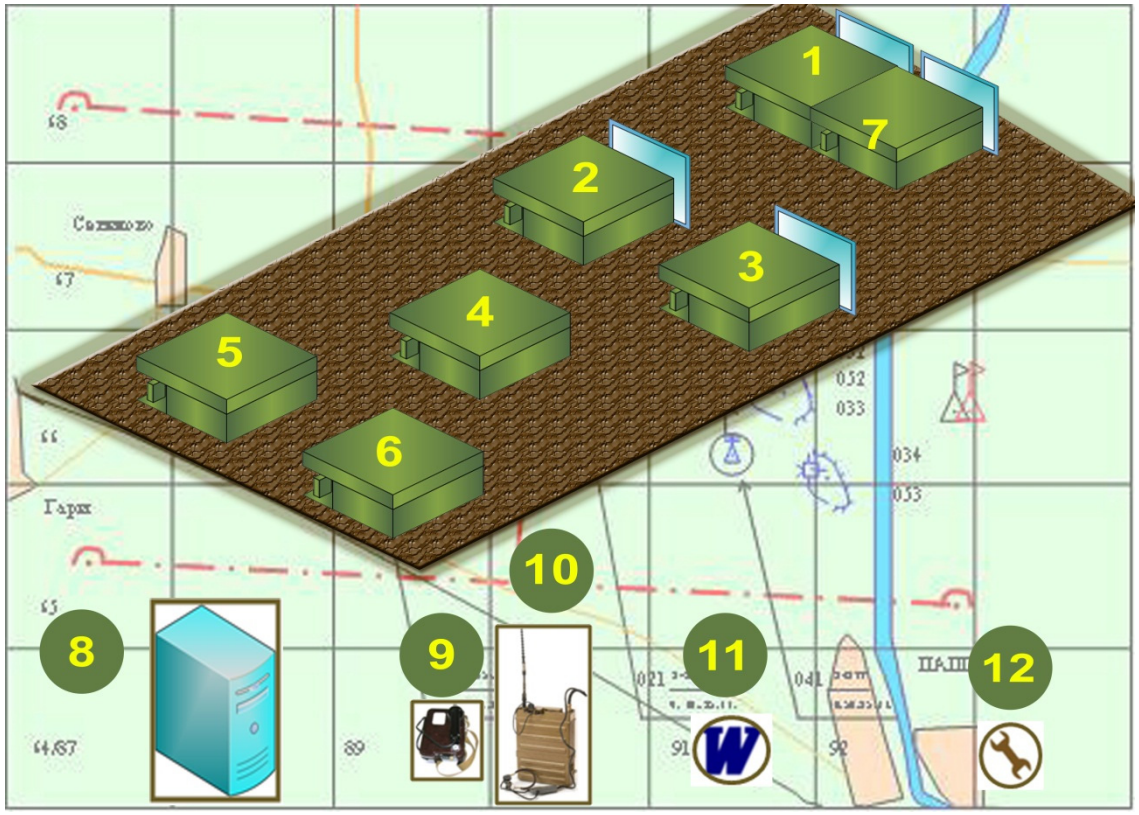
MORTAR BATTERY FIRE CONTROL SIMULATOR ‘MFCS-B’

The ‘MFCS-B’ simulator is designed for conducting classes (training) to shape, maintain and improve practical skills in performing the functional duties of mortar battery personnel during preparation for fire and fire control activities, command and observation post (CP) personnel collective training, observation post (OP) and battery fire control post (FCP) under complex and dynamic environmental conditions of a modern combined-arms battle.

The simulator provides training in fire control with mortar battery personnel equipped with 120 mm (2B11) and 82 mm (2B14) mortars using simulation capabilities.

THE SIMULATOR COMPOSITION



Serial №	Module's (system) title	Quantity, pcs
1	The Instructor and Roles Playing (OPFOR/HICON/LOCON) operator module	1
2	Battery CP module	1
3	Battery OP module	1
4	Battery FCP Module	1
5	Fire platoons module	2
6	Fire operator module	3
7	Software and hardware suite	
8	Distributed local area network	1
9	Voice communication system	1 set
10	Operating documents	1 set
11	SPTA	1 set

The set of modules and its equipment provides simultaneous operations in a unified virtual information environment in the real-time mode of all command and fire control elements (CP, OP, FCP) of the mortar battery consisting of two fire platoons.

