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# FINDING INTERNATIONAL CONTRACTING OPPORTUNITIES: AI EXTENSIONS TO EDI

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## ABSTRACT

Electronic Data Interchange (EDI) offers a telecommunications infrastructure for inter-business communications. This paper proposes a particular use of that infra-structure to aid firms in identifying contracting opportunities, particularly where international trade is involved. We focus on two aspects of this problem: navigating the legal procedures relating to such contracts and managing the multi-lingual communications.

### 1. THE INTERNATIONALIZATION OF BUSINESS

Increasing competition and the globalization of markets require that businesses large and small interact effectively on an international scale. A basic problem of doing business internationally is differences in language. Formerly, Britain's success as a colonial power and America's economic dominance after World War II established English as a *lingua franca*, a language adopted (sometimes imposed) to facilitate communication between parties with different native languages. However, the utility of English as a *lingua franca* is nearing its limit. Many nations, having achieved economic status in the world community, seek to maintain their cultural identities, especially as embodied in their languages. For example, the European Economic Community recognizes the languages of all its members and designates nine official languages in which its policies, regulations, and other official documents must be published.

Another obstacle to international business are the legal procedures ("red tape") required for most international transactions. Within a single legal system, conventions, trading practices, and statutory law (e.g., the Uniform Commercial Code in the US) simplify and expedite the contracting process. However, when international contracts involve diverse legal systems and trading practices, additional precautions must be taken to ensure that each party's interests are protected. These extra steps greatly increase the paperwork required and extend the contract negotiating time several-fold,<sup>1</sup> significantly handicapping companies too small to employ their own legal staff and too inexperienced to cope with these bureaucratic complexities.

This paper presents a prototype model of a computer-mediated contracting system whose purpose is to facilitate the entrance of smaller business firms into the global marketplace by enabling them to identify contracting opportunities and to navigate the legal and bureaucratic

complexities. The model supports the formation and execution of contracts over a telecommunications network by providing a multi-lingual interface and, equally important, by capturing the expertise needed to reason about the procedures and to guide the parties' communications to a successful outcome.

### 2. ELECTRONIC CONTRACTING

Contracting is one of the most fundamental concepts of Western economics. Essentially, a contract is a generalization of the notion of direct exchange that supports cross-temporal transactions, allowing one party to offer goods or services at one time in exchange for other goods or services at another time.<sup>2</sup> In doing so, an enormous gain in flexibility is achieved in that the contracting parties are able to negotiate complex arrangements specialized to the needs of the parties involved (Williamson 1975, 1979). Precise language and carefully specified procedures help to reduce the potential confusion and disagreement in contracting, but they also add greatly to the expense and time required to form and execute a contract. An apparently straightforward arrangement may become lengthy and complex as contingencies and details are worked out. For this reason, certain types of contracts have been standardized and streamlined to facilitate negotiation, e.g., the commodities contracts used by organized exchanges such as the Chicago Board of Trade. Also helping to reduce contracting overhead are statutes such as the Uniform Commercial Code (UCC), which provides default terms and standardized interpretations for contracts involving sales of goods within the US.

Today, despite the availability of instantaneous and worldwide electronic communications (phone, telex, electronic mail), contracts are still recorded mostly in the medium of paper documents. In this section, we consider how contracting can be and is supported by information technology. Clearly, telecommunications and database management can be – and are – used to speed communi-

cations and facilitate storage and retrieval. However, our focus is the language and formal procedures of contracting and the exploitation of standardized classes of contracts in order to further reduce the transaction costs of contracting. Here we briefly discuss electronic data interchange (EDI), one of the most recent and most effective uses of information technology in business, and propose an extension of EDI's capabilities using artificial intelligence techniques.

## 2.1 Electronic Data Interchange

EDI is "the inter-company computer-to-computer communication of standard business transactions in a standard format that permits the receiver to perform the intended transaction" (Sokol 1989, p. 12). Instead of exchanging purchase orders and invoices as paper documents, EDI trading partners transmit standardized electronic versions of these documents (called transaction sets) from the originator's computer directly to the receiver's computer, thus eliminating the manual processing and paper handling costs typically required in these business transactions.

The most important component in an EDI system is a set of standards for inter-firm telecommunications, i.e., a *lingua franca* for business computers. In the United States, these standards are being developed by the American National Standards Institute (ANSI) task group X.12 (ANSI 1987). At an international level, the United Nations and the Economic Commission of Europe are working to develop a coordinated international standard, called EDIFACT, Electronic Data Interchange for Administration, Commerce and Transport (see Evans 1989; Harrington 1988; ISO #9735 1988). EDI systems have been extensively and successfully implemented, often involving multiple business functions (such as shipping and billing), multiple industries (such as railroads and insurance), and, in the case of the EDIFACT standards, multiple countries. For example, 50 percent of all transactions in the grocery industry and 90 percent of all transactions in the railroad industry are performed using EDI. Furthermore, most transactions between suppliers and manufacturers in the automotive industry are completed using an industry EDI standard developed by the Automobile Industry Action Group (AIAG).

Since EDI transactions involve computer-to-computer communications, one problem of international contracting - translating from the sender's language to the receiver's - is largely avoided (limited to writing programs to convert from the EDI format to the local data formats, which in turn are communicated to the user through existing data processing applications). EDI also offers substantial improvements in transactional efficiency, both in cost and speed. We believe that EDI's fundamental impact can be extended using artificial intelligence techniques, thereby significantly supporting the ability of even relatively small firms to negotiate and execute contracts on a much broader scale and giving them access to worldwide markets.

