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Visualization Support for ENS

Communications Engineering

Negotiations constitute complex and sophisticated problems which often involve multiple stakeholders and multiple issues. There exists a vast amount of literature on how the negotiation process and the tasks and activities occurring during this process can be supported by the usage of computer systems. Traditionally papers on Electronic Negotiation Systems (ENS) focus on architectural and modeling aspects. Nevertheless literature assigns ENS to the area of human-machine-interaction. For this reason this paper roughly explains the phases and activities of a negotiation process and then demonstrates a couple of prevailing visualization techniques in order to support the phases and activities from a human-machine-interaction point of view.

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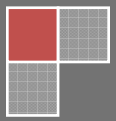

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1 Introduction

[Kersten2007, p. 1] describes the role of information and communication technology as "ubiquitous". This also applies to the area of negotiations "*which involve people communicating via and working together with computer software"*. For this reason the aspect of human-machine-interaction plays a very important role in the context of systems supporting negotiations. Therefore papers like [Bendahan2005], [Kersten1999], [Monzani2004] and [Swaab2002] demonstrate and study the impact of visualization techniques in the context auf electronic negotiation systems (ENS). Furthermore [Lee2007] reports that visualization also fosters the user acceptance. Hence this paper reviews a couple of visualization techniques used in contemporary ENS.

According to literature like [Kersten2007] a common approach to examine the negotiation process is to divide it to into the three phases

- Pre-Negotiation phase
- Negotiation phase
- Post-Settlement phase

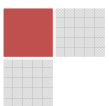
This paper is structured according to these phases and will explain which tasks and activities are relevant for each phase and how these tasks and activities can be supported via visualization techniques. Apart from adopting a technique common in economics, this paper does not introduce any new types of diagrams nor does it provide any information on how to implement the presented techniques.

The structure is as follows: Section 2 explains visualization techniques for the pre-negotiation phase. Literature research has shown that the majority of techniques support the pre-negotiation phase. Therefore this section is structured into three case studies in order to provide a richer explanation of the context in which the techniques can be used. Section 3 starts with an introduction of the tasks of the negotiation phase and summarizes a couple of visualization techniques which provide support for this phase. Section 4 explains how the already presented techniques can be used in the post-settlement phase. Furthermore this section also tries to adopt the concept of an Edgeworthbox, known from the field of economics, to the area of ENS. The final section concludes.

2 Pre-Negotiation Phase

As described by [Weber2006, p. 189] the pre-negotiation phase is when „*parties read case material and undertake activities leading to the construction of a value function*". A more specified description of the pre-negotiation phase is done by [Kersten2007], who tells that in this phase parties are organizing useful information and developing strategies including simulations, tactics and also acceptable alternatives to reach the most benefiting goal.

In this chapter the focus is primarily set on the visualization of present facts and not on visualization of strategies and simulations.



Negotiation as well as visualization is an extensively used term. Therefore the authors start showing one simple example of negotiation (single actor, multi issue) in combination with spreadsheet visualization in example one [Kaklauskas-A2005]. Example two and three describe a much more complex situation (multi user, multi issue) and its visualization using Allas tools [Allas2001] respectively using OMEN [Monzani2004].

2.1 Example One: A web-based negotiation and decision support system for real estate

Before the upcoming of the internet and its possibilities, only the human real estate agent had the overview on the parameters which were required to deliver outstanding results. But the problem exists since ever: There is a large number of parameters per real estate to know and – in addition – a great number of real estate to administrate, too. Therefore the objective comparison of the real estates is quite difficult, and a good real estate agent may distinguish his- or herself by just having a good gut feeling. Kaklauskas also mentions the "*rapidly changing of real estate market conditions and the large demand and supply for real estate*" [Kaklauskas-A2005, p. 236] as a good reason for the use and development of decision support systems which help getting an overview and making rational decisions.

The *Vilnius Gediminas Technical University* therefore realised the so called *Knowledge based e-negotiation decision support system for real estate* which can be found at http://dss.vgtu.lt/realestate/ [Vilnius2008]. Besides the *database management system* which includes attribute data about real estate objects there is also a so called *model-base management system* which includes several models for analysing, calculating and negotiating. Since this paper focuses on visualization techniques in e-negotiation systems a detailed discussion on formal models and the derivation of results from these models is omitted. The paper rather tries to present techniques and concepts on how these results can be visualized.

The first step is to filter out some real estates. In the example it is being searched for *2-room apartments in the Old town* having the area between 50 and 55 m^2. The given result is a list of some real estate objects including textual descriptive information and photographs which are useful getting a first impression of the objects as you see in Fig. 1.

A more expert and quantitative description is given by following the link above the table. In the spreadsheet approximated are the values, the weights of the criteria and the criteria, such as area, year of construction and others (see Fig. 2).

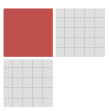


Fig. 1: Textual descriptive information and photographs of the real estates (based on [Vilnius2008])

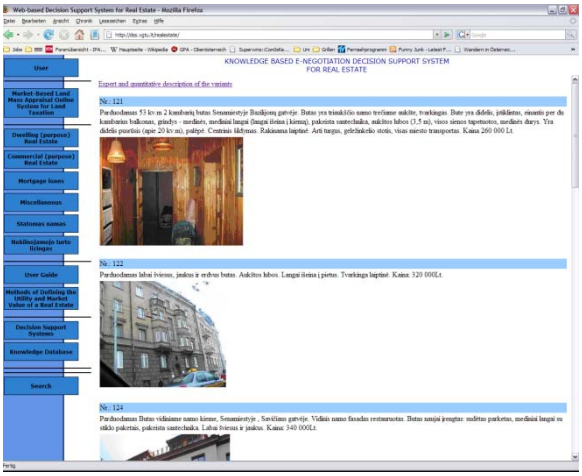


Fig. 2: Quantitative description of the real estates (based on [Vilnius2008])

No.	Criteria under evaluation	Measuring units of criteria	*	Weights of criteria	121	122	124	126	128	129	130	133
1	1 m^2 kaina	Lt	-	1	4906	6037	6296	5115	6415	6075	6204	6000
2	Buto plotas	1sup>m	+	0.06	53	53	54	52	53	53	54	55
3	Pastato aukštis	balai	+	0.02	3	4	3	2	2	4	3	5
4	Buto aukštas	balai	+	0.08	3	3	2	2	2	4	2	3
5	Statybos metai	Metai	-	0.1	1940	1940	1940	1960	1960	1940	1940	1940
6	Buto būklė	balai	+	0.15	2	3	4	1	3	2	3	4
7	Vieta automobiliui	balai	+	0.08	1	2	2	1	2	2	2	1
8	Šildymas	balai	+	0.07	1	1	2	1	1	1	1	1
9	Vieta	balai	+	0.02	1	3	3	2	2	3	2	3
10	Komunikacijos	balai	+	0.06	2	2	2	1	2	2	2	2
11	Transporto srautai	balai	-	0.09	2	2	1	2	2	1	3	3
12	Užterštumo lygis	balai	-	0.09	3	2	1	2	2	1	3	3

The way goes on and ends by clicking *Results of Multiple Criteria Evaluation*, which results also in a spreadsheet, but showing weighted values of the criteria of the alternatives and the main result of the evaluation: among some other things the object's priority and the utility degree in relationship to other alternatives as some preprocessed facts as a result of the pre-negotiation phase, which may be useful in the followed negotiation phase (see Fig. 3).