SIMULATOR ADEQUACY

- compliance of the modular structure of the simulator control elements with the mortar battery command-and-control elements;
- compliance of algorithms and functioning modes of mortar systems application with the adequate modeling of flight paths of mortar-rounds as per Firing Tables with respect to ammunition used, ballistic and meteorological firing conditions
- correspondence of angular dimensions, shape, detailing rate of observed objects with real perception of them at the specified distance with various magnification rate with/without use of observation and surveillance devices
- generating of 3D models of static objects (buildings, trees, etc.) and dynamic objects (combat and transportation vehicles, civilian cars, air planes and helicopters), as well as objects specific to the area where training session is conducted
- synthesizing of 3D tactical units models and typical targets in compliance with Artillery Training Course for particular artillery system with or without imitation of their combat activity, moving or static
- using of 3D particular area models, where upcoming combat activity is planned or possible;

Simulator general capabilities

- generating of a virtual tactical situation against the background of a 3D terrain model that is appropriate for performing of the Artillery Training Course tasks based on the implementation of modern geo-information technologies
- generating and visualizing of the tactical situation on the 2D digital topographic map of the training area
- providing the workplaces for Battery CP (OP) personnel with semi-natural observation devices' mockups, and simulated communication equipment;
- visual observation and surveillance of ground situation (from CP, OP) within the visual range on 3D terrain model with/without use of visual observation devices' mockups
- shaping and improving of CP (OP, FCP) personnel skills in the organization and accomplishment of fire missions, determination of calculated fire settings to conduct firing in the full (abbreviated) preparation mode and approximate shifting of fire using various non-automated fire control instruments and its correction (PUO-9, corrections calculation instrument, etc.)
- communication training in exchanging of the service information between of command-and-control elements using simulated communication means

SELECTION OF ARTILLERY SYSTEMS, AND FIRING MODE CAPABILITIES

Type of mortar	Type of mortar round	Type of fuse	Type of charge	Firing mode
120-mm 2B11 mortar	OF-843 D-843 Z-843	GVMZ M-5	1,2,3,4,5,6	Mortar
	OF-843B	GVMZ	Long-range 1,2,3,4,5,6	Mortar
82-mm 2B14	O-832	M-6	Long-range	Mortar
	O-832 D-843	M-6	Main 1,2,3	Mortar

Simulation of firing is implemented following the Firing Tables with respect to meteorological and ballistic firing conditions and rounds dispersion

CAPABILITIES TO SIMULATE TYPICAL TARGETS FOR ENGAGEMENT

1	Battery (platoon) of self-propelled armoured artillery systems	11	Group of radar stations or communications vehicles
2	Battery (platoon) of self-propelled unarmored artillery systems	12	Manpower and fire weapon openly located
3	Battery (platoon) of covered flat-trajectory artillery towed cannons	13	Sheltered manpower and fire weapon on positions, in assembly, standby or departure area
4	Battery (platoon) of towed cannons openly located	14	Platoon strong point
5	Battery (platoon) of covered field rocket launchers	15	Command or command-and-control post openly located (in uncovered trucks, buses)
6	Battery (platoon) of field rocket launchers openly located	16	Tanks (BMP, BTR, BRDM) in assembly, standby or departure area
7	Battery (platoon) of covered towed (portable) mortars	17	Helicopter at helipad
8	Battery (platoon, section) of towed (portable) mortars openly located	18	Helicopter unit at helipad
9	Platoon (section) of self-propelled armoured mortars	19	Unarmored ATGM, antitank cannon (or other single unarmored target)
10	Platoon of self-propelled air-defense missile launchers with unified targeting system	20	Armoured ATGM, tank, BTR (or other single unarmored target)

SIMULATOR VISUALIZATION SYSTEM

The three-channel projection system with software computer synthesis is used in the simulator visualization modules, providing characteristics no worse:

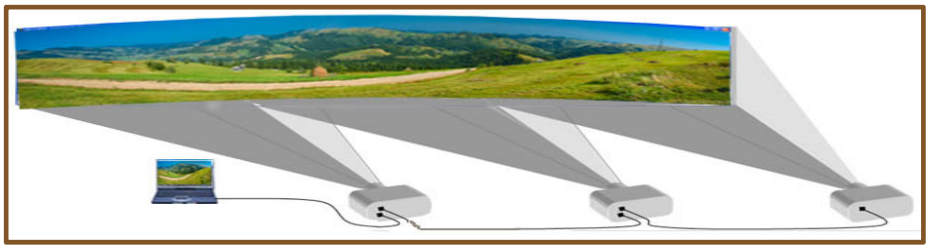
- ✓ resolution - at least 1024 x 768 (XGA) per each channel;
- ✓ frame rate - at least 50 frames per second.

