

LLC «Research and Production Enterprise «Energy 2000»



Training and Simulation Systems Design and Manufacturing

Individual training simulators

- 1 Driver's wheeled and tracked vehicles dynamic simulators
- 2 Tank, IFV, APC gunners dynamic simulators
- 3 ATGM gunners simulators
- 4 Radar operator's simulators
- 5 MANPADS gunners simulators

Collective crew (section) training simulators

- 1 Tank, IFV, APC crews dynamic simulators
- 2 Air-defense systems crews simulators
- 3 MANPADS sections simulators

Collective branch units training simulators

- 1 Mechanized (tank) platoon simulator
- 2 Company (battalion) level combined arms simulation center
- 3 Anti-aircraft missile (artillery missile) platoon simulator
- 4 Multimedia marksmanship training complex

Fire control simulators

- 1 Artillery battalion (battery) fire control simulator
- 2 Air defense missile battalion fire control simulator

Flight simulators

- 1 Mi-17 helicopter crew dynamic simulator
- 2 L-39 aircraft crew dynamic simulator

General information

“Energy 2000” enterprise is specialized on design and manufacturing of simulators for mechanized (tank), air-defense, artillery units and flight simulators. The company operates in the market of military simulators since 1999. International agreements on the delivery of simulators have been performed since 2004.

Forty five highly qualified specialists are employed at the enterprise including candidates of technical and military science. Simulators, that are produced, have high degree of modernity which is confirmed by fifteen registration certificates and thirty patents.

The list of produced simulators includes:

- ✓ Tank, IFV, APC, tracked towing vehicle, trucks driving dynamic simulators
- ✓ BMP-2 (BMP-1) IFV crew dynamic simulators
- ✓ T-72 (T-64, T-55, T-55MB, T-69IIMG, T-62, MBT-2000) Tank crew dynamic simulators
- ✓ BTR-80, BTR-82A, BTR-3E1 APC crew crew dynamic simulators
- ✓ Mechanized and tank platoon simulators
- ✓ MANPADS «Igla» («Igla-S») gunner and section simulators
- ✓ Integrated Crew Simulators of ADMS «Strela-10», air defense missile/gun system «Tunguska»
- ✓ Anti-tank guided missile system «Konkurs» («Fagot», «Stugna-P», «Korsar», «Kornet-E») gunner simulators
- ✓ Multimedia optoelectronic marksmanship training complex with the pneumatic recoil simulation suite
- ✓ Mi-17 helicopter crew full-mission simulator
- ✓ L-39 aircraft crew flight simulator

The enterprise performs warranted and post-warranted maintenance, and author’s supervision and modernization of delivered simulators.