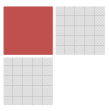


Fig. 3: Results of the multiple criteria evaluation (based on [Vilnius2008])

No.	Criteria under evaluation	Measuring units of criteria	*	Weights of criteria	121	122	124	126	128	129	130	133
1	1 m^2 kaina	Lt	-	1,0000	0,1043	0,1283	0,1338	0,1087	0,1364	0,1291	0,1319	0,1275
2	Buto plotas	1sup>m	+	0,0600	0,0074	0,0074	0,0076	0,0073	0,0074	0,0074	0,0076	0,0077
3	Pastato aukštis	balai	+	0,0200	0,0023	0,0031	0,0023	0,0015	0,0015	0,0031	0,0023	0,0038
4	Buto aukštas	balai	+	0,0800	0,0114	0,0114	0,0076	0,0076	0,0076	0,0152	0,0076	0,0114
5	Statybos metai	Metai	-	0,1000	0,0125	0,0125	0,0125	0,0126	0,0126	0,0125	0,0125	0,0125
6	Buto būklė	balai	+	0,1500	0,0136	0,0205	0,0273	0,0068	0,0205	0,0136	0,0205	0,0273
7	Vieta automobiliui	balai	+	0,0800	0,0062	0,0123	0,0123	0,0062	0,0123	0,0123	0,0123	0,0062
8	Šildymas	balai	+	0,0700	0,0078	0,0078	0,0156	0,0078	0,0078	0,0078	0,0078	0,0078
9	Vieta	balai	+	0,0200	0,0011	0,0032	0,0032	0,0021	0,0021	0,0032	0,0021	0,0032
10	Komunikacijos	balai	+	0,0600	0,0080	0,0080	0,0080	0,0040	0,0080	0,0080	0,0080	0,0080
11	Transporto srautai	balai	-	0,0900	0,0112	0,0112	0,0056	0,0112	0,0112	0,0056	0,0169	0,0169
12	Užterštumo lygis	balai	-	0,0900	0,0159	0,0106	0,0053	0,0106	0,0106	0,0053	0,0159	0,0159
Total sum of maximizing normalized balanced rates S_{+j}					0.0578	0.0737	0.0839	0.0433	0.0672	0.0706	0.0682	0.0754
Total sum of minimizing normalized balanced rates S_{-j}					0.1439	0.1626	0.1572	0.1431	0.1708	0.1525	0.1772	0.1728
Object's significance Q_j					0.2347	0.2302	0.2458	0.2212	0.2162	0.2375	0.2118	0.2227
Object's utility degree N_j					95%	94%	100%	90%	88%	97%	86%	91%
Object's priority					3	4	1	6	7	2	8	5
Supply price					4.906,00	6.037,00	6.296,00	5.115,00	6.415,00	6.075,00	6.204,00	6.000,00
Market value					4.906,00	5.980,43	6.296,00	4.576,17	5.609,75	6.075,00	5.114,43	5.530,15
Mass Appraisal Value					N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

As one can see, although the output information is not that complicated and complex, it is relatively difficult to interpret the result by taking a short look at it. It is even more difficult to see the dependencies between two or more attributes.

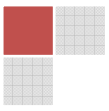
The subsequent section will demonstrate how visualization can support the understanding and interpretation of quite complicated correlation facts by the method of Allas [Allas2001] on the basis of the following example.

2.2 Example Two: Allas visualization techniques for analysing complex (multi-actor multi-issue) situations for a European electricity supplier industry

As mentioned above the visualization tools from Allas support multi-issue multi-actor analyses. This is necessary if more than one issue is to be considered and more than one actor is involved (or should be involved) in the negotiation process. The questions that have to be answered first are: What defines an actor? And what can be defined as an issue?

According to [Bendahan2005] there are two properties that distinguish a passive stakeholder from an active one. The first is that the stakeholder must be interested in one or more issues which are going to be bargained in the negotiation process, or the stakeholder must be interested in the possible outcome of the process. The second one is that the stakeholder must be able to influence the process or the process outcome. In the following we use the term actor as a synonym for stakeholder and player.

Bendahan also gives a definition of what an issue can be: "*Issues can be generally defined as open and debatable questions, events, problems, or other forthcoming developments that are open to*



discuss or dispute and whose realization can significantly influence the ability of an organisation to achieve its objective" [Bendahan2005, p. 141].

And this is where the example starts. In detail it is about a European government that decided to liberalize its electricity generation and supply industry, including the spin off of a near-monopoly utility, which is called *Power* in Allas example [Allas2001, p. 88]. After defining actors and issues it is also necessary to answer some questions about the actors to better estimate their behaviour in every single issue in the negotiation process. These questions are about position, salience and clout, and are defined by [Allas2001, p. 89] as the *key characteristics*.

1. Position: What does the actor define as the optimal outcome? Is there a range of positions or has the actor not stated his position at all? What position could he have?
2. Salience: How important is the issue to the actor in comparison to each other issues?
3. Clout: How much the actor can influence the outcome of each issue in comparison to other actors?

By expressing this information by assigning a number from 0 to 100 and setting the actors in relationship to the *key characteristics* a table is given which may look as shown in Fig. 4.

Fig. 4: Relationship between actors and key characteristics [Allas2001, p. 89]

Issue: 'Green' subsidies

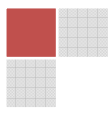
Issue: Forced divestitures

Issue: Wholesale-market structure

Issue: End-user tariffs

Stakeholders	Key characteristics[2] Position	Salience	Clout
Power	0	90	70
Regulator	100	85	100
Ministry of Industry	30	35	50
Treasury	0	40	60
Labor unions	0	20	20
Competitors	50	50	20
System operator	0	30	50

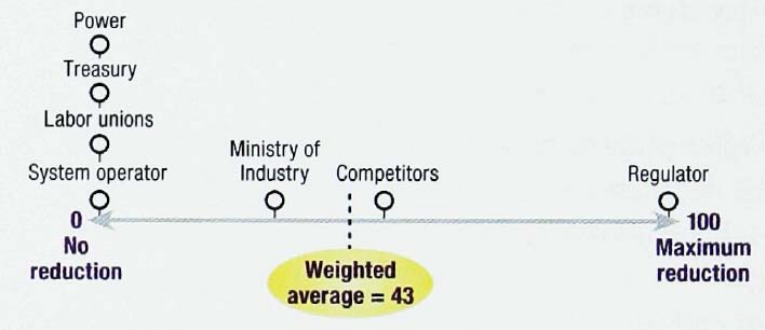
The challenge thereby is to get the right values for the *key characteristics*. The answer is given by Bendahan. He suggests a method he describes as "*a kind of Delphi method […], a technique for discerning common opinions regarding uncertain issues based on iterative submissions of questionnaires to groups of experts.*" [Bendahan2005, p. 143]. In detail a so called group monitor prepares questions about actors and issues and sends them to some experts. These experts independently think over the questions a give back their answers to the group monitor, who summarizes the results and then sends them back again to the experts, who reconsider their



answers. After a few rounds later consensus may be found which then flows into the negotiation process as values for position, salience and clout.

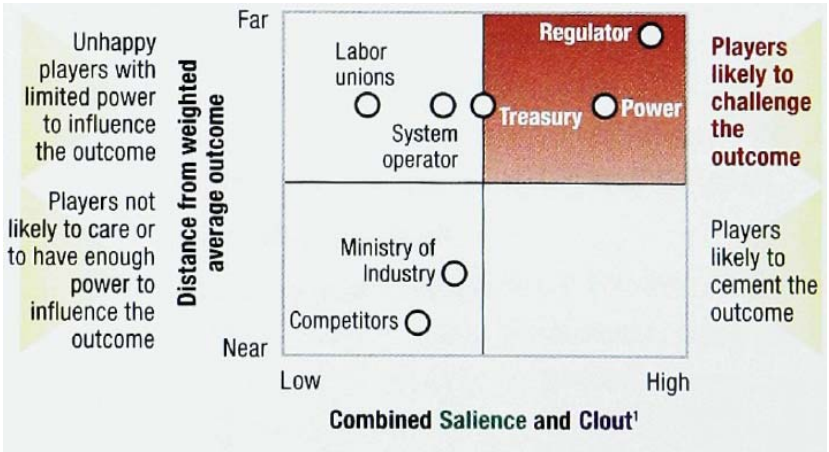
Allas calls his first tool the *outcome continuum*. In this graph the position of each actor in relation to the minimum and maximum position value is shown (see Fig. 5). This graph also has to be produced on every issue (in our example it is about the end-user tariffs). Furthermore in this step a weighted average has to be calculated which is unfortunately sparely described by [Allas2001, p. 90] as followed: *"[…] weighting the players' positions according to salience and clout and then calculating the average […]"*. This average can be seen as a pure compromise which is in our case far away from *Powers* optimum.