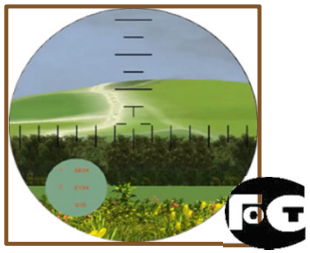
Visualization system provides:

- continuous representation of ambient environment with visibility angles of at least 120° horizontally and 20° vertically (with ability of selecting the main direction of observation);
- the picture of the Earth's surface landscape within the visualization sector, as well as typical ground objects;
- correspondence of detailing rate of observed objects with real perception of them at the specified distance with various magnification rate with/without use of observation and surveillance devices;
- simulation of tactical background with simulated effects associated with the use of various ammunition (shell bursts, smoke, characteristic of objects and targets destruction);
- compliance of angular dimensions, shape of local objects, vegetation, and ground targets to real objects within field of vision of optical observation and aiming devices.
- providing of visibility and illumination conditions change with regard to geographic latitude, time of a day and meteorological conditions;
- the possibility of local changes in visibility, such as smoke, fog, cloud cover.

2D visualization

3D visualization



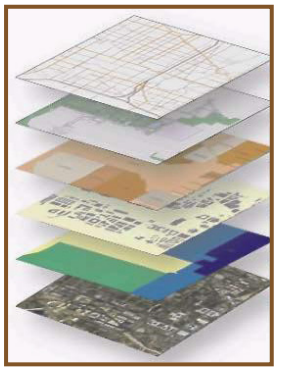


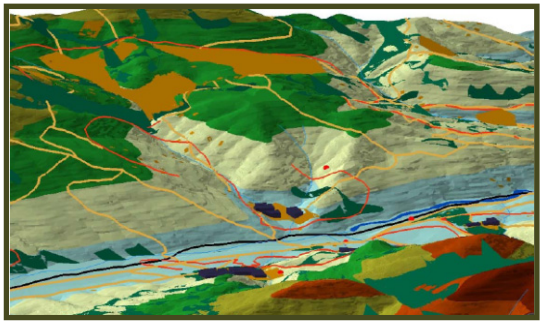
USE OF GEO-INFORMATIONAL TECHNOLOGIES

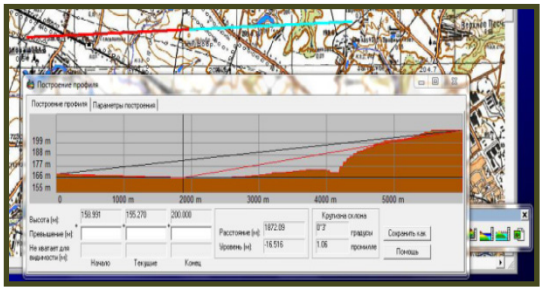
Geo-information technologies are implemented in the simulator allowing to work with an electronic area map.

Geo-information technologies enable generating of fire control training conditions that are close to real conditions due to:

- the most complete account of terrain characteristics (relief, vegetation, elements of the infrastructure);
- using of 3D particular area models, where upcoming combat activity is planned or possible;







SURVEILLANCE AND OBSERVATION DEVICES' MOCK-UPS

- synchronization of spatial location of optical axis of observation devices' mock-ups (B8x30 binocular, PAB-2M azimuth compass, 1D11M quantum or LDR-1 laser rangefinder) with projected picture on circular screen;
- adequate 3D visualization of terrain models, target reference points, targets and tactical situation within field of vision of optical reconnaissance devises' mock-ups;
- identity of optical characteristics (fields of vision, magnification rate, accuracy) of rangefinding and angles computation of observation and surveillance devices' mock-ups and its correspondence to those of real;
- adequate correspondence of scales of the surveillance and observation devices' mock-ups (PAB-2M, B8x30, 1D11M or LDR-1) to conduct of spatial computations with scales of real devices;

EDUCATIONAL AND METHODOLOGICAL CAPABILITIES

The flexible simulator structure with an intuitive interface allows conducting firing training of battery (consisting of two platoons), equipped with various systems, and fire control training in all firing modes, and different engagement methods of attack in the different combination of weapons in real-time mode, assessing the degree of targets destruction and automated evaluating the fire tasks accomplishment.

