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Team 1: Peace Support Operations with the PAX Model

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TEAM 1 MEMBERS

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TEAM PROPOSAL

The Peace Support Operations Team at International Data Farming Workshop 13 will use the simulation system "PAX" to gain insight into specific aspects of peace support operations.

The model PAX was developed by EADS under contract of the German Bundeswehr to model peace support operations with the focus on individual civilians and emerging group behavior. The heart of PAX is the modeling of collective aggression on the civilian side. Civilian agents are characterized by several personality factors and internal processes that generate a situation-dependent behavior driven by their motivational and emotional state.

This modeling is persistently based on empirical findings from the psychological research on aggression.

The IDFW 13 scenario addresses CRC[2] operations in a post civil-war city. Within the scenario, different – potentially violent – civilian groups will be modeled and the effects of different approaches of the security forces will be simulated and analyzed.

For IDFW 13, the Peace Support Operations Team has the following goals:

1. Review and face validate the upgrades made to the PSO model PAX between PAIW 12 and IDFW 13, especially the implementation of extended possibilities for the setup of scenarios.
2. Develop and test a potentially violent CRC scenario with different civilian groups. Develop and test two alternative scenario versions with different approaches.
3. Conduct experiments with different designs (both NOLH and gridded.
4. Identify needs for further work.
5. Gain insight into other models (participation in plenary sessions).
6. Provide information about the simulation model PAX (plenary session briefing).

TEAM ACTIVITIES

PAX is able to show dependencies between the soldiers' behavior and the escalation of violence, which may occur between soldiers and civilians as well as between different civilian groups. Furthermore, PAX allows for the investigation of many other measures of effectiveness (MOEs), such as the level of escalation or the number of civilians and / or soldiers who get injured or killed, to give an example.

In advance of IDFW13, LTC Hartmann distributed among the team members a scenario proposal which was taken as a basis for further discussions. The PSO team was instructed to act as an operation analysis cell and to elaborate recommendations for the given problems. To be able to do so, the described situation was modeled and simulated in PAX.

The first day of IDFW13 was used to set up the scenario in PAX. In the following days single simulation runs as well as extensive experiments were accomplished and analyzed.

Scenario Overview

The IDFW 13 scenario is based on the following background events: The newly-elected president of an interim government in a post war country (DANUBIA) just recently introduced his cabinet. However, a part of the population