Output products

ATGM "Konkurs" ("Fagot") gunner simulator



BMP-2 crew dynamic simulator



BTR-80 driving dynamic simulator



Output products

MANPADS "Igla" gunner simulator

T-69IIMG tank crew dynamic simulator

KamAZ driver's dynamic simulators



Output products

T-72 tank crew dynamic simulator

MI-17 helicopter crew dynamic simulator

L-39 aircraft crew dynamic simulator



Output products

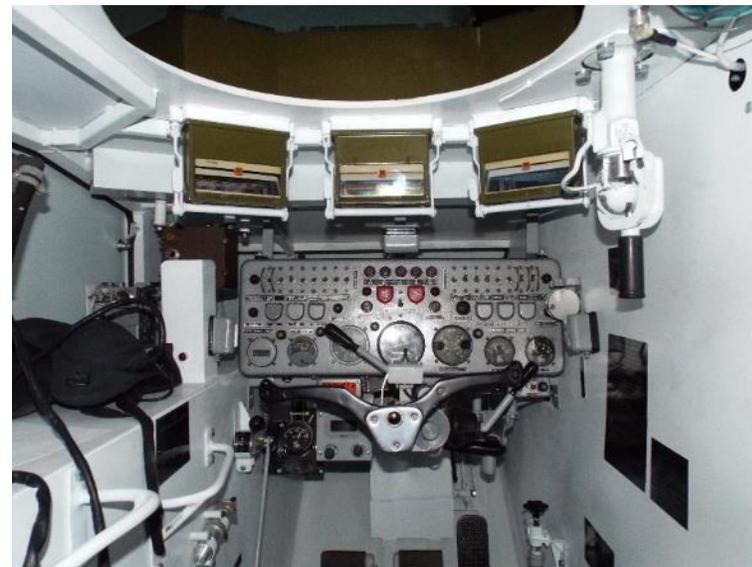
BTR-80 APC crew dynamic simulator



BMP-2 driver's dynamic simulator



Ural track driver's dynamic simulators



Output products

BTR-3E1 APC dynamic simulator

BAT-2 and IMR-2M engineering vehicle drivers dynamic simulators



Simulators specifications

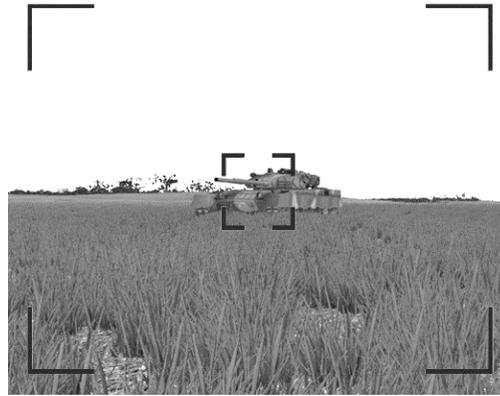
Design adequacy

- Correspondence of geometrical dimensions of simulator cabins and location of equipment and assemblies replica to the real vehicles
- Full package of controls, observation devices and sights, indicators and signaling information, assemblies and components and weapon systems is simulated
- Full replica of frontal instrument control board with realistic panel lighting
- Full correspondence of travel range, efforts and reaction of levers, pedals, handles and hand wheel etc.



Simulators specifications

Functional validity



- Full range of simulated functions of observation devices, sights, controls, indicators and signaling devices
- Correspondence of simulated functional algorithms of devices and outfit real weapon systems with full range of modes and reaction of controls on trainees actions
- Shells and bullets trajectory calculation based on ballistic characteristics and firing tables of machine-guns, and guns (cannons) and ammunition used; antitank guided missiles trajectory calculation based on characteristics of semi-automatic targeting contour
- Accounting of defeated by simulated weapon ground targets
- Computing of target visibility with respect to optical characteristics of observation devices and sights
- Considering of all main characteristics of vehicles (weapon systems) in the motion mode (including power of an engine on the particular gear, transition features, and weight) as well as terrain conditions (terrain features, soil, pavement surfacing)
- Considering of principles of vehicle's mobility (weapon systems) in the swimming mode
- Correspondence of running engine and firing sound effects
- Replication of rocking angle of cabin while moving and acceleration effects during speeding up, slow downing, turns, and hull vibration while crossing obstacles and collisions
- High quality of visualization of external conditions

Simulators specifications

Learning and teaching capabilities



Simulators provide:

- Collective training of tank, BMP, BTR crew by means of:
 - Execution of driving, firing exercises, and tactical missions under different terrain and weather conditions, night and day, summer and winter alike;
 - Execution of fire exercises on tank firing range in accordance with Gunnery Course;
 - Execution of driving exercises on tank driving range in accordance with Combat Vehicle Driving Course;
 - Development of teamwork amongst crew members while detecting targets, executing training and verification firing exercises in line with execution of tactical tasks
- Individual (discrete) tank, BMP, BTR crew members training:
 - Training of tank, BTR, BMP drivers to manipulate controls, read control board, indicators and signaling devices under all equipment working conditions
 - Execution of driving exercises in accordance with Combat Vehicles Driving Course under different terrain conditions and while swimming;
 - Commander and gunner training in manipulating of fire control system equipment;
 - Commander and gunner training in detecting targets, their identification and selection, weapon selection and target engagement;
- Shaping and maintaining sound skills of crew members to operate equipment, read indicators and react on signaling devices while driving, conducting surveillance and target engagement under conditions close to reality.
- Crew live monitoring and recording system

