Construction Negotiation Online

Sai On Cheung1; Kenneth T. W. Yiu2; and Henry Suen3

Abstract: Disputes are common in construction projects and negotiating disputes are part of the daily routine of project managers and contract administrators. The recent wave of information technology (IT) has a tremendous impact on the way businesses function. The construction industry is also undergoing major structural changes due to the effects of IT. This paper discusses the application of IT in construction dispute negotiation. Making use of the current IT technology, a computerized construction dispute negotiation program namely CoNegO (construction negotiation online) is proposed. CoNegO utilizes the SmartSettle software technology. With the built-in facilities of SmartSettle, it is possible to conduct negotiations online, hence removing geographical barriers between negotiators. SmartSettle was developed based on the concept of “Even Swaps” in which negotiators are required to evaluate possible options available on the basis of their relative importance. As construction disputes are characterized by multiple factors and dimensions, the problem fits nicely with the “trade-off” methodology that underpins Even Swaps. The use of CoNegO is illustrated by a simulated negotiation.

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CE Database subject headings: Construction management; Internet; Dispute resolution; Negotiations; Information technology (IT).

Introduction

The application of Information Technology (IT) has attracted world-wide attention. In construction, ample research has been conducted to investigate the applications of IT (CICA 1990; Betts et al. 1991; Aouad and Price 1994; Aouad et al. 1996; O’Brien and Al-Soufi 1994; Aouad et al. 1996; Shash and Al-Amir 1997). Advancement in IT enables construction activities to be programmed and executed in a speedy and cost-effective manner. It is no longer regarded as an enhancement to traditional business, but an innovative agent. Ahmad et al. (1995) suggested that IT makes previously impossible things possible for the enterprises in the industry. The rapid development of software products has made the most impact. For example, three-dimensional computer-aided drafting tools, such as AutoCAD and Integra, are indispensable planning and design tool for architects, engineers, and contractors (Reinschmidt et al. 1991). In addition, project information management System is now widely used to handle tasks, such as construction programming, information storage, and retrieval (Lloyd et al. 2001). Access to project information through the Internet is also well documented (Huang et al. 1999; Lam and Chang 2001). As for the use of IT in construction dispute resolution, reported studies include the use of: Computer simulation for claim assessment during a mediation process (AbouRizk and Dozi 1993); computer-supported conflict mitigation system (Pena-Mora et al. 1993), computer agents to facilitate negotiation (Pena-Mora and Wang et al. 1998), and projects for improving communication to help engineers to carry out negotiation task (Cutkosky and Tennenbaum 1996; Fruchter 1996; Divita et al. 1998; Rezgui et al. 1998; Rodiss 1998; Schmitt 1998). Nonetheless, the use of online system to facilitate construction dispute resolution remains minimal. In practice, dealing with construction disputes is in fact an important part of project managers’ daily routine. Hence, with the effective and cost-saving dispute resolution process, they can easily settle the disputes without the intervention of third parties. This is also the reason why negotiation is always the preferred option other than mediation, arbitration, and litigation among the various dispute resolution procedures. In fact, negotiation is the most commonly used dispute resolution procedure (Fisher and Ury 1986; Merna and Bower 1997). Due to the important role that negotiation plays in construction management, the use of online facilities to assist a negotiation is not only of academic interest but is also invaluable to improving communication at project operation level.

Current Development

Computer-based negotiation support system (NSS) and other group decision-support system products have been developed to deal with negotiations and decision makings in response to the needs of industry. These systems are often used in group decision-makings, which take place in an electronic meeting room environment, such as PLEXSYS (Nunamker et al. 1987). Bui and Shahun (1997) introduced the utility of a conflict resolution framework “evolutionary systems design” (ED) by utilizing a NSS. Kersten and Noronha (1999) developed a negotiation support system known as InterNeg Project, assisting users to analyze decisions. This paper discusses an online construction negotiation system, Called “CoNegO” hereafter. In this paper, the concept of
CoNegO (construction negotiation online) is first introduced, followed by an examination of the SmartSettle system (platform for CoNegO) and its associated online facilities. The development of CoNegO is then presented.

**Underpinning Concepts**

The aim of negotiation is to settle a dispute. In a negotiation process, proactive communication, exchange of ideas, and prioritization of issues are essential. Incidentally, the computing abilities of speedy communication, data accessibility and common system make it ideal for the development of CoNegO (Ahmad et al. 1995). Fig. 1 presents the conceptual framework for the development of CoNegO.

