Group Decis Negot (2018) 27:9–31
https://doi.org/10.1007/s10726-017-9547-5

Negotiation Engineering: A Quantitative Problem-Solving Approach to Negotiation

Tobias W. Langenegger[1] · **Michael Ambühl**[1]

Published online: 6 October 2017
© Springer Science+Business Media B.V. 2017

Abstract Although they are often complex, negotiations are practical problems that can be solved with the aid of specialized, ad hoc methods. We introduce a problem-solving approach to difficult negotiations inspired by the established solution-oriented discipline of engineering, which we term "Negotiation Engineering". It is based on the reduction of problems to their most formal structures and the heuristic application of quantitative methods for problem solving. We argue that mathematical language in negotiations helps to increase logical accuracy in negotiation analysis and allows for the use of a variety of existing helpful mathematical tools to achieve a negotiation agreement. We demonstrate the practicability and usefulness of this approach using four case studies in the area of international diplomacy in which Negotiation Engineering was applied to achieve negotiation solutions.

Keywords Negotiation Engineering · Negotiation · Problem solving · Quantitative · Heuristic method · Mathematical language

1 Introduction

The solution of negotiation problems is often a complex and challenging process. Particularly in more elaborated negotiations (e.g., intergovernmental negotiation), it is important to find feasible mechanisms to tackle these problems. Such mechanisms

✉ Tobias W. Langenegger
tlangenegger@ethz.ch

Michael Ambühl
mambuehl@ethz.ch

1 Department of Management, Technology and Economics, ETH Zurich, Weinbergstrasse 56/58, 8092 Zurich, Switzerland

for solving negotiation problems must be adequately sophisticated in order to address these complex challenges while, at the same time, they must be practical enough to be applicable to real-world problems.

Research on negotiation, including the areas of applied game theory, negotiation analysis, decision theory, behavioral sciences, and more, has made considerable progress over the last decades by utilizing a variety of elaborate methods. However, it remains a constant challenge to bring these insights and techniques into practice. This is particularly true for quantitative methods, which often face difficulties in practice, even though they could additionally contribute to finding a solution for complex problems. Existing quantitative approaches focus mainly on the general analysis of negotiation (Raiffa 2007) whereas solution-oriented approaches often limit themselves to the use of qualitative methods (Fisher and Ury 1981).

While established quantitative analysis-oriented, as well as qualitative solution-oriented approaches exist, we see a need for a quantitative solution-oriented concept. This paper introduces such an approach, which we term *Negotiation Engineering*. This practice-oriented approach enables to harness the benefits of quantitative methods to find a solution for real-world negotiation problems.

We start by providing an overview of the existing literature and general modeling remarks. Next, we present the underlying basic concepts before introducing the Negotiation Engineering method, as well as its underlying rationale. We then highlight a distinction from existing, well-established approaches and exemplify Negotiation Engineering using four cases. We continue with a discussion on the strengths and limitations of this method and conclude by giving an outlook on further research.

2 Negotiation Models

2.1 Literature Review

As a joint decision-making mechanism, negotiation is an omnipresent process at all levels of human society, whether in politics, business, or private life. Consequently, the field of negotiation studies is highly interdisciplinary and benefits from the influence of a wide range of schools of thought. Reviewing the historical development of the field, two strands have been especially prominent in the advancement of this area of research: the mathematical approach and the social science approach.

In the field of applied mathematics, the greatest influence has come from the development of game theory launched by von Neumann (1928) at ETH Zurich in 1926 (Ambühl 2014). He refined this concept as a structured analysis of strategic interaction in the groundbreaking book *Theory of Games and Economic Behavior* (von Neumann and Morgenstern 1944). Especially important for the study of negotiation has been the analysis of bargaining problems based on Nash's (1953) elaboration of cooperative games between two persons, which Harsanyi (1963) later simplified and generalized to n persons, leading to substantial literature in the area of cooperative bargaining (e.g., Thomson 1994). Rubinstein (1982) formulated a non-cooperative, sequential bargaining model, which includes alternating offers through an infinite time horizon, thus opening up the field to new types of bargaining games and leading to substantial research in the field of non-cooperative bargaining problems (e.g., Roth 1985).

Research on game theory has provided numerous valuable insights into strategic interaction through precise mathematical description and analysis. This helped to understand the general characteristics of negotiations (Muthoo 1999), including, for example, threat (Nash 1953) and impatience (Rubinstein 1982). Nevertheless, this research has limitations and constraints. The assumption of super-intelligent, rational decision makers and the simplification of reality in closely defined abstract mathematical models results in a limited practical application (e.g., Rubinstein 2012).

In social science, Walton and McKersie's (1965) classic *A Behavioral Theory of Labor Negotiations*, which built on the work of Follett (1942), opened up the field of negotiation to the social and behavioral sciences. While introducing to the field defining terms, such as *distributive* and *integrative bargaining*, *resistance point*, and *bottom line,* Walton and McKersie (1965) promoted the idea of interest-based negotiation. Expanding their work in *Getting to Yes*, Fisher and Ury (1981) developed one of the most popular approaches to negotiation and explored important concepts, such as the role of the *best alternative to a negotiated agreement* (BATNA). Building on behavioral decision theory (e.g., Tversky and Kahneman 1974; Kahneman and Tversky 1979), scholars have attempted to anticipate opponents' likely actions in reality by identifying and studying negotiation situations in which people depart from rational behavior (e.g., Neale and Bazerman 1985). Starting from simple assumptions, many scholars have worked to understand more realistic, complex, multi-issue (e.g., Sebenius 1983), and multi-party (e.g., Susskind and Crump 2008) negotiations and to develop a more problem-solving-oriented approach. An extensive literature developed in the area of social psychology with regard to negotiations (e.g., Rubin and Brown 1975; Druckman 1977; Pruitt 1981), applying an empirical experimental research approach. This research investigated mainly the influence of individual differences (e.g., Walters et al. 1998) and situational factors (e.g., Marwell et al. 1969; Pruitt and Drews 1969) affecting negotiations. An overview of this literature can be found in Bazerman et al. (2003) or Thompson et al. (2010).

Research in social science has led to useful findings and recommendations for negotiators; however, even though much research has been done using empirical, quantitative methods, most practice methodologies developed from these insights focus on a qualitative approach.

The two strands of research—mathematics and social science—have influenced and inspired each other but stayed mostly separate in applications to real-world negotiation. Raiffa (1982), one of the most important scholars in the field of negotiation studies, tried to bridge this gap between the two research directions. Based on his background in game theory and his work in the field of decision analysis, he integrated many insights from the social sciences to develop the hybrid approach of negotiation analysis (Raiffa 1982, 2007). This work strengthened the strategic analysis of negotiations, which considers the objectives, preferences, and strategies of the involved parties. It can be seen as a comprehensive analysis of the generic characteristics of negotiation, which allows for learning about negotiation situations and obtaining some general prescriptive advice.