Simulators specifications

Reliability

Simulators reliability program is based on following principles:

- Usage of proven by exploitation reliable components with their incoming control
- Program 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 longterm lifecycle of mechanical nodes
- Functional and phased check of quality of mechanical and electrical simulator assembly
- Exclusive usage of non contacting angle of rotation sensors (based on magneto sensitive microchips)
- Usage of protective means of print boards of electronic devices and connectors from environmental effects
- Usage of industrial computers
- Usage of uninterrupted power supply units
- Providing of required simulator hardware thermal conditions
- Providing power margin of power supply equipment

Warranty and life-cycle

- ▶ Simulators warranty and life-cycle is 1-2 years under conditions of strict adherence of exploitation and maintenance rules in accordance with operating instructions
- ▶ Simulators exploitation term is not less than 10 years

® Daily non-stop operation is 12 hours

® No-failure operating time is not less than 1000 hours

Simulators specifications

Performance characteristics



No serial	Item (feature) name	Measure	Figure
1	Minimum space requirements	m ²	20-30
2	Facility type	---	Training classroom
3	Readiness upon actuation	min.	No longer, than 15
4	Daily non-stop operation	hours	Not less, than 12
5	Electricity supply voltage	V.	220±10%
	Frequency	Hz	50±1
6	Maximum import power	kW	36
7	Medium import power	kW	10
8	Excessive working and extreme temperature	°C	Up to +35
	Lessened working temperature		Up to +5
9	Relative degree of humidity under +25°C	%	Up to 80
10	Diagnostic system	---	Inbuilt semi-automatic
11	No-failure operating time	hours	Not less, than 1000
12	Switching On/Off	---	From the instructor's seat
13	Spare parts and accessories	---	Individual and group (per 4 simulators)
14	Maintenance	---	Checkup
15	Exploitation hours	---	Mineral oil in reducing gear of dynamic platform
16	Electro safety of trainees and operating staff	---	Dangerous voltage shutdown in the simulator fighting compartment (direct current, volts +24 V) Short-circuit relay protection
17	Accounting hours in service		Program counter of operating hours
18	Operating instructions	---	Logbook, Operations manual, Installation and maintenance guide, List of Spare parts and accessories

Simulator's life time phases

I. Design

Usage of robust technical solutions of mechanical and electronic nodes.
Usage of simulator's software operational stability methods

II. Manufacturing

Usage of proven by exploitation reliable components with their incoming control.
Quality control at all production, assembly and tuning phases

III. Shipping

Assembly and commissioning work.
Customer's technical staff training. Acceptance tests.
Handover to the Customer

IV. Warranty 1-2 years

Устранение возникающих неисправностей и отказов и восстановление работоспособности тренажеров (работа по заявкам и рекламациям Заказчика)

V. Post warranted exploitation for 8-10 years

Troubleshooting and performance restoration (subject to customer request). Regular technical inspections (once per 3 months) with the purpose of detection hidden defects, unreliable nodes or technical solutions. Replenishment of spare parts and accessories
Modernization of hardware and software package.

