

## **About Secret Missions, Rules of Engagement and Officers wearing their caps askew**

Warning: This paper should not be taken *too* seriously.

### **Introduction**

Consider the following scenario: the Dutch Army Command wants to fulfil a secret mission, but does not want anybody to know about this, even the officers that participate in the mission. Therefore, the Army Command decides to give all officers a small task. At the end of the day, a more complicated task must be accomplished. It is obvious that this is possible if every officer gets a different assignment, but in this paper, I shall show that it is possible to get tasks done, even when all officers of the same military unit have an identical assignment. This behaviour resembles swarm behaviour, or perhaps multi-agent behaviour. The outcome of this mission is a mathematical calculation, so it is easy to prove that it works. But of course, other missions are possible as well.

In this example both naval and army officers are involved. The Dutch Army Command chooses up to 16 officers all with a different rank. Dutch naval and army ranks are not exactly the same, but for this purpose we simply assume that for every naval rank there exists an equivalent army rank. The officers are allowed to move freely in a certain area, and when they meet another officer from the other military service with a similar rank, they may have to act. When an officer meets another officer of his own military service, but with the next higher rank, he may also have to do something.

### **Starting and goal situations**

At the start, the Local Army Command inspects the officers, to make sure everyone is wearing his clothes correctly, including gloves. Certain officers are ordered to hold their rifles in a higher position. All other officers leave their rifle in the lower position.

In the goal situation, the Army Command will have to consider whether or not:

1. An officer is properly dressed.
2. An officer is or is not wearing gloves.
3. An officer's rifle is in the high or low position.

To make things simple, let us say the highest-ranking officers will not get the order to put their rifles in the high position.

### **Rules of Engagement**

Now it is time the Dutch Army Control informs the officers of what they should do, so here are the detailed rules:

If an officer meets an officer of the same rank and both are not wearing gloves they should do nothing. If only one of them is wearing gloves, one of the officers should report to the Army Command that the other officer is trying to obstruct the mission and unfortunately the mission

must be called off. An impartial observer (or an officer with a different rank) cannot tell which of these officers should be reported, but one of both officers will know!

When two officers with the same rank meet and both are wearing gloves, they must do the following:

- Both pull off their gloves.
- If both have their rifle in the low position, then they do nothing.
- If both rifles are in the high position, then both officers place the rifles in the low position and the naval officer pushes his cap to one side.
- If only one of both rifles was in the high position, then both officers lift their rifles into the high position. *If* the army officer has not changed his rifle position then he pushes his cap to one side.

If an officer meets another officer with the next higher rank and with the same colour uniform, nothing happens except when the lower-ranking officer is not properly dressed (i.e. his cap is not in the correct position) AND the higher-ranking officer does not wear gloves. In that case, the following happens:

- The lower-ranking officer puts his cap in the correct position.
- The higher-ranking officer changes the position of his rifle (so that high becomes low or vice versa).

Now the higher-ranking officer looks at his rifle and

- If he is a naval officer with his rifle in the low position, he pushes his cap to one side.
- If he is an army officer with his rifle in the high position, he pushes his cap to one side.

Nothing else ever happens!

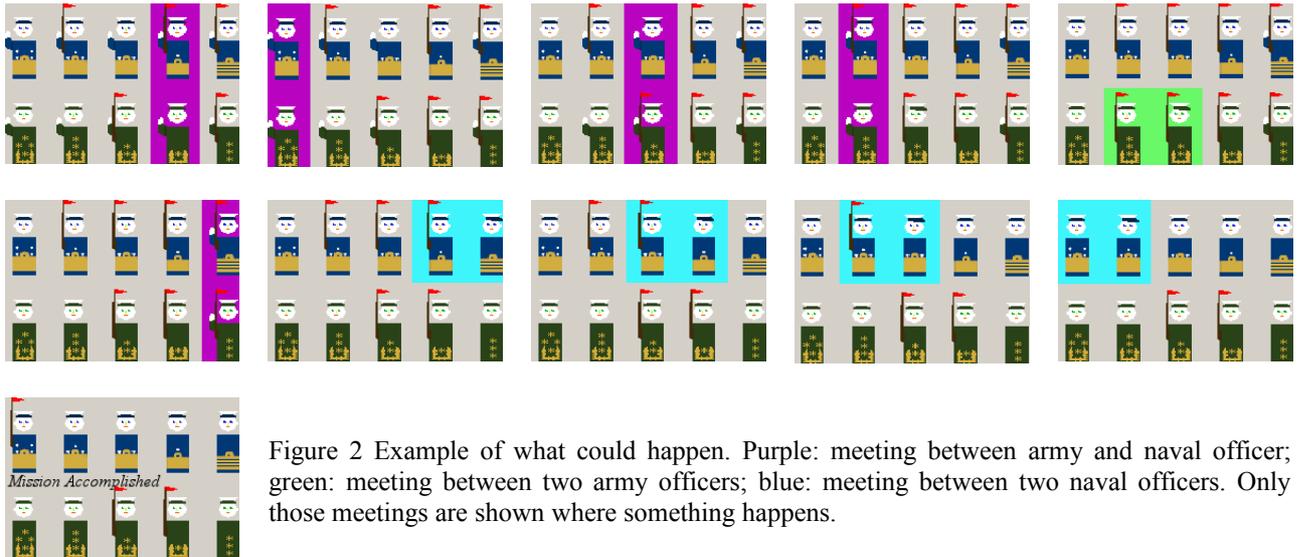
Assuming all officers are loyal, after some time the Dutch Army Command discovers that all officers are correctly dressed and that no officer is wearing gloves anymore. After a roll call, the Dutch Army Command will be satisfied, because the secret mission has been accomplished.