2.2 Generalizability of Negotiation Models

A key issue in the study of negotiations is the analysis of commonalities across different negotiation contexts and the question to what extent an approach can be generalized and applied to different negotiation cases. To contribute to this objective, abstract models are used to draw general conclusions about generic negotiation situations. A good presentation of approaches to model the different structures of negotiation is presented in the second part of the *Handbook of Group Decision and Negotiation* (Kilgour and Eden 2010).

Mathematics provides a powerful instrument for modeling complex problems. However, if such models remain on a high level of abstractness, their usefulness in complicated real-world negotiations are often reduced. We illustrate this with a generalized formulation of a "give-and-take" negotiation in the form of a mathematical program. If we look at a complex negotiation process, for example, the Brexit negotiations between the United Kingdom (UK) and the European Union (EU), the problem can be seen as a process where $\bar{a}$ actors ($a = 2, \ldots, \bar{a}$) negotiate over a set of issues $I = \{i | i = 1, \ldots, \bar{\imath}\}$. We assume that the actors agree to split the complex negotiation into $\bar{p}$ phases ($p = 1, \ldots, \bar{p}$), in each of which a part of the issues $I_p \subseteq I$ is negotiated and brought to a conclusion. However, the conclusions are not put into force until all phases are completed. This is a common practice in complex intergovernmental negotiations (e.g., trade negotiations, EU membership negotiations). In the case of Brexit negotiations, a first phase is the so-called divorce settlement; further phases include a transitional arrangement and a deal on the UK-EU's long-term relationship, concerning, for example, market access and security arrangements. For all the different issues i, each actor a has a utility function u_{ai}. Each actor has a set of constraints C_a limiting his scope of actions (e.g., legal limits, limits for acceptance), the so-called reservation prices, defining the area of a possible solution for actor a. The intersection of all constraints C_a forms the well-known concept of the zone of possible agreement (ZOPA), where the solution of the negotiation problem must be an element of the feasible region $C_1 \cap \ldots \cap C_a \cap \ldots C_{\bar{a}}$.

In a world of rational, far-sighted actors, each actor a tries to maximize in every phase p his or her utility[1] u_{pa}. In the negotiation, the actors want to find a common solution that ideally maximizes a combination of the utility functions, a sort of joint welfare function. Nash (1950) proposed a convincing concept in the form of a mathematical program: maximize the product of the utilities, which are subject to a so called negotiation set (Pareto optimal and above security levels). In other words, maximize

[1] The utility of actor a in phase p is $u_{pa} = \sum_{i=1}^{\bar{\imath}} \beta_{ai} u_{ai}, i \in I_p$, where β_{ai} is a weighting factor, weighting the importance of issue i for actor a.

a function subject to a set of constraints.[2] Nash proved that this solution satisfies four axioms that define, according to him, a reasonable negotiation solution.

As soon as all phases are completed, each actor checks the overall result and, if she/he is not satisfied, asks to re-negotiate the crucial phase until eventually everything is agreeable.[3] Even though this process could go through many iterations in theory, in practice, the time-consuming and burdensome re-opening of a closed phase does not often happen (e.g., in EU membership negotiations, where closed chapters (phases) are rarely re-opened).

One can easily see that a generalized model, such as the one presented here, might be of limited help in a complex negotiation for two main reasons: First, it is almost impossible to precisely define the different utility functions. Second, even if it were possible, the mathematical programming problem remains almost unsolvable. The feasible regions are not necessarily convex and the utility functions are often not even continuous.

Therefore, the search for optimality in a mathematical sense is often overambitious in real-world negotiations, including many international negotiations. In the end, all that matters is finding a solution that lies within the feasible region and, therefore, does not overstep any red line. In a complex world, each negotiation seems to represent a unique problem, which is thus hard to approach with generic models, even though these models can provide important insights into negotiations in general.

However, these difficulties should not lead to the conclusion that quantitative methods per se are not useful tools in negotiations—quite the contrary, as we attempt to show in the next chapter. Furthermore, the uniqueness of a complex problem does not mean that no commonalties exist at all in the approach to find a solution. In this sense, we introduce a generally applicable method to real-world negotiation problems aided by formal modeling and calculation. We call this solution-oriented approach *Negotiation Engineering*. It is rooted in the existing literature[4] and builds on the anal-

[2] Somehow generalizing Nash's concept of a combined utility function F_p, the negotiation in phase p could be modeled, e.g., as follows:

$$\max F_p\left(u_{p1,}, \ldots, u_{pa,}, \ldots, u_{p\bar{a},}\right)$$
$$\text{s.t. } C,$$
$$\text{where } F_p\left(u_{p1,}, \ldots, u_{pa,}, \ldots, u_{p\bar{a},}\right) = \prod_{a=1}^{\bar{a}} \alpha_a \cdot u_{pa}$$

where α_a being a weighting factor, weighting the importance of actor a,

$$\text{and} \quad C = C_1 \cap \ldots \cap C_a \cap \ldots C_{\bar{a}}.$$

[3] This is a typical proceeding through which the advantages of a *sequential* and *simultaneous* resolution of issues is combined when, on one hand, the number of issues is too large to be negotiated at once but, on the other hand, the combination of different issues (which are differently valuated by the actors) allows to trade them off against each other. The well-known principle 'nothing is agreed until everything is agreed' allows a re-negotiation of already-concluded phases if the overall result should not satisfy one of the actors. In practice, the acceptance of a 'not so perfect' result in a previous phase often acts as a bargaining chip in later phases.

[4] See, e.g., Kersten (2003), who speaks about the engineering approach to negotiation in the context of e-negotiation.

ysis and solution conceptualization of cases in international diplomacy from our own experience.

3 Negotiation Engineering

Before discussing the Negotiation Engineering approach, we briefly address the underlying concepts of negotiation and engineering with an emphasis on the rationale of the engineering method. Then we point out how Negotiation Engineering differs from existing methodologies.

3.1 Basic Concepts of Negotiation and Engineering

The *Cambridge Dictionary* defines "negotiation" in a conventional way, as "[a] formal discussion with someone in order to reach an agreement" (Landau 2008). Although this definition might be too general for a precise understanding of the negotiation concept, it indicates that the essence of negotiation lies in the effort to reach an agreement.

"Engineering", on the other hand, is defined as "the study of using scientific principles to design and build machines, structures, and other things" (Landau 2008). In this definition, the focus is not on the final product of the engineering process but on the method used to find a useful solution. The use of mathematical language allows for the formalization of complex issues and connections, which aids in the understanding and allows accessing existing mathematical tools. To achieve such formalization, it is helpful to break down problems into sub-problems, which can often be solved faster and more easily than the original problem.