Design and production capacity

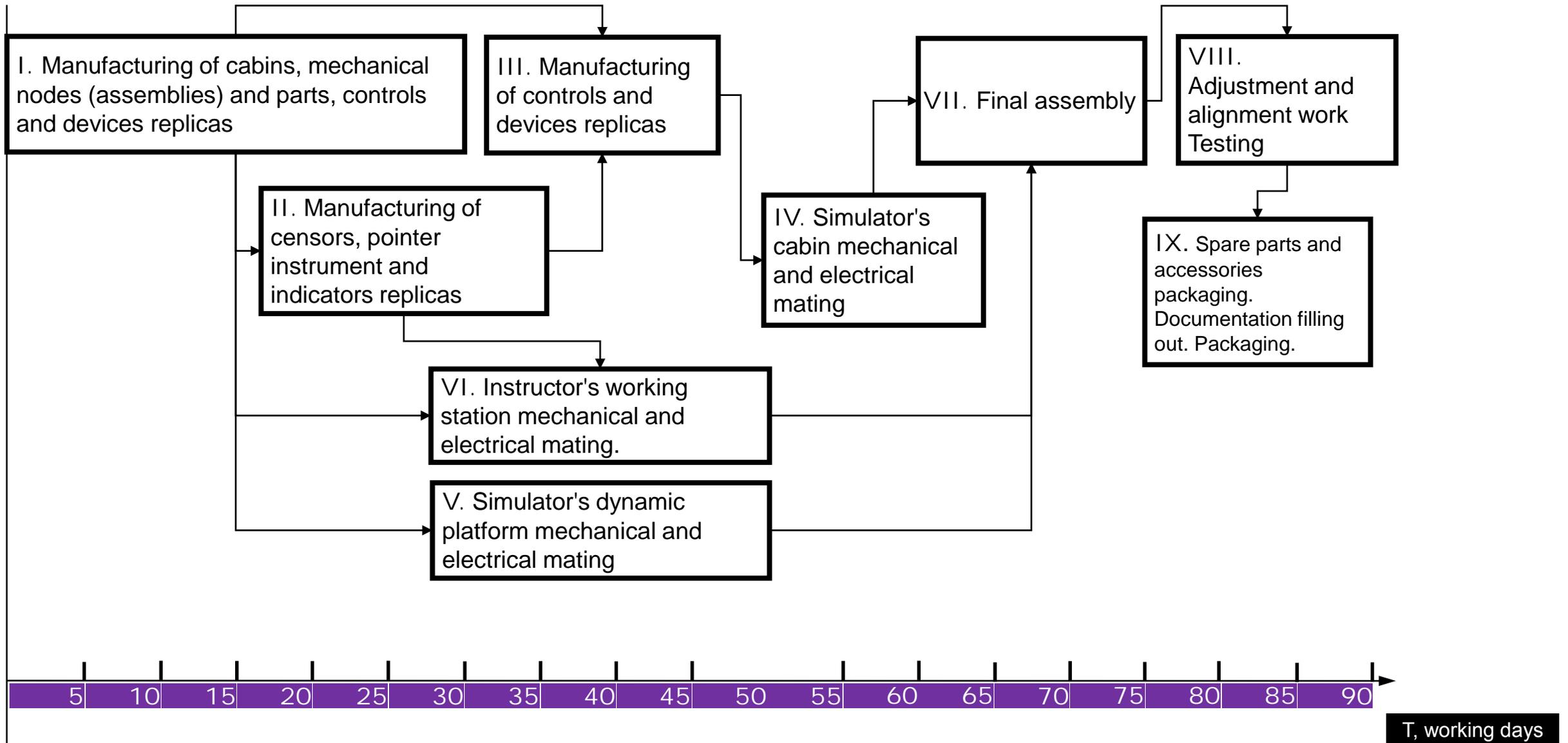
Based on scientific and engineering capacity, as well as manufacturing capability, the enterprise is able:

- ☐ To develop independently integrated crew (team, section) simulators of Army Soviet and foreign-made combat vehicles and weapon systems with average development term of 6-12 months
- ☐ To develop independently integrated helicopter and aircraft crews flight simulators of Soviet and foreign-made with average development term 12-18 months

Simulators manufacturing capacity

Serial #	Simulator name	Quantity, pcs.	Duration, months
1	Trucked vehicle driver's simulator (wheel vehicle driver's simulator)	1	2-3
		3	4-5
2	Integrated tank, BMP, and BTR crew simulator	1	3-4
		3	6-8
3	Anti-tank missile system, air defense system gunner simulator	1	2-3
		3	3-4
4	Integrated Crew Simulators of ADMS «Strela-10»-type, «Osa»-type	1	8
		3	9-10
5	Mechanized (tank) platoon simulator	1	8-9
6	Integrated helicopter (aircraft) crew simulator	1	9-11

Network manufacturing of Integrated tank, (IFV, APC) crew simulator timetable



The terminology of simulator-making

- A simulator is a model of a weapon (unit) that partially or completely reproduces its functioning in an operational environment in which the weapon (or military unit) supposed to perform its intended tasks