- Shaping and improvement of skills in firing missions accomplishment and standards, specified by Artillery Training Course and Standards Book, to carry out their functional duties during preparation and execution of the firing tasks
- preparation and execution of surveillance, communications, meteorological, ballistic and technical training objectives accomplishment;
- planning, preparation for weapons firing, firing, corrections, and fire mission results assessment;
- training under different conditions close to real, accomplishment of firing missions under specific tactical conditions
- development of data base for after-action review, evaluation of training results;

THE SCOPE OF TRAINING APPLICATION OF THE SIMULATOR

In the combat training system of forces

Theoretical classes

- ✓ group training
- ✓ seminars

Practical exercise

- ✓ Mortar battery fire control training
- ✓ Firing and fire control training with officers (sergeants)
- ✓ Fire missions accomplishment (record service practice)

In the educational process

- ✓ Self-training
- ✓ Group training
- ✓ Practical exercise
- ✓ Training of tactical tasks execution
- ✓ CPX, War gaming

FIRE CONTROL TRAINING PREPARATION AND EXECUTION

Fire and fire control training plan development

Fire and fire control training plan approval

Training scenario development and tasks assignment to trainees

Capabilities of Instructor's workstation

- ✓ electronic map of the training area;
- ✓ graphics editor with classifier of military symbols
- ✓ database of battery weapons, organizational structures and attracted assets

Technical readiness check of the simulator's components to conduct exercise

Control of trainees' readiness for training

EXERCISE CONDUCT

T_{tr}=0

At the battery and firing platoons CP (OP, FCP) work stations

- ► Occupation of work places by CP, OP, FCP personnel, actuation and open up communications
- ► Firing missions assignment
- ► Controlling units during accomplishment of scheduled and unscheduled fire missions
- ► Maneuvering
- ► Radio communication exchange

Ttp=Tk

At the Instructor 's (exercise director) and OPFOR operator module

- ► Supervision of trainees' activity
- ► Tactical situation analysis and it's development
- ► Roles playing
- ► Monitoring of radio exchange in the trainees' nets
- ► Receiving of summarized results on battery elements' activities

Exercise after-action review and allocation of tasks for future training

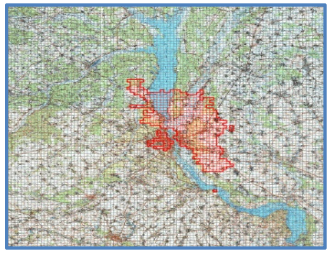
- Playback of recorded training episodes and discussion
- Demonstration of summarized results of trainees' activities
- Results announcement
- Assignment of tasks to fix deficiencies and improve the level of training

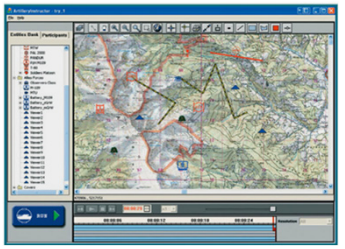
HARDWARE AND SOFTWARE SUITE

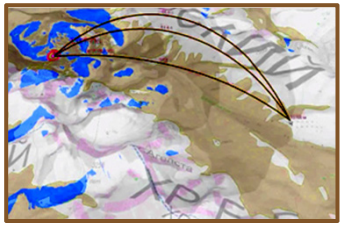
Simulator's software and hardware complex includes the general and special software suite, computing tools, as well as coupling devices between surveillance devices and computing means.