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[2] Crowd and Riot Control

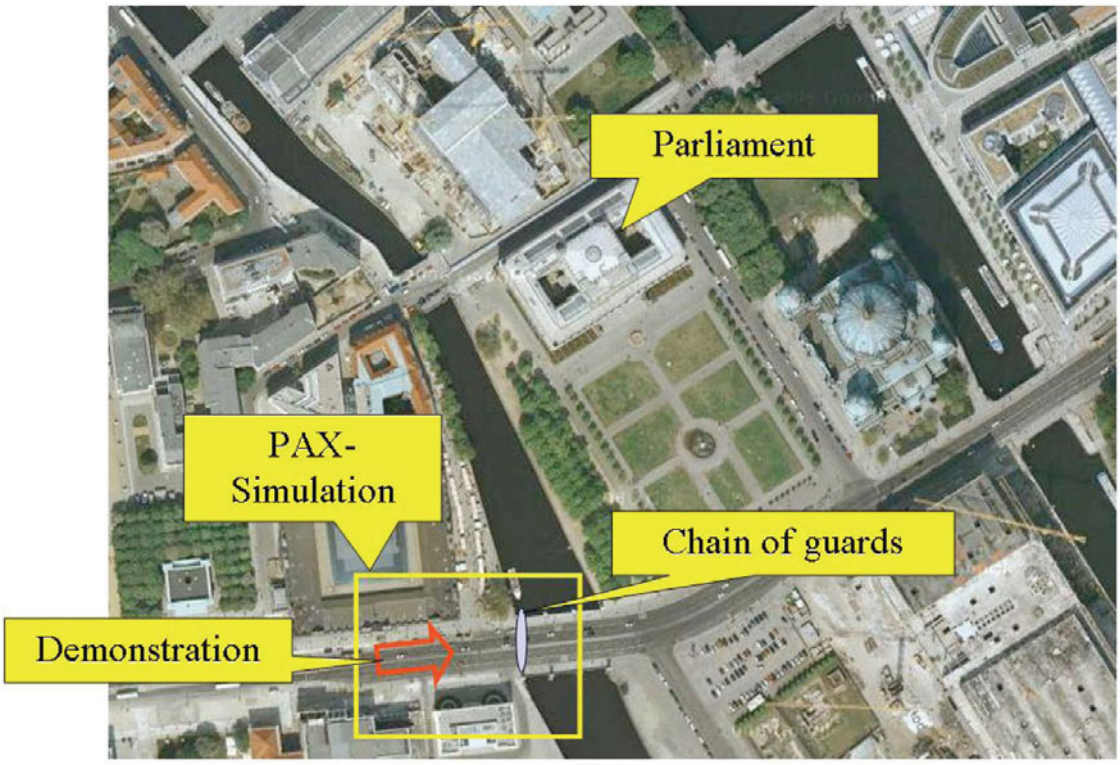

Figure 1: Aerial view of the real-world scenario

(20%), the Paxians, feels disadvantaged and inadequately represented. Only a few days ago, an initially peaceful demonstration of this group led to violent riots during a mass rally of the governing party. Messages of the local news service suggest the possibility of further demonstrations within the governmental district. The security assistance forces DAPFOR are instructed to protect the governmental buildings and the representatives of the Danubian parliament. This task is intended to be transferred to the newly established Danubian police forces. In the concrete situation the question arises whether the DAPFOR on the one hand or the Danubian police forces on the other should undertake the task of blocking the access roads to the governmental district. Simulating the situation with PAX shall help to assess which alternative is best to avoid the evolvement of collective aggression and to prevent the opponents' violence as early as possible. Thus, several objectives are to be pursued: while preventing the demonstrators from passing, the chain of guards own losses are to be minimized and violence should be avoided whenever and wherever possible.

Within the scenario, two different civilian groups are modeled, both unsatisfied with the current political situation and trying to demonstrate in front of the Parliament. The majority group is quite peaceful whereas a small minority will not flinch from using force. The military forces try to hold the civilians back. The effects of various tactics, techniques and procedures of these forces will be simulated and analyzed.

The situation in the whole area is expected to be initially calm, but with potential for escalation due to some

