An Expert System Based Approach to Analyse the Underlying Structure of a Multilateral Crisis

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SUMMARY

The paper describes an experimental expert system approach to support the analysis of the structure of a multilateral crisis. The focus is not only put on the immediately visible contentious issues but also on the underlying concerns and grievances, which often are based on divergent political or economic interests, mutually different perceptions of intentions or actions, different culture, different value systems.

The various interests, internal conflicts and goals of the key players in an area where a mission has to be carried out, may impose serious constraints/ restraints on our planning alternatives, rules of engagement and acceptable courses of action.

The information we normally can access consists in most cases of a sometimes affluent quantity of unstructured bits and pieces of data, which needs to be transformed into meaningful knowledge relevant for our decisions.

*The approach introduced here has been designed to support this transformation process by helping to structure and formalize the available data and draw decision-relevant conclusions by applying a set of pre-defined, comprehensible inference – and decision rules. A prototype version of the system has been implemented in PROLOG, which is a so-called descriptive, predicate logic based language, which allows describing chains of **if-then** statements, applying rules recursively and even adding new rules dynamically.*

1.0   INTRODUCTION

In peace keeping operations, where containing and de-escalating of a conflict is required rather than winning a war , where often no marked separation line between "good guys" and "bad guys" exists, we cannot afford an indifferent attitude towards the various faction's interests, goals, feelings and concerns. Since those factors may influence the success of a peace keeping-operation significantly, it is important to obtain knowledge of

- the various factions goals and interests
- their mentalities and value systems

- their perception of the situation

- their concerns and grievances

- their possible misperceptions of our intentions

- their attitudes on our own activities

- anticipate constraints and restraints imposed on our courses of action by concerns and grievances

- their possible reactions on our activities

When talking about factions, not only opposing groups, but also parties which in general co-operate with us, our Allies and the public opinion are included.

In the Operations Research Division at NC3A, we had a great variety of tools like combat simulation models available to support studies and exercises dealing with classical combat situations, where force ratio, weapon mix, military strategy and tactics were prevailing. With the shift to scenarios with the pure military aspects being just one factor among many others like we saw us confronted with the need of developing methodologies and tools to support primarily exercises using these types of scenarios, but later also real mission planning. The first challenge we had to face was the introduction of a new peace keeping scenario in 2001, which includes all the factors listed below.

- Resource conflicts

- military dominance

- political dominance

- economic problems

- negative perception and rejection of globalisation

- ethnic problems

- rejection of and hostile feelings against "Western Culture"

- terrorist and guerrilla war activities

- allies with serious internal problems

- influence of press and public opinion

2.0   METHODOLOGY

In the scenario book, we found an affluent quantity of data and information, most in narrative form and often more or less unstructured.

What we needed was to transform these data into meaningful knowledge relevant for the decisions we have to make, such as:

- knowledge about the parties goals and interests

- understanding the parties mentalities, views of the situation, cognitive style etc.

- assess the parties attitudes on our own activities

- anticipate the parties possible reactions on our activities

- anticipate constraints and restraints imposed on our courses of action by
  - concerns and grievances of parties which in general co-operate with us
  - our own governments
  - public opinion

2.1   Basic Concept

In order to support this transformation process by helping to structure the various pieces of information, a simple experimental expert system has been developed at the OR Division of NC3A using PROLOG, a predicate logic based descriptive programming language. PROLOG allows constructing chains of **if-then**'s quickly, applying deduction rules recursively and even dynamically adding new rules.

The PROLOG version we used, called STRAWBERRY PROLOG, is a free shareware downloaded from the internet. For the output of the results, the graphic functions of an existing simulation model have been used and adapted to support visualisation of the results.

The two main language elements of PROLOG are **predicates** and **rules**.

> A **predicate** is a statement which may or may not be true

> A **rule** defines, that a certain predicate is true, if one or more other predicates are true.