No	Classification feature		The simulators' types
1	Completeness of the functioning process		Operating (specialized) Full-functional simulators
2	Method for modeling the external environment	Computer-based simulation of a virtual battle space perceived through trainees' organs of senses	Virtual - Computer-based simulators with computer-aided controls
		Using a real external environment	Stand - Semi-realistic simulators with the real controls
		Using a augmented environment	Live - Full-sized simulators with the real controls
3	Dynamic characteristics	Without the motion platforms	Static
		Based on the motion platforms	Dynamic

The simulators' basic characteristics

The design adequacy

- The adequacy of the size of the functional equipment's, controls', indicating and alarm means' mock-ups
- Full compliance of the ranges of movement (moves) and efforts of simulator controls (control consoles, pedals, levers, switches) with the characteristics of the real weapon system equipment.
- Adequacy of the frontal instruments panels, the lighting of equipment, instruments scales, signs, and labels to the real weapon system.
- Physical modeling of the moving parts of the cabins and compartments
- Reproducing of an outer environment in the field of view of all observation and aiming devices with no exception. Physical replication of tilts and turns, linear and angular movements of functional cabins' mock-ups

The functional adequacy

- The complete list of functions and adequacy of functional algorithms of all the systems in all working modes
- Shooting simulation based on ballistic characteristics of guided and unguided weapons
- Compliance with a real sample of the reaction of actuators, indicating and signaling means to the crew's controlling actions
- Compliance of operating engines' and units' sound effects, as well as firing from barreled and rocket weapons to the characteristics of a real sample
- Adequacy of the dynamic characteristics of a weapon sample through the reproduction of body tilts and acceleration effects
- Realistic visualization of the ambient environment (the outside world)
- Simulation of vehicles' movement based on its characteristics
- Adequacy of the functioning of radio and radio equipment in a noise-free environment and in conditions of interference.

Combat training terminology

- 🕒 **Military specialist's level of training** - aggregated knowledge, professional skills and abilities to use weapon as intended under all operational conditions and modes
- 🕒 **Unit commander's and staff officers level of training** - aggregated knowledge, professional skills and abilities of situation assessment, decision making, exercising of command and control over the units and fire control during the battle against different foes and under different operational conditions
- 🕒 **Crew cohesion** - an ability of military specialists to execute collective synchronized actions in complete using of tactical and technical characteristics of weapon system under all battle conditions
- 🕒 **Command post personnel cohesion** - an ability of military specialists to execute collective synchronized actions to effectively control fires and unit's actions under different combat conditions
- 🕒 **Unit cohesion** - an ability of crews (teams, sections) and command posts to execute collective synchronized actions with the purpose of maximum possible realization of combat capabilities of units under different combat conditions against different enemies
- 🕒 **Desired level of training** - the level of skills and abilities of military specialists and unit cohesion that ensure missions accomplishment with desired effectiveness
- 🕒 **The purpose of combat training system** - ensure desired level of professional skills of military specialists and cohesion of crews and entire units

Skill - ability to act without deliberate element-by-element control and adjustment

Perception skills - sensual perception of characteristics and features of well known object, which was repeatedly perceived in the past