In CoNegO, the communication component is the Internet. The data accessibility component manages the sharing of information by the negotiators. In negotiation, fact or evidence is often called upon to justify an argument. Hence, a well-organized set of project data is not only useful but essential. The common system component concerns with tools that can be used to aid decision making and help to reach a settlement in a more systematic manner. Commonly used tools are Knowledge-based Expert System and Case-based Reasoning Approach (Li 1996).

To be a useful tool, CoNegO needs to provide a set of standard and rational principles to guide negotiators. This is vital as it is common that negotiation principles are often neglected during the negotiation process. The SmartSettle Program is sophisticated negotiation software which takes advantage of the power of the network to bring disputants solutions, it can take any tentative agreement and suggest alternative approaches that give each party more than they were willing to accept in the settlement. It also makes use of a trade-off technique called Even Swaps (Hammond et al. 1998, 1999) which provides a practical way of making tradeoffs among a given set of objectives across a range of alternatives. The use of the Even Swaps Method in construction claims negotiation has been demonstrated in a previous study (Cheung et al. 2002). In addition, the built-in online facility of SmartSettle is also central to the CoNegO (ICAN 2000).

**Construction Negotiation Online**

The advancement of IT has further removed geographical barriers to communication. SmartSettle, via the Internet, enables online negotiation. SmartSettle is the central component of CoNegO. It is negotiation software with an interactive online facility for the negotiating parties. During negotiation, SmartSettle elicits the case description, preference information, and proposals from all parties. The primary objective of SmartSettle is to help parties reach a settlement.

The contents of negotiation can easily be stored in the computer database for further retrieval and record. In an e-negotiation

### Table 1. Acceptable Ranges of the Negotiator

<table>
<thead>
<tr>
<th></th>
<th>Client Pessimistic value</th>
<th>Client Optimistic value</th>
<th>Contractor Pessimistic value</th>
<th>Contractor Optimistic value</th>
</tr>
</thead>
<tbody>
<tr>
<td>EOT (Unit: day)</td>
<td>40 30</td>
<td>35 55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L/E (Unit: $/day)</td>
<td>6,500 3,200</td>
<td>6,000 7,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acceleration cost pay to contractor (Unit: $/day)</td>
<td>13,000 7,000</td>
<td>10,000 20,000</td>
<td></td>
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</tr>
</tbody>
</table>

Note: EOT=extension of time; and $/E=loss/expense.

### Table 2. Bargaining Ranges with Relative Importance Weights

<table>
<thead>
<tr>
<th>Issue abbreviation</th>
<th>RI</th>
<th>Worst</th>
<th>Best</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Client side</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. EOT</td>
<td>30</td>
<td>40</td>
<td>30</td>
</tr>
<tr>
<td>2. L/E</td>
<td>40</td>
<td>6,500</td>
<td>3,200</td>
</tr>
<tr>
<td>3. AccCost</td>
<td>30</td>
<td>13,000</td>
<td>7,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Contractor side</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. EOT</td>
<td>60</td>
<td>35</td>
<td>55</td>
</tr>
<tr>
<td>2. L/E</td>
<td>30</td>
<td>6,000</td>
<td>7,000</td>
</tr>
<tr>
<td>3. AccCost</td>
<td>10</td>
<td>10,000</td>
<td>20,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100</td>
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<td></td>
</tr>
</tbody>
</table>

Note: RI=relative importance; EOT=extension of time; and $/E=loss/expense.
environment, two disputing parties are communicating with each other by using a neutral server. Fig. 2 shows the mechanism of online facilities of SmartSettle. The server assists in the negotiation process by providing instantaneous responses from either party upon accepting or exchanging proposals so that each party can acquire the updated information as the negotiation progresses. Furthermore, the server stores details of the case so that the users can extract information from the server instantaneously or through a subsequent continuation if the negotiation stopped midway or could not be concluded in one setting.