## 2.2 An AI Extension of EDI

In its present design, an EDI system assumes point-to-point communications. Metaphorically, EDI is like a telephone system between business computers: company X's computer calls company Y's computer and transmits a purchase order. As with the telephone, company X must know who to call beforehand. Suppose instead that we introduce a feature allowing company X to simply stipulate the characteristics of the product or service it wishes to purchase. Then it could access a public database of vendor/product information, analogous to the Yellow Pages of the phone directory but with much more detailed product and price information. Given this capability, company X's computer could poll a larger number of potential vendors, including ones the company may not have known about. The technology to achieve this is a relatively straightforward database management system with remote access, a facility that has been implemented in various specialized contexts, but has not (yet) become commonplace.

Identifying candidate vendors is often only part of the problem. If seller and buyer are geographically remote, delivery arrangements must be made, the goods must be insured, and payment must be specified and arranged. The steps in the procedure increase tremendously if several connected delivery contracts must be negotiated; furthermore, international transactions necessitate customs and other inspections and the payment of import/export and other taxes. Add to these procedures the complexities of exchanging currency and obtaining letters of credit, and the net cost of a transaction escalates rapidly.

Under the current, point-to-point system of EDI, the buyer (or the buyer's computer) must know about each of these intermediate steps to identify and query the relevant vendors, carriers, banks, and other agents and to assess the feasibility and attractiveness of a transaction. Clearly, this process is practical only for large scale purchases and/or highly repetitive transactions. However, if the relevant procedural steps could be encoded in a flexible fashion, reflecting not only the vendors' product information but also the services offered by each of the intermediary agents, then making complex contract arrangements could be worthwhile even for lower volume sales.

We visualize a **computer-mediated contracting system**, an artificial intelligence extension of EDI, to provide these capabilities. The eventual commercialization of this model would take the form of a **contracting network**, implemented using existing telecommunication networks, but with restricted access. The contracting network would obtain legal force by means of an **umbrella contract**, which all network participants must sign, that defines the "rules of the game" for the contracting network (Baum 1989). For example, an umbrella contract might indicate that a certain sequence of keystrokes constitutes an acceptance of an offered contract, or it might stipulate the body of law

applicable in the case of disputes. Separate contracting networks would be established on an industry-specific basis, thereby limiting complexity. To develop a special-purpose contracting network, a third-party company or agency would use the proposed system to specify rules about the specific products or services to be traded. Additionally, the computer-mediated contracting system would provide commonly applicable contracting rules and constructs, including general rules for reasoning about obligations, temporal concepts, transfers of money, transportation and deliveries, etc. These rules could be modified as necessary to meet the needs of the specific contracting application.

As this explanation shows, a contracting network offers a new form of third-party mediation, differing from human intermediaries not only in efficiency (much more rapid, lower cost) but also in the degree of control maintained by the contracting parties (Williamson 1979) and greatly adding to EDI's functionality. More specifically, the functions of an international contracting network are summarized below:

- to provide a **multi-lingual communication channel** between parties (Lee 1988a);
- to aid users in **finding contracting opportunities** by matching complementary needs;
- to expedite contract negotiations by **structuring and monitoring negotiation procedures** (Lee 1988b);
- to assist users in **formulating contracting communications**, checking for legal correctness and completeness;
- to **advise users of potentially unfavorable outcomes** in the draft contract;
- to **monitor contract performance**, reminding users of approaching deadlines and detecting contract breaches (Dewitz and Lee 1989); and
- to provide a **precise and complete audit trail** of the contract history, valuable if human arbitration or litigation becomes necessary.

In the remainder of this paper, we focus on two of these functions: navigating the legal procedures of international contracting and supporting multi-lingual communications.

### 3. COMPUTER-MEDIATED CONTRACTING

#### 3.1 Performative Communications in Contracting Conversations

A requirement of electronic contracting is the ability to perform contracting procedures via the network, a goal made possible because the acts that constitute these procedures are primarily linguistic. Within the philosophy of language, speech act theory has distinguished two basic

types of linguistic statements: **informative statements** that merely describe the world and **performative statements** that, when used in certain conventional situations (such as contracting), perform acts that change the state of the world. An instance of the second type of statement might involve one party making a formal offer that the other party accepts. Both offer and acceptance are acts performed by using words, in either spoken or written form. We call these acts **performative communications**.

Performative communications alter the legal status of the parties by conferring rights, imposing obligations, and prohibiting or waiving certain acts. We refer to these changes in legal status as changes in **deontic state** (Von Wright 1968; Hilpinen 1981a, 1981b). A deontic state is one in which certain permissions, obligations, or prohibitions hold. For example, issuing a letter of credit entitles the named beneficiary to payment upon compliance with the stated terms and conditions (performative communication: letter of credit; deontic states created: the beneficiary's contingent right to payment; the issuer's contingent obligation to pay). Similarly, issuing a negotiable bill of lading gives the legal holder of the document title to the goods if the document directs that they are to be delivered to bearer or to the order of a named person (performative communication: bill of lading; deontic states created: the named bearer or holder's right to take delivery; the carrier's obligation to deliver).

In its temporal aspects, a contractual agreement is much like a plan in that it specifies a (possibly contingent) series of activities, some to be performed sequentially, others to be performed concurrently. Contracts differ from plans in that contracts involve (promises between) multiple agents (the contracting parties) and in that they create contingent obligations.<sup>3</sup> Thus the performance of one party's activity (a payment) may be contingent on the other party's completion of another activity (compliance with the letter of credit's terms and conditions). The performance of these activities is also commonly governed by time. Contracting procedures refer to relative time in the form of sequential and concurrent activities and absolute time in the form of deadlines.

The combination of these three aspects – performative communications, deontic states, and contracting procedures – leads us to the concept of a formalized **contracting conversation**: a structured sequence of performative communications, governed by explicit rules and conventions (the legal rules governing contracts) that determine how deontic states are formed and satisfied. To coordinate contracting conversations, the proposed computer-mediated contracting system must be able to track the evolution of deontic states and to record and to reason about the obligations, permissions, and prohibitions of the contractual parties.