In the process of making science and mathematics practically useful, the engineering method can be understood as a strategy for causing an improvement in a poorly understood or uncertain situation within the available resources (Koen 1985). This strategy to achieve an enhancement and solve posed problems is the use of heuristics.

"Heuristic" is defined as "a way of solving problems by discovering [...] and learning from experience" (Landau 2008). It can be understood as any approach that helps to find an adequate, though often imperfect, solution to problems. It is problem-solving behavior that focuses on plausible, provisional, useful, and achievable approaches to discovering solutions (Polya 1957). These approaches can be a rule of thumb, strategy, trick, simplification, or any other means that reduce the time needed to solve a problem (Feigenbaum and Feldman 1963). It includes an iterative process, where learning, discovering, and trial-and-error, lead to an adequate solution.

To better understand the essence of engineering, it is important to distinguish the engineering method from the scientific method. While science can be seen as the discovery of new theories supported by experimental results, engineering is a solution-oriented procedure that considers requirements and constraints. Whereas science looks for *the* answer to a problem, engineering seeks *an* answer to a problem that is consistent with the resources available (Koen 1985). Many problems allow for a multitude of solutions. Accordingly, engineering aims to find a good solution under the given constraints and existing environment. Finding the optimal solution requires valuation and weighting. Consequently, engineering is not always completely objective and value free, as science is presumed to be, but is rather influenced by the social perception of the problem (Didier 2009).

3.2 Concept of Negotiation Engineering

This section brings the two concepts of “negotiation” and “engineering” together into the concept of “Negotiation Engineering”—a *modus operandi* that draws on problem-solving mechanisms of engineering to tackle negotiation problems.

3.2.1 Definition

We define *Negotiation Engineering* as a solution-oriented approach to negotiation problems that uses quantitative methods in a heuristic way to find an adequate solution. In particular, it is based on the *decomposition* and *formalizatio*n of the negotiation problem and the *heuristic* application of *mathematical* methods to facilitate the process of reaching an agreement.

3.2.2 The Basic Elements

The following four elements form the basis of the Negotiation Engineering concept.

Decomposition: The problem is decomposed into the underlying sub- and sub-sub-problems of which it consists. This reduction of complexity to the level of single issues is fundamental to the structured problem-solving approach because it allows for the identification of the underlying key problems, as well as the structure and relationship between the different issues involved in the negotiation.

Formalization: Each critical sub-problem is translated into and restated in formal mathematical language. This step further reduces the problem down to its most formal structure in order to reveal its core construction.

Mathematical method: If required, mathematical tools based on objective, measurable criteria are applied to the formalized sub-problems. A variety of mathematical tools in, for example, the areas of game theory, mathematical programing, and statistics can be applied if the problem is formulated in mathematical language.

Heuristics: The mathematical tools are applied in a heuristic way similar to a practical engineering approach. There is no one-size-fits-all, out-of-the-box method to solve the underlying formalized problems. Instead, experience-based techniques, learning, and discovery promote a solution that is not guaranteed to be optimal but is good enough for the given set of goals. The process of finding a solution often has to go through many rounds, thus making it iterative by nature. In the negotiation process, as in the solutions process for all real-world problems, multiple reasonable solutions exist. Therefore, it is important to evaluate the different options based on their merits and to select the solution that best meets the requirements.

3.3 Differences from Existing Methodologies

A variety of practice methodologies can address negotiation problems. These approaches are distinguished mainly by their different *methodical* orientations and a different focus in their*objectives*. We differentiate these two dimensions in order to locate Negotiation Engineering in the field of well-established practice methodologies for negotiation.[5]

The first dimension of differentiation is the method used to address negotiation problems. This dimension is a continuum that goes from "purely qualitative" to "purely quantitative" methods. This classification does not refer to the research areas and research methods but to the methods applied in practice. The second dimension is the objective of the approach, which is a continuum that goes from "purely analysis oriented" (ex-post) to "purely solution oriented" (ex-ante). Figure 1 presents a classification of well-established practice methodologies using these two dimensions.

Diplomatic history is an example of an approach used in the area of qualitative methods with a focus on analysis. The concept of "Getting to Yes" (Fisher and Ury 1981) is located in the area of a qualitative, solution-oriented approach, and Negotiation Analysis (Raiffa 2007) is positioned in the quantitative, analytical area. Game theory would be located on the clearly quantitative side of the spectrum with an emphasis on analysis, as well as solutions. Negotiation Engineering is located in the quantitative, solution-oriented section.

It is evident that analysis-oriented approaches generate insights that can contribute to solving future negotiation problems, and particularly Negotiation Analysis has a prescriptive component. Knowing that such an approach is not easy to put in a box, we do this only to clarify the differences with our method. Raiffa's analytical work and focus on decision theory is inherently more analysis-oriented, while Negotiation Engineering is more solution-oriented, although many arguments from the two approaches are related. Instead of a comprehensive analysis of general negotiation situations, Negotiation Engineering focuses on the application of situation-specific instruments and tools.

Compared to the well-known solution-oriented approach "Getting to Yes", Negotiation Engineering distinguishes itself through the methods it uses. Negotiation Engineering emphasizes the heuristic utilization of quantitative methods to increase logical accuracy and help structure the negotiation.

The solution-oriented character of Negotiation Engineering leads to a "teasing out" of a pragmatic solution, which is adequate given the available resources and constraints. Furthermore, Negotiation Engineering focuses on solving a given problem.

[5] It could be argued that there are other decisive dimensions on which these approaches should be distinguished. This is certainly a relevant and interesting issue, which we cannot conclusively discuss here, as it would go beyond the scope of this article. Nonetheless, we have considered additional criteria, such as "needed abstraction", "methodological pluralism", "temporal considerations", and "strategicness", as well as the differentiation between "descriptive, prescriptive, and normative methods" (Bell et al. 1988). According to our view, these criteria are not fully independent of the two dimensions described above because they are related (e.g., "higher abstraction" correlates with "quantitativeness" and "temporal considerations" are related to the question of whether one uses an ex-ante or ex-post approach). For this reason, we limit our distinction to two dimensions.