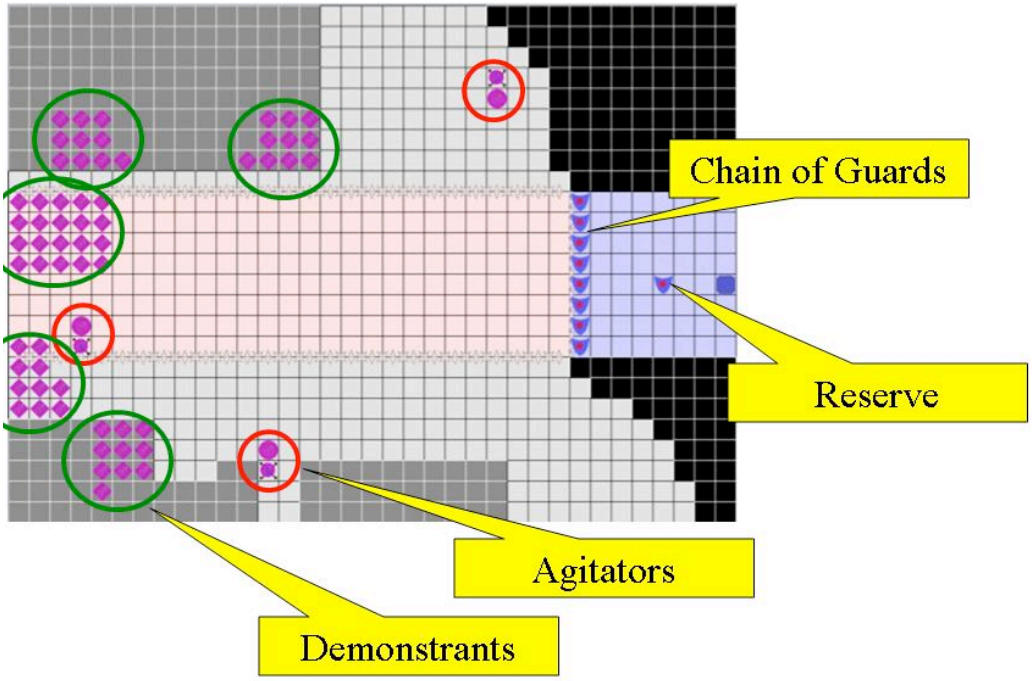

Figure 2: Peace Support Operations Team Basecase Scenario

aggressive agitators in the area and the still present experiences the civilian population has made during the recent war. Thus, the team hopes to get insights into the evolvement of collective aggression throughout the course of the simulation.

Figure 1 shows an aerial view of the real-world scenario.

An equivalent base case scenario developed by the PAX team members is shown in Figure 2. A chain of guards is controlling the access road to the governmental district where civilian demonstrations and counter-actions are expected.

Civilian group "Demonstrators" – identified by a diamond shape – consists of men who want to demonstrate peacefully against the newly established cabinet.

The intention of civilian group "Agitators" is primarily to pick a fight and especially to interfere with the military operation. Members of this group are symbolized by a hexagon and are partly equipped with throwing or impact weapons while the remaining members may throw stones at the utmost. Small groups of civilians of this group may occur during the scenario as a kind of a "planned" attack towards the soldiers.[1]

PAX Setup

During the first day, the PAX team became acquainted with the improved scenario editor of PAX version 2.10, allowing users to create new PAX scenarios in a comparatively short time. The newly designed agent editor was used to create new agent classes for the different civilian and military agent types. Instances of these agent classes could then be used for the concrete scenario setup.

Four alternative scenario versions were developed, investigating

- the deployment of both, the Danubian Peace Forces DAPFOR (case A) and the local Danubian police forces (case B) but also analyzing
- two different Demonstrator-Agitator ratios on the civilian side (case 1: 50 demonstrators and 28 agitators; case 2: 60 demonstrators and 18 agitators).

The rather peaceful Demonstrators were led by one leader and characterized by the following attributes:

- Low values of fear, anger and readiness for aggression
- High willingness for cooperation
- High motivation to demonstrate and to pass the chain of guards
- Only equipped with throwing weapons (e.g. stones)

The Agitators are divided into three smaller groups, each group having its own civilian leader. The Agitators' behavior was determined by the following characteristics:

- Low values of fear and willingness for cooperation
- High values of anger and readiness for aggression
- Medium motivation to demonstrate and to pass the chain of guards
- Equipped with throwing weapons and impact weapons

The two different mission approaches A and B could be modeled by parameterizing the military agents in different ways:

- DAPFOR (A): higher protection and authority, but only passive reserve
- Danubian Police (B): less trained and experienced and more "hated" by the civilians, but active reserve that behaves according to a "Zero Tolerance" rule set.

Using the NOLH Design

Having reviewed the upgrades made to PAX between PAIW12 and IDFW13 (especially regarding the Scenario and Agent Editors) PAX parameters of main interest and presumable importance in the scenario were identified. These 11 parameters were used as input for the Nearly Orthogonal Latin Hypercube (NOLH) design and four different experiments (representing the four possible combinations of cases A, B, 1 and 2) were set up in order to analyze the consequences of the two different mission approaches (A and B) on the overall escalation of violence and on the mission success.

The used NOLH Design considered the following parameter variations:

- Threshold for calling reinforcement by the chain of guards
- Increase of the soldiers' stress level in case of getting wounded
- Threshold for intervention of the police's active reserve
- Agitators' anger, readiness for aggression and dog factor[2]
- Demonstrators' fear, anger, readiness for aggression and dog factor

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[1] Modeling detail: Planned actions are not yet built into PAX so that these groups will only be set to appear in the scenario at a predefined point in time, from which on they will act according to their given motivations.

[2] The dog factor describes the soldiers' or police's threatening effect on the civilians. A higher dog factor leads to a higher increase of fear whenever a soldier defends himself against a civilian's attack.

Thus, 11 PAX parameters were examined in more detail, resulting in a total number of 33 design points according to the NOLH design.