Contracting conversations normally divide into two distinct phases: negotiation and performance. In the negotiation

phase, various performative communications progressively develop the conversation to its eventual deontic states as represented by the contractual agreement. For instance, an **offer** is a kind of contingent obligation that *if* the designated party responds with an **acceptance**, a contract is formed, creating mutual obligations between the parties. Other performative communications during negotiation include **retraction** of an offer (by its originator), **rejection** of an offer, and a **counter-offer**. Other performative communications, such as a **notarization** (confirming the party's identity and intent) and a **verification** (e.g., of financial position), do not directly create the deontic status of the parties, but may be pre-conditions for the creation of that deontic status.

The performance phase of a contracting conversation normally includes various physical activities such as the manufacture and shipment of goods or the payment of money. These physical activities are usually controlled and monitored through performative communications. Examples include a **shipping-receipt**, which certifies transfer of goods from the manufacturer to the carrier, or a **bill-of-lading**, which allows transfer of goods from the carrier to the customer. Payment procedures are also monitored by means of performative communications, e.g., a **letter of credit**, an **invoice**, or a bank **deposit-slip**.

Processing the performative paper associated with contracting contributes greatly to the transaction cost. EDI reduces these costs for highly routine, well-structured transactions. However, transaction costs are aggravated for less standardized contracts, particularly those in which extended negotiations are involved, legal intermediaries are required, or the contracting parties are geographically separated. A goal for computer-mediated contracting is to convert these paper documents to electronic documents, ones less structured than EDI's transaction sets but sufficiently structured to allow computer mediation and to support the negotiation and execution of contractual commitments directly through the network. Because electronic documents are more easily altered without detection than paper documents are, this conversion also entails automating certain controls, including reliability and security safeguards, to ensure that contractually performative communications are not lost or tampered with and to authenticate transactions between the contracting parties. These concerns are beyond the scope of the current paper; we refer the interested reader to a number of other sources on security and reliability issues (see Amory and Thunis 1988; Even, Goldreich, and Lempel 1985; Haskell 1987). The next section describes a system for representing the procedures that use the electronic documents; later we describe a system for representing the documents themselves.

### 3.2 Rule-Based Representation of Contracting Procedures

Normally (legal and bureaucratic) procedures are regarded as having a pre-determined sequence, e.g., the sequence of

steps in applying for a mortgage. However, from a broader perspective, different steps in different orders are possible depending on the location and characteristics of the parties, the specific terms and conditions of the contract, and other aspects of the contracting situation. One function of a computer-mediated contracting system is to help navigate this procedural maze, not only finding a desirable contracting opportunity but also delineating the procedural steps necessary to complete the transaction.

In order to do this, the actions of various procedures must be "unbundled" into separate rules. We refer to these as **transition rules** in that they describe how the situation being modeled changes from one state or set of conditions to another. Each transition rule describes a single possible **action** in terms of a set of **pre-conditions** that must be true for the action to be permitted (enabled) and another set of **post-conditions** that become true after the action has been taken. Each condition represents a static property or relationship. These are denoted using a predicate notation; for example

```
sales_contract(adams, jones, widget, 100, 10, usd)
```

indicates that there is a sales contract between parties Adams and Jones for 100 widgets at a unit price of 10 U.S. dollars. Conditions may also contain variables, which are denoted with leading capital letters:

```
sales_contract(Buyer, Seller, Good, Qty, UnitPrice, Currency)
```

We distinguish between **conditions**, which describe a static property or relationship, and **actions**, which cause a change from one set of conditions to another. Actions have the notation `<agent> : <action-predicate>` where `<agent>` specifies an individual or firm, and `<action-predicate>` describes the action. For example, **Forwarder: despatch\_notice(Shipper, Good)** indicates the action of a forwarder notifying a shipper to prepare goods for despatch. In this representation, actions are regarded as occurring at a point in time. (To model activities having longer duration, one would use two actions: one for the start, the other for the completion of the activity.) Combining the notation for conditions and actions, a transition rule has the following form:

```
from <conditions>
when <actions>
next <conditions> .
```

The **from** clause gives the pre-conditions for the action (the conditions that must be true for the action to be enabled). The **when** clause specifies the action itself. The **next** clause gives the post-conditions for the action. If more than one condition or action applies, these are connected by the word **and**. An optional **where** clause may be included to specify arithmetic calculations. An example transition rule is the following:

```

from ship_contract(Shipper, Forwarder, Good)
whenForwarder: shipping_instruction(Liner Agent, Good) and
  Forwarder: transport_instruction(Carrier, Good)

next liner_contract(Forwarder, Liner Agent, Good) and
  transport_contract(Forwarder, Carrier, Good).

```

Notice that the actions here require the forwarder to send two performative communications: a shipping instruction to the liner agent and a transport instruction to the carrier. A key consideration in designing these transition rules is whether certain conditions persist after an action has been completed. Normally, conditions in the **from** clause are assumed **not** to persist (they are deleted from the ongoing list of current conditions). Conditions that **do** persist must be listed again in the **next** clause. For example, in the above rule, the condition **ship\_contract** is assumed to be terminated after this transition. Two other types of rules – deductive rules and deontic rules – augment the inferencing of the transition rules. **Deductive rules** are used to deduce additional conditions about a given state.<sup>4</sup> Their syntax is `<condition> if <conditions>`. **Deontic rules**, a special kind of deductive rule, specify constraints on the actions that may be taken using the following syntax: `<deontic-condition> if <conditions>`, where a `<deontic-condition>` is one of the following:

```

permit <action>
forbid <action>
oblig <action>
waive <action>