Fig. 5: Allas outcome continuum (example end-user tariffs) [Allas2001, p. 90]

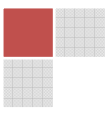


The weighted average is also being used in Allas second tool called the *stability analysis*. This visualization of given facts shows in a two dimensional matrix how far the position is away from their actors optimum and puts this in relation to the importance of reaching the target outcome and the possibility to influence the outcome (which is the product of salience and clout). Allas splits the matrix into four regions having various meanings (see Fig. 6).

Fig. 6: Allas stability analysis (example end-user tariffs) [Allas2001, p. 90]

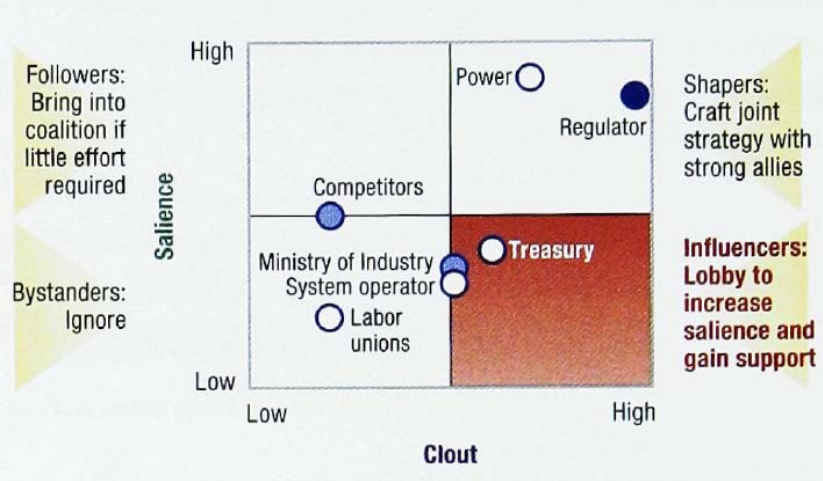


The highlighted area top right above points out, that actors in this quarter are far away from their optimal outcome and that attaining that outcome is important to them and that they do have the power to influence it. In our example *Power* will go on bargaining for a much better deal and it has the realistic chance to improve ones condition.



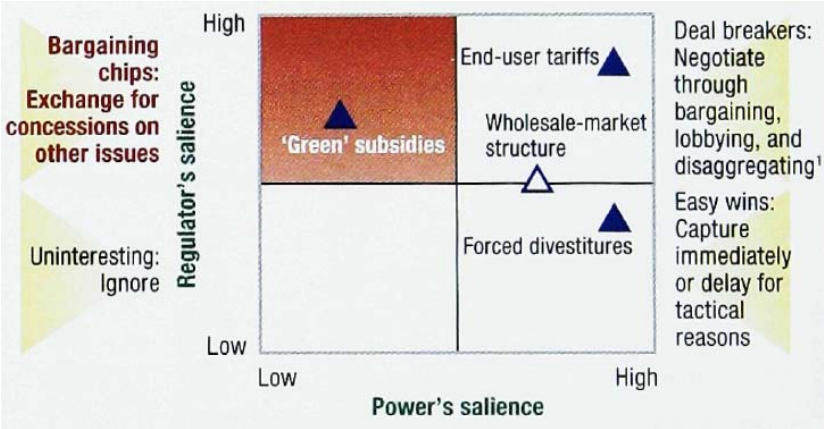
Next step is to identify which actor on *Power's* perspective is an enemy, ally or is in-between – on every issue. To find out the most useful friends Allas sets salience and clout of every actor in relation and marks enemies (dark points), allies (white points) and in-betweens (grey points). These so called *negotiation landscapes* (each for every issue) are also split into four areas (see Fig. 7). There are two areas that deserve closer attention: Top right are the *shapers*, which all care about the issue and do have the power to influence the outcome of the issue. Actors in there can be powerful allies (white points) or by contrast powerful enemies (black points). Down right are the influencers, which have power to influence but are not very much interested on the issue. In our example for *Power* it is important to get them on Power's side.

Fig. 7: Allas negotiation landscape (example end-user tariffs) [Allas2001, p. 92]



Persuade some influencers may be enough to reach the target, but if not Allas presents his fifth tool, which is called *relationship analysis*, where the actors salience of every issue (*Powers* salience in our example) is set in relation to the other problematic actors salience (see Fig. 8).

Fig. 8: Allas relationsship analyses (example *Power* and regulator) [Allas2001, p. 92]



The best issues to deal with are found in the top left area: The regulators salience is high and in contrast Powers salience is low. In the example it may be a good deal to accommodate to the

regulator in case of the *'green' subsidies* if the regulator accommodates to *Power* in case of *end-user tariffs*.

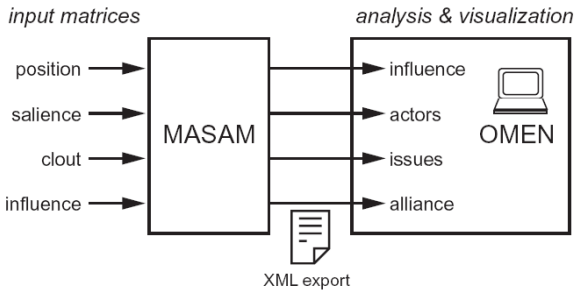
As Allas five tools show there are excellent possibilities to plot easy to understand and meaningful graphs with little time and effort. Complex dependences are shown in this multi-user and multi-issue pre-negotiation phase, and furthermore strategies can easily be derived from simple looking matrices to reach the optimum outcome.

Our last example for the pre-negotiation phase is similar in many ways but extends Allas' tools and especially differs in the *key characteristics.*

2.3 Example Three: Pre-Negotiation Phase in the WISP-Scenario using the OMEN-System for analysis and visualization

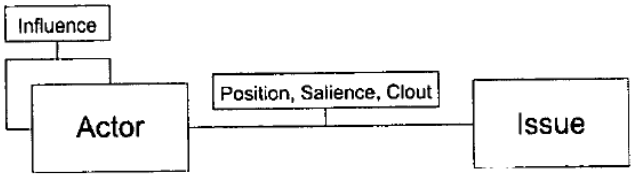
Compared to [Allas2001], [Monzani2004] presents a whole software solution for the negotiation process. The one part of it is *MASAM* (Multi-issue Actor Strategic Analysis Model) which is described as a "*proposition which integrates all the possibilities of two models, the MACTOR [5] method and a model developed by Allas.*" [Monzani2004]. The other part is called *OMEN* and is a tool for *strategic visualization*. The connectivity of the two is shown in Fig. 9.

Fig. 9: Connecting *MASAM* and *OMEN* [Monzani2004]



Unlike [Allas2001] there is one more input parameter used in the *MASAM* model, which is called *influence*. The difference between *clout* and *influence* is that by *influence* is meant the bearing of an actor on another actor, while by *clout* is meant the bearing of an actor on an issue [Bendahan2005].

Fig. 10: UML-Diagram showing the difference between clout and influence [Bendahan2005, p.141]



The outcome of MASAM results in OMEN, the visualization part. Monzani points out that "*simultaneously displayed charts are fundamental for comparing actors and issues*" [Monzani2004] and unites the most important charts in one single window. Fig. 11 shows a global screenshot of OMEN having a WISP-Sceanrio (Wireless Internet Service Provider) as an example.