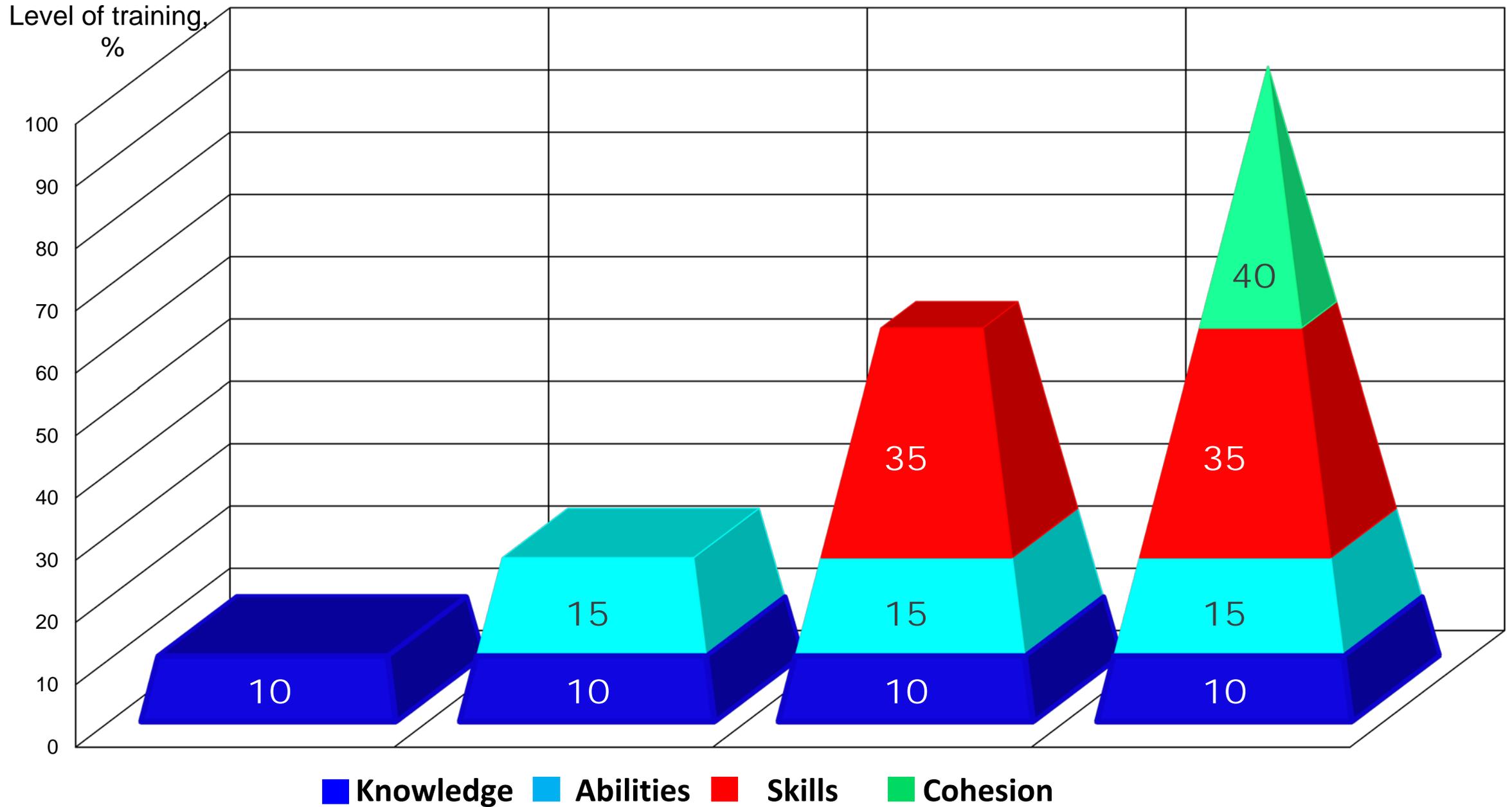
Intellectual skills - cognitive method of problem solving and accomplishment of task encountered in the past

Motor skills - ability to use motions against external object to achieve its transformation

Collective skills - ability of military personnel to use norms, rules and interoperability requirements to ensure execution of coordinated actions during accomplishment of missions by entire unit (crews)