For example: The fact that country A demands 70 % of the crude oil reserves in a certain region and country B demands 60 % in the same region is expressed by the two following predicates:

> **claims (country_A,oil,region1,0.7).**

> **claims (country_B,oil,region1,0.6).**

A conflict obviously exists, if the sum of the demands exceeds 100 % which is expressed in PROLOG by the rule:

> **resource_conflict (F1,F2,X) :- claims(F1,Res,R,P1),claims(F2,Res,R,P2),X := P1 + P2,X > 1.**

A PROLOG query to find out whether or not there is a resource conflict between country A and country B looks like this:

> **?- resource_conflict (country_A,country_B,X),**
> **write(" there is a resource conflict between country_A and country_B "),**
> **Y := X*100,write(Y), write(" %") .**

and PROLOG's answer:

> **there is a resource conflict between country_A and country_B 130 %   _Yes_.**

When setting up the system, the most difficulty and time consuming part is defining the rules. But fortunately, most of the rules are generally valid, as well as some predicates. Thus, for a new scenario one normally only has to translate the inputs available in the scenario description in an exercise or from G2 /G3 an other sources in a real mission into the corresponding PROLOG predicates as schematically in figure 1.
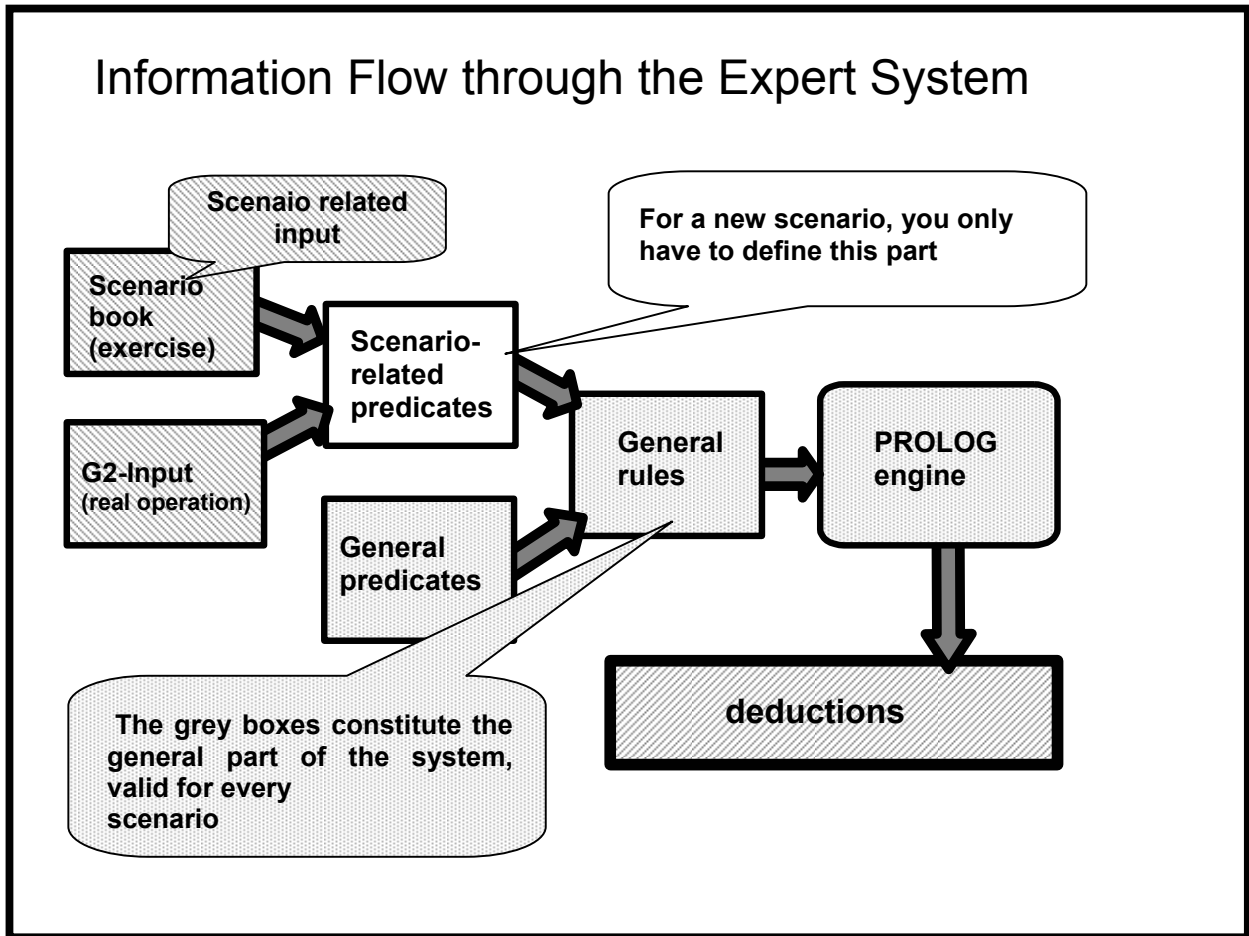
Figure 1: Information Flow through the System.

