TANK DRIVER AND TANK GUNNER TRAINING SIMULATORS

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INTRODUCTION

We are witnessing a growing interest from utilizers in classroom training for tank crews. Simulators exist, or are being developed, which provide efficient training. The purpose of this paper is to specify the concept of tank crew training and to isolate the functions of each new member, in order to better define the features of the simulators to be used for their training.

Analysis of the interworking of the members of a tank crew shows that coordination is provided entirely by the tank commander; there is practically no direct relationship between the gunner and the driver. It is true that their actions are coordinated - reducing speed, or taking up a suitable firing position - but the information, especially visual, which they individually use and the actions they undertake are either totally independent or only slightly correlated. Tank crew training can thus be broken down into independent and specialized phases.

- Training of the driver who receives orders and comments from the tank command
- Training of the gunner whose role generally overlaps with that of the tank commander.

The function of the loader can be neglected at this stage; it is a very simple function and does not require the same training resources. Simulators have been developed for driver and gunner training. Their principles are described below.

DRIVING SIMULATOR

The driving orders given to the driver result from the tank commander's analysis of the near and distant situations. For this, the commander must be given a wide field of view.

Driving orders are simple orders which define:

- the rallying point
- the speed, fast or slow
- if necessary, the path to be followed.

The driver carries out these orders using the near field of view. Except for giving new orders, the tank commander takes little part in the driving process. The driver is responsible for carrying out all orders received; he has considerable independence of action. This is important for defining the student/instructor relationship in the simulator.

The conditions for good driving are as follows:

- Good practical knowledge of the vehicle. The driver must use the vehicle to the best effect in all circumstances, even in the event of malfunctions. The simulator - and this is an inherent feature of all training simulators - must faithfully reproduce the behavior of the vehicle. This implies good reproduction of driving forces and good modeling. The rest is conventional.

- Good situation appraisal. Note that situation appraisal is obtained almost exclusively from visual sources; obstacles, road bends, terrain difficulties, judgement of distances are often appreciated from visible details. Visual representation of the terrain must therefore be of high quality. A closed circuit television system is used, servo-coupled to the driving controls and filming a 1/300-scale terrain model (figure 1). It is important that the model is rich in details. The image display must allow driving in the head-up or head-down position.

- Correct translation of the orders received into driving commands which take the visually perceived terrain difficulties into account. The effects of driving action are perceived in two ways:

  a. The effects of driver actions alone; acceleration, deceleration, steering. These effects are produced by movement of the image, movement of the platform, and by sound effects.

  b. The effects due to terrain irregularities; these are foreseeable effects whose origin is not the driver but whose amplitude is strongly dependent on driving conditions. It is absolutely essential that these disturbing effects be correctly simulated for the driver to obtain the same response from the simulator that he would obtain from the vehicle. He can then appreciate, by being subjected to them himself, the strains his driving imposes on the vehicle - especially during rough driving battle conditions.

The cabin motion system must have good dynamic characteristics and a large angular excursion in the pitch axis. The most important disturbing effect is the elevator effect caused by pitch motion and due to the driver's station being forward of the center of rotation. This effect is obtained in the simulator by placing the cabin forward of the pitch rotation axis of the platform (figure 2).

Instructor's role

The simulator instructor can take the part of the tank commander.

- He will give driving orders. The simulator instructor is given the same information he would have in a real tank (figure 3):

  a. The same scene as viewed by the driver; repetition of the trainee's TV picture at the instructor's station.

  b. Knowledge of the terrain which would possibly be obtained in a real tank from a panoramic observation of the terrain; a 1/10-scale map of the terrain model, on which the tank's position is continuously displayed, allows the instructor to give general driving orders ("Follow the road for one mile"), or particular orders, which could result in reality from a change in a battle plan ("Turn right, off the road"). It is important that the instructor has the information he needs to be able to give driving orders in good time. The terrain map gives him this advance information.

- He will comment on the driving. A repetition of the image seen by the driver and of the main driving instruments (speedometer, rpm counter, etc.) allow the instructor to comment on the trainee's actions. Using a set of dual controls, he can even demonstrate correct driving technique by driving the simulator from the instructor's station.

Automatic evaluation

The simulator digital computer can also be used to provide automatic evaluation of the trainee's performance. This type of evaluation must be based on a number of criteria selected with the user's approval. The available computing power is sufficient to allow appropriate weighting of each evaluated parameter.

