```
reply :-

     A,                                                    (cont...)
```

```
                    B,
                    C,
                    send_offer_message(W,X,Y,Z).

                where A, B, C, W, X, Y, & Z are
                Prolog terms.

                    */

reply :-

/* A */ ill_act(
            context(Inquirer, smith, -, Inquirer_address,_),
            ask,
            price(Item,Each)),
/* B */ favored_customer(Inquirer),
/* c */ favored_customer-price(Item,Each),
        send_offer_message(Inquirer,Inquirer_address,Item,Each).
                    /* W       X       Y       Z    */

send_offer_message(Inquirer,Inquirer_address,Item,Each) :-
/*    Get the time:  */
        current_time(Time),
/*    Get the sender's address:    */
        address(smith,My_address),

/*    Determine the answer:  */
        Ans=ill_act(
                context(smith,Inquirer,Time,My_address,_),
                offer,
                deal_A_if_b(deliver(smith,Inquirer,Item,Each),
                    pay(Inquirer,smith,Item,Each))),

/*    Send the answer to the Post Master, addressing it to the Inquirer's
    address on the network:                    */
    send_to_post_master_the_message(Ans, Inquirer_address).
```

---

to sell widgets if the price is less than $105.00 and the offerer is a standard vendor for widgets. So Jone's knowledge base looks like this:

Now, the illocutionary force, offer, would be defined in terms of the primitive illocutionary force, commit, in such a way that if you offer a

---

```
standard_vendor(widget,smith).  /*    Presumably, other statements would
                                    be present to indicate other vendors.
                                        */

reply :-

        ill_act(context(offerer,jones)Offerer_address,_),
                offer,
                deal_a_if_B(deliver(Offerer,jones,Item,Each),
                    pay(jones,Offerer,Item,Each))),                    (cont...)
```

```
            Item=widget,
            Each=lt) 105.00
            standard_vendor(Item,Offerer),
            Deal=deal_a_if_B(deliver(Offerer,jones,Item,Each),
                             pay(jones,Offerer,Item,Each)),
            send_accept_message(Offerer,Offerer_address,Deal).

send_accept_message(Offerer,Offerer_address,Deal)    :-

/*    Get the time:  */
        current_time(Time),
/*    Determine the sender's address: */
        address(jones,My_address),
/*    Determine the answer:  */
        Ans=ill_act(
                    context(jones,Offerer,Time,My_address,_),
                    accept,
                    Deal),
/*    Send the answer to the Post Master:   */
        send_to_post_master_the_message(Ans,Offerer_address).
```

deal_A_if_B(A,B) and the offer is accept (i.e., if the offeree replies with a proper accept illocutionary act, then the offerer is legally obligated to do A and the offeree is legally (or contractually) obligated to do B. Similarly, the illocutionary force, accept, would be defined in terms of the primitive illocutionary force, commit, in such a way that if the offer is for a deal_A_if_B(A,B) and the offeree replies with a proper accept, then the offeree is legally (or contractually) obligated to do B, once A is done. Thus, in part, we would have:

```
obligated(Speaker,A,Hearer)    :-
    ill_act(context(Speaker,Hearer,_,_,_),
            offer,
            deal_A_if_B(A,B)),
    ill_act(context,(Hearer,Speaker,_,_,_),
            accept,
            deal_A_if_B(A,B)).
obligated(Hearer,B,Speaker)    :-
    ill_act(context(Speaker,Hearer,_,_,_),
            offer,
            deal_A_if_B(A,B)),
    ill_act(context(Hearer,Speaker,_,_,_),
            accept,
            deal_A_if_B(A,B)),
    A.
```

The definitions of offer and accept, which we shall not give in full because there is insufficient space to present them adequately, would be publicly known. Accepting the definitions would be a consequence of agreeing to use their defineinda when communicating on the network. In this way, electronic contracting might be effected.

This may seem like a long and complicated apparatus for such a simple exchange, especially when we note that not all the predicates have been defined and that in any realistic situation the complexity of the messages would be much greater.[10] But the complexity is mostly the cost of setting up the language. Once any contractual agreement can be made, the additional work to arrange for another type of contract to be supported is minimal. For example, the deal_A_if_B(A,B) predicate used here to make and accept offers can take as arguments any Prolog structures. To extend what they can say, all the communicating parties need to do is come to some explicit agreement on the syntax and interpretation of the structures to be used in the arguments of deal_A_if_B. Also, given the language setup, it is possible to provide fairly simple definitions for important business concepts. For example, we might define Jones' liabilities as the set of (Prolog predicates finaladd, setof or bagof) A's and Agent's, such that: obligated(jones,A,Agent). In these ways,

[10] There would be more checking to do, the offer would have a more complex set of conditions, etc.

the range of expressions can be extended indefinitely.

CONCLUDING REMARKS

Obviously much more analysis needs to be done than can be presented in the space available here (see Kimbrough and Lee, forthcoming, for some of this analysis and its initial implementation in Prolog). In addition, developing a workable implementation of these concepts in Prolog (or any other language) will involve a great deal of work. We believe, however, that the case in favor of having and using a formal language for inter- and intraorganizational communications is a strong one. Employing illocutionary logic (perhaps with modifications) appears to be a promising and feasible tack. The framework of Searle and Vanderveken discussed here, and the analysis of business concepts presented in the previous section appear to fit quite well together.

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Note

The main philosophical literature on speech acts and related ideas can be found, or found in the references, in Austin (1975) and in the several works by Searle listed in the reference section below. The work by Austin is an edited version of his William James Lectures at Harvard University in 1955. That work presents the results of Austin's thinking on uses of language, over a period of 20 years, and it is the most mature and developed statement by Austin of his views on performatives, speech acts, and related notions. Searle's book, *Speech Acts* (1969) represents the next major development in speech act theory in the philosophical literature. The idea that there are exactly five illocutionary points is first published in Searle's "A Taxonomy of Illocutionary Acts" (1975). This idea is key to the formalization developed in Searle and Vanderveken (1985).

The information systems literature on speech acts has heretofore been sparse and mainly programmatic. Flores and Ludlow (1981) discussed performatives in the context of office automation. Lyytinen (1984) presents an overview of five approaches to the study of language, including speech act theory, and argues that these perspectives ought to be useful and used in doing systems analysis. Kimbrough, Lee and Ness (1984) distinguish performative, informative and emotive expressions and argue that: (a) performatives play a central and critical role in business communications and (b) the information systems literature has largely neglected performatives. Lee (1984) and Stamper and Lee (forthcoming) are additional works in this category.