2.2 Predicates and Rules

Below, some of the general (scenario independent) predicates we defined for our experimental expert system are listed

- **goal (1, market economy)** assigns a number to a possible goal of one of the players

- **resource (1,oil).** Defines a number to a resource which could be source of conflict

- **goals_contradicting (market economy, command economy).** defines conflicting goals

- **consequence (1,unemployment).** defines a possible consequence of a goal (in this case goal #1 which is market economy)

- **action_category (1,military).** defines action categories

- **action (17,7,taking_hostages,0.8)** the action "taking hostages" has the number 17 been assigned to, it belongs to action category 7 and it requires a criminal energy of 0.8 (0 = none, 1 = maximal possible)

- **potential (2,economic).** assigns a number to a certain capability/potential

- **potentialvector_for_action (military intervention, military power, financial power, organisation, intelligence).** defines the areas, in which a certain potential is required for a particular action

The next list shows a selection of predicates, where the values of their arguments are scenario dependend. These are the predicates the arguments of which have to be specified for a particular scenario:

- **faction (1,alliance).** Relates a number to a faction

- **potentialvector_of_faction (9,[2,6,7,9]).** The capabilities of each faction are defined in a list (numbers within square brackets) is Faction # 9 has potential in the areas 2,6,7 and 9, where 2 for example means ecomic potential (see predicate above)

- **cognitive_style (1,0.4).** indicates the willingness or ability of a faction to understand the opponent's point of view. This property is set for each faction as a number between 0 and 1 (0 = extremely narrow minded and self-opinionated, 1 = maximal openmindedness). In this example: Faction # 1 has a cognitive style of 0.4, that means: he is not too openminded. The possibility to dispel misperception is calculated as own cognitive style multiplied with square root of opponent's cognitive style. One could argue whether or not is correct to give the own (own = the one who tries to dispel) a higher weight and in fact we have no data or research results justifying this. We nevertheless introduced this assumption in order to emphasize the importance of the ability to see a problem with the opponent's (or the ally's) eyes (even if we do not share his ideas and opinions) particular in a multi-cultural and multi-ethnic conflict like in this scenario.

- **has_criminal_energy (1,0.3).** determines, which of the possible actions a faction is willing to carry out (how far he would go). Since even legal actions like special forces operations or psychological warfare sometimes inevitably violate the civilian criminal code, in this system even the "good guys" have to have a certain amount (not very high of course) of criminal energy like in this example, where Faction # 1 (the Alliance) has the low amount of criminal energy of 0.1

- **action_of_party_supports_goal (1,4,14,100).** Action # 4 of faction #1 supports goal #14 in region # 100

- **associates_with_goal (4,14,7,-0.5).** Faction 4 associates with goal # 14 consequence # 7 which he does not like and thus scores it with a - 0.5

- **pursues_goal (2,11,100,0.9).** Faction 2 pursues goal # 11 in the geographic region 100 with the intensity 0.9

- **pursues_to_prevent (9,14,1,100,0.9).** Faction 9 tries to prevent Faction # 1 to achieve goal #14 in region # 100 with intensity 0.9

- **perceives_that_action_supports_goal (7,3,4,6,100)** Faction 7 thinks, that action type 4 of faction 3 in region 100 supports goal 6