```

The initial conditions for a given problem, i.e. the facts, are given by the following syntax: `fact :: <condition>`. To initiate a search<sup>5</sup> for a path to achieve a given condition, one executes the command: `?- findway <condition>`. For example, suppose the rules and facts given below:

---

```

from solicits(Seller, Good, Qty, UnitPrice, Currency)
when Buyer: purchase_order(Seller, Good, Qty, TotPrice, Currency)
next pending_order(Buyer, Seller, Good, Qty, TotPrice, Currency)
where TotPrice is UnitPrice * Qty.

from pending_order(Buyer, Seller, Good, Qty, TotPrice, Currency)
when Seller: invoice(Buyer, Good, Qty, TotPrice, Currency)
next sales_contract(Buyer, Seller, Good, Qty, TotPrice, Currency).

fact :: solicits('Cathay Bicycles', bicycle, 100, 180, nfl).
fact :: solicits('Tam Bicycles', bicycle, 100, 150, hkd).

```

---

An execution of this "toy" rulebase is as follows, where italicized text indicates the user's typed command and the normal text indicates the computer's output:

---

```

?- findway sales_contract('Hans Brinker', Vendor, bicycle, 100, TotPrice,
  Currency).

```

Actions to achieve goal:

```

Hans Brinker:purchase_order(Cathay Bicycles,bicycle,100,180,nfl)
Cathay Bicycles:invoice(Hans Brinker,bicycle,100,18000,nfl)

```

Actions to achieve goal:

```

Hans Brinker:purchase_order(Tam Bicycles,bicycle,100,15000,hkd)
Tam Bicycles:invoice(Hans Brinker,bicycle,100,15000,hkd)

```

No (more) ways to achieve goal.

This output tells the user that, to achieve the condition of a sales contract between Hans Brinker and an unspecified vendor, Hans can send a purchase order to either of the vendors listed on the network: Cathay Bicycles at a unit price of 180 Dutch guilders (nfl) or Tam Bicycles at a unit price of 150 Hong Kong dollars (hkd). If either vendor responds with an invoice, then a contract has been formed. A more extensive example of the system's capability to find contracting opportunities and to delineate the steps of a contracting procedure is given in a later section.

#### 4. MULTI-LINGUAL INTERFACE AND TEXT GENERATION CAPABILITIES

Once the system has identified a contracting partner and has described the contracting procedure, the user prepares the performative communications required by the procedure. In this section, we discuss how a computer-mediated contracting system could assist the user in generating these documents. Of special concern in international contracting is the probable necessity of interacting with agents and of generating contracting documents in multiple languages. We discuss these issues here and present prototype models of both a multi-lingual interface and a multi-lingual text generation system.

##### 4.1 Machine Translation Approaches

A key problem of international contracting is coping with differences in language. One approach perhaps is to apply natural language (NL) translation techniques to this problem. Although machine translation is one of the most difficult computational challenges, several machine translation systems have enjoyed some success.<sup>6</sup> These systems provide NL translation, which, while very difficult, is nonetheless distinctly easier than natural language understanding. The translation task relies mainly on syntactic processing. The understanding task requires, in addition, an internal representation of semantic content and rules to reason about this content.

While a natural language interface may be a desirable feature for some systems, we believe it is an unnecessary complication given the purposes of a computer-mediated contracting system. The goal in contracting is precise communication: the recipient of a message must be able to understand it clearly. It is not necessary – nor perhaps even desirable – that the sender express the message originally in natural language. Perlman (1982) recommends that we design "natural artificial" languages to facilitate concise and unambiguous communication within a restricted domain and to provide a convenient, easy-to-

use interface. In our communication model, we adopt Perlman's recommendation and restrict the user's input by means of a structured dialogue, allowing us to develop a formal language representation of the message and to paraphrase it back to the user. This dialogue utilizes electronic forms to structure the user's input and to provide structured output. Additionally, text generation techniques are used to supplement the electronic forms approach for less structured data.

Although our model system does not attempt to parse natural language input, it must establish and maintain the correspondence between terms in the various languages in the electronic forms interface and in the text generation rules. This correspondence must be carefully understood, not only for purposes of communicating between the contracting parties but also with respect to its significance in the relevant legal systems. To translate legal texts (or in our case, to write rules to generate legal text in multiple languages), the translator must understand not only the meaning of the terms but also the legal effect they create (Schroth 1986). In legal translation, substituting the English words "bill of lading" with the Dutch "vrachtbrief" or the Portuguese "carta de embarque" is not sufficient; rather, the translation must capture the "substantive equivalen[t]" of the legal concept of bill of lading in these other legal systems (Schroth 1986). Various resources<sup>7</sup> are available to help us perform legal translation during future development of the interface and text generation system.

#### 4.2 Multi-Lingual Electronic Forms

As part of our multi-lingual interface for more structured communications, we have developed **electronic forms**. In this interface, an electronic form appears on the screen much like a paper form, with labels and boxes to be filled in. Data can be entered in any sequence by pointing to the appropriate box with a mouse. A principal advantage of the electronic form over its paper counterpart is that the system can provide on-line verification of the data entered; for instance, numeric fields can be checked for appropriate ranges. Further, interdependence between fields can be controlled; e.g., if the user has entered "unmarried" for marital status, the system will not display a question about spouse's employment. Additionally, electronic forms can automatically insert commonly used reference data, such as name, address and phone number, from a stored database.