Illustration

To illustrate the use of CoNegO, a hypothetical case is utilized. The hypothetical case was concerned with a negotiation between contractor and client regarding the settlement of a dispute involving extension of time, loss/expense, and cost of acceleration. Extension of time (EOT) refers to the additional time granted to the main contractor under the stipulated ground of the contract. Loss/expense (L/E) refers to the amount reimbursed to the contractor due to the causes for which the employer is responsible. Cost of acceleration refers to the additional cost reimbursable to the contractor for catching up with qualifying delays. In this respect, one of the experts was selected from a consultant firm and the other was from a contractor firm. They were invited to participate and negotiate on the hypothetical case using CoNegO. Both experts have over 10 years of experience in dealing with construction claims and negotiations, and are referred to as “negotiators” hereafter. The simulation process was arranged as shown in Fig. 3. Negotiators were briefed with the workings of CoNegO before actual simulation.

During the simulation, both negotiators were physically separated. A briefing was first given to the negotiators to introduce the SmartSettle program and explain the procedures involved in the simulated environment. These include a brief description of the hypothetical case and a fill-in data in-take form (DIF). The DIF collects preliminary information on the negotiators, such as the case information, individual preferences, and bargaining ranges of each issue.

The two negotiators first study the hypothetical construction claim case. Having understood the circumstances of the case, the negotiators then formulate the bargaining ranges for each of the three issues to be negotiated. A bargaining range is set of possible decision values for a particular issue (ICAN 2000). These ranges were then recorded in the DIF. The form is designed to record their bargaining ranges in numeral values. Table 1 shows the client and contractor acceptable bargaining ranges. The pessimistic value represents the baseline of the baseline of the negotiator for a particular issue which implies that no further concession will be offered beyond this value. While the optimistic value represents the value with the highest satisfaction for the negotiator.

Having familiarized themselves with the case and established the acceptable range for each issue, the negotiators were then required to assess the relative importance of the issues. The rela-

<table>
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<th>Table 3. Even Swaps Exercise</th>
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<tr>
<td><strong>Issue abbreviation</strong></td>
</tr>
<tr>
<td>---------------------------</td>
</tr>
<tr>
<td>Client Side</td>
</tr>
<tr>
<td>EOT</td>
</tr>
<tr>
<td>L/E</td>
</tr>
<tr>
<td>AccCost</td>
</tr>
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</table>

| Contractor side           |          |            |            |            |
| EOT                       | 50       | +1         | 51         | 50         |
| L/E                       | 6,800    | +100       | 6,900      | +200       |
| AccCost                   | 18,000   | 18,000     | +1,500     | 19,500     |

Note: EOT = extension of time; and L/E = loss/expense.

<table>
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<tr>
<th>Table 4. Assessment of Satisfaction Rating</th>
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<tbody>
<tr>
<td><strong>Issue abbreviation</strong></td>
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<tr>
<td>------------------------</td>
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<td>AccCost</td>
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</table>

| Contractor Side         |                          |                             |                             |                             |                          |
| EOT                    | 35                       | 37                          | 39                          | 45                          | 55                       |
| L/E                    | 6,000                    | 6,100                       | 6,400                       | 6,600                       | 7,000                    |
| AccCost                | 10,000                   | 13,000                      | 15,000                      | 17,500                      | 20,000                   |

Note: EOT = extension of time; and L/E = loss/expense.

Fig. 4. Satisfaction graph from client side (a) extension of time; (b) loss and expense; and (c) cost of acceleration
tive importance is an indication of how important one issue is relative to another. Basing on the information from Table 1, Table 2 shows the DIF with relative importance weights included.

The next task was to define tradeoffs by using the Even Swaps Method. As shown in Table 3, Swaps 1, 2, and 3 were performed by the negotiators. The term “Ref.” stands for reference alternative package. It is the value which the negotiators consider to be a possible final outcome. In going from the reference alternative package to Swap 1, the client side reasoned that a one day increase in EOT would sufficiently counter a 100 decrease of $L/E$ from 4,000 to 3,900. Hence, three equivalent alternatives are generated in this way.

Finally, negotiators were asked to provide satisfaction ratings for the range of acceptable values. By default, the satisfaction

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Fig. 5. Rating comparisons after Even Swaps (Client and Contractor): (a) issues and (b) packages

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Fig. 6. First proposal
Fig. 7. Second and third proposal

Fig. 8. Fourth proposal (Client’s view)
graphs are linear for all issues. In order to finetune the satisfaction value of each party, SmartSettle allows negotiators to plot satisfaction graphs. In this simulation, the data for these graphs are set in stage of 25% satisfaction scale. Table 4 summarizes the results.