Issues solved by the hardware and software complex

- Setting up of initial data for training (the type of mortar system, topographic and geodesic preparation of meteorological conditions for firing, ballistic preparation of fire, number and types of targets, ammunition for firing missions, positions and status of units)
- Initial and current control of work places status
- synthesis of the terrain and visual environment corresponding to the field of vision of the CP, OP, and observation devices
- calculation and simulation of the mortar-round flight path with respect to meteorological, ballistic, and geophysical conditions, and the current position of the mortar tube, following the Firing tables, and impact effects in the target area
- simulation of battle audio effects
- evaluation of firing missions results
- visualization of firing process, and targets kill
- responsive control of the training session
- unbiased evaluation of trainee’s actions
- generating the data base of training results
- information sharing via local computer net







DISTRIBUTED LOCAL AREA NETWORK

The purpose of distributed computer network

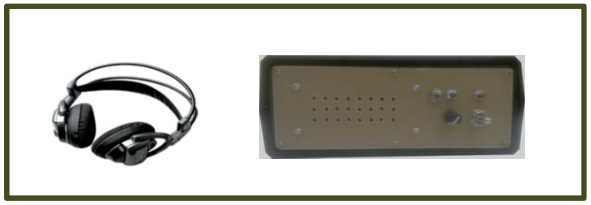
control of the simulator equipment and ensuring the coordinated operation of computers.

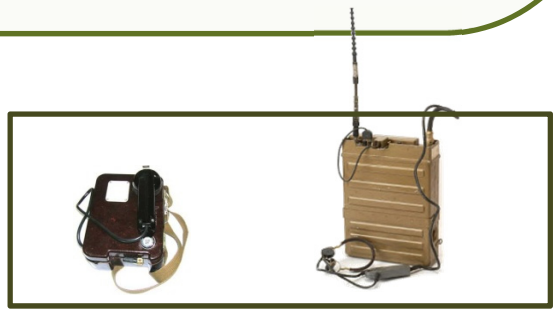
Distributed local computer network with software contains:

- adapted computers (server and satellites);
- network equipment;
- software, containing the database, tactical situation development, saving, editing and demonstration program; 3D visualization, demonstration and editing program; simulated mortar firing and sound control program

WIRE AND RADIO COMMUNICATION SYSTEM

- imitation of radio communication within and between battery CP, OP, FCP and with IWS (Roles playing)
- imitation of enemy radio communication suppression system (partial or full) effects from Instructor’s workstation with provision of communication renewal with further transition to either “free” radio channel, or work in wire communication mode.
- Sending of 'METEO-MEDIUM', METEO-APPROXIMATE' information from Instructor's workstation (IWS) and its receiving by CP (FCP) modules radio-telephone operators
- CP, OP, FCP wire communication with the Instructor's workstation (IWS) and within them
- provision of restoration of command-and-control communication system under conditions of particular battery command-and-control elements failure as the result of enemy firing effects

