REPRESENTATION of C3I in ARTILLERY SIMULATION

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1. INTRODUCTION

My name is Martin Deister and I am responsible for marketing in the defence planning division of the DORNIER GmbH in Friedrichshafen, Germany. I would like to give you a short view over an artillery simulation model we have developed under contract of the German MOD, using a special commercial simulation system to represent the C3I system.

The name of this model is SMArACD, which is the abbreviation for

- Simulation
- Model for
- Artillery
- Acquisition and
- Combat on the
- Division level

As the name suggests this model simulates the combat of the complete artillery system of a Division

- from target acquisition over
- the process of command and control up to
- the weapons employment.

Basis for the development of this model was a study, where we had to analyse the future German artillery system and had to make recommendations for increasing the system efficiency by harmonizing the partial components.

As illustrated in FIGURE 1, every artillery system consists of the following partial components:

- acquisition means,
- command control and communication systems,
- weapon systems and, related with these,
- the ammunition.

From the enemy scenario there is an input to that system, and from the system there should be an output to the enemy scenario. The intensity of this output depends on the efficiency of the entire system and this again depends on the
performance of every partial system as well as the degree of interaction between these partial systems.
That means, for the efficiency of any artillery system, the C3I system is as important as the weapon systems, the ammunition or the target location systems are.

Starting to develop a simulation model to evaluate system efficiency of the artillery, we had to take into account, that the portrayal of the C3I system had to be very detailed and precise.
2. **THE SIMULATION MODEL**

SMArACD is written in the simulation language SIMAN, a simulation tool used for the analysis of complex material flow or production processes. (FIGURE 2)

The model is built using a modulare structure that reflects the real structure of the artillery system. The flow of information, target reports and fire commands in the model is exactly the same as it is in reality (FIGURE 3):

- When a target is detected, the target location system (TLS) transmits a target report to the superior station, for example to the fire direction officer or to the battalion command post.
- After the decision process is completed, the target report is converted into a fire mission and transmitted to the responsible fire direction center. The FDC computes the fire command and sends it to the performing weapon system.
3. REPRESENTATION OF C3I

3.1. Command and Control

In the model, each target location system (TLS), weapon system (WS), command post (CP) or fire direction center (FDC) is represented by an independent "station". So altogether we have about 130 different stations implemented in the model. In these stations the decision making process is simulated as it exists in reality. That means all the steps a commander has to do to come to a decision are represented in the model.

The stations themselves are defined differently, depending on type and level of the decision that has to be made within each station (FIGURE 4). For example we have defined

TLS (like FO and RADAR) by the parameters

- Number of resources in the station (e.g. personnel, computer terminals)
- Process time for the decision process
Fire Support Officer (FSO) by the parameters
- number of resources
- types of decisions that have to be made
- decision criteria
- process times

Command Posts (CP) by the parameters
- number of resources
- maximum length of queue for waiting reports
- decision tables
- process times

FIGURE 4
Number and type of decisions and the decision making process itself are also defined differently in each type of station (FIGURE 5)

FIGURE 5
The SIMAN software automatically keeps track of the resources and the queues. That is for example, if a target report is worked on, the corresponding resource is seized for the delay time, and additional incoming reports are queued up if no other resource is idle. After the delay time, the resource is unseized, the next report taken out of the queue and the resource is seized again.

3.2. Information

The SIMAN software provides so called entities that contain the information and flow through the system like the reports in reality (FIGURE 3). Each entity has a number of attributes that represent the information to be transferred from one station to another. When the entity has arrived at the station, the information stored in the entity is available e.g. for the decision making process. We have used 19 different attributes per entity for the information transfer (FIGURE 6) most of them containing the same data as the real target report does.

<table>
<thead>
<tr>
<th>ATTRIBUTE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mel_Typ</td>
<td>type of report</td>
</tr>
<tr>
<td>I_Nr_Ze</td>
<td>target identification number</td>
</tr>
<tr>
<td>ZieTyp</td>
<td>target type</td>
</tr>
<tr>
<td>Pri_M</td>
<td>priority of report</td>
</tr>
<tr>
<td>Auf_Zel</td>
<td>target location time</td>
</tr>
<tr>
<td>Attri_06</td>
<td>variable</td>
</tr>
<tr>
<td>ZE_K_XY</td>
<td>target coordinates</td>
</tr>
<tr>
<td>TOT</td>
<td>time on target</td>
</tr>
<tr>
<td>AM_L_Ko</td>
<td>coordinates of TLS</td>
</tr>
<tr>
<td>UPDATE</td>
<td>last update target report</td>
</tr>
<tr>
<td>Aufl_Mi</td>
<td>identification number TLS</td>
</tr>
<tr>
<td>Mun_Art</td>
<td>type of ammo</td>
</tr>
<tr>
<td>Attri_13</td>
<td>variable</td>
</tr>
<tr>
<td>Attri_14</td>
<td>variable</td>
</tr>
<tr>
<td>St_Z_ZE</td>
<td>target time in position</td>
</tr>
<tr>
<td>Attri_16</td>
<td>variable</td>
</tr>
<tr>
<td>Entf_ZE</td>
<td>distance target - fire unit</td>
</tr>
<tr>
<td>NSt_LSt</td>
<td>transmitter and receiver</td>
</tr>
<tr>
<td>Attri_14</td>
<td>variable</td>
</tr>
</tbody>
</table>

**FIGURE 5**
In each station the attributes of the active entity can be read and changed, so that the entities can be used to transfer information from one station to another, as conventional messages do.

A second way to manage information is to use the SIMAN internal data base or external data files, where all relevant information can be read from or stored to.

3. Communication

The stations are automatically connected to each other (FIGURE 7) by the underlaying software.

![FIGURE 7](image)

Each station can work as a transmitter or a receiver. The receiving station is addressed by its name or station number. So in the model, the entities can be sent
from each station to every other station, just by supplying the name of the receiving station. The radio circuits are defined as resources with a time delay for the transmission so that per radio frequency only one report at a time can be transmitted. This allows us also to simulate brakedowns of the communication system.

4. MODEL APPLICATION

Up to now we have used the model in several studies for the German artillery. In all these studies we have made a lot of simulation runs to find out (FIGURE 7)

- the effect of parameter variations within the components onto the system efficiency and
- the dependencies between the components related to the relevant parameters.

For the C3I systems FIGURE 9 shows the kind of parameter variations we have made in these studies and indicates the results related to these variations.
5. CONCLUSION

Using a simulation language like SIMAN for the simulation of the complete artillery system gave us the flexibility and advantages we needed to represent the C3I systems in sufficient detail. These advantages are

- the portrayal of the simulated system is very near to reality,
- each participant in the C3I system can be defined as a separate station, this makes the model comparatively independent from force structures,
- all stations are working as transmitter and receiver, that allows to variate the flow of information easily,
- all processing times, resources and queues are automatically managed by SIMAN,
- radio circuits can be simulated as resources, with the possibility to bring in breakdowns,
- a connected animation tool allows to animate the running simulation on line on the screen, so the user can have a first impression of the results of the simulation while it is running.