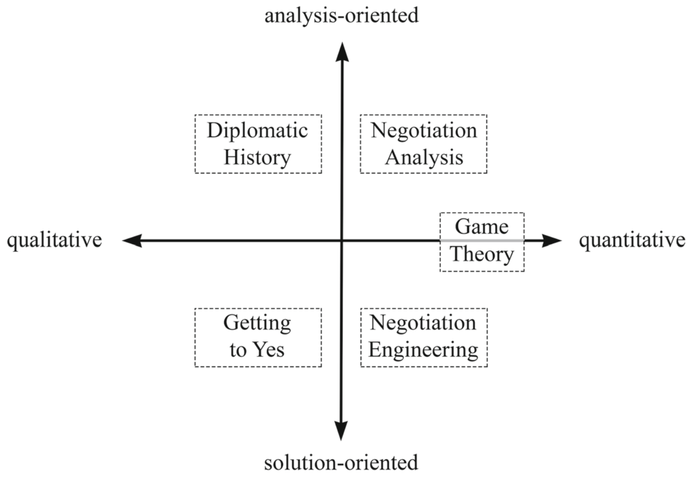

Fig. 1 Positioning of practice negotiation methodologies along the dimensions qualitative/quantitative and analysis-oriented/solution-oriented

It does not necessarily include a strategic discussion of whether a problem is justified from a historical, social, or moral perspective, even though this question may be crucial. The solution to the problem stands at the center, rather than the description and discussion of the problem.

4 Cases

In the following section, we show the application of Negotiation Engineering in four cases. All are in the area of international diplomacy and come from the personal experience of one of the authors (MA). He was a member of the Swiss negotiation team in *Case* 1, the Swiss chief negotiator in *Case* 2, the Swiss facilitator in *Case* 3, and the drafter of a solution proposal in *Case* 4. The intention here is not to provide a detailed analysis of the different cases but rather to describe the application of Negotiation Engineering elements in specific negotiation situations to allow for a better understanding of the method.

4.1 Case 1: Land Transport Agreement Between Switzerland and the European Union

4.1.1 Background

In 1993, Switzerland and the European Union agreed to start negotiations on a package of bilateral treaties[6] in seven areas: free movement of people, air traffic, road

[6] Not being a member of the EU, Switzerland's relations with its most important partner (the EU) are governed by bilateral treaties. This bilateral relationship is as an alternative to membership, which could also

traffic, agriculture, technical trade barriers, public procurement, and science. In early 1994, the Swiss population voted on a federal initiative regarding the protection of the alpine regions from transit road traffic. Approval of this initiative opposed EU demands on free transit traffic through Switzerland and blocked the negotiation of the package of the bilateral treaties. The EU insisted on negotiating the seven areas as a whole, and the blockage in the negotiation of the land transport agreement therefore became a crucial point in the overall negotiations (Swiss Federal Council 1999).

The two positions seemed incompatible. Switzerland, on the one hand, had to follow its new constitutional article, which states that transalpine goods must be transported from border to border by rail (and not by road), de facto affecting only foreign transports and therefore violating the non-discrimination principle. The EU, on the other hand, requested the abolishment of the 28-ton weight limit on trucks, as well as the non-discriminatory treatment of transports.

4.1.2 Negotiation and Results

A first step in the solution was found when Switzerland proposed an interpretation of its constitution, which was not literal but followed the sense and spirit of the relevant article. The overall volume reduction of all traffic categories (transit, bilateral, and domestic) could contribute to the protection of the alpine regions from transit traffic. This proposal permitted non-discriminatory treatment of EU transports.

The second step was the regulation of demand through market-based instruments to reduce goods traffic on the road. In this step, the Swiss proposed three approaches (Ambühl 2001): First, a tariffication[7] of the weight limit, which the EU rejected as being too academic. Second, an internalization of external costs, a concept that the EU did not favor. Finally, the Swiss developed a more pragmatic Negotiation Engineering approach to determine the tariffs. Instead of *one* price that was dependent on weight and distance, the tariff was split into *three* categories according to ecological criteria. Regarding the determination of the tariffs, the parties agreed on a weighted average, depending on the composition of the total truck fleet. This measure ensured that the tariffs would stay the same on average, even when vehicles become cleaner in the future. The calculation of this weighted average is a linear optimization problem in which the weighted average is G, the highest tariff is not above the threshold P, and the tariff split is maximized, but not more than 15% of the average.

$$
\begin{aligned}
&\max_{x,y,z}\,(x-z)\ s.t.\\
&\quad \alpha\cdot x+\beta\cdot y+\gamma\cdot z=G\\
&\quad x\leq P\\
&\quad 0\leq x-y\leq 0.15\cdot G
\end{aligned}
$$

Footnote 6 continued
be of interest to other states. It could be a possible model for the future relationship between Great Britain and the European Union after the British withdrawal from the EU (Brexit).

7 A tariffication is the transformation of quantitative restrictions into tariffs.

$$0 \le y - z \le 0.15 \cdot G$$
$$x, y, z \ge 0$$

where x, y, and z are the tariffs for the three truck categories, and α, β, and γ are the shares of the corresponding truck categories.

This mechanism allowed for an agreement to be reached that was acceptable to both sides. The 28-ton weight limit for trucks was abolished without a major increase of transport volume and without discriminating against foreign transport. The agreement was signed in 1999 and approved by a public vote in Switzerland the following year.

4.1.3 Analysis

The application of Negotiation Engineering allowed the parties to reach an agreement on this issue and to make progress on the overall package of negotiations, which were later called the Bilateral I agreements. Notably, the decomposition of the problem into a single key issue (defining the tariffs) and the subsequent iterative process of defining the solutions, along with the implementation of a mathematical tool (linear optimization), led to a compromise. The difficult negotiations, which lasted four years, made important progress when the parties could agree to an abstract, algebraic formulation of the underlying problem. Once the problem was decomposed into an algebraic formula, the determination of the specific values was the "only" remaining question, which was then easier to solve.

4.2 Case 2: Pre-Negotiation of the Schengen/Dublin Agreement Between Switzerland and the European Union

4.2.1 Background

After completing the first round of bilateral treaties (Bilateral I), the EU was skeptical about new negotiations with Switzerland. However, a new round of negotiations (Bilateral II) was considered because the EU had two topics of particular concern: cross-border taxation of savings and combatting financial fraud. Switzerland had other areas of special interest: cooperation in the areas of security and asylum and, in particular, Swiss participation in the Schengen/Dublin system.[8] In addition, there were some open areas mentioned in the Bilateral I agreement's declaration of intent: processed agricultural products, statistics, the environment, media, education, pensions, and services (Swiss Federal Council 2004).

The Swiss saw themselves as highly associated with the EU due to their geographical location in the middle of its area. After the successful completion of the Bilateral I negotiations, especially the agreement on the free movement of persons, it seemed logical for Switzerland to also become part of the Schengen Area and to participate in the Dublin System.

[8] Schengen is a joint European area with no internal border control, and the Dublin System establishes uniform criteria for examining asylum applications by assigning each application to only one state.

The EU, however, was reluctant and saw participation in the Schengen/Dublin system as reserved for EU member states. The EU wanted to start with negotiations about the taxation of savings and combatting financial fraud. Brussels was willing to consider talks about Swiss participation in the Schengen/Dublin system only later, under the condition of Switzerland's "good behavior" in the previous negotiations. However, Switzerland wanted all negotiations conducted simultaneously to ensure that the dossiers of interest to the EU were not the only issues negotiated.