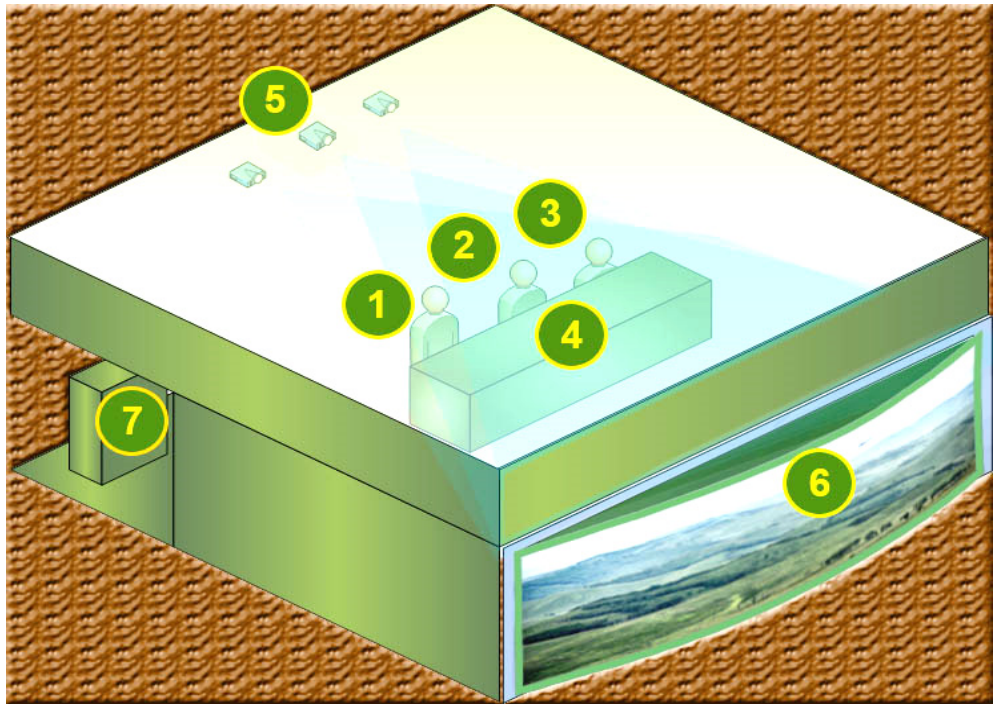




THE STRUCTURE OF SINGLE MODULES

The simulator is the set of separate isolated from each other modules, where battery CP (OP, FCP) key personnel work stations are placed and organized with the simulated elements of open-type fortification and fully provide the functions of the mortar battery fire control activity.

Typical CP (OP, FCP*) module



1,2,3	**CP (OP, FCP) personnel**
4	Equipment to ensure CP (OP) personnel operations (observation devices, communication means)
5	LED or Laser-LED projectors
6	Cylindrical screen
7	Ventilation and conditioning system

* FC CP modules are not equipped with a projection system (cylindrical screen, projectors)

Instructor's workstation (chief instructor)

Voice communication panel

Roles playing operator workstation

- loading and start testing of hardware and software suite and its separate modules;
- development, storage, editing, selection and loading of the training scenario as per training objectives, or selection an exercises from the simulator's library;
- data entering on composition of command posts (CP, OP, FCP) and personnel participating in training session (family name, initials, positions);
- selection of the training area, and conditions for training (time of a day, season, weather conditions)
- monitoring of the training session, generating and output of the resulting data, recording, processing and storage;
- temporary suspension of current training session with provision of further renewal;

- support for interaction of the battery CP module with the senior commander and attached intelligence assets.
- on-line amendments and corrections of unit strength both enemy and friendly;
- determination of attached reconnaissance assets application and fire adjustment procedures and issue by them target situation data.

BATTERY COMMAND-AND-OBSERVATION POST MODULE

Battery commander work place	Battery headquarters platoon commander work place	Surveillance work place	Rangefinder work place	Radio-telephone operator work place
				
B8x30 binocular mockup fire control instrument PUO-9 PTK KSA	B8x30 binocular mockup	PAB-2M periscopic artillery azimuth compass mockup	1D11M (DAK-2M) or LDR-1 rangefinder mockup	Radio station R-159 mockup Telephone TA-57

- fire control arrangement and subordinate elements maneuvering;
- providing necessary equipment to assist key personnel in performing of their duties: observation devices mockups (PUB-2M, B8x30, 1D11M or LDR-1), simulated communication system;
- provision to conduct surveillance and observation by all personnel using projection equipment and observation devices' mockups within angular limits of ±60 degrees relatively assigned surveillance direction in horizontal plane and up to 20 degrees in vertical plane;
- arrangement of communication and information sharing within CP elements via wire and radio communications using simulated communication system.
- Imitation of current combat sounds' and noise background
- monitoring of fire missions accomplishment

Stereophonic acoustic system

OBSERVATION POST MODULE (FORWARD, FLANK)

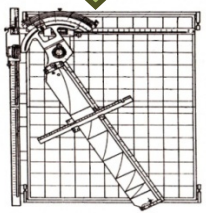
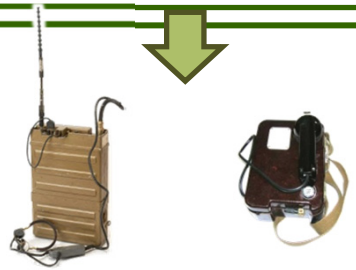
Senior reconnaissance officer work place	Rangefinder work place	Radio-telephone operator work place
 	 or 	 
PAB-2M periscopic artillery azimuth compass mockup	1D11M (DAK-2M) or LDR-1 rangefinder mockup	Radio-station R-159 mockup TA-57 telephone set

- necessary equipment to assist key personnel in performing of their duties: observation devices mockups (PUB-2M, B8x30, 1D11M or LDR-1), simulated communication system;
- provision to conduct surveillance and observation by all personnel with use of projection equipment and observation devices mock-ups within angular limits of ±60 degrees relatively assigned surveillance direction in horizontal plane and up to 20 degrees in vertical plane;
- Information sharing within command post via radio and wire communications using simulated communication system;
- simulation of the acoustic background and battle sounds of the current tactical situation