Electronic forms effectively manage multi-lingual communication in that they restrict the user's input to facilitate translation. The initial step in translating a form is to consult a dictionary listing the field labels in multiple languages. More important, however, is actively structuring the user's input by confining the data entered to one of four types of parameters:

1. **Numeric parameters** are for numbers, such as order quantities, prices or weights. Most languages use the same (Arabic) representation for numbers and so these normally do not require translation.
2. **Fact parameters** have values of either true or false (yes/no, oui/non, ja/nein, etc.).
3. **Choice parameters** describe a qualitative attribute, such as the color or shape of the product or the marital status of an employee. These parameters ask the user to select from a limited set of choices, i.e., a menu. Internally, each choice is maintained as an integer number, corresponding to the position of the choice.
4. **Name parameters** are used to input proper names (of persons or companies) that remain the same in each translated form.<sup>8</sup> Between languages using Roman script, these normally do not need any conversion. Converting in and out of Cyrillic script can be done using a straightforward character substitution. For ideographic scripts such as Chinese, Korean and Japanese, name parameters are more difficult in that they require special keyboards in their home script. (At present, we simply utilize the Roman spelling in these cases.)

A very simplified example of an electronic form, illustrating the four different parameter types, is given below. The first field, **Name**, is a name parameter; the second, **Quantity**, is numeric. Both of these require keyboard entry and are not translated. The field **Tax** (whether or not tax is to be applied) is a fact parameter, while **Color** is a choice parameter. Both of these fields are input using a mouse and their labels are translated to other languages as necessary.

Name:	<input type="text" value="Gorbachev"/>
Quantity:	<input type="text" value="12"/>
Tax:	<input type="radio"/> yes <input type="radio"/> no
Color:	<input type="radio"/> red <input type="radio"/> blue <input type="radio"/> green

A Russian version of this electronic form is the following:

фамилия	<input type="text" value="Горбачев"/>
количество	<input type="text" value="12"/>
налог	<input type="radio"/> да <input type="radio"/> нет
цвет	<input type="radio"/> красный <input type="radio"/> синий <input type="radio"/> зелёный

Illustrating the handling of ideographic scripts, a Chinese version of this form is as follows:

姓:	<input type="text" value="Gorbachev"/>
數量:	<input type="text" value="12"/>
稅:	<input type="radio"/> 是 <input type="radio"/> 否
顏色:	<input type="radio"/> 紅 <input type="radio"/> 藍 <input type="radio"/> 綠

#### 4.2 Multi-Lingual Text Generation

In certain circumstances, such as the preparation of a contract document, electronic forms are too structured. Nonetheless, the message content in these cases is not altogether unstructured. The types of phrases, as well as the vocabulary, are reasonably bound and quite explicit. Here we take advantage of the document's structure and the boundedness of its message content to control the formation of the message in such a way that it can be represented formally.<sup>9</sup> In the course of interacting with the text generation system, the user is given an ongoing paraphrase of the text fragment being composed. Simultaneously, the system constructs the formal language representation of the message. When the message is complete, it is transmitted to the target recipient, who presumably has a different native language. What is transmitted, however, is not the natural language text that the originating user saw, but rather its formal language representation. When the message is received, a new natural language version is generated in the recipient's native language. (This translation process is analogous to the translation from the sender's application format into the EDI format for transmission and then into the receiver's application format for processing.)

Central to these capabilities is the development of a multi-lingual text generation facility. Our text generation design uses definite clause grammar (DCG) rules, a technique commonly used for natural language parsing. We use DCG rules in reverse fashion to generate natural language sentences. Since multiple natural languages are involved, the rules are distinguished by their language. For example, a rule from an English (eng) text generation grammar is the following:

```
eng: delvy_sent == >
  'The', @qty, 'units shall be shipped from',
  location(@seller_loc), nl,
  'to', @buyer_name, 'by', date(@del_date), period.
```

This rule specifies the sentence form for delivery terms (`delvy_sent`). The parameters `@qty`, for quantity, and `@buyer_name` are inserted directly into the output text. The parameter `@seller_loc`, giving the city and country of the seller, is further processed by another rule, `location` (not shown); likewise `@del_date`, for delivery date, is translated by the `date` rule. The terms `nl` and `period` also call other rules, which insert a new line and a period, respectively. After parameter values have been supplied by the user, this rule will generate a sentence such as the following:

The 100 units shall be shipped from Taipei, Taiwan to Witte Fiets Handel by November 15, 1989.

A Dutch version of this rule is the following (`ned` is for Nederlands)

```
ned: delvy_sent == >
  'Deze', @qty, 'stukken zullen uiterlijk op',
  date(@del_date), 'verscheept worden uit',
  location(@seller_loc), nl,
  'met bestemming', @buyer_name, period.
```

Using the parameter values supplied by the user, this rule generates the following sentence:

Deze 100 stuks zullen uiterlijk op de vijftiende november 1989 verscheept worden uit Taipei, Taiwan met bestemming Witte Fiets Handel te Amsterdam, Nederland.

Note that the word and phrase ordering is quite different between the two rules (for instance, the delivery date, `date(@del_date)`, appears last in the first rule but near the beginning in the second rule). Note also that only the words and phrases between single quotes are represented in the indicated language; parameter names and calls to other rules use the same terminology no matter what language is being processed. Given suitable font capabilities, these techniques can also be used to generate texts in ideographic languages, such as Chinese. In this case, a Romanized form (called Pinyin) is used to express the rule, and this is converted in a second pass to the ideographs. For instance, dates in Chinese are expressed using the numeric parameters directly, along with labels for year, month and day:

```
chi: date(Day - Mo - Yr) == > Yr, nian2, Mo, yue41, Day, ri4.
```

Using this rule, the date value 30-7-1989 becomes:

1989 , nian2, 7, yue41, 30, ri4

which is then converted to the ideographic form:

一九八九年七月三十日

More extensive examples of text generation using this technique appear in the scenario below.