4.2.2 Negotiation and Results

In preparation for the pre-negotiations (the discussion of which topics were to be included in the negotiation process), the Swiss administration applied a Negotiation Engineering approach to assess the situation. The decision on whether or not Switzerland should insist on parallel negotiations for all topics was seen as a key problem. The interaction of the different decisions, therefore, was modeled as a non-cooperative, two-person game in extensive form with perfect information, as shown in Fig. 2.

In this negotiation model, Switzerland decides in the first step whether to insist on or abandon parallelism in negotiations. If the Swiss abandon parallelism, the game is over, but if they insist on parallelism, the EU has to decide whether to accept or reject it. In the first case, the game ends. In the second case, Switzerland has to decide whether to agree or refuse to negotiate even if the EU rejects parallelism. The payoffs for both players in all four possible outcomes can be determined, and the equilibrium states can be calculated using backward induction. This game-theoretic method was used to conduct a sensitivity analysis of the situation in order to assess whether small changes in the payoffs would be likely to lead to different outcomes. The analysis was

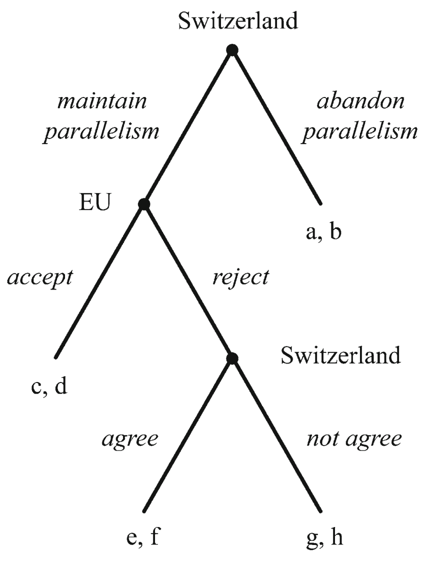

Fig. 2 A non-cooperative, two-person game in extensive form with perfect information, with the variables a, c, e, and g representing the outcomes (payoffs) for Switzerland and the variables b, d, f, and h representing the outcomes (payoffs) for the EU

then included in the Swiss government's decision documents to determine its strategy in pre-negotiations with the EU.

As suggested by the game-theoretical analysis (if one assumes the inequalities $e > g$, $f > d$, and $e > a$), the Swiss government insisted on parallelism (i.e., including the Schengen/Dublin system in negotiations with the EU), which was ultimately accepted. An agreement for Bilateral II was reached in 2004 after several rounds of negotiation starting in 2002, and the Swiss electorate approved the Schengen/Dublin Association in a 2005 referendum.

4.2.3 Analysis

The decomposition of the problem to its formal structure and the assessment of the negotiation situation with a game-theoretic sensitivity analysis by a dynamic game in extensive form provided the necessary insights and encouraged the Swiss Government to stay firm in its request for parallel negotiations. It is likely that the EU would not have agreed to Swiss participation in the Schengen/Dublin system had Switzerland not insisted on the linkage of the issues, which included not only the EU's requests but also the areas of interest to Switzerland. As far as we know from our experience in more than 20 international governmental negotiations, this is a rare international example of a government basing its decision on game theoretic analysis.

4.3 Case 3: Facilitating Nuclear Talks between Iran and P5+1

4.3.1 Background

After the revelation of Iran's uranium enrichment program in 2003, concerns were raised regarding its possible non-peaceful purpose. A dialogue between Iran and the P5+1[9] started in 2006 to assure Iran's right to enrich nuclear fuel for civilian purposes under the Treaty on the Non-Proliferation of Nuclear Weapons and assure that it would not develop nuclear weapons. The situation was very difficult, particularly between the United States and Iran, who share a problematic past and maintain no diplomatic relations. It was difficult to agree on the pre-conditions, with one side demanding a stop of all nuclear program-related activities and the other side wanting a guarantee for enrichment. Furthermore, the rhetoric was tense with one side demanding a regime change and the other maintaining unacceptable views on historic events.

In this situation, the Swiss Foreign Ministry offered its support to re-launch the negotiations in consultation with important actors, in particular the Secretary General of the International Atomic Energy Agency (IAEA), Mohamed ElBaradei (ElBaradei 2011). Since 1980, when diplomatic relations were broken off, Switzerland has been the protecting power of the United States interests in Iran. As a neutral country that is neither an EU nor NATO member and does not have a colonial past, Switzerland saw

[9] P5+1 represents the five permanent members of the UN Security Council (China, France, Russia, the United Kingdom, and the United States) plus Germany.

the possibility to contribute to this difficult process not only by providing a platform for the dialogue but also by introducing new ideas to the process.

4.3.2 Negotiation and Results

In 2007, Switzerland proposed a re-launch of the negotiations in a non-paper[10] to the two parties. This non-paper consisted of both diplomatic-procedural and thematic proposals. The diplomatic-procedural proposal included: (i) confidence-building measures (P5+1 will not table any new sanctions, and Iran will not develop any new nuclear enrichment-related activities; the so-called "freeze for freeze" concept), (ii) guiding principles for the negotiations, and (iii) a phased approach for the talks.

The thematic proposal consisted of two sets of formulas. The first set of formulas concerned the construction of centrifuges and created a mechanism for negotiating the exact number of centrifuges and their development over time. The formula defined the number of centrifuges at a given time as the number of existing centrifuges one time-period before (for example, two months) plus a rate of increase. This rate of increase was defined as the average number of centrifuges constructed in the time before the mechanism would come into place, multiplied by a factor β. This coefficient was crucial for the development of the future number. It could be between 0 and 1 and defined if the number of centrifuges would stay the same ($\beta = 0$) or if it would increase at the same rate as before ($\beta = 1$), with any possible value in between.[11] The parties would have to agree on this coefficient. The second set of formulas controlled the production of low-enriched uranium in research and development, as well as at industrial plants. It stated that the amount of low-enriched uranium produced had to be smaller or equal to the amount produced before the mechanism was in place, multiplied by a factor γ, which the parties had to agree upon. The non-paper, including both sets of formulas, can be found in the "Appendix" section.

4.3.3 Analysis

The decomposition of the problem into the crucial (yet not the only important) question of the number of centrifuges, and the formalization of this question through a set of mathematical formulas, allowed the parties to define a key negotiation point and to show indirectly that the problem itself was not unsolvable. The formulated mechanism helped to focus the negotiations on specific, clearly defined dimensions of the problem; in this case, a set of formulas that described and quantified the future development of nuclear enrichment activities. Once this negotiation framing was done, the remaining

[10] A non-paper is an informal negotiation text for discussion among delegations. It has no identified source or attribution and does not commit the originating delegation's country to the content.