### **The mission**

The secret mission can now be revealed: the naval officers should add two numbers and the army officers should subtract the same two numbers. In the above scenario, the Army Command uses a binary representation of those numbers, where rifle high means binary one and rifle low means binary zero. It would be possible to use decimal numbers but then the interactions become much more complicated and are not convincing as an example of swarming behaviour. The Dutch Army Command has made sure the naval officers take the largest number, to avoid having a negative difference. This requirement is not strictly necessary, but it makes the interpretation much easier. Otherwise, at the end of the day, the highest army officer might be the only one wearing his cap askew, which is not a good example for the lower officers of course.

## Explanation

Instead of a theoretical treatment, I shall give a very simple example using two small numbers (11 and 5). When written in binary, these numbers are 1011 and 101. Thus, the Dutch Army Command needs five naval and five army officers. So after they have accomplished their mission we expect the naval officers to display binary 10000 (decimal 16) and the army officers to display 00110 (decimal 6). Please note that this is just an example of what might happen, because the officers can meet other officers in a random order. Nevertheless, the outcome will always be the same!



## Redundant Air Force Officers

The Air Defence Command (ADC) wants to use air force officers, two of each rank, for a similar secret mission. However they want to have some redundancy and also they want to speed up the mission. So they decide to make the rules a little bit more complicated. Since air force officers usually do not carry rifles, the right hand of the air force officers will replace the rifles. An air force officer can either put his right hand up or down.

Now, the rules of engagements are:

When two officers of equal rank meet of which at least one is wearing gloves:

- If only one of them is wearing gloves
  - Both officers change the position of their right hand (from up to down or vice versa);
  - If the right hand of both officers is down, one of the officers (not both!) pushes his cap to one side;
- If both are wearing gloves
  - If both do have their hands up, one (not both!) of the officers pushes his cap to one side;
  - If exactly one officer has his right hand up, then the other officer also puts his right hand up. In any other case, both officers put their right hand down;
- At the end of the encounter both pull off their gloves.

If an officer whose cap is askew meets another officer with the next higher rank then

- The lower-ranking officer puts his cap in the correct position.
- If the higher-ranking officer is wearing gloves, he changes the position of his right hand. Now the higher-ranking officer considers the position of his right hand. If it is low, then he puts his cap askew;
- The higher-ranking officer puts his gloves on.

Now the ADC waits until all gloves are off and all officers are correctly dressed. Then they pick out officers, one of each rank, and place them in the correct order. The ADC will see that the mission is accomplished. Amazingly, although at some points the officers were able to choose who put his cap askew, this makes no difference for the final result. Now the ADC can look at the officers who were not chosen. They will show the same result, so there certainly is some redundancy in this system. Obviously, if the results are not the same, at least one of the officers has violated the rules of engagement. Unfortunately, however, the opposite is not true. If one of the officers violates a rule concerning his cap or his gloves, this will usually give the same (but wrong) result for both groups of officers. So although the ADC was able to obtain redundancy, its usefulness is limited.

Instead the ADC should instruct the officers to verify that all officers they meet behave according to the rules. They will always be able to notice any misbehaviour during the encounter. Also they have to take care that no officer changes anything between two encounters.

By the way: in this case the secret mission is to add two numbers.

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