- **threat_perception_from_action (7,11,2,120,0.7)** Faction 7 feels threatened by action type 2, from Faction 11 in region 120 with threat intensity 0.7

General Rules

The predicates shown below with self explanatory names constitute the result predicates (dependent predicate on the left side) of the general (scenario independent) PROLOGG rules defined in the system:

- **conflict_of_resources** (arguments) **:- other_predicates** (arguments)

- **conflict_of_goals** (arguments) **:- other_predicates** (arguments)

- **common_interest** (arguments) **:- other_predicates** (arguments)

- **threat_perception_from_action** (arguments) **:- other_predicates** (arguments)

- **support_of_action (**arguments) **:- other_predicates** (arguments)

- **misperception** (parameters) **:- other_predicates** (arguments)

- **possibility_to_change_opponents_mind** (arguments) **:- other_predicates** (arguments)

- **possibility_of_reaction** (arguments) :- **other_predicates** (arguments)

Below, an example is shown of the complete **threat_perception_from_action** rule stating that Faction **F1** feels threatened by faction **F2**'s action in region **R1,** because she thinks, that this action supports a goal **G2** which might thwart her own goal **G1.**

> **threat_perception_from_action (F1,F2,A,R2,Perc1)** :-
> > **commits_action (F2,A,R2),**
> > **pursues_goal (F1,G1,R1,Perc1),**
> > **faction (F1,Faction1),faction(F2,Faction2),**
> > **F1 =\= F2,**
> > **perceives_that_action_supports_goal (F1,F2,A,G2,R1),**
> > **same_region (R1,R2),**
> > **goals_contradicting (G1,G2),**
> > **goal (G1,Goal1),goal (G2,Goal2),region (R2,Region),**
> > **action(A,_,Action,_),**
> > **Procontra = pro, Supporting = supporting,**
> > **write_threatperception (Faction1,Faction2,Goal1,**
> > **Goal2,Procontra,Supporting,Action,Perc1,Region),**
> > **fail.**

3.0   THE SCENARIO

In order to give you an impression of what the scenario we used is all about and we give a brief summary of the story:

In a stragic and economic important area is comprised of two major regional powers AQUILA and VULPECULA and a couple of newly independent smaller states, two of which, PERSEUS and in particular AURIGA are the focus of interest in the scenario.

AURIGA has large crude oil and gas resources and contracts with multinational companies who are exploiting the resources. A part of AURIGA is inhabited by the BATARIs, an ethnic minority striving for independence and increasingly attacking AURIGA's regular troops, evicting non BATARI ethnic population from their enclave and committing all kinds of terroristic activities. These BATARIs get support from VULPECULA, who is striving for political and military dominance in the area and who also has her eyes on AURIGAs oil and gas resources. Finally, foreign nationals (mainly western) who are working foe the multinational companies are taken hostage, a civilian aeroplane gets shot down and the international airport gets ocupied by the BATARIs. AURIGA's government gets destabilised and asks for United Nations help. UN in turn tasks an

Alliance (kind of NATO) to fix the problem, which means: free the hostages, defeat or at least contain the BATARIs, defend against VULPECULA in case they attack, restore law and order. In addition, to make the trouble complete, there is an international terrorist organisation, led by a "highly educated radical intellectual and self made billionaire, who is committed to a protracted war against globalisation and the spread of international capitalism ….". This group's activities even more destabilise the AURIGAN government because their ideas and promises are falling on fertile ground in AURIGA, where the majority of the poor population does not see any benefit from the oil and gas wealth. Other than VULPECULA, the second major power AQUILA keeps neutral and is not involved in the current conflict.

In the exercise, the students have to plan the mission. A brief glance onto this scenario shows, that just doing military planning like in the old days, where the main focus was put on force comparison and assessment of different courses of action, along with logistics of course, is not enough. Here, not only para-military and terroristic activities but also the government of an ally which is on the brink of collapsing, ethnic and cultural clash directly influence the way how the mission can be carried out and thus also the planning process.

