THE ON-BOARD GUNNERY SIMULATOR (OBGS)
A SMALL SIMULATOR WITH HIGH PERFORMANCE

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ABSTRACT

The French Army has ordered a large quantity of On-Board Gunnery Simulators (OBGS) for the intensive training of gunners on small caliber cannon at their regiments. Small and versatile, the OBGS can be fitted to a large number of armored vehicles and anti-aircraft guns. The simulator generates a simplified synthetic image in the gunsight reproducing a variety of air and ground target attack scenarios including the tracers appropriate to the weapon simulated. It has the salient advantage of providing training on the real weapon without wear on the equipment or expenditure of ammunition. The instructor operates near the weapon used by the simulator. He can continuously monitor the target and aiming data and the firing results and can call upon a range of progressively graded training aids. A built in test facility gives immediate and precise diagnosis of all failures which can be repaired rapidly on-site. Delivery of the first series of 50 OBGS commenced at the beginning of 1984.

OBGS OPERATIONAL REQUIREMENTS

Because of the increasing number of small caliber quick fire cannon in service at all levels in armored and mechanized units and the rapidly rising cost of ammunition, French Army Headquarters issued a specification in 1980 for an On Board Gunnery Simulator capable of providing intensive training for gunners at their units.

Main operational requirements were as follow:

1) Improve training in the unit ; that is why this simulator should be an on board gunnery simulator.
2) Ease of utilization
   - . versatility
   - . adaptation to different kinds of weapons
   - . mounting on real weapons without any modification
   - . modularity
3) Large training possibilities
   - . ground targets
   - . aircraft or helicopter targets
   - . training aids
4) Availability : training should be independant of weather conditions and targets availability. So, the design of the simulator is based on :
   - . simulated targets
   - . simulated landscape
   - . simulated firing effets

Designed in close cooperation with French Army Technical Headquarters, the OBGS was adopted by the French Army in 1982 after operational trials. The acquisition program is for a series of 150.

PURPOSE

The purpose of this simulator is to train gunners in the four phases of engaging moving land or airborne targets:

- . acquisition on the tank commander's order,
- . aiming taking into account elevation and lead angles,
- . firing (single shot or bursts depending on the type of gun simulated),
- . adjustment of fire.

The simulator is intended for basic training, advanced training and practice for experienced gunners.

OPERATIONAL CHARACTERISTICS

Simulation realism

The OBGS faithfully reproduces the man-machine environment and the visible and audible effects of firing:

- . the gunner trains on a real anti-aircraft gun or gun turret. Therefore the environment, the controls and panels are real. Control loading realism in particular is perfect,
- . the sound environment (the detonation of the shot) is reproduced at the gunner's station and the instructor's station,
- . the way in which the targets are presented allow them to be identified and an estimation of their attitude, range and course to be made,
- . simulation of firing and its effects is represented by one (or more) tracers following a trajectory which takes into account the parameters of the weapon and the ammunition used. A hit is represented by an overbrilliance of the tracer. A miss is shown by the extinction of the tracer as it hits the ground or passes behind a screen or when it simply burns out.

Progressive training

The simulator confronts the gunner with numerous attack scenarios graded in order of increasing difficulty. This is achieved by using a library of different target tracks under more and more tricky conditions of fire. The instructor has access to the different levels of difficulty in a few seconds.

Training aids

On the TV screen of the instructor's station is a continuous display of the scene, the target, the aiming point and the gunner's shots together with other parameters such as exercise number, target range and speed, shots fired/hits and aiming errors.

The instructor also displays information in the sighting optics which assist the gunner: for example, to help training the gun onto the target, the cannon off-aim angles and the ideal position of the target on the sighting reticle can be displayed. He can also show the gunner an ideal aiming sequence and use the "Play-back" system to comment on the last firing sequence.

Adaptability

This simulator is designed to be used in succession on several different types of carrier.

For example, the French Army uses the same simulator for the AMX10P, the VTT/AMX13, the AMX30 20mm coaxial machine gun and the 53T1 and 53T2 anti-aircraft guns.