## 5. APPLICATION

### 5.1 Documentary Credit Operations

To illustrate the capabilities discussed so far, we present a scenario in which a hypothetical buyer uses a computer-mediated contracting system to find a supplier, identify the necessary steps in the contracting procedure, and generate the appropriate performative communications. Our problem domain is the formation and execution of an international contract for the sale of commercial goods. Commonly, international sales contracts are executed by a **documentary credits** procedure, subject to the rules set forth in the **Uniform Customs and Practices for Documentary Credits** (ICC 1983). Documents play an important role in these transactions in that payment for the goods is made not on the delivery of the goods themselves but on the presentation of stipulated documents. Stipulated documents may include a commercial invoice, an insurance certificate, a certificate of origin, and a transport document (a bill of lading or an airway bill), among others. The seller receives payment by presenting the stipulated documents to a bank (the advising bank) that the buyer has instructed to make payment.

Two attributes make documentary credit procedures in international sales contracts an appropriate problem domain for our computer-mediated contracting system. First, these procedures involve numerous agents who often must interact in disparate languages. The agents in an international sale using documentary credits may include two or three banks, a forwarder/broker, a liner-agent, a land transport carrier, a customs official, an insurance agent, a stevedore (to load the goods on the ship), a ship's captain, and several others in addition to the buyer and seller. Opportunities abound for applying the contract matching capability of our proposed system. Also, the goods may have to cross several borders in their transit from seller to buyer; thus, multiple versions of documents in various languages may be required. Our system's multi-lingual interface and text generation capabilities would be a boon here as well.

Second, these procedures are mired in bureaucratic complexity and are subject to a host of confusing rules depending on the countries of the exporting/importing parties.<sup>10</sup> At one time, as many as thirty forms (i.e., performative communications) were required to ship goods

from one country to another and to arrange payment (Kindred 1988). The task of processing these myriad forms was so cumbersome that the goods commonly travelled faster than the forms, arriving before the documents did. When the goods being shipped were perishable foodstuff, the buyer was placed in the untenable position of watching his "goods" go bad as he waited for the documents allowing him to claim the shipment. Using information technology to generate, process (i.e., reason about) and transmit these documents could avoid these problems.

Although EDI systems have alleviated some of these problems for very well-structured transactions, much remains to be done. The following scenario describes how we envision that a computer-mediated contracting system could extend EDI and provide several capabilities beyond EDI's largely communicative function. Although we focus on the opportunity finding, procedure navigating, and text generation capabilities discussed here, the scenario also describes some of the inferencing functions we expect such a system to provide. For more information on these inferencing functions, we refer the reader to earlier papers (Dewitz and Lee 1989; Kimbrough and Lee 1986; Lee 1988b).

### 5.2 A Scenario

Contracting to import/export goods using a documentary credit involves four major steps. First, the parties **form a contract** stipulating the contractual goods and the procedures for delivery and payment. Second, the buyer asks with his bank to **issue a letter of credit** usually to a bank in the seller's country. Third, the seller arranges to deliver and insure the goods and then **present documents** to his bank. Fourth, the seller's bank pays the seller to **settle the credit** and sends the documents to the buyer's bank, requesting reimbursement (if appropriate); upon receiving the documents, the buyer's bank notifies the buyer, who then settles with the bank, takes the documents, and claims the goods.

During the first phase of this scenario, **formation of the contract**, Hans Brinker, owner of Witte Fiets Handel of Amsterdam, logs on the system and chooses the "Generate Procedure" option from a menu of options, requesting a procedure to conduct an international sales transaction using documentary credit as the means of payment. The system's output is shown in the box on the following page.

On July 30, Hans transmits an offer to buy 100 bicycles to Cathay Cycles of Taiwan via the network. K. T. Chen, owner of Cathay Cycles, communicates his acceptance, also via the network. To formalize their agreement in a written contract, Hans logs on the network and chooses "Generate Document." Hans is prompted to answer a series of questions to provide values for the parameters of the contract (buyer, seller, contractual goods, etc.). Then, the document is generated, as shown here in English:

Actions to achieve condition procedure\_completed(Witte Fiets Handel, Cathay Bicycles,Tot\_price,Tulip Bank,Bank of Taipei,irrevocable, confirm,payment):

Witte Fiets Handel: purchase\_order(Cathay Bicycles,bicycle,100,180,nfl)  
Cathay Bicycles: invoice(Witte Fiets Handel,bicycle,100,18000,nfl)  
Witte Fiets Handel: order\_to\_issue(Tulip Bank, credit)  
Tulip Bank: request to confirm(Bank of Taipei, credit)  
Bank of Taipei: confirm(Cathay Bicycles, credit)  
Cathay Bicycles: verify(credit)  
Cathay Bicycles: transport\_instruction(Worldwide Transport)  
Cathay Bicycles: insurance\_instruction(Prudential)  
Cathay Bicycles: customs\_approval(Customs)  
Cathay Bicycles: ship\_goods  
Cathay Bicycles: send\_docs(Bank of Taipei)  
Bank of Taipei: approve\_docs  
Bank of Taipei: pay(Cathay Bicycles,18000)  
Bank of Taipei: request\_reimburs(Tulip Bank)  
Tulip Bank: approve\_docs and Tulip Bank:reimburse(Bank of Taipei,18000)  
Witte Fiets Handel: pay(Tulip Bank,18000)  
Witte Fiets Handel: present\_docs\_to\_ship\_captain

#### CONTRACT FOR SALE OF GOODS

This agreement made this 30th day of July 1989 between Cathay Cycles of Taipei, Taiwan (herein called "Seller") and Witte Fiets Handel of Amsterdam, The Netherlands (herein called "Buyer"), witnesseth: That the Seller agrees to deliver to Buyer: a quantity of 100 men's 3 speed 26 inch bicycles, color white, with weight of 11 kg., at a unit price of 180 Dutch fl. The 100 units shall be shipped from Taipei, Taiwan to Witte Fiets Handel by November 15, 1989. The total purchase price of 18000 Dutch fl shall be paid as the goods are shipped pursuant to this agreement within 30 days net cash against bill of lading and documents at the time the goods leave the Seller's factory at Taipei, Taiwan.