3.1   Questions to the Expert System

The questions, the system should help to answer are

- what are the goals and interest of the players in the area

- where and why are interests and goals conflicting

- what is the attitude of the players towards the UN authorised Allied mission

- what is the reason of possible concerns

- which of the concerns are based on misperceptions

- is there a possibility to dispel misperception based concerns

- which activities from the players do we have to expect in response to our mission

These questions correspond to the general rules which have been defined for the system and listed in 2.2.

3.2   Input of the Scenario Data into the Expert System

The input into the expert system basically consists of translating information given in natural language into appropriate PROLOG predicates.

Here is an example how the characteristics of one of the key players described in the scenario book has been transferred in the PROLOG syntax:

> *……. S. is a highly educated radical intellectual and self made
> billionaire, who is committed to a protracted war against globalisation
> and the spread of international capitalism………..*

is translated into PROLOG syntax as:

perceives_that_action_supports_goal (S, Allied, military intervention, globalisation, Zoran Sea Area).

associates_with_goal (S, globalisation, loss of cultural identity, -0.9).

associates_with_goal (S, globalisation, profit for foreign companies at the expense of the own economy, -0.85).

The two predicates associates_with_goal and perceives_that_action_supports_goal describe perceptions rather than facts. In this example, we do not know exactly, but we think that S. thinks that globalisation might destroy the own cultural identity and that the purpose of the Allied intervention is to get control over the oil fields.

All conclusions drawn by the system are based on both, perceptions and facts. By comparing perception based and objective fact based predicates the system is able to detect misperceptions.

Since the system did not find a corresponding <u>action_of_faction_supports_goal</u> predicate confirming this assumption, the system identifies a misperception.

3.3   The Results

Figure 2 shows the threat perception of each party with respect to a particular action from one party (Alliance in this case). The colour of the connection lines from each faction (rectangular boxes) to the hexagonal action box indicate the kind of feelings, the lines' thickness shows the feelings intensity. The system also identified the reasons of the threat perception of a particular faction. When clicking the faction's box a list of possible reasons will be displayed. This graph not only shows what we expected to see: VULPECULA, BATARI and S. rejecting, AURIGA, PERSEUS and the multinational companies welcoming the intervention. As a result of the interests, goals and capabilities of AQUILA (which according to the scenario book stays neutral and has not yet uttered any concerns at all) the system has assumed, that also AQUILA must have some hidden reservations against the ALLIANCE's mission.
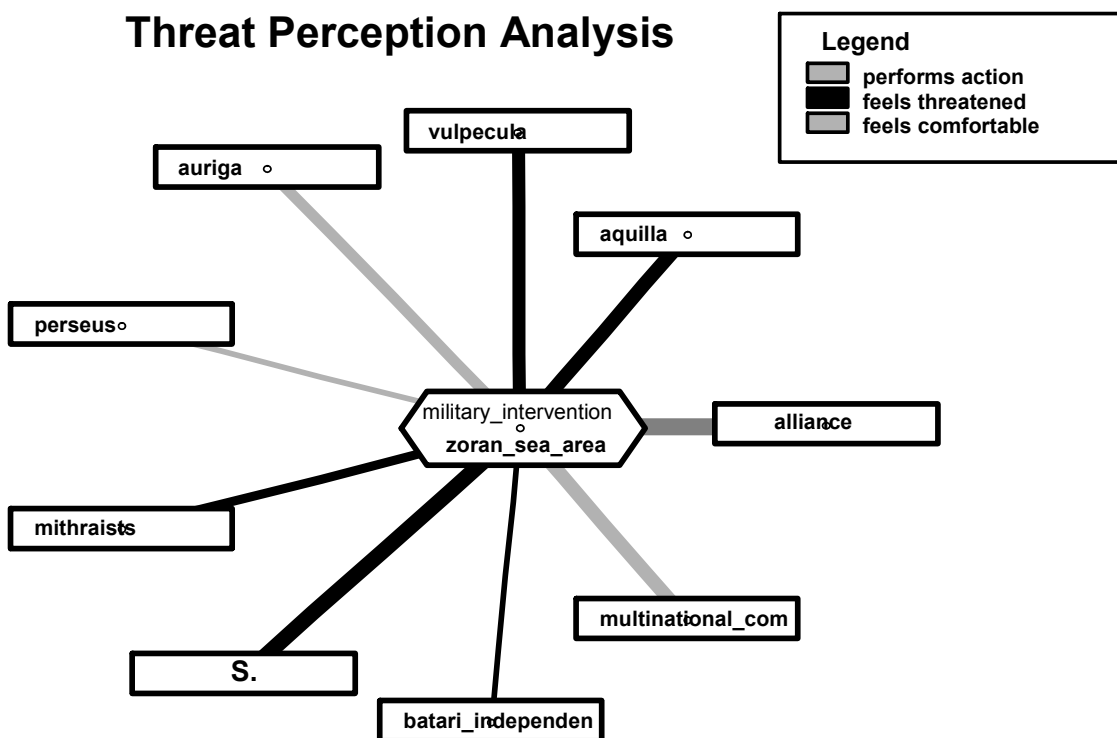