[11] It seems remarkable that there was no reduction in the number of centrifuges mapped in the model. This is because it was impossible to agree on such a reduction at the time. Even in the negotiated agreement of July 2015, it was not possible to agree on a reduction below the level of 2007. On the contrary, Iran had, according to the data of the International Atomic Energy Agency (IAEA), 656 centrifuges in February 2007. Over the following years, Iran increased its nuclear program and in 2015, the P5+1 agreed to allow Iran 6104 operational centrifuges, with 5060 allowed to enrich uranium.

problem (i.e., the determination of the values of the specific variables) could be tackled more efficiently. This is a typical Negotiation Engineering approach to facilitate the process and promote an agreement.

However, the two parties did not agree to start the negotiations at this stage and continued escalation.[12] The time was not politically ripe, as neither the U.S. nor Iran saw its respective preconditions for negotiations fulfilled. The formulas were not of such nature that they could overcome the lack of political will. Nevertheless, the Swiss proposals laid the groundwork for direct talks in Switzerland in July 2008, which were the first talks of this kind between American and Iranian officials since the rupture of diplomatic relations in 1980 (Sciolino 2008). Furthermore, elements of the proposal—such as the dropping of preconditions, "freeze for freeze", confidence building measures, and phased negotiations—were taken up by the parties in the negotiations, which started in 2013 in Switzerland and came to an end in Vienna on 14 July 2015 with the "Joint Comprehensive Plan of Action".

4.4 Case 4: Negotiation Regarding the Free Movement of Persons Agreement Between Switzerland and the European Union

4.4.1 Background

The issue of immigration is an important topic in many European countries. This is also the case in Switzerland, which has a relatively high percentage of foreigners (23.3% of the total population in 2013) and a relatively high immigration rate (1.7% in 2013) compared to other European countries.[13] The Swiss political system features strong, direct, democratic instruments, and in February 2014, the Swiss population approved a federal initiative entitled "Against Mass Immigration", requiring the national government to control immigration in the interests of Switzerland. This new constitutional article stands in contrast to the free movement of persons agreement with the European Union and threatens the whole package of Bilateral I treaties, which are legally interlinked with each other.

4.4.2 Negotiation

In this context, Switzerland seeks a negotiated solution with the EU, which allows them to keep the Bilateral I treaties but also follows the new constitutional article. One suggestion based on Negotiation Engineering reasoning is the introduction of a safeguard clause (Ambühl and Zürcher 2015; Ambühl et al. 2016). A safeguard clause would allow the free movement of persons agreement with the EU to continue and only in exceptional cases could immigration be capped. In this proposal,"exceptional"

[12] A more detailed analysis of this escalation and the underlying mechanisms was presented at the International Conference on Group Decision and Negotiation 2016, Bellingham, USA (Langenegger 2016).

[13] Percentage of foreigners and the migration rate for comparable European countries in 2013 based on data from EUROSTAT: Austria 12%, 1.1%; Belgium 11%, 0.9%; France 6%, 0.3%; Germany 9%, 0.7%; Netherlands 4%, 0.6%; Sweden 7%, 1.0%.

is defined by objective statistical methods, using the migration data from all 32 EU/EFTA[14] states as a reference. The safeguard clause defines the cap for county i as

$$d_i = m + \alpha_i \cdot \beta_i \cdot x \cdot \sigma,$$

where m is the average of the relative migration balance, α_i is a function of the stock of EU/EFTA citizens, β_i is a function of the job market, x is an integer (1, 2, or 3), and σ is the standard deviation. An exceptional case could be defined as at least two standard deviations ($x = 2$) from the mean value. In the case of normal distribution of the data, this would only affect 2.2% of all cases. Which therefore could truly be called exceptional.

This proposed safeguard clause could bring the two contradictory legal obligations together without dismissing either one. The advantage of this proposal is the definition of an exceptional case that is based not on the situation in Switzerland but on the overall situation in Europe. The exact values for such a formula would have to be decided in negotiations. This measure, at least in theory, would also allow the application of such a mechanism to other countries.

4.4.3 Analysis

Negotiation Engineering seems to offer a promising way to find a solution to this complex problem. By decomposing the problem into a formula where "only" the values of α, β, and x have to be defined, one can de-emotionalize a highly controversial question. The objective approach based on quantitative criteria, mean values, and standard deviation, seems to allow for a more constructive discussion that moves beyond the fixation on incompatible positions. As in the other three cases, the modeling of the problem (i.e., the choice of the formula) is part of the heuristic method. There is no guarantee that the chosen formula models the real problem perfectly, but there is a good chance that it will be a useful approximation.

5 Strengths and Limitations

Applying Negotiation Engineering has several *strengths*.

- The reduction of the problem to its most formal structure through the highest possible abstraction helps to reveal the core of the problem and provides an understanding of its underlying mechanisms. Using mathematical language forces to an increased logical accuracy. In addition, it creates the possibility of accessing many helpful mathematical tools that can be of an analytic (e.g., game theory) or solutions-oriented (e.g., mathematical optimization methods) nature.

[14] The 28 EU states and the four EFTA states (Iceland, Liechtenstein, Norway, and Switzerland) form a free movement of person's area.

- The formal description of a problem allows a mechanism for the solution to be defined without pre-imposing the outcome of the negotiated agreement. This allows to write the solution mechanism in a formula while leaving room to negotiate the values of the variables in the formula. Such a process helps to frame the negotiation, indicating a list of questions to be discussed. A solution can be reached more easily due to more precise knowledge of the issue being negotiated based on objective, measurable criteria.
- The "technical" approach of Negotiation Engineering can lead to a de-emotionalization of the problem, which often helps in finding pragmatic solutions to complex negotiation problems.

However, Negotiation Engineering also has its weaknesses and *limitations*.

- Its orientation toward technical problem solving can be perceived as not strategic enough. It can be argued that such a solution-focused approach does not thoroughly consider higher-level inquiries, such as the questions of whether the right problem has been defined or whether solving it is justified in the first place.[15] It is evident that Negotiation Engineering cannot replace the discussion of certain questions of principles. However, it can be an important complement to such a discussion. Both levels have to be considered for real-world problems.
- The formalization of a problem is always a reduction, leaving out some aspects of the problem, which can be controversial for the other party. Therefore, it is important to find the essential underlying problem accepted by all involved parties to increase the acceptance of the formal representation and modeling. If an aspect is left out that a party considers essential, then a formalization might not be helpful in finding a solution. Furthermore, a reduction should only be applied to sub-problems.[16] A mutually accepted formalization of the larger initial problem is often not possible due to its complexity. There is no universal solution to this process of reduction. The art of formalization in a constructive way lies in using it in a mutually accepted way in sub-problems. This process remains a difficult aspect of negotiations.
- There are limits to where Negotiation Engineering can be applied. Problems may exist that are not quantifiable or should not be reduced to a quantitative level. Examples include deep value disputes or interpersonal conflicts, such as family disputes. The Negotiation Engineering method is most suitable for problems with a particular degree of complexity, involving actors that hold a certain analytical capacity and are open to a rational approach.