Stereophonic acoustic system


BATTERY FIRE CONTROL MODULE

Battery executive officer work place	battery surveyor work place	Radio-telephone operator work place
		
Notebook with general and special software PTK KSA	fire control instrument PUO-9	Radio-station R-159 mock-up TA-57 telephone set

- necessary equipment to assist key personnel in performing of their responsibilities, as well as determination of firing data settings with use of fire control instrument PUO-9, notebook, communication simulation system;
- sending of required data to battery CP to calculate initial firing settings, determination of corrections and receiving commands from the battery commander;
- control of platoons during accomplishment of firing missions;
- maintaining of communication and information sharing within CP via radio and wire communications using the simulated communication system.
- Imitation of current combat environment sound and noise background

Stereophonic acoustic system

Battery fire settings operator module

Role playing operator work place

Notebook with general and special software

Handset

Telephone communication terminal

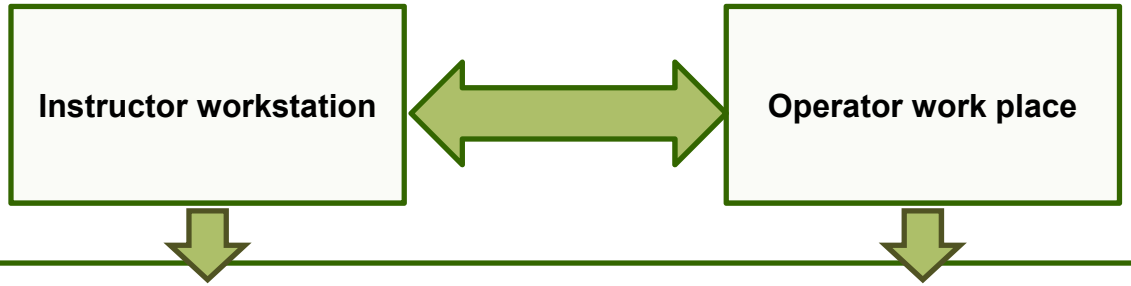
- communication with battery FCP (battery executive officer) module and information exchange to support mortars preparation for, laying and firing;
- accomplishment of assigned tasks by battery executive officer to occupy positions, orientation of the main firing direction;
- input of initial firing data settings (the type mortar, charge number, shell, fuse; elevation, levelling, deflection shift, corrections) into program-computing complex for virtual tube laying following data prepared by battery executive officer;
- simulated firing (salvo) by a mortar battery, and preparation for the next firing

120-mm mortar platoon

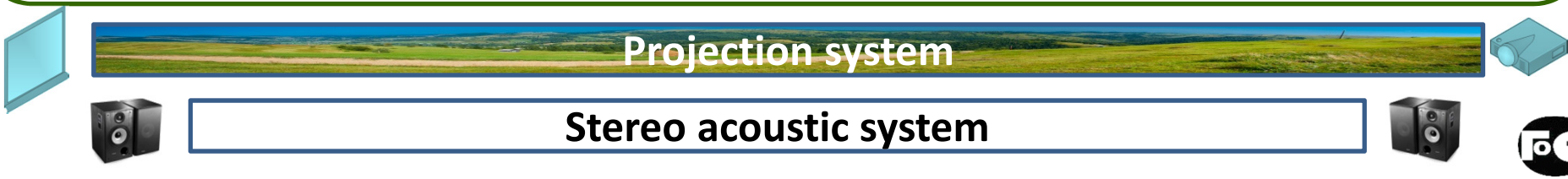
82-mm mortar platoon

- Mortar-man 1 sets the specified angle of the MPM-44M sight, reports the end of settings; sets the bubble of the longitudinal level to the middle with lifting mechanism and sets the vertical thread of the reticle with the aiming point using traversing mechanism, while keeping the bubble in the middle position; constantly holds the bubble of the transverse level in the middle using horizontal laying mechanism
- Mortar-man 2 takes the mortar-round from the mortar-man 4, removes the cap from the fuse, inserts the round-fin into the muzzle and, having sunk it approximately to the centering belt, lowers it
- Mortar-man 3 repeats the specified charge and puts the specified quantity of propellant powder charge or a package of long-range propellant charge on the cartridge container, checks the presence of the main propellant charge, prepares the specified number of mortar-rounds
- Mortar-man 4 brings the mortar-rounds to the mortar-man 3, and helps him to prepare mortar-rounds for use. Mortar-man 4 accepts the round prepared for firing from the mortar-man 3, brings it up and passes it to the mortar-man 2