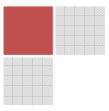
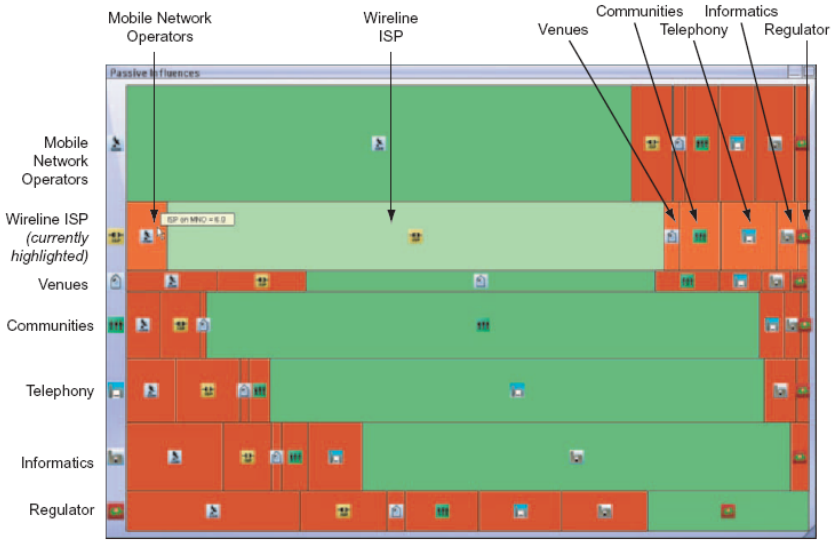


Fig. 11: A global snapshot of OMEN [Monzani2004]

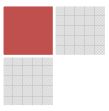
According to Fig. 9 a look at visualization possibilities in influence, issue, actor and alliance analysis will be done before leaving the pre-negotiation and coming to the negotiation phase.

Influence analysis by OMEN results in a mosaic graph (see Fig. 12) where every actor is represented in a horizontal band. The higher the band the more important is the actor. The sections show the influence on the actor, where green points for self influence and red for other influence. In our example the *Mobile Network Operators* are very important and are less influenced by other actors.

Fig. 12: The influence graph [Monzani2004]

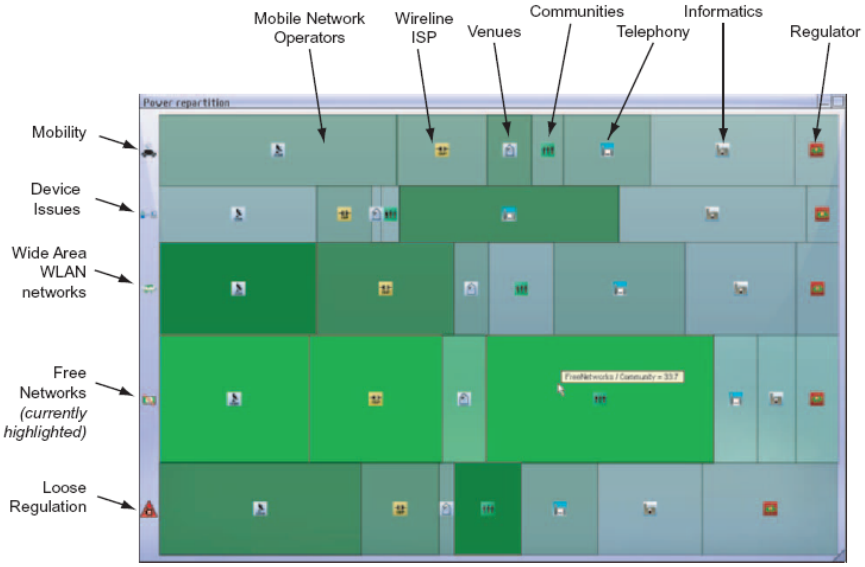


Related to the influence graph above is the graph showing the result of the actors influence on issues (*actor analysis*). The issues are represented in a horizontal band and the height of the band signals their importance. The section shows the influence the actor has on the issue. The less important the



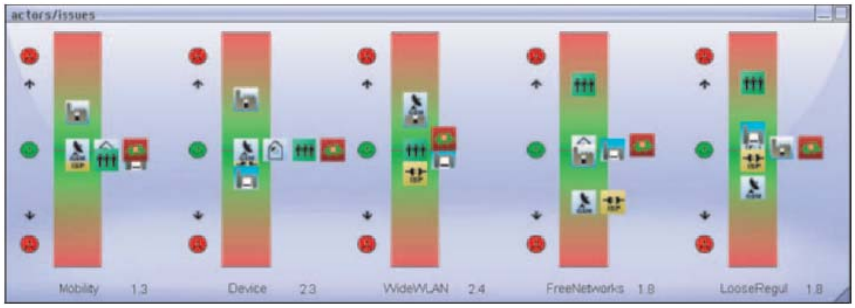
issue is to the actor, the more translucent is the sector (see Fig. 13). According to the example *Free Networks* is the most important issue and *Communities* have the most influence on it (and they find the issue important).

Fig. 13: Visualization of actor analysis [Monzani2004]



The *issue analysis* results in the dissatisfaction graph (see Fig. 14). Every issue is arranged as a column side by side. Every actor has his symbol which is positioned along this column. If it's positioned in the middle, the actor is at low dissatisfaction. A position near the top means the position is higher than the expected result, if it's near the bottom, then the position is lower than the expected result.

Fig. 14: The dissatisfaction graph [Monzani2004]



Finally a look at the proximity map is taken which is the result of the *alliance analysis* which shows the relationships between the actors. Like in the *issue analysis* every actor has its symbol. The distance between the actors (symbols) is defined as the "*composition of their difference of positions and salience*" [Monzani2004]. And so a grid is going to be formed which visualizes the relationships in a 2-dimensional plane. Fig. 15 shows this topology allocation.

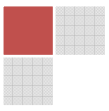
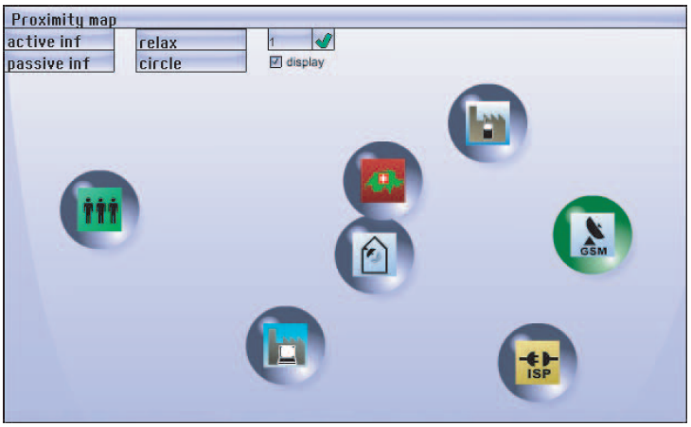


Fig. 15: Proximity map by Monzani [Monzani2004]



As the examples above have shown, this graphs and methods may be primarily being started using in the pre-negotiation phase. Anyway, the borderline between pre-negotiation phase and negotiation phase is not clearly defined by using this tools, and what is starting in the beginning of the negotiation process may be consistently continued in the proper negotiation phase. But there are some special visualization techniques which only make their sense in the running negotiation process and which will be explained in the next chapter.

3 Negotiation Phase

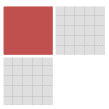
In this phase, according to [Weber2006, p. 190] the parties create and exchange offers and counter-offers. If the parties reach a common agreement the phase ends. As described by [Kersten1999, p. 141] in addition to the creation and exchange of offers this phase also covers tasks like the analysis of offers and counter-offers, the *"review of negotiation history"* and the *"analysis of negotiation dynamics"*. The study of negotiation dynamics may be an important issue because as [Bendahan2005, p. 162] explains, actors *"may modify their positions on particular issues"*. This includes both, their *"real position that represents the unchangeable extrinsic preference of an actor"* and also their *"revealed position"*.