Ease of use

The simplicity of the instructor's station and the modular design of the simulator facilitate its use:

- installation is simple and fast,
- initial setting up (boresighting) can be achieved in under one minute without any difficulty,
- a junior instructor having received a half day course on the equipment is capable of operating the simulator, since it was designed to be operated by the tank or gun commander or to be used on a self service basis by a gunner alone.

Ease of maintenance

Most of the maintenance tasks can be undertaken by the regiment NCO radio technician. Maintenance is facilitated by the following:

- built in test which either confirms correct operating status or simply designates the defective modules or subassemblies,
- subassembly modularity and interchangeability,
- the use of plug-in electronics.

TECHNICAL DESCRIPTION

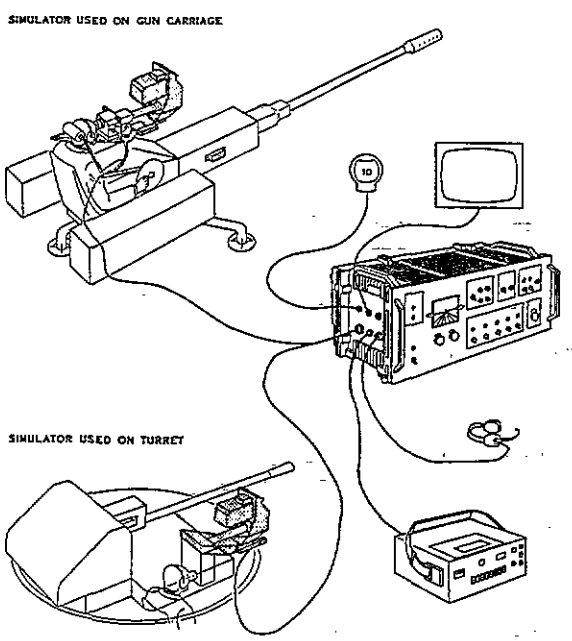
The OBGS is a small simulator with a high performance particularly concerning target realism, firing accuracy and monitoring, the quantity and progressive nature of the training aids and its simplicity of operation and maintenance.

After a brief description of the simulator we shall discuss further the technical features which give the operational facilities mentioned above.

General description

As its name suggests, this simulator is mounted on the real weapon used for training. It consists of the following two assemblies:

- Parts fitted on the weapon
. an image projection optical system including a miniature, black and white, high precision TV monitor projecting the simulated targets, the landscape and any training aids the instructor may select, into the gunner's sighting optics,
. a motion sensor continuously providing the computer with data on the position of the gun barrel,
. a trigger operation detector,
. the mechanical and optical interface and attachment devices specific to the weapon used, which itself requires no modification,
. an interphone system allowing the gunner to hear comments from the instructor and firing noises.



- Parts available to the instructor
These parts are located near the weapon used for training.

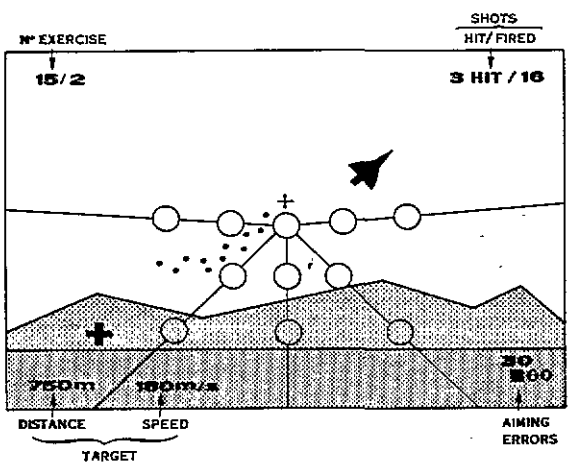
. a small instructor's station used for setting up the simulator, starting and monitoring the exercises and for bringing the training aids into operation. This instructor's station contains the simulator computer consisting of a micro processor and an interface consisting of electronic boards. The landscape seen by the gunner in the sights is generated by the instructor's station.
. an image generation system which can be either a video recorder located near the instructor's station or memory modules plugged directly into the instructor's station.