INSTRUCTIONS AND AFTER-ACTION REVIEW MODULE

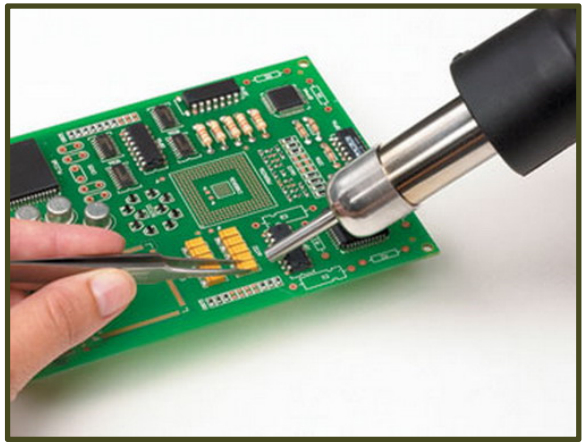


- placement of CP personnel participating in training for briefing, clarification of the training progress and training objectives assignments, the structures of involved units (control modules), training area; familiarization with training scenario and plan, call signs of officials and control nodes, tactical control code signals;
- placement of CP key personnel for after-action review of battery commander's decicions and subordinate elements' actions during preparation to conduct of battle actions, quality of combat documents, the proficiency in controlling fire units when executing fire missions;
- the provision of large-format playback using projection equipment in real (accelerated, slow) time-scale of the battery's combat actions or its elements in 2D and 3D format with the ability to select the dynamic positioning of the point of observation;
- the limits of the visualization of projection equipment: ±60 degrees relatively assigned main observation direction in horizontal plane and up to 20 degrees in vertical plane;
- synchronized playback of the command audio channel when fire missions are assigned by key staff of the control elements and their reports on performance of firing results with the visualization of the battery's combat actions.



Simulator reliability

- use of proven by exploitation, the best quality and reliable components along with their incoming control
- program solutions development that exclude conflicts between specific and general software, as well as conflicts between software and hardware elements
- multiple repeated check of design solutions that provide long-term lifecycle of mechanical nodes
- use of protective means of print boards of electronic devices and connectors from environmental affects
- the ability to use computers in a protected version (optional);
- use of uninterrupted power supply units
- ensuring of required simulator hardware thermal conditions
- providing power margin of power supply equipment



SIMULATOR OPERATING CHARACTERISTICS

№ seq.	Parameter name	Measuring units	Parameter value
1	The type of facilities	---	Modular-sectional
2	Minimum area	m2	140
3	Minimum height	m	3
4	Warm-up time upon actuation	min	up to 15
5	Duration of continuous work,	hours	at least 12
6	Electric power supply: voltage	V	220±10%
	frequency	Hz	50±1
7	Maximum consumed power	kW	10
8	Average consumed power	kW	7
9	Increased operating and limiting temperature	°C	Up to +35
	Reduced operating temperature		Up to +5.
10	Relative humidity at the temperature of +25° C	%	Up to 80
11	Diagnostic system	---	In-build semiautomatic
12	SPTA	---	Individual
13	Maintenance	---	Check-up, daily check, maintenance -1 (once per 6 months), maintenance -2 (once a year)
14	Trainees and operating personnel electric safety	---	Circuit protection device, short-circuit relay protection
15	Operating documentation	---	Logbook, operating manual, repair manual, SPTA List

The developer and manufacturer of the 'MFCS-B' mortar battery fire control simulator:
LLC “Research and production company “Energy-2000, Ukraine, Kiev, Povitrophlotsky avenue, 94-A

Developer and manufacturer provides:

- ✓ fabrication and delivery of simulator to the place of intended use
- ✓ assembly, adjusting, commissioning and acceptance tests
- ✓ training of customer's technicians
- ✓ warranty service for 2 years
- ✓ post-warranted maintenance (subject to separate contract)
- ✓ author's supervision and software modernization during the entire period of operations