Figure 2: Threat Perception Analysis.

Figure 3 shows resource conflicts. Each line between a faction's box and a resource represents a claim with the thickness of the line representing the claims extent. However, lines are only drawn, if the sum of claims for a particular resource exceeds 100 %, otherwise no resource conflict would have been identified.
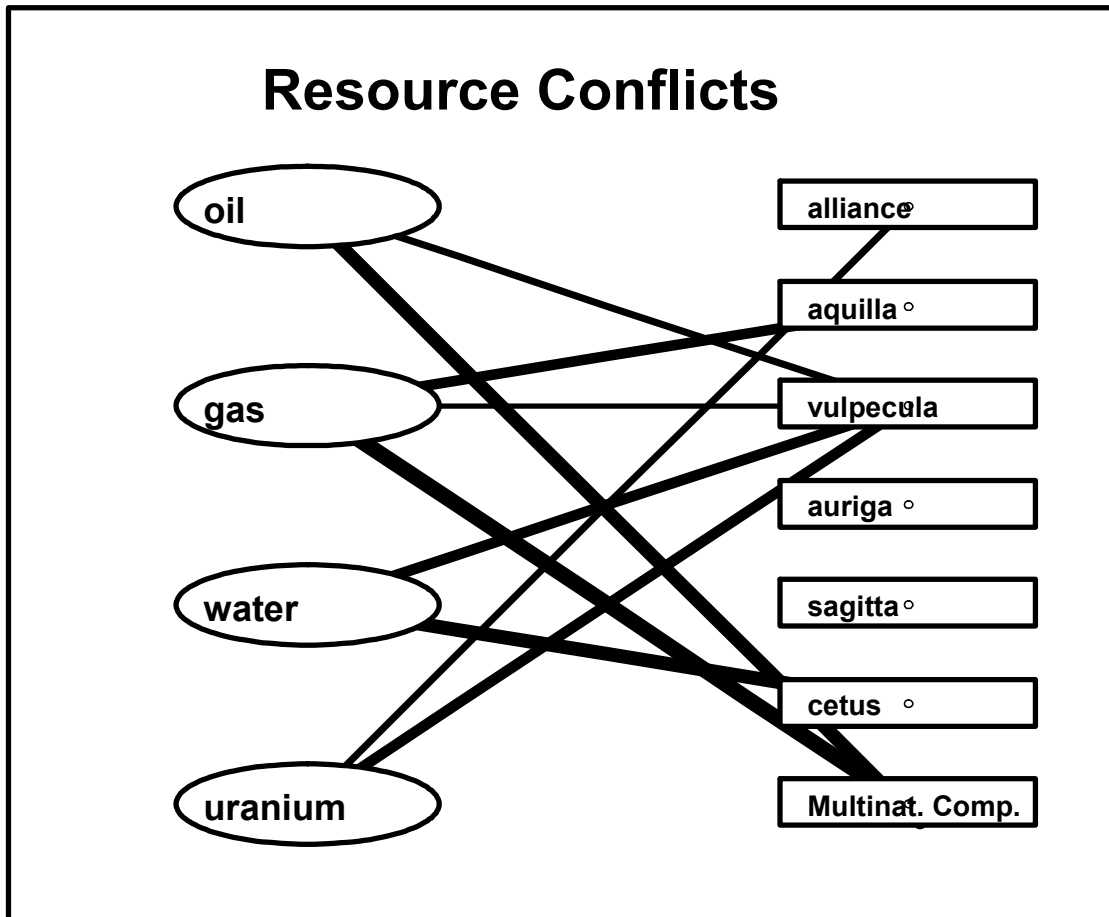
Figure 3: Resource Conflicts.