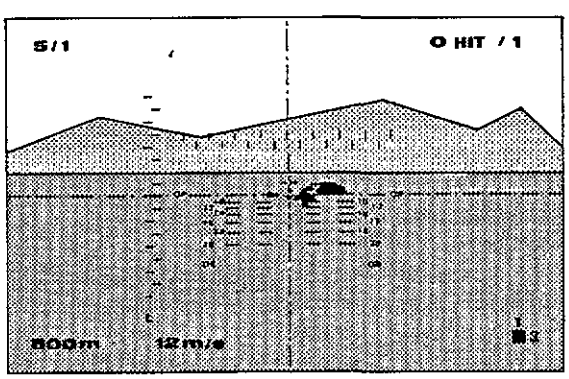
The simulator is transportable. It can be transported in transit cases (French Army version) or installed as a group of 2 or 4 in an air conditioned trailer.

REALISM OF VISUAL AND AURAL SIMULATION

Simulated landscape

The targets move in an artificial landscape consisting of two crest lines (the first horizontal at about 1000 meters and the second representing hills at about 3000 meters) defining three areas giving a good representation of depth.





This landscape enables the targets to hide behind the first crestline and to reappear at a location unknown to the gunner. The view of the landscape moves realistically on the gunner's TV monitor (and in the gunsight) and on the instructor's TV monitor in synchronism with movement of the gun in azimuth and elevation. The panorama has been left fairly bare so as not give the gunner landmarks whose range would become rapidly familiar.

Simulated targets

In the version of the simulator currently being delivered, the trajectories are recorded on video cassettes from scale models .
The trajectories are defined by the purchaser. Their complexity and masking effects are graded to to provide exercises of progressive difficulty.
. The targets are displayed in the form of very realistic silhouettes allowing them to be identified. Their attitude and dimensions are perfectly homogenous with the path they have been programmed to take. Many types of target can be represented.
Each cassette can hold about 40 different attack scenarios which means that a large library of scenarios suitable for all levels of training can be built up inexpensively.

Accuracy of gunnery evaluation

Great attention has been paid to the evaluation of the results of gunnery in the simulator. This is an aspect sometimes left to the visual appreciation of the instructor. The objective accuracy of the firing results is, in our opinion, one of the essential features of a training simulator.

Accuracy has been obtained by the following :

- the sensor attached to the cannon, whose accuracy (0.2 thous) is considerably less than the dispersion of the cannon.
- the trajectory of each shell is generated separately taking dispersion into account.
- the real contour of the target is taken into account and not the escribed rectangle.

Simulation of gunnery

Shells are simulated at the moment of firing by light points representing the tracers of the real ammunition with dispersion taken into account.
Impact on the target or on the ground is indicated by an overbrilliance at the moment of the impact followed by the disappearance of the tracer.
The sound of the shots are reproduced in the gunner's headset and at the instructor's station. When medium or heavy caliber guns are being simulated, firing effects are enhanced by muzzle flash and smoke when the shot is fired.

COMPLETE AND EASY TO USE INSTRUCTOR'S STATION

Continuous monitoring of gunnery

On his monitor screen the instructor can see not only everything the gunner sees in his sights, but also the following:
. the number of the exercise in progress,
. target range and speed,
. aiming errors,
. number of shells fired and the number of hits,
. the ideal aim cross.

Since he has no manual operation to perform, the instructor can readily assist the trainee by advice over the interphone or by switching on the most suitable training aid.

Numerous training aids

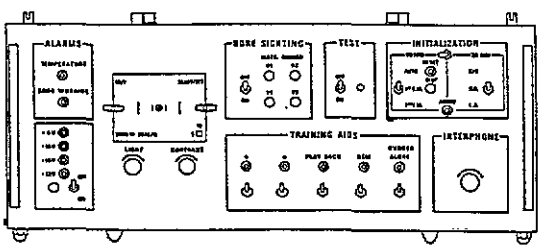
Demonstration: the gunner without touching his controls, observes the ideal aiming to be effected throughout the exercise.

Ideal aiming point: a cross is inserted electronically in the sighting optics indicating the ideal aiming point as a function of target speed and trajectory.

Display of shells traversing the plane containing the target by overbrilliance of the tracer enabling the gunner to judge, especially in anti aircraft gunnery, if he is firing wide.

Playback which replays the gunner's last sequence.

Gunner self training: this command inserts all the information normally available to the instructor into the gunner's optics enabling him to train himself on his own using a series of exercises which run sequentially after having been started from the instructor's station.