3.1 Visualization techniques

For this reason this section explains a couple of visualization techniques supporting the aforementioned tasks of the negotiation phase. All of the described methods can either be directly found in scientific literature or are based on prevailing concepts found in contemporary literature.

3.1.1 Contract and Message Visualization

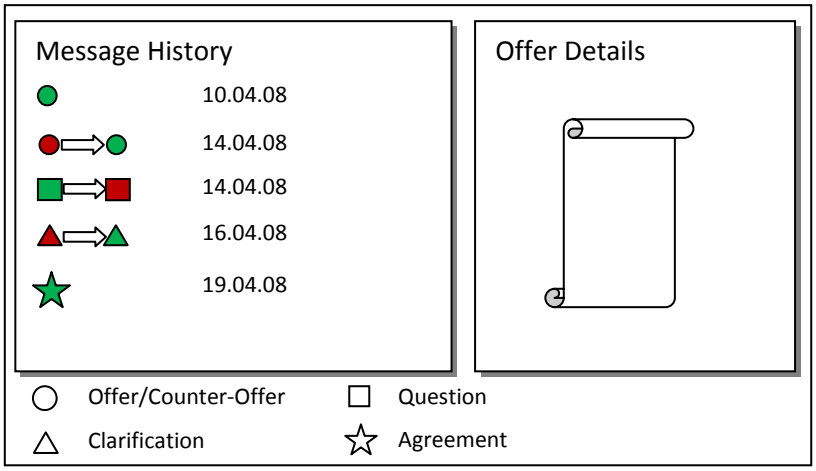
Main goal of the participating parties during the negotiation phase is to reach an agreement on the negotiated topic in order to set up a contract. In ENS like INSPIRE ([Kersten1999] and [Weber2006]) and Negoisst ([Schoop2003]) the negotiating parties submit offers/counter-offers and communicate via an internal messaging system. Especially for negotiations which last for a longer period of time (e.g. a couple of months) it is useful for the negotiators to keep track of the sent and received messages.



According to [Schoop2003, p. 393] Negoisst visualizes this negotiation process by providing a so called *"message movement"* dialogue. This dialogue shows a chronological ordered list of messages sent during the negotiation. For each message Negoisst displays the date and time when the message has been sent/received and furthermore a graphical icon, showing the message type (offer/counter-offer/question/clarification) and whether it is an incoming or outgoing message.

If the user clicks on a specific message, the system displays detailed information of the offer/counter-offer like the specific contract items and their values. Fig. 16 shows an exemplary depiction of such a message movement dialogue.

Fig. 16: Example: Message Movement



[Schoop2003, p. 379] defines offer and counter-offer as *"comissive acts"*, whereas question and clarification represent informal parts. If further information or explanation on e.g. a specific point of an offer is required, the negotiator can issue a question. [Schoop2003, p. 379] calls the answer to such a question *"clarification"*.

3.1.2 Offer ratings

As explained in the last section a history of messages can be used to keep track of a negotiation. Nevertheless, this technique does not give any information on the value of an offer or counter-offer from the perspective of a negotiating party.

For this reason a couple of authors like [Weber2006] and [Kersten1999] introduce the concept of an *"offer rating"*, which is a number between 0 and 100 and indicates the value of an offer. Because the value of an offer depends on the negotiators point of view, the authors use the revealed preferences from the negotiator to compute a utility function. The output of the utility function is an ordinal measure of the value of an offer. This process is depicted in the figure below.

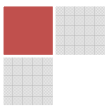
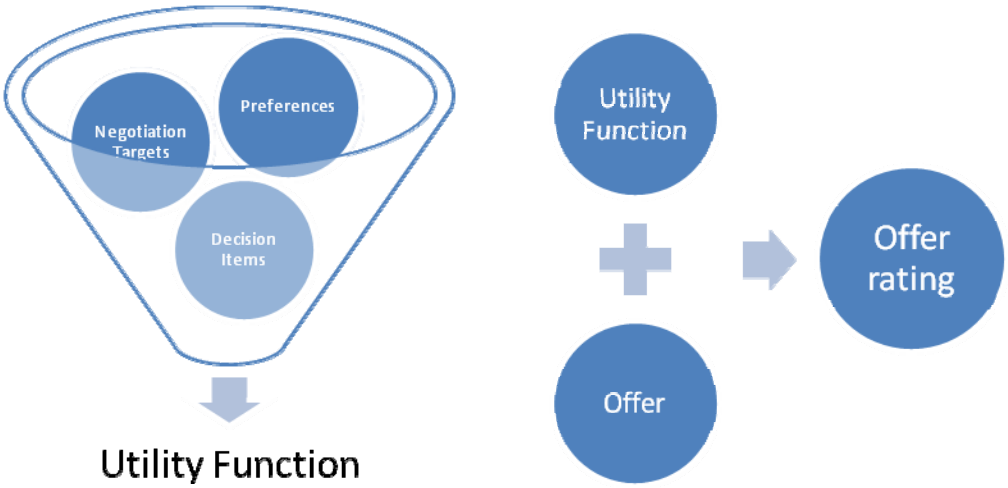
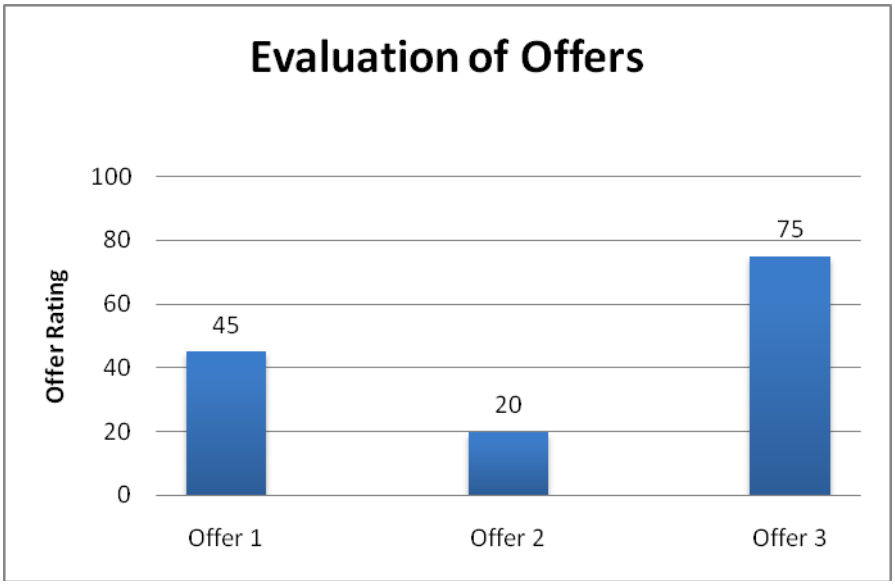


Fig. 17: Derivation of the Offer Rating



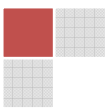
A detailed discussion on the computation of the utility function is beyond the scope of this paper and will be therefore omitted. The offer rating can then be used to compare different offers. One could for example use a bar chart to evaluate three alternative offers. An example is given in Fig. 18.

Fig. 18: Example for comparison of offers using the concept of the Offer Rating



As one can see, in above example Offer 3 clearly dominates the other two offers. Another thing which can be observed is that if those three offers were no alternatives, but would rather represent a chronological sequence of offers, one could track the negotiation process from the negotiator's utility point of view. This concept is called *"History of Offers"* and will be described in the subsequent section.

Because the offer rating is computed via the utility curve by compressing all the information on an offer into a single number it is suited for negotiations with multiple issues.