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Based on the data from the DIF, the rating and satisfaction graphs of each issue are generated. The satisfaction graph of the Client is shown in Fig. 4. The satisfaction graphs are linear by default. The negotiators can adjust these graphs in accordance with their bargaining range and issue values. The results of such mathematical function can accurately predict the level of satisfaction for each value of the related issue.

**Processing Even Swaps Method in SmartSettle**

The relative importance (RI) weightings shown in Table 2 are the value subjectively assessed by the negotiating parties. These values may not accurately predict the relative importance of each issue. Based on the satisfaction scale and the Even Swaps Method, RI can be defined in a rational way. By analyzing the data in Table 3, Even Swaps Method can successfully be applied in such a way to make the three packages (i.e. Swap 1, Swap 2, and Swap 3) equivalent to the Ref., and to each other in terms of satisfaction. The changes in rating and relative importance are tabulated in SmartSettle and the screenshot of such tables are shown in Fig. 5. By comparing the current and previous RI, it is found that both parties regard EOT as the most important issues in this simulation.

In terms of the algorithms adopted in SmartSettle for analyzing the preference of each party, alternatives which are equivalent to the reference are required to enable SmartSettle to determine more precisely the total satisfaction levels by comparing the alternatives. In this hypothetical case, for example, on the client side, the rating of the alternative (EOT=1 days, L/E=3,900, and AccCost=9,500) is equivalent to (EOT=32 days, L/E=3,800 and AccCost=8,500). The total satisfaction TS, for each party k associated with equivalent alternative k will equal to the sum over all decisions i of the weighted relative additional satisfaction functions $R_{ij}(V_{ijk})$ selected by that party. Thus, for each of the parties j, such as the client side (Cl) in this hypothetical case, the total satisfaction associated with the first alternative (k=1) is

$$TS_{Cl} = w_{1(Cl)} \times R_{1(Cl)}(EOT_{(Cl)}) + w_{2(Cl)} \times R_{2(Cl)}(L/E_{(Cl)}) + w_{3(Cl)} \times R_{3(Cl)}(AccCost_{(Cl)}) + C_{Cl}$$

(1)

where $C$ is an unknown scale adjustment constant. Thus, for the other alternatives (say k=2 and 3), the satisfaction equations are

$$TS_{Cl} = w_{1(Cl)} \times R_{2(Cl)}(EOT_{(Cl)}) + w_{2(Cl)} \times R_{2(Cl)}(L/E_{(Cl)}) + w_{3(Cl)} \times R_{3(Cl)}(AccCost_{(Cl)}) + C_{Cl}$$

(2)

and

$$TS_{Cl} = w_{1(Cl)} \times R_{3(Cl)}(EOT_{(Cl)}) + w_{2(Cl)} \times R_{2(Cl)}(L/E_{(Cl)}) + w_{3(Cl)} \times R_{3(Cl)}(AccCost_{(Cl)}) + C_{Cl}$$

(3)

In these three equations, for each party j, the weights $w_{ij}$ are still unknown, as is the total additional satisfaction $TS_j$. We can also introduce two other equations defining the zero and 100% levels of total satisfaction as:

$$0 = w_{1j} \times R_{1j}(EOT_{j}) + w_{2j} \times R_{2j}(L/E_{j}) + w_{3j} \times R_{3j}(AccCost_{j}) + C_j$$

(4)

where the EOT$_j$, L/E$_j$, and AccCost$_j$=least preferred values in the identified bargaining ranges and
100 = w1j × R1j(EOT jm) + w2j × R2j(L/E jm) + w3j
× R3j(AccCost jm) + Cj
(5)

where the EOT jm, L/E jm, and AccCost jm = most preferred values in the identified bargaining ranges. With the above equations, the unknown value can be solved. The calculation of total satisfaction functions can also be done for the expanding decision variables.

After the preferences and relative importance were clearly defined, the two negotiators are ready to negotiate online. In this hypothetical case, a total of six proposals were exchange between the contractor and client negotiators. The screenshots of the initial proposal of both sides are shown in Fig. 6.

The “flags” in Fig. 6 shows the value of each issue. The given rating beside each proposal reflects the users’ satisfaction in respect of that issue. The distant between the flags become closer every time the parties make a concession. When the flag on a particular issue is overlapped, agreement on that issue becomes possible.

In the first proposal, the satisfaction rating of the first proposal on the client side and contractor side is 96 and 94, respectively. On the other hand, the rating of the contractor’s proposal, (assessed by the client’s satisfaction curve) is −242. The rating of client’s proposal, (assessed by the contractor’s satisfaction curve) is −119. Thus, in the first proposal, both parties cannot reach an agreement.
agreement and further proposals are needed in this simulation.