GUNNERY TRAINING SIMULATOR

The gunner's functions and their overlap with the tank commander's functions vary considerably depending on the type of tank and on Army procedures.

However, it is possible to define the main functions of a gunner and the characteristics which a gunnery training simulator should possess.

The most important functions are:

- Operating knowledge of the weapon control system
- Visual situation appraisal and identification of the target designated by the tank commander
- Aiming at mobile targets
- Shooting and observation of the shot in an extremely disturbing environment
- Correction of aim and further shooting.

Use of the weapons system

The gunner's station is faithfully reproduced. The most important features concern:

- The sighting head; field of view, magnification, various reticles
- The aiming controls; play, thresholds, efficiency.

The gunner's station, which is subjected to the shock of simulated recoil, must be rigid. Uncoupled from the image generating system, it can be replaced by the gunner's station for another type of tank, giving the simulator considerable versatility.

Visual situation appraisal

Shooting at a distant moving target is difficult. The simulator must provide this type of training. Identification by the gunner of the target designated by the tank commander requires a high quality image.

A combat environment can be created by a "photo quality" image and by a target moving realistically in a realistic landscape. The representation of an aggressive target trajectory must be able to induce apprehension in the trainee and the desire to neutralize as quickly as possible the enemy who is taking advantage of the countryside (hollows, thickets) to create a dangerous situation.

Aiming - Rangefinding

The main difficulty in this phase is due to target mobility. Movement of the target over the terrain - track and speed -

must be modifiable by the instructor to avoid trainee familiarity and to grade the exercise difficulties to the trainee's ability to overcome them.

It is important that sighting and tracking errors are quantified in the simulator.

Shooting - Observation of results

The main objective of the simulator in this phase is to teach the trainee to disregard the perturbations accompanying shooting:

- recoil
- noise
- hot air
- smoke,

and to observe the tracer and the impact to be able to correct the following shot.

The classroom simulator is superior in its ability to simulate the disturbing environment which is one of the important difficulties of this phase of training. The trainee must overcome this difficulty before he fires his first real shot.

The shell trajectory is accurately simulated and includes the following effects:

- environmental effects; external temperature, wind, etc.
- weapon effects; dispersion, barrel wear, etc.

Instructor's role

The instructor can take the part of the tank commander in three essential phases:

- Target designation. As the instructor himself selects the sequences - type of target, initial position in range and bearing from the tank, type of course - he can then take the following action depending on the Army procedure:
  - Bring the weapon to bear and designate the target or,
  - give the gunner the orders and information allowing him to bring the weapon to bear, identify the target, and shoot.
- Tracking and shooting at a moving target. The instructor has a repeated display of the picture seen by the gunner; the landscape, the target, and the reticles. He is therefore in a position to comment on the trainee's actions at any time. His assessment of performance is supported by a quantified indication of the gunner's errors with respect to the ideal aim.
- Post-shooting commentary. The instructor bases his comments on information obtained from two sources:
  - The repeated display of the picture seen by the gunner.
  - Display of the aiming error and impact error memorized by the computer.

The gunner therefore receives the same directives and comments from the instructor that he would receive in reality from the tank commander.

Instructional aids

The simulator uses a digital computer. All effects (trajectory, masks, etc.) are computed.

Data are thus available to give the instructor the following information:

- numerical readout for the three most important parameters; the time taken by the trainee to effect an operation, aiming error, and impact error.
- exercise evaluation aids; display of the ideal aiming axis, freeze of the shell at the point, for example, where it passes through the vertical plane containing the target.

The simulator can also be used to provide automatically an objective assessment of trainee performance; all the necessary parameters exist and the computing power is adequate.

CONCLUSION

The simulator designs described above are fully suited to efficient classroom training of the driver and gunner. Each can be trained in his own function and get the same assistance (orders and advice) from the instructor as he would from his tank commander.

For loader training, a very simple special-purpose trainer would be quite adequate.

Training of the tank commander in his full command function must cover not only his relation with the other crew members but also, and above all, the tactical situations he will face. Simulation of these situations would require an evolving, complex display including:

- a wide angle of view including both near and far fields

- multiple targets so that the risk from each can be assessed

- friendly vehicles so that the support potential of each can be assessed.

At the present time, it is considered that classroom simulators, although particularly cost-effective for training drivers and gunners, are less cost-effective for training tank commanders.