Figure 4 shows the issues of concern the system identified as a result of misperception of the goals or their possible consequences related to the Alliances military intervention along with a bar depicting the intensity (0 <= intensity <=1) of the concerns. Among the faction having concerns on our activities, we do not only find our potential opponents but also two of our allies (AURIGA and PERSEUS), although both of them welcomed the ALLIANCE's mission and one of them even asked for it But nevertheless, as the analysis results show, they have concerns, which might lead to problems at a later time.

If there are misperceptions, then we should be strongly interested in dispelling them by appropriate means. The system tries to estimate the chances to do this successfully with both, opponents and allies, by calculating a corresponding number between 0 and 1 (0 = no way, 1 = fair chance). The driving factor for this calculation is the willingness or ability of the conflicting factions to understand the opponent's point of view which is defined by predicate **cognitive_style** (see description of predicates).

Misperceptions
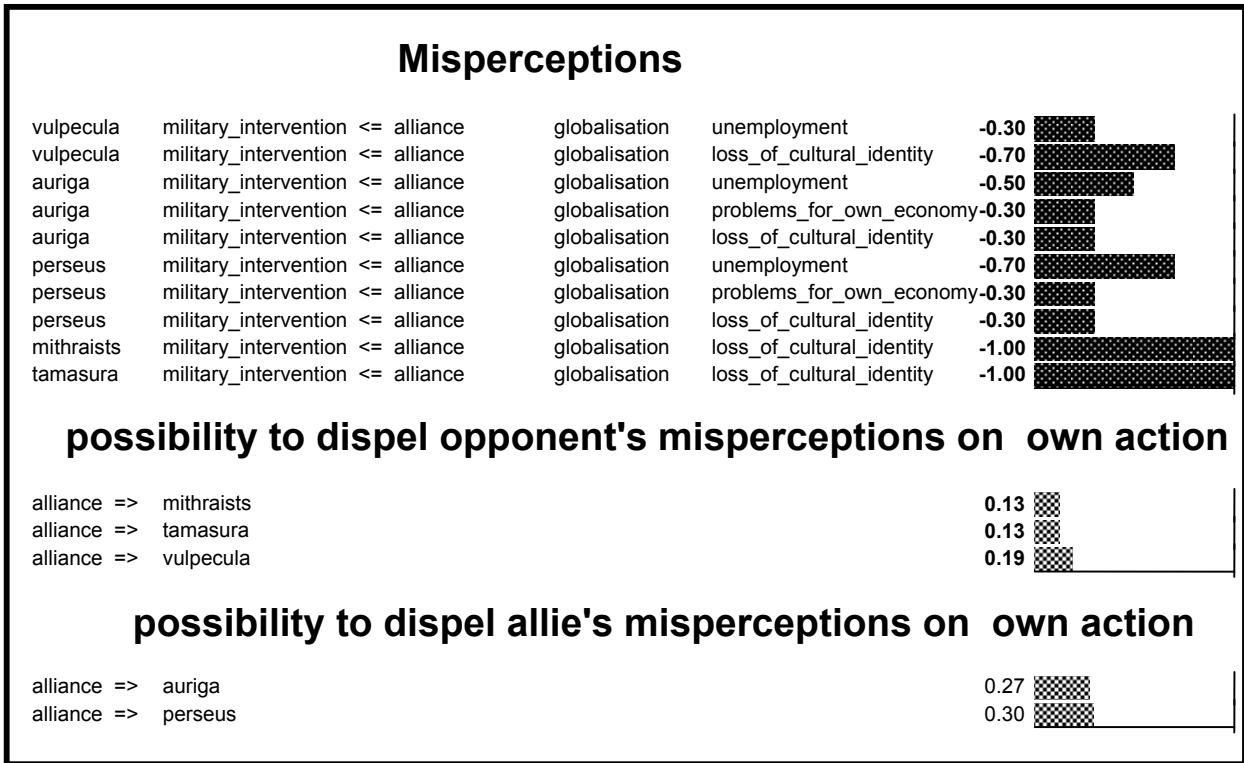
vulpecula	military_intervention	<=	alliance	globalisation	unemployment	**-0.30**
vulpecula	military_intervention	<=	alliance	globalisation	loss_of_cultural_identity	**-0.70**
auriga	military_intervention	<=	alliance	globalisation	unemployment	**-0.50**
auriga	military_intervention	<=	alliance	globalisation	problems_for_own_economy	**-0.30**
auriga	military_intervention	<=	alliance	globalisation	loss_of_cultural_identity	**-0.30**
perseus	military_intervention	<=	alliance	globalisation	unemployment	**-0.70**
perseus	military_intervention	<=	alliance	globalisation	problems_for_own_economy	**-0.30**
perseus	military_intervention	<=	alliance	globalisation	loss_of_cultural_identity	**-0.30**
mithraists	military_intervention	<=	alliance	globalisation	loss_of_cultural_identity	**-1.00**
tamasura	military_intervention	<=	alliance	globalisation	loss_of_cultural_identity	**-1.00**