On the second proposal, concession was offered by the parties. The Client’s view is shown in Fig. 7. The ratings of the second proposal are reduced. The distance between the flags are now shortened as compared with the first proposal.

Further progress was made in the third proposal (see Fig. 7). In particular, agreement is reached for the acceleration cost issue due to the great concession on the contractor side. Fig. 8 shows that the flags on the AccCost issue are overlapped. No further negotiation on this issue was required. When comparing the two outstanding issues, EOT appeared to be a barrier to reaching an agreement. With the concession on the client side in the fourth proposal, a further step was made to reach an agreement on $L/E$ (see Fig. 8). However, the difference with regard to EOT remains large. Both parties must consider further concession in order to reach the agreement.

In the fifth proposal (see Fig. 9), both parties decided to offer a larger concession on this outstanding issue. However, such a concession was not adequate to reach a mutual agreement and a further exchange was made (sixth proposal, see Fig. 10). The simulation came to the end with mutual agreement regarding to the three issues of this dispute.

**Maximize Benefits**

After a tentative agreement was reached, the negotiators can achieve further “Improvement.” The improvement function of SmartSettle enables the search for an optimal package on the efficiency frontier that distributes benefits to all the negotiating parties according to their level of influence (ICAN 2000). The concept of efficiency frontier can easily illustrate the benefit of CoNegO (see Fig. 11). Referring to the hypothetical case, the efficiency frontier represents the best possible outcomes for both parties. Based on the tentative agreement, SmartSettle attempts to divide benefits fairly to each party by generating Improvement package that moving toward the efficiency frontier. The rating of such package is certainly higher than the tentative solution made by both parties, who can consider the suggestion as the new settlement agreement.

The improved generated package has a higher satisfaction rating than the tentative agreement. It is found that the rating of the improved package is 68, which is higher than that of the tentative agreement (with satisfaction rating of 62). This is shown in Fig. 12. After several proposal submissions, negotiation, and the generation of improvement, both parties have no hesitation in accepting the Improvement package as the mutual agreement in this simulation. Fig. 13 summarizes the proposals made by the negotiating parties.

**Discussion**

The hypothetical case illustrates the workings of CoNegO, the main advantages of which include the following.

1. **Enhanced efficiency of negotiation preparation.** CoNegO formalizes the process involved in typical construction negotiation. The Internet connection of CoNegO enables the negotiation to take place at a distance. Negotiators can exchange their offers/counteroffers data through a secure neutral server. Thus, the time for document presentation/negotiation meetings can be reduced. Furthermore, the use of DIF improves the negotiation preparation stage which enables negotiators to list, define, and eventually evaluate their alternatives on disputing issues.

2. **Computing facilitates of CoNegO.** CoNegO, utilizing the computing capacity and the communication strength of the Internet, provides a user-friendly, interactive environment and reliable outcome for negotiators. Through constructing the Satisfaction Graphs, negotiators can better understand their satisfactions on each issue and define tradeoffs with a set of unique equivalent alternatives using the Even Swaps Method. CoNegO, by making use of the computing power to conduct a tradeoff, can devise satisfaction and suggest improvement. These tools can reduce negotiating time and cost.

3. **Flexible management and involvement.** In the preliminary stage of negotiation, it is normally started at the site level between the contractor and the client’s agent. With CoNegO, senior staff can observe or even supervise the negotiation through access to the neutral server. This can lead the senior members to understand the development of the negotiation thus avoiding failure due to discontinuity of negotiators involved.

**Concluding Remarks**

CoNegO is an Internet-based computerized construction negotiation support system. It is developed based on the SmartSettle program that embraces the Even Swaps method for trade-off analysis. Construction negotiation typically involves a multiplex of issues, the systematic prioritizing approach and making tradeoffs assist in the formulation of a settlement package. CoNegO is an invaluable tool to complement the often subjective approach to negotiation. It is aimed primarily to provide a more systemic and structured approach in construction negotiation. With the help of experts in the field, the use of CoNegO was simulated with a hypothetical case. New directions have been identified to advance current research work in the topic of negotiation. Further studies should also look into the development of the Intranet-version of CoNegO in which multiple parties to a negotiation can proactively interact in a secured environment.

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