3.1.3 History of Offers

[Weber2006, p. 190] states that the History of Offers in INSPIRE *"shows a negotiation timeline with offers indicated by their ratings".* According to [Kersten1999, p. 150] the History of Offers *"is a graph of the dynamics of the negotiation process"*. Therefore it is an adequate method to accomplish the tasks *"review of negotiation history"* and the *"analysis of negotiation dynamics"* as listed by [Kersten1999, p. 141].

The advantage of such a graph is that it can be directly computed during the negotiation process. It shows the successive steps on the way to a final agreement. Compared to the approach from the previous section, the History of Offers displays the timeline of offer ratings for both parties in a single picture.

Fig. 19: History of Offers – Hotel Playa's View

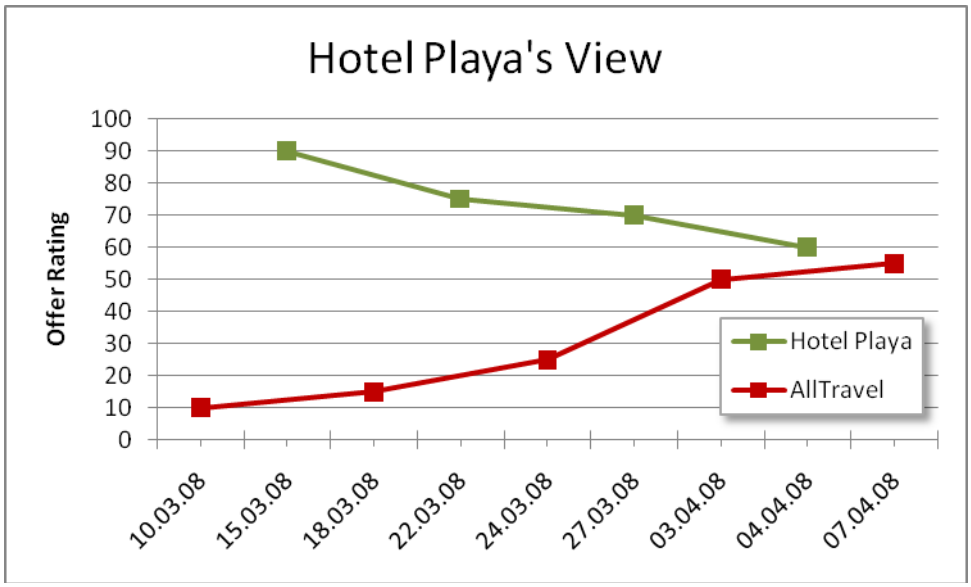
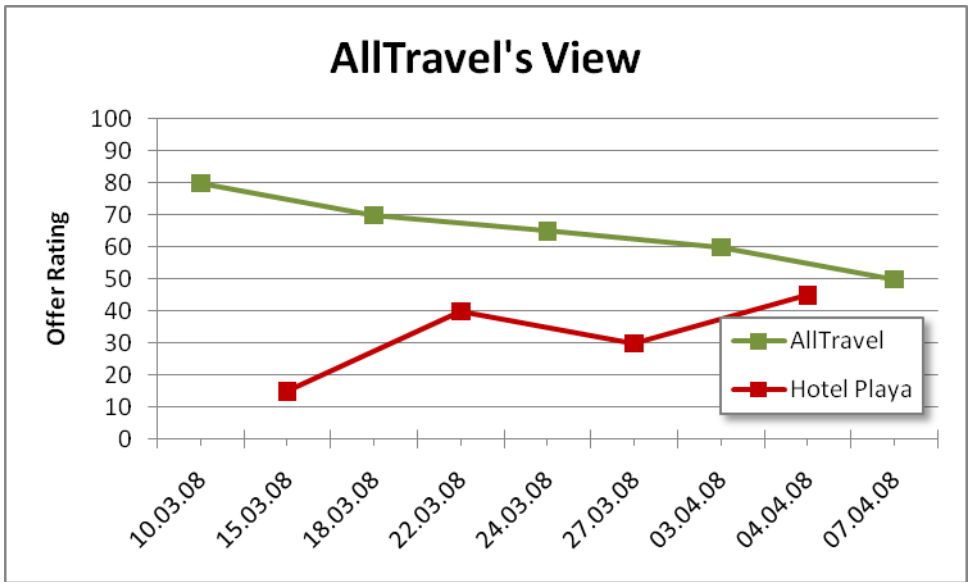


Fig. 20: History of Offers – AllTravel's View



As one can observe in above figures there are two History of Offer graphs; one for each negotiator. This is because each graph represents the perspective of a single negotiating party, i.e. it shows the perceived value of the offers of both sides, from the perspective of a certain individual. The first part shows the perspective of Hotel Playa. The second part shows AllTravel's perspective.

In order to clarify that the two diagrams depicted above are two sides of the same coin, one should take a look at the third offer of Hotel Playa. From AllTravel's view the third offer of Hotel Playa (offer rating: 30) is a little bit worse than the second offer (offer rating: 40). But this in turn does not imply that Hotel Play would rate its third offer higher than its second offer. When looking at the History of Offers from the perspective of Hotel Playa, one will notice that the offer rating for the third offer of Hotel Playa is lower than the offer rating from the second offer.

A possible explanation for this phenomenon will be demonstrated with the following simple example:

Assume that the decision variables are the number of beds and the price per bed. AllTravel has already accepted bookings for 500 beds. Therefore from AllTravel's point of view it is very important that Hotel Playa provides at least 500 beds. AllTravel's customers a willing to pay €40,- per bed. Now suppose the second offer of Hotel Playa is to provide 550 beds at a price of €35,-. Furthermore the third offer of Hotel Playa is 450 beds at €30,- per bed. Therefore the revenues of Hotel Playa at offer three would be smaller than at offer two, i.e. Hotel Playa is put worse off. On the other hand AllTravel has already accepted 500 bookings. Therefore, even though the travel agency would have to pay less, it still would prefer the second offer.

The last feature of the History of Offers is that it enables the negotiator to examine the distance between two opposing offers. As [Weber2006, p. 191] argues the History of Offers *"shows how far apart the two sides are"*.

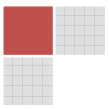
Although offer ratings are suitable for multiple negotiation issues, the History of Offers has only been described in the case of bilateral negotiations. If this technique is used to display the offers of more than two negotiating parties the graph becomes difficult to read and hard to interpret.

3.1.4 Negotiation Map

The concepts of OMEN's Power Distribution Map and Proximity Map have already been introduced in section 3. But as [Bendahan2005, pp. 162] demonstrates these approaches are also useful for the negotiation phase because they enable the negotiator to simulate different negotiation scenarios. According to [Bendahan2005, pp. 162] these simulations *"permit actors to sensibly modify their positions on particular issues"*.

In order to do so, [Bendahan2005, pp. 162] enhances the Power Distribution Map with the following elements:

- A line in the middle of each cell *"to identify the middle position on issues"*. OMEN uses an icon to represent actor. In the enhanced Power Distribution Map the vertical position of this icon indicates alleged position of the actor concerning a specific issue. If the icon is placed



above the middle line, this shows that the actor is in favor of increasing the outcome of the particular issue.
- A red line representing the real, extrinsic position of the actor.
- A yellow line indicating the expected outcome. The expected outcome is determined by the alleged position of the actor via the salience and clout of each actor. Therefore the expected outcome will move if the alleged position of one or more actors is changed.

Incorporating these enhancements the Power Distribution Map can be used to forecast the expected outcomes of different negotiation scenarios by altering the alleged position of one or more actors. Because as [Bendahan2005, p. 166] states: *"If the actor's position is higher than the expected outcome, that actor is more likely to defend a position that raises the outcome, rather than defending an absolute value for this position."*

In accordance to the new expected outcomes OMEN also computes new results for the Proximity Map. Although the map itself is not enhanced by any elements, it can be used to simulate new strategic alliances.