To be able to measure the mission success of the different military forces (DAPFOR or Danubian police) the PAX team evaluated the following measures of effectiveness:

- Overall escalation (resulting from aggressive actions performed by civilians and soldiers)
- Escalation performed by different groups
- Number of wounded or killed civilians and soldiers

For each of the 33 parameter constellations 50 replicates were submitted to the German 128 node cluster in Immenstaad. In advance of analyzing the experiments' results, the PAX team members wrote down their expectations regarding the overall aggregated escalation for the two mission approaches (see Figure 3).

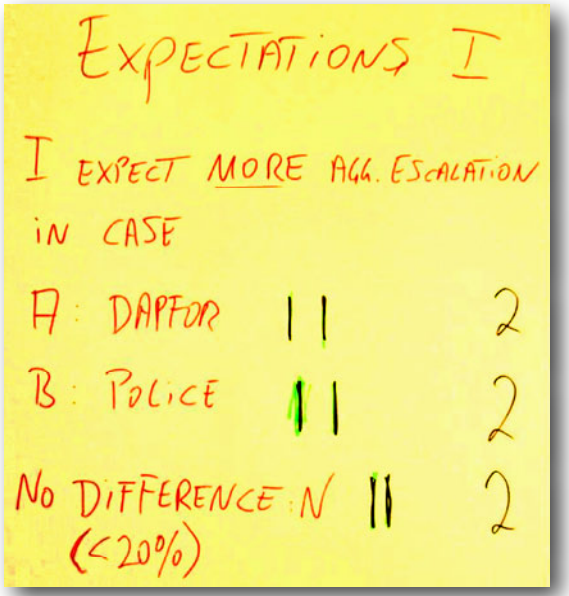

Figure 3: Team members' expectations for NOLH experiment

These expectations were than compared to the actual results, which are shown in Table 1.

	Ratio 1: 50 demonstrators 28 agitators	Ratio 2: 60 demonstrators 18 agitators
DAPFOR (A)	5699	5666
Danubian Police (B)	7749	7163

Table 1: The overall aggregated escalations caused by aggressive actions performed by civilians and soldiers

Thus, the Danubian Police seems to perform better with regard to the prevention of escalation. When looking at the experiments' results in more detail using statistical software (JMP 5.1), the soldiers' thresholds for intervention, the civilians' respect for the security forces and the civilians' readiness for aggression turned out to be the most important factors regarding the evolvement of collective aggression. Since the first two factors characterize the different mission approaches (the Danubian Police reserve intervenes much faster than the DAPFOR reserve, who waits to be called), it was decided to set up another gridded design experiment, varying both the Demonstrators' and the Agitators' readiness for aggression taking into account three different sets of RoEs for the soldiers.

Using the Gridded Design

In the gridded design, the agitators' readiness for aggression was varied in the range of 50 to 100 (maximum value) and the Demonstrators' readiness for aggression was set to values in the range of 20 to 70. The soldiers' behavior was determined by three different rule sets:

- Gandhi: the soldiers try to deescalate whenever possible
- PSO Manual: all types of actions (deescalating, threatening and defending) are performed by the soldiers
- Zero Tolerance: no deescalating actions are performed by the soldiers

Again, the team wrote down its expectations for case 2 (60 demonstrators and 18 agitators).

Figure 4 shows, for instance, that all team members were convinced that DAPFOR would perform best in the case of high values for both, the demonstrators' and the agitators' readiness for aggression. However, the results of the gridded experiment showed that the opposite was true. The Danubian Police was more effective than the DAPFOR soldiers in avoiding escalation.

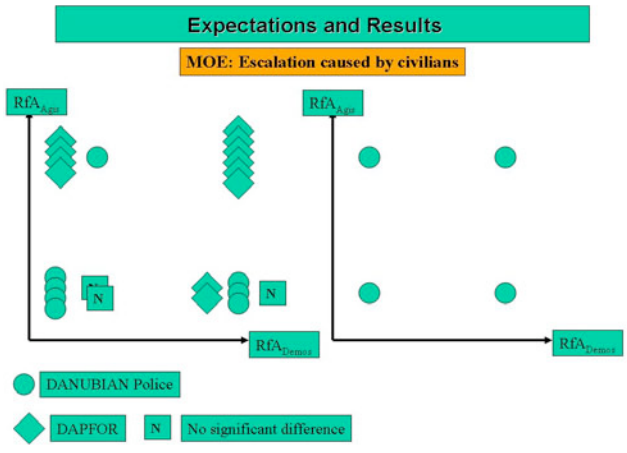

Figure 4: The team members' expectations for the gridded experiment compared to the actual results

In the analysis of the fitness landscapes resulting from the gridded experiment performed on the German 128 node cluster, some of the expectations of the group were not met. The results were examined in more detail looking at the course of action of relevant single PAX runs.