However, the version that Hans sees is actually in Dutch:

#### CONTRACT VOOR DE VERKOOP VAN GOEDEREN

Deze overeenkomst, opgemaakt de dertigste juli van het jaar 1989 tussen de partijen Cathay Cycles te Taipei, Taiwan (hierna te noemen 'verkoper') en Witte Fiets Handel te Amsterdam, Nederland (hierna te noemen 'koper'), getuigt, dat: verkoper instemt aan koper te leveren de volgende goederen: 100 stuks herenrijwielen, kleur wit, voorzien van drie versnellingen, met een wielhoogte van 26 inches, en een gewicht van 11 kilogram, tegen een stukprijs van 180 gulden. Deze 100 stuks zullen uiterlijk op de vijftiende november 1989 verscheept worden uit Taipei, Taiwan met bestemming Witte Fiets Handel te Amsterdam, Nederland. De totale koopsom van 18000 gulden zal netto contant tegen vrachtbrief en documenten, binnen 30 dagen na verscheeping van de goederen, waaronder verstaan wordt he tijdstip waarop de goederen de fabriek van verkoper verlaten, ingevolge deze overeenkomst worden voldaan.

To generate this document, the system first creates a formal language representation of the contract and then paraphrases from the formal language. The intermediary formal language representation is used to reason about the contract (to determine what legal effect the contract has). For example, to be sure that the document will create the legal effect desired, Hans chooses "Show Obligations" from a system menu to see what obligations this contract creates:

#### Obligations of Cathay Cycles:

deliver: goods=men's 3 speed 26 inch bicycles,  
unit=each, number=100, color=white,  
unit weight=11 kg., unit price=180 Dutch fl.  
deliverdate=by 15-nov-1989.

#### Obligations of Witte Fiets Handel:

present: document=irrevocable letter of credit,  
beneficiary=Cathay Cycles,  
beneficiary address=Taipei, Taiwan  
advising bank=The Bank of Taipei,  
bank address=35 Queen Street, Taipei, Taiwan,  
amount=18000 Dutch fl.,  
expiration date=shipdate + 30 days.

Because K. T. Chen speaks and reads only Chinese, Hans switches to the Chinese text generation rules, causing the network to generate the following Chinese version of the contract:

銷貨契約本契約由臺灣臺北之國泰單車公司(以下簡稱賣方)及荷蘭阿姆斯特丹之易華單車公司(以下簡稱買方)簽訂於一九八九年七月三十日據以證實:賣方同意運交買方一百輛之男用三速二十六吋單車,顏色白色,重量十一公斤,價銀每輛一百八十荷幣。上述一百單位貨品應於一九八九年十一月十五日前,由臺灣臺北運至易華單車公司。總價一萬八千荷幣應於契約所載貨品運離賣方臺灣臺北之工廠三十日內,根據運貨及提貨單據付現。

During the second phase, issuance of the credit, Hans uses the network's electronic forms option to apply for a letter of credit.<sup>11</sup> By responding to the prompts, Hans completes the application form instructing Tulip Bank, the issuing bank, to issue an irrevocable credit in favor of Cathay Cycles to be confirmed by The Bank of Taipei, the nominated bank.

Hans transmits the letter of credit application via the network to Tulip Bank, where an officer in the Credit Department processes Hans' application. Once approved, the letter of credit is transmitted to The Bank of Taipei, which informs K. T. that the credit has been issued. Using the system's "Show Obligations" function, K. T. requests that the system evaluate the letter of credit and enumerate the documents he must present to collect payment for the goods:

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present: document1=marine bill of lading,  
consignee=Witte Fiets Handel,  
consignee address=Amsterdam, The Netherlands;  
document2=certificate of insurance  
insurance amount=invoice value plus 10%;  
document3=commercial invoice.

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During the third phase of the procedure, **presentation of documents**, K. T. prepares the documents and presents them to The Bank of Taipei. Here again, the computer-mediated contracting network assists K. T. in meeting these requirements by performing completeness and consistency checks on the documents.<sup>12</sup> K. T. creates an invoice and insures the goods, requiring that the insurer post on the network a certificate of insurance naming Witte Fiets Handel as the beneficiary. Then K. T. ships the goods through a carrier, Worldwide Transport, which creates a seaway bill and posts it to the network. Finally, K. T. informs The Bank of Taipei that the stipulated documents are available on the network for examination. The Bank of Taipei uses the system's "Verify Documents" function to compare the documents against the credit. If the documents are satisfactory, the bank pays Cathay Cycles the amount of the credit.

During the last phase of the procedure, **settlement of credit**, The Bank of Taipei requests reimbursement from Tulip Bank. Tulip Bank logs on the network, upon verification of the documents, reimburses The Bank of Taipei, and transmits the stipulated documents to Witte Fiets Handel upon payment of the amount due or under the terms of their agreement. To complete the transaction, Hans presents proper identification and takes delivery of the goods.

## 6. CONCLUDING REMARKS

A prototype model of a computer-mediated international contracting system has been presented, which applies artificial intelligence techniques to contracting procedures in order to support multi-lingual communication and to expedite opportunity searching among international businesses. As a working prototype, this system illustrates a practical application of numerous aspects of artificial intelligence theory. When fully operational, it may facilitate the entry of small businesses into the international marketplace. Scaling up from the prototype to an operational system requires a brief discussion of computational complexity.