possibility to dispel opponent's misperceptions on own action

alliance	=>	mithraists	**0.13**
alliance	=>	tamasura	**0.13**
alliance	=>	vulpecula	**0.19**

possibility to dispel allie's misperceptions on own action

alliance	=>	auriga	0.27
alliance	=>	perseus	0.30

Figure 4: Misperceptions of the Alliance's Intentions.

Next then and probably most important is the system's assessment of what reaction and counter-measures we will have to expect as a response to the ALLIANCE's mission shown in figure 5.

This assessment is based (among others) on the information the system found in the threat perception analysis, the potentialvector and the assumed criminal energy of each of the factions. Here again also for the neutral AQUILA, possible reactions are listed.

possible reactions by parties
in response to military_intervention from alliance

aquilla	diplomatic_demarche	zoran_sea_area
aquilla	diplomatic_protest	zoran_sea_area
aquilla	military_intervention	zoran_sea_area
aquilla	press_campaign	zoran_sea_area
aquilla	psychological_warfare	zoran_sea_area
aquilla	surprise_coup	zoran_sea_area
aquilla	special_forces_operation	zoran_sea_area
aquilla	support_of_nonstate_radical_groups	zoran_sea_area
vulpecula	diplomatic_demarche	zoran_sea_area
vulpecula	diplomatic_protest	zoran_sea_area
vulpecula	military_intervention	zoran_sea_area
vulpecula	press_campaign	zoran_sea_area
vulpecula	psychological_warfare	zoran_sea_area
vulpecula	surprise_coup	zoran_sea_area
vulpecula	special_forces_operation	zoran_sea_area
vulpecula	support_of_nonstate_radical_groups	zoran_sea_area
mithraists	terror	zoran_sea_area
mithraists	taking_hostages	zoran_sea_area
mithraists	attack_on_military_facilities	zoran_sea_area
tamasura	terror	zoran_sea_area
tamasura	taking_hostages	zoran_sea_area
tamasura	attack_on_military_facilities	zoran_sea_area
batari_independence_movement	taking_hostages	batari_etnic_area
batari_independence_movement	attack_on_military_facilities	batari_etnic_area

Figure 5: Possible Reactions in Response to the Alliance's Mission.

4.0   OUTLOOK

The work presented in this paper could just be seen as an experiment of directing operational analysis effort on to the various other-than-military aspects we encounter in peace keeping. The probably greatest benefit one can retrieve attempting to describe a piece of real world using a formal system is not the perfect solution, instead, it is the insight into the complexity of the problem and the discovery of questions nobody ever has asked before, which however have to be asked, and, hopefully at least some of them will be answered in the future.