At first glance, the Danubian Police with the reserve acting very proactively even in case of quite low escalation seems to be the best way to minimize escalation. However, when looking at other MOEs, some negative aspects could be identified. The reserve using high show of force (making civilians more fearful) and intervening immediately may help to keep the overall escalation low, but this also leads to quite a high number of wounded civilians (see Figure 5). By contrast, in the case of deploying the DAPFOR soldiers no civilians were wounded (see Figure 6). Therefore another experiment was submitted, analyzing the effect of the Danubian reserve's proactive behavior by specifying a very high value for the reserve's threshold for intervention (i.e. the reserve only intervenes when being called by the chain of guards). Applying this parameter constellation, no civilians got wounded and with regard to the escalation expected there was no significant difference to the DAPFOR experiment.

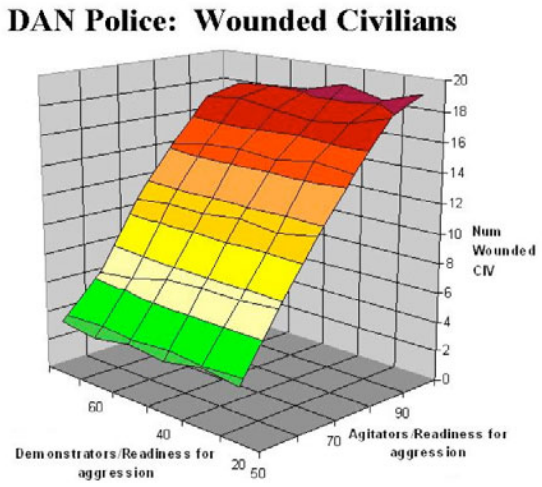

Figure 5: Number of wounded civilians in case of experiment B (Danubian Police), ratio 1 (50 demonstrators, 28 agitators)

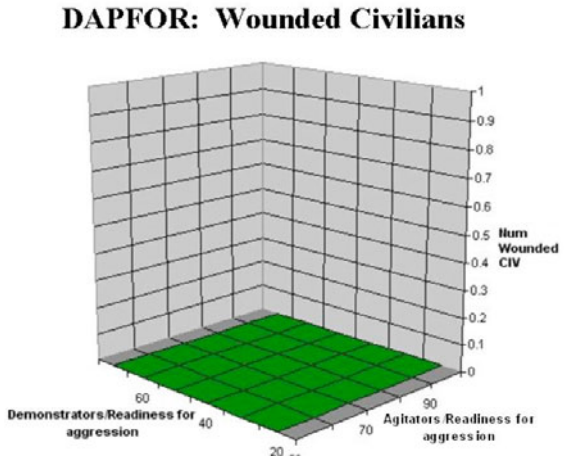

Figure 6: Number of wounded civilians in the case of experiment A (DAPFOR), ratio 1 (50 demonstrators and 28 agitators)

Thus, with the help of the PAX simulation, the PSO team was able to issue some recommendations for the commander on-site. The task of securing the government district can be transferred to the Danubian Police without hesitation since no significant difference with regard to the evolvement of escalation is to be expected. However, to avoid negative side effects, the Danubian reserve should behave rather passively.

SUMMARY

The new PAX features allow for more realistic scenarios which are easy to set up. The different experimental designs (NOLH and gridded design) help to figure out important parameters. It is possible to measure the influence of parameters the peace keeping forces can actively change and to gain insight into the different possible outcomes of an operation depending on these parameters. Suggestions for improvements could be found and working in a multinational group helped broaden the view. The PAX team attended all plenary sessions which gave insight into other ongoing work.