[15] An interesting example for the question "what is the right problem?" is the current debate about the distribution of refugees within the EU (e.g., Grech 2016). According to the EU Commission a mathematical formula for a fair distribution key is necessary, while some Member States argue that the search for a formula is the wrong problem to address; the real question is the one about the competences and the moral duties.

[16] Examples of such key issues are the definition of the tariffs in Case 1 and the number of centrifuges in Case 3. They were identified as key sub-problems to the negotiation and their formalization helped to facilitate the discussion.

6 Conclusion

This paper advocates for the application of an engineering-inspired negotiation method. We introduce a problem-solving approach called Negotiation Engineering that considers the complex properties of real-world negotiation problems and applies proven methods from the problem-solving discipline of engineering. It is distinguished from other established practice methodologies by its focus on quantitative methods and its solution-oriented direction. The approach is supported by the analysis and conceptualization of cases from our own experience in the area of international diplomacy, of which four are presented in this paper.

Negotiation Engineering is based on four elements that help solve negotiation problems: (1) decomposition of the problem, (2) translation of a sub-problem into mathematical language along with the reduction to its most formal structure, and (3) the application of mathematical tools (4) in a heuristic way. We argue that such a process leads to increased logical accuracy in analysis using mathematical language. It allows for the development of suitable solutions, particularly through the application of quantitative, mathematical tools. Thereby, the focus lies on the heuristic approach to find pragmatic solutions under existing constraints.

Negotiation teachers could benefit from supplementing their toolboxes with such heuristic and quantitative problem-solving methods, which do not have to be limited to use in international diplomacy. Practical application is possible in many fields in governmental or business (company or individual) negotiations. This could also open up the field of professional negotiation to more technically educated people who could use their skills more effectively.

Further research is needed to understand and develop heuristic solution methods for real-world negotiations. It would be important to analyze how these methods could be used more systematically in the negotiation process (or is a "systematic use" of heuristic methods a contradiction in itself?). Furthermore, it would be interesting to investigate the supposed contradiction between the reduction of complexity through the decomposition of problems and the increase in complexity through generally recommended issue linkage. Both aspects play a crucial role in reaching an agreement.

Appendix

Swiss non-paper to the United States and Iran in April 2007

RELAUNCHING THE NEGOTIATIONS

Step 1: Informal Pre-Talks

In order to relaunch a negotiating process leading to a comprehensive settlement ("package"), the P5+1 and Iran (hereinafter referred to as "the Parties") agree to the following initial confidence-building measure (CBM):

a. the P5+1 will not table any new resolutions and sanctions on the UNSC level as well as on an unilateral way.

b. Iran will not develop any new nuclear enrichment-related activities on an industrial scale at the Fuel Enrichment Plant in Natanz (FEP).

This initial CBM will last for the duration of the pre-talks under Step 2 and will be extended for the duration of the negotiations once they take place under Step 3.

Step 2: Pre-Talks

As soon as Step 1 is implemented, the Parties will start pre-talks lasting no longer than 60 days unless otherwise agreed in order to prepare the negotiations. During these pre-talks, the Parties will agree on the following guiding principles and modalities as a basis for the negotiations:

1. recognition and reaffirmation by the P5+1 of Iran's full rights under the NPT.
2. recognition and reaffirmation by Iran of its obligations under the NPT and under its safeguards agreement with a view to resolving all outstanding issues with the IAEA. To this end Iran will present a timetable to the IAEA and act according to the Additional Protocol when requested by the IAEA. As soon as the IAEA has resolved all outstanding issues the dossier will return from the UNSC to the IAEA and Iran will act according to the Additional Protocol pending its ratification.
3. the modalities of all Iran's nuclear activities and programmes are based on the NPT, the Safeguards Agreement and the Additional Protocol in order to provide assurances with regard to non-diversion of nuclear material for non-peaceful purposes. These modalities will be negotiated in good faith with the aim of achieving a comprehensive settlement ("package") including nuclear issues and non-nuclear issues such as economic cooperation, international security and political dialogue.
4. additional CBMs to be extended for the duration of the negotiations including a time-out by Iran on all enrichment-related activities and by the P5+1 on the implementation of all UNSC resolutions and sanctions. The commitment to CBMs does not prejudge the outcome of the negotiations.
5. procedural questions for the negotiations (schedule, agenda, level and composition of delegations, venues, etc).

The agreement reached on the above following guiding principles and modalities will be incorporated in a joint declaration signed by the Parties at a high level.

Step 3: Negotiations

As soon as Step 2 is implemented, the Parties will enter into the negotiations on the comprehensive settlement ("package") mentioned under Step 2 (point 3). These negotiations will last no longer than 6 months unless otherwise agreed.

Iranian nuclear program

Construction of centrifuges

Let

t : time [measured in months]

t_0 : time of reference

t_i : deadline i, $i \geq 1$

$n(t_0)$: number of centrifuges at t_0

$n(t)$: number of centrifuges at t

a_0 : average number of centrifuges constructed per month in the time period before t_0

a_i : rate of increase of centrifuges constructed per month during the time period $[t_{i-1}, t_i]$

β_i : coefficient ; $0 \leq \beta_i \leq 1$

Then

$$\boxed{n(t) = n\,(t_{i-1}) + (t - t_{i-1}) \cdot a_i \quad ; \quad t \in [t_{i-1}, t_i]}$$

Whereas

$a_i = a_0 \cdot \beta_i$; $i \geq 1$

(If a differentiation does not prove to be necessary: $a_1 = a_2 = a_3 = \ldots$)

For example:

t_0 : 1 September 2007

t_1 : $t_0 + 2$ months

t_2 : $t_1 + 4$ months

Uranium Enrichment

Let

e(t) : enrichment of fuel (≤ 5%) per time unit at time t [e.g. g/day]

P : Pilot enrichment plant (PEP) ; R+D

F : Fuel enrichment plant (FEP) ; industrial

$e_P(t)$: enrichment of fuel at P

$e_F(t)$: enrichment of fuel at F

γ_{Pi} ; γ_{Fi} : coefficients, for the time period $[t_{i-1}, t_i]$

Then

$$e_P(t) \leq e_P(t_0) \cdot \gamma_{Pi} \; ; \qquad t \in [t_{i-1}, t_i]$$

$$e_F(t) \leq e_F(t_0) \cdot \gamma_{Fi} \; ; \qquad t \in [t_{i-1}, t_i]$$

Whereas

$0 \leq \gamma_{Pi}$

$0 \leq \gamma_{Fi}$

(If a differentiation does not prove to be necessary:

$\gamma_{P1} = \gamma_{P2} = \gamma_{P3} = \ldots$ and $\gamma_{F1} = \gamma_{F2} = \gamma_{F3} = \ldots$)

References

Ambühl M (2001) Zur Konzeption der koordinierten Verkehrspolitik. In: Felder D, Kaddous C (eds) Accords bilatéraux Suisse–UE (commentaires)/Billaterale Abkommen Schweiz–EU (Erste Analysen). Helbing & Lichtehahn/Bruylant, Basel, pp 510–518

Ambühl M (2014) Janos, Johann, John-Budapest, Zurich, Princeton. In: Folkers G, Schmid M (eds) IdEAS ETH Zurich: where context favors innovation. Chronos Verlag, Zurich, pp 63–72

Ambühl M, Zürcher S (2015) Immigration and Swiss-EU free movement of persons: question of a safeguard clause. Swiss Political Sci Rev 21:76–98. doi:10.1111/spsr.12143

Ambühl M, Antonini C, Zürcher S (2016) The "bottom-up safeguard clause". Canton of Ticino, Bellinzona

Bazerman MH, Curhan JR, Moore DA (2003) The death and rebirth of the social psychology of negotiation. In: Fletcher GJO, Clark MS (eds) Blackwell handbook of social psychology: interpersonal processes. Blackwell Publishers Ltd, Malden

Bell DE, Raiffa H, Tversky A (eds) (1988) Decision making: descriptive, normative, and prescriptive interactions. Cambridge University Press, Cambridge
Didier C (2009) Professional ethics without a profession: a French view on engineering ethics. In: Poel I, Goldberg D (eds) Philosophy and engineering. Springer, Dordrecht, pp 161–173
Druckman D (1977) Negotiations, social-psychological perspectives. Sage, Beverly Hills
ElBaradei M (2011) The age of deception: nuclear diplomacy in treacherous times. Metropolitan Books, New York
Feigenbaum EA, Feldman J (1963) Computers and thought. McGraw-Hill Inc, New York
Fisher R, Ury WL (1981) Getting to yes: negotiating agreement without giving in. Penguin, London
Follett MP (1942) The collected papers of Mary Parker Follett. In: Urwick L (ed) Dynamic administration. Harper & Row, New York
Grech P (2016) Undesired properties of the European Commission's refugee distribution key. Eur Union Politics. doi:10.1177/1465116516649244
Harsanyi JC (1963) A simplified bargaining model for the n-person cooperative game. Int Econ Rev 4:194. doi:10.2307/2525487
Kahneman D, Tversky A (1979) Prospect theory: an analysis of decision under risk. Econometrica 47:263–291. doi:10.2307/1914185
Kersten GE (2003) The science and engineering of e-negotiation: an introduction. In: Proceedings of the 36th annual Hawaii international conference on system sciences, 2003, pp 27–36
Kilgour DM, Eden C (eds) (2010) Handbook of group decision and negotiation. Springer, Dordrecht
Koen BV (1985) Definition of the engineering method. American Society for Engineering, Washington
Landau SI (ed) (2008) Cambridge dictionary of American English, 2nd edn. Cambridge University Press, New York
Langenegger TW (2016) A sequential repeated sanction model exemplified by the case of Iran. In: Proceedings of the international conference on group decision & negotiation. Western Washington University, Bellingham
Marwell G, Ratcliff K, Schmitt DR (1969) Minimizing differences in a maximizing difference game. J Personal Soc Psychol 12:158–163. doi:10.1037/h0027574
Muthoo A (1999) Bargaining theory with applications. Cambridge University Press, Cambridge
Nash JF (1950) The bargaining problem. Econometrica 18:155–162. doi:10.2307/1907266
Nash JF (1953) Two-person cooperative games. Econometrica 21:128–140. doi:10.2307/1906951
Neale MA, Bazerman MH (1985) The effects of framing and negotiator overconfidence on bargaining behaviors and outcomes. Acad Manage J 28:34–49. doi:10.2307/256060
Polya G (1957) How to solve it: a new aspect of mathematical method, 2nd edn. Princeton University Press, Princeton
Pruitt DG (1981) Negotiation behavior. Academic Press, New York
Pruitt DG, Drews JL (1969) The effect of time pressure, time elapsed, and the opponent's concession rate on behavior in negotiation. J Exp Soc Psychol 5:43–60. doi:10.1016/0022-1031(69)90005-5
Raiffa H (1982) The art and science of negotiation. Harvard University Press, Cambridge
Raiffa H (2007) Negotiation analysis: the science and art of collaborative decision making, 1st edn. Harvard University Press, Cambridge
Roth AE (ed) (1985) Game-theoretic models of bargaining. Cambridge University Press, Cambridge
Rubin JZ, Brown BR (1975) The social psychology of bargaining and negotiation. Academic Press, New York
Rubinstein A (1982) Perfect equilibrium in a bargaining model. Econometrica 50:97–109. doi:10.2307/1912531
Rubinstein A (2012) Economic fables. Open Book Publishers, Cambridge
Sciolino E (2008) Nuclear talks with Iran end in a deadlock. N. Y. Times
Sebenius JK (1983) Negotiation arithmetic: adding and subtracting issues and parties. Int Organ 37:281–316
Susskind L, Crump L (2008) Multiparty negotiation, four-volume set edition. SAGE Publications, Thousand Oaks
Swiss Federal Council (1999) Botschaft zur Genehmigung der sektoriellen Abkommen zwischen der Schweiz und der EG. BBl 1999 028, Bern
Swiss Federal Council (2004) Botschaft zur Genehmigung der bilateralen Abkommen zwischen der Schweiz und der Europäischen Union, einschliesslich der Erlasse zur Umsetzung der Abkommen (« Bilaterale II »). BBl 2004 063, Bern

Thompson LL, Wang J, Gunia BC (2010) Negotiation. Annu Rev Psychol 61:491–515. doi:10.1146/annurev.psych.093008.100458

Thomson W (1994) Cooperative models of bargaining. In: Aumann RJ, Hart S (eds) Handbook of game theory with economic applications. Elsevier, Amsterdam, pp 1237–1284

Tversky A, Kahneman D (1974) Judgment under uncertainty: heuristics and biases. Science 185:1124–1131. doi:10.1126/science.185.4157.1124

von Neumann J (1928) Zur Theorie der Gesellschaftsspiele. Math Ann 100:295–320. doi:10.1007/BF01448847

von Neumann J, Morgenstern O (1944) Theory of games and economic behavior. Princeton University Press, Princeton

Walters AE, Stuhlmacher AF, Meyer LL (1998) Gender and negotiator competitiveness: a meta-analysis. Organ Behav Hum Decis Process 76:1–29

Walton RE, McKersie RB (1965) A behavioral theory of labor negotiations. McGraw-Hill, New York