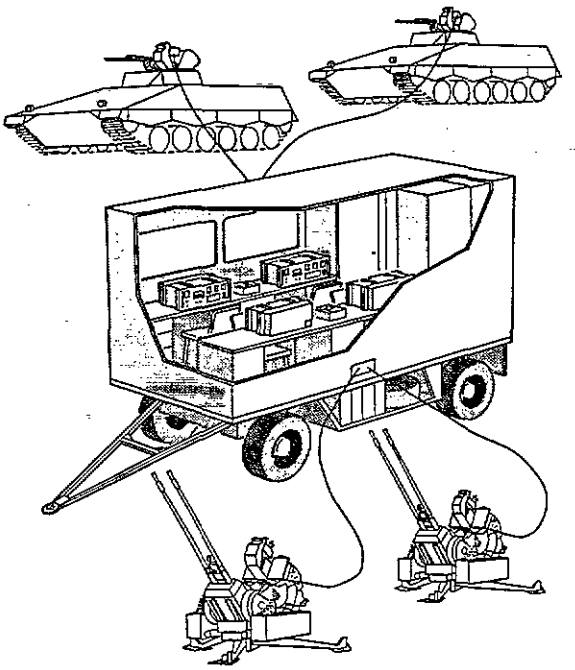


Operating simplicity

The instructor's station is equipped with the following controls:
- setting up controls with BIT and overheat alarms,
- an electronic boresighting system which boresights the simulation system to the cannon in several seconds after the simulator has been attached to the real weapon,
- a comprehensive built in test (BIT) system provides rapid diagnosis of defects to module or sub-assembly level (e.g. electronic boards). Defective items can be changed at battalion level thus giving an excellent availability rate.

OTHER POSSIBILITIES

The OBGS can be delivered with a high speed printer giving a permanent record of firing results.
The video recorder image generation system can be replaced by a stored image system using plug-in memory modules at the instructor's station.



TRAILER INSTALLATION

CONCLUSION

The compact OBGS is a high performance trainer for small and medium caliber gunnery against airborne and landbased targets. It has several operational advantages :

Versatility

By its modular design, the same OBGS can be adapted to many different carriers by changing the mechanical and optical interfaces fitted to the weapon, but also to different types of cannon by modifying certain mechanical and electronic parts on the instructor's station.

Mobility

Being light and compact, all parts of the OBGS are easily transportable, especially those fitted to the weapon. Overall mobility can be greatly increased when several OBGS are grouped in a trailer to improve instructor comfort and to protect the equipment. The OBGS can be completely installed in less than half an hour and be ready for use within a few minutes of its installation.

Training is more realistic and effective than on a firing range, especially for anti-aircraft fire. Realism of the gunner's environment is perfect since he trains using the real weapon. The moving targets can follow an infinite variety of absolutely realistic trajectories practically impossible to achieve using real targets and impossible for the gunner to memorize. Monitoring of the gunnery is immediate and absolutely accurate thus enhancing motivation for both gunner and instructor.

Training is faster, more progressive and more effective than with conventional training methods. Both the quantity and variety of the training aids and the immediate selection of the exercises enable the instructor to adapt the training to the level of each trainee.

Operation under cover eliminates all climatic and visibility constraints, reduces lost time and enables training to be provided 16 hours a day or more, 7 days a week.

Trials carried out using the OBGS for only 8 hours per working day have given the following results for a 21 day month :

TIME	GUNNERS	SCENARIOS	ROUNDS FIRED	
			20mm	90mm
15'	1	15	450	30
DAY	32	480	14 400	960
MONTH	670	10 000	300 000	20 000

There are considerable economic advantages. Operating the simulator under cover results in significant cost savings:

- a normal garage is used, requiring no particular infrastructure,
- turret power comes from the tank batteries floating charged from a small rectifier,
- there is no wear on chassis, engine, transmission or gun barrel,
- firing ranges and targets are not required,
- there is no consumption of fuel or munitions,
- there is an appreciable reduction in labor and maintenance expenses for vehicles, weapons and firing ranges.

Availability of the OBGS is better than 95% because of its modular design, its built in test system, and its extremely short installation time enabling it to be transferred from one carrier to another as training requirements demand.