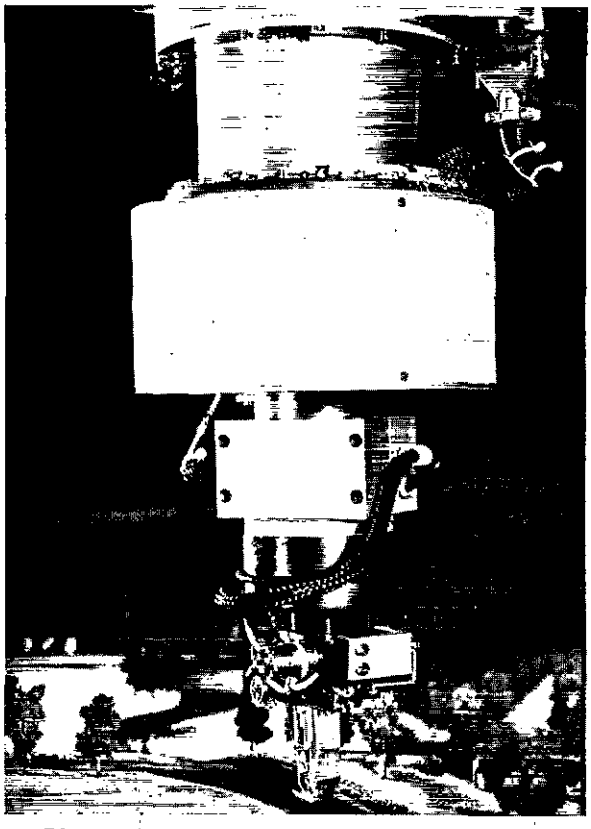

Figure 1. Visual system - Optical probe

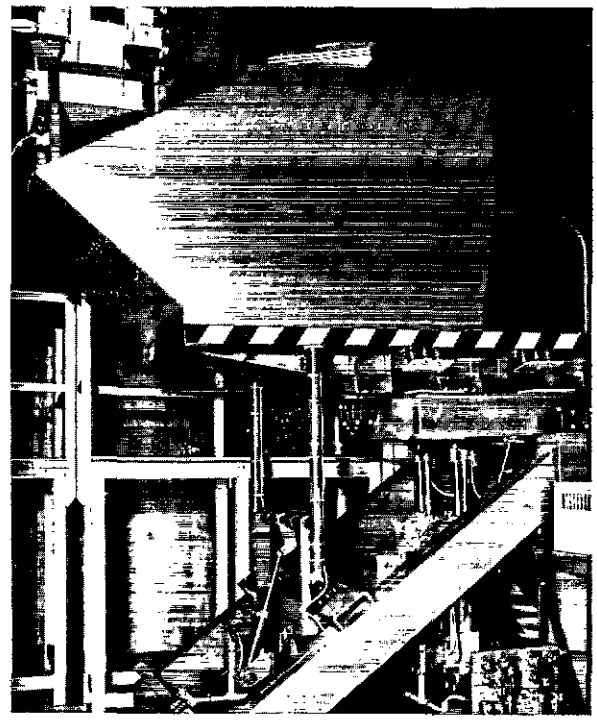

Figure 2. Cabin motion system

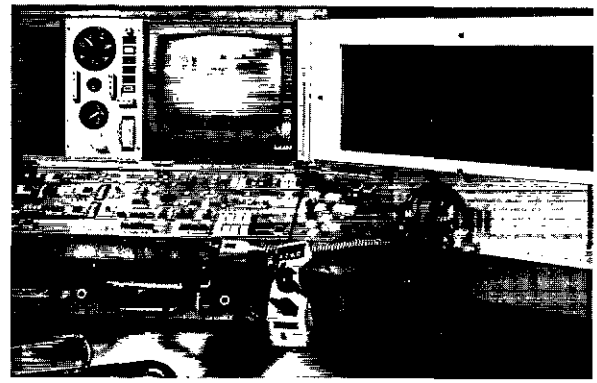

Figure 3. Instructor's station

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MR. JEAN BARADAT is the Technical Director of the Simulators and Electronic Systems Division of L.M.T. (FRANCE). He has over 18 years experience in the design and project management of training simulators. He is a member of the Institute of Electrical and Electronic Engineers. Mr. Baradat holds an Engineering degree from the Ecole Superieure d'Electricite - PARIS.