3.2 Empirical Findings

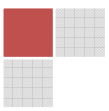
The previous sections listed the tasks of an ENS and explained approaches how these tasks can be supported by the use of visual aids and visualization techniques. The following section tries to give an overview on empirical findings concerning the impact of visualization techniques during the negotiation phase.

A rather recent study has been released by [Weber2006] where the authors state and check the following hypothesis:

- The number of negotiations reaching an agreement will be increased by the usage of visual aids.
- Visual aids decrease the time needed to reach an agreement by reducing the number of required offers.
- Visual aids decreases the amount textual communication needed to reach an agreement.

[Weber2006, p. 192] check these hypothesis with an experiment where *"the experimental comparison is between the experimental model without graphical support and the full model with graphical support"*. The results of this experiment do neither support the first nor the second hypothesis, but as [Weber2006, p. 195] postulates, *"the number of words per message is […] much higher for the no-graph model than the full model"*.

The findings of [Weber2006] suggest that although visualization techniques may not accelerate negotiations, they definitely support and improve the communication between the negotiating parties.



4 Post-Settlement Phase

[Weber2006, p. 190] claims that this phase only occurs if the agreement from the negotiation phase turns out to be inefficient. Therefore *"the system suggests efficient improvements and the users may engage in agreement re-negotiation"*. Unfortunately [Weber2006] does not give any information on the definition of the term *"efficient"*. A more detailed explanation of this phase can be found in [Kersten1999, p. 142]. He defines *"efficient"* in terms of pareto-optimality and furthermore states that *"this is the stage when the system acts as a mediator and takes into consideration the utilities of the two parties"*. In such a case an electronic negotiation system (ENS) may work out one or more efficient solutions and present them to the negotiating parties.

Another important point mentioned by [Kersten1999, p. 142] is that *"in the post-settlement phase, users cannot revise their preferences […] because the system uses the preference information to determine and display efficient packages"*. If one of the parties changes their preferences the computed packages may be inefficient. Furthermore the final agreement from the negotiation phase which had been declared as inefficient may transform into an efficient solution.

4.1 Visualization Techniques

As pointed out in the previous section, the most important tasks of the post-settlement phase are the evaluation of the agreement and, in the case of inefficiency, the presentation of efficient alternatives. Therefore the following sections demonstrate visual aids for these tasks.

4.1.1 Offer Ratings and History of Offers

As described in section 3.1.2 one can compute the offer ratings for both, the agreement from the negotiation phase and the alternatives proposed by the ENS. The results in turn can be visualized using bar charts as presented in Fig. 21. The usage of this concept during the post-settlement phase is analogical to the negation phase. For this reason a more detailed discussion is omitted.

As [Kersten1999, p. 142] states, *"the list of the post-settlement phase activities is similar to that of the conduct of the negotiation phase"*. Therefore the History of Offers can be used in the same way as described in section 3.1.3.

4.1.2 Edgeworthbox

The Edgeworthbox is a tool used in economics to visualize the general equilibrium in an economy. The box itself consists of two diagrams for indifference curves, which are curves representing the utility of an individual. An indifference curve shows all possible goods packages, which yield the same utility.

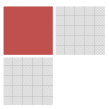
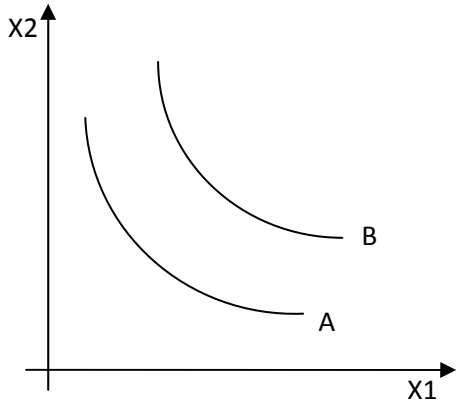


Fig. 21: Representation of an individual's utility function using indifference curves



In economics this type of visualization is used to display the preferences of an individual which can consume only two goods, namely X1 and X2. An example for such a diagram is given in the figure above. The abscissa represents the quantity consumed of good X1, whereas the ordinate represents the consumption of good X2. Both goods are considered to be "goods" and no "bads", i.e. the larger the quantity an individual consumes of each good, the higher is his or her utility. For this reason, higher indifference curves represent a higher utility. Therefore an individual would prefer each combination (X1,X2) from curve B to each combination (X1,X2) from curve A.

The convex curvature stems from the fact that individuals prefer balanced packages of goods to packages which are slanted towards only one of the two goods. A detailed discussion on the properties of indifference curves and preferences in general is beyond the scope of this paper. The interested reader may be referred to standard economic textbooks like [Varian2001].

An Edgeworthbox is the combination of two indifferences diagrams, where the second diagram is upside down, yielding an enclosed box (see Fig. 22). The figure represents the indifference curves of two individuals A and B. A pareto-optimal solution is characterized by a point where the marginal rate of substitution is equal for both individuals in the economy (cf. [Varian2001, Ch. 29] for a detailed formal derivation of this proposition).

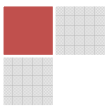
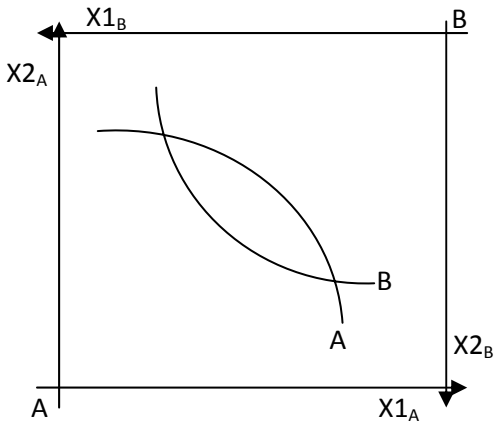


Fig. 22: Example of an Edgeworthbox



The underlying concepts of the Edgeworthbox, namely two individuals whose preferences are represented by utility functions are also applicable to ENS. Therefore it seems reasonable to use the Edgeworthbox as a visual aid to determine whether the agreement from the negotiation phase is pareto-optimal.

Assume AllTravel (AT) and Hotel Playa (HP) were only negotiating on the following two issues:

- x-axis: Price per bed (P/B)
- y-axis: Fraction of the transfer cost from the airport to the hotel covered by the opposing party (FoTC)

Furthermore assume that there is a choke price of €50,-, i.e. if the price per bed exceeds €50,-, then AllTravel is not going to book any beds at all. This allows that the origin of the x-axis for AllTravel to start at the choke price. During the negotiation phase the hotel and the travel agency agreed on a price of €35,- per bed and that AllTravel has to come up for 70% of the transfer costs. This situation is depicted in Fig. 23. Additionally assume that the preferences of the two negotiating parties can be expressed with indifference curves.