The decision problem illustrated here normally requires the user to analyze costs and benefits by weighing product costs plus transaction costs (including transaction time) against less quantifiable factors such as product quality and reliability, schedule reliability, etc. The search problem deals primarily with determining transaction costs and times. The set of transition rules in this search constitute a Petri net (Peterson 1981); searching such a network for a goal state satisfying the specified constraints is a reachability problem – or, if optimization is performed, a shortest path problem. Even for reachability (the easier case), this is known to be exponentially hard in both space and time, though decidable (Murata 1989). Finding the shortest path (the optimal procedure) becomes increasingly complex as the number of factors and alternatives in the search problem increases.

Although searching for contracting opportunities and effective procedures is clearly a difficult problem, certain of its characteristics make it computationally more tractable than one might think. For example, because contracts are considered one at a time, the graph is always forward directed – hence without cycles – and "safe," that is, each place may have at most one token. Furthermore, the concurrences that arise in these procedures usually have a common point of convergence. Thus, these subgraphs (which are marked graphs, like a PERT diagram) have only a single reachability point, therefore further simplifying the computation required.

Another key factor that reduces computational complexity is the modularity of the chosen problem domain. The first level of modularity allows partitioning by product class: for instance, contracts for bicycles versus computer chips versus wheat will be largely independent in their search graphs (except perhaps for financial aspects). Further, within a given problem domain, aspects of the search problem typically can be modularized by country or by country pair. For example, each country of import will have fixed import and customs inspection procedures common to a product class. Likewise, the domestic transportation alternatives (from supplier to port) will be relatively uniform within a given country for a given product class. International transport, by contrast, can be modularized by country pairs for a given product class. For example, the alternatives for shipping bicycles from Taiwan to Holland are certain modes of sea and air transport whereas the alternatives from Holland to Germany are limited to rail or truck. Similarly, financial arrangements are constrained by country pairs: if the two countries have banks that are members of SWIFT, payment through these banks will usually be the most attractive alternative. Because many aspects of the problem domain can be modularized, these subgraphs do not have to be re-searched for each new query; rather they can be searched once (or whenever the subgraph changes), and the results stored and retrieved as needed.

A final factor in managing the complexity of the search problem is the use of heuristics and constraints provided by the user during the search process. The problem here can be compared to that of bibliographic retrieval, such as with the DIALOG system. As with retrieval systems, the use of the contracting network itself has transaction costs. For a given user query, the system can provide an estimate of the search cost. If the search appears too complex, the system can suggest constraints to trim the problem size. Through such real-time interactions, users can help navigate the search procedure to satisfice on their objectives.

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## 9. ENDNOTES

1. While various projects are underway to provide international trading standards (e.g., by the International Chamber of Commerce), progress is understandably slow considering the combinatives of the problem.
2. Technically, a direct exchange is also a contract, which is executed immediately. Throughout this proposal, the term "contract" will refer to cases where a promise for later performance is involved.
3. A plan is an intended series of actions by a single agent or legal entity. It is in effect a promise to oneself. A contract is an exchange of promises between multiple legal entities.
4. Deductive rules are analogous to (the declarative interpretation of) Horn clause rules, as in Prolog.
5. The search algorithm used is essentially a goal-directed search through a Petri net (Peterson 1981), where each transition rule corresponds to a transition node and each of the pre- and post-conditions corresponds to input and output places, respectively. To limit the search space, the Petri net is searched backwards, in dynamic programming fashion, from goal to initial conditions.
6. For example, Systran, a machine translation system used by the European Commission, translates between scientific/technical texts in English, French, German, and Italian, producing understandable sentences about 99 percent of the time (Siebenaler 1985). Another system, Eurotra, was recently funded by the European Commission to reduce the translation burden among its institutions and trading partners (Vollmer 1989). Its goal is to support translation among all nine of the Commission's official languages. Both of these systems are used to translate existing documents created off-line. Another system, called MetaL, is being developed under sponsorship from Siemens at the University of Texas Linguistics Research Center. This system is actually a meta-language for writing translation systems (hence the name) and is currently being applied to English-German translation, with a companion effort in Spain for translation between Romance languages.
7. For example, the International Chamber of Commerce (ICC) has developed Publication No. 417, *Key Words in International Trade* - a listing of about 1,800 English terms commonly used in international trade and their equivalents in German, Spanish, French, and Italian. The ICC also has developed and continues to revise its set of *Incoterms*, technical terms related to the transport of goods in international sales transactions. Contributing to international trade in a different way are the standards developed by the International Standards Organization (ISO). The ISO supports numerous technical committees, which have published over 300 international standards and are working on almost 250 more standards (French 1986). ISO/TC 154 deals with terminology common to documents and data elements in administration, commerce, and industry. Also supporting legal translation are several bilingual dictionaries of legal terms (Renner and Tooth 1971; DeMello 1984). A fairly recent addition to these tools is West Publishing's *Law and Commercial Dictionary in Five Languages* (1985).
8. Not all proper names qualify as name parameters; the names of cities, countries, days of the week, and month names are often different from one language to another.
9. The formal representation we use is an applied predicate logic; see Lee (1988b) for a more detailed explanation.
10. See *The Export Documentation Handbook*, an annual publication of Dun's Marketing Services, which describes the documentation requirements (import/export licenses, customs documents, required language of the documents, authentication requirements, etc.) of all import/export nations.
11. TexTrade, a system allowing businesses to apply for letters of credit via a modem, is described in "Letters

of Credit Go Electronic," *Cashflow*, October 1987, p. 64. Also described is a system, called Trade Manager, that allows Chase Manhattan trade customers to "access the bank's computer to check on the status of their...letters of credit."

12. Studies show that **half** of the documents presented to satisfy letters of credits contain discrepancies that delay – even render void – payment because the bank is not obligated to pay if the documents are unsatisfactory.