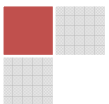
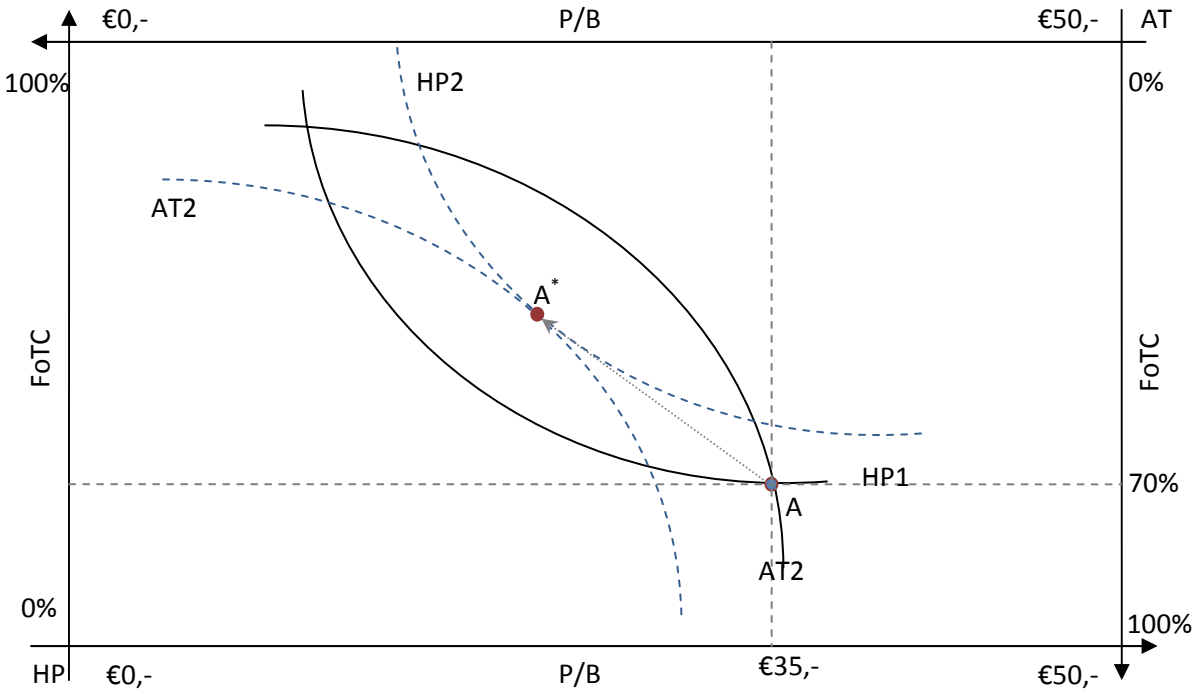


Fig. 23: Using an Edgeworthbox to find efficient agreements



Above figure shows the agreement (A) and the indifference curves for both parties. One can observe that the indifference curves cross each other and constitute a lens. Taking a closer look at the lens reveals that each package in the lens would put at least one negotiating party better off without worsening the situation of the other party.

After choosing a point in the lens one can again draw the corresponding indifference curves and check whether the area of the lens is greater than zero, i.e. checking if there is still room for improvement. The process comes to an end if the two indifference curves are tangent to each other. This point is depicted as A* in Fig. 23. Agreement A* represents an efficient outcome of the negotiation.

One has to keep in mind that efficient agreement found in the Edgeworth box depends on the initial agreement from the negotiation phase, i.e. this technique cannot be used to automatically find the perfect solution for the given negotiation problem.

4.1.3 Negotiation Map and Dissatisfaction Analysis

As already mentioned in section 3.1.4 the Negotiation Map in OMEN introduced by [Monzani2004] and [Bendahan2005] shows the alleged position of an actor concerning a specific issue, his or her real position and also the expected outcome. As pointed out by [Bendahan2005, p. 164] because of these properties of the Negotiation Map, *"it is also straightforward to determine the dissatisfaction of the actor by comparing the distance between its position and the expected outcome, and by taking into account the salience of the issue for the particular actor"*.

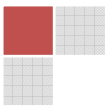
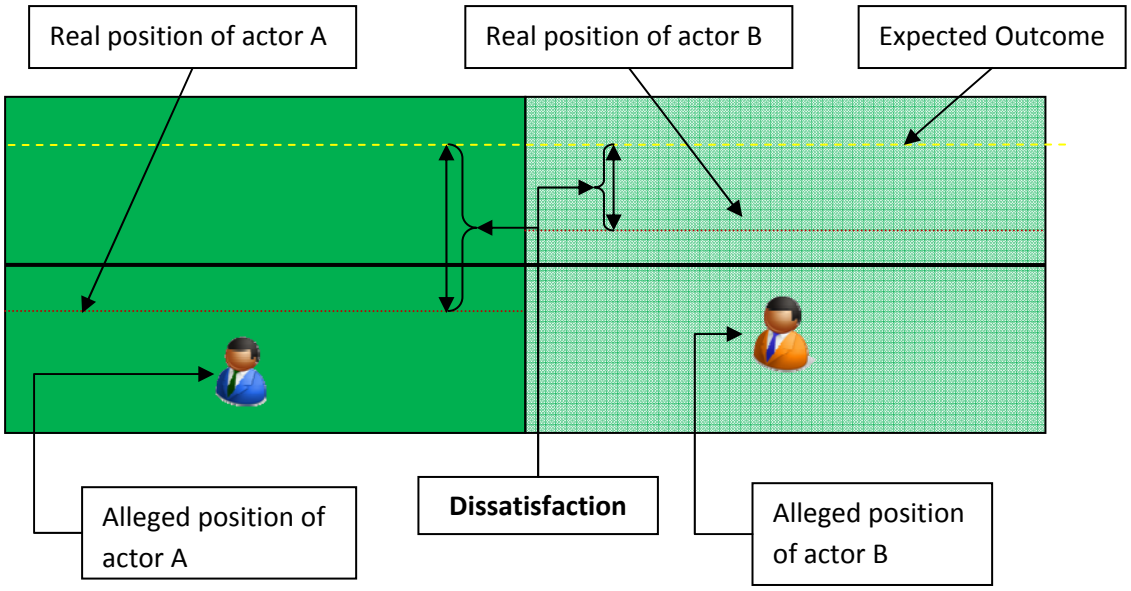


Fig. 24: Negotiation Map and Dissatisfaction Analysis



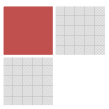
Above figure shows an extracted part of a Negotiation Map depicting the position of two actors towards a certain issue. As one can observe in the figure the dissatisfaction is the difference of the expected outcome and the real position of an author. Furthermore it is also influenced by the perceived importance (which [Monzani2004] and [Bendahan2005] term as *"salience"*) of the issue. The importance of an issue is indicated by the transparency of the filling color of the large rectangles. The more important an issue is to a specific actor the larger is the impact of the distance between the expected outcome and the real position.

If the outcome of the negotiation phase is inefficient, the Dissatisfaction Analysis in accordance to the Negotiation Map can be used in the post-settlement phase to display efficient alternative agreements. This could be done by contrasting a Dissatisfaction Analysis for the agreement of the negotiation phase with the analysis of an efficient alternative found by the ENS. In such an environment a user can quickly check whether the suggested agreement puts any actor worse off.

4.2 Empirical Findings

[Swaab2002] carried out an empirical study to examine the impact of visual support in negotiations on ENS. The main focus of this study was on the construction of shared mental models, but amongst other hypothesis [Swaab2002, p. 134] also observed whether the negotiating parties were more satisfied with a visually supported negotiation process and with the outcome of such a process.

Although the hypothesis that there is a statistical significant increase in satisfaction concerning the process and the outcome of the negotiation had to be rejected, [Swaab2002, p. 142] reports that *"visualization support increases the consensus among negotiators"*.



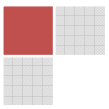
5 Conclusion

The paper summarized how the different phases of a negotiation process can be supported by visual aids. It has been shown that during the pre-negotiation phase visualization can help, to put the perception of the negotiating parties on equal footing, reducing the possibility of misunderstandings.

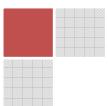
For the negotiation phase the paper illustrated techniques, on how to visualize the process of the negotiation itself and it provided an approach on how to evaluate and compare offers in a graphical way. Furthermore it has been reported that visual support during the negotiation phase reduces the required amount of communication between the negotiating parties.

Since the negotiation phase and the post-settlement phase exhibit similarities, it is no surprise that the visualization techniques can often be applied to both phases, although this may require some minor changes to the graph or diagramm. In addition the paper has shown that an Edgeworthbox can be used to visualize the inefficiency of an agreement.

Finally, it has to be said that, according to current studies on the impact of visualization techniques on ENS, visual aids do support the negotiation process. Especially the communication between the negotiation parties is fostered and eased by the use of visual aids. But that does neither imply that agreements will be reached faster nor that the negotiating parties are more satisfied with the negotiation outcome.



6 Table of figures



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