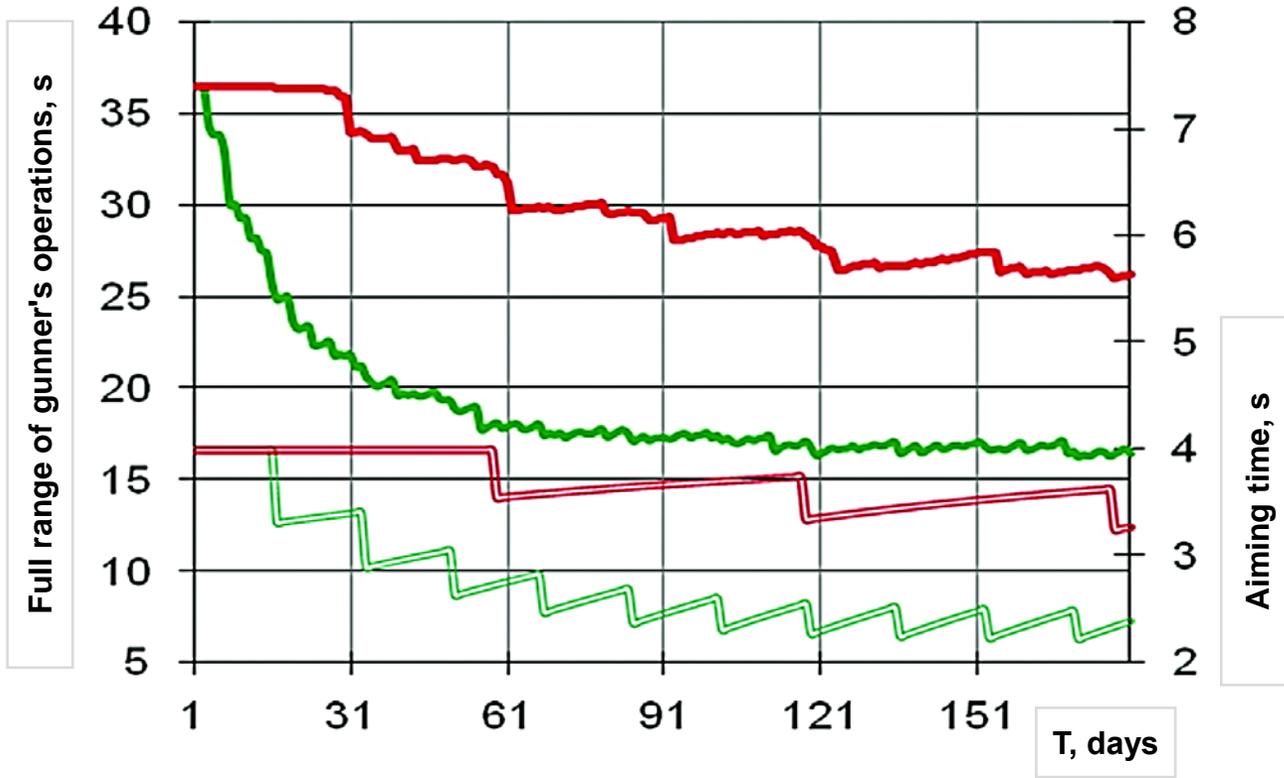
All of those skills are interrelated and materialized in the unity, despite of playing separate role depending on different tasks and conditions of their accomplishment

Military personnel training level components

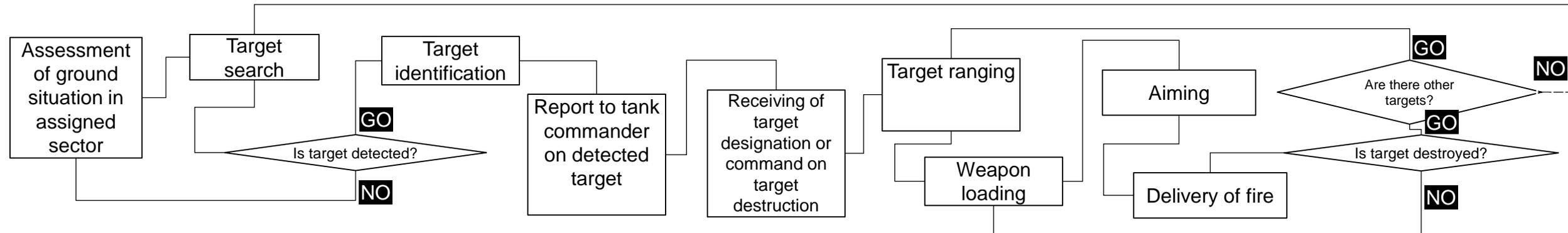


Specialist's proficiency shaping dynamics

Shaping of tank gunner's skills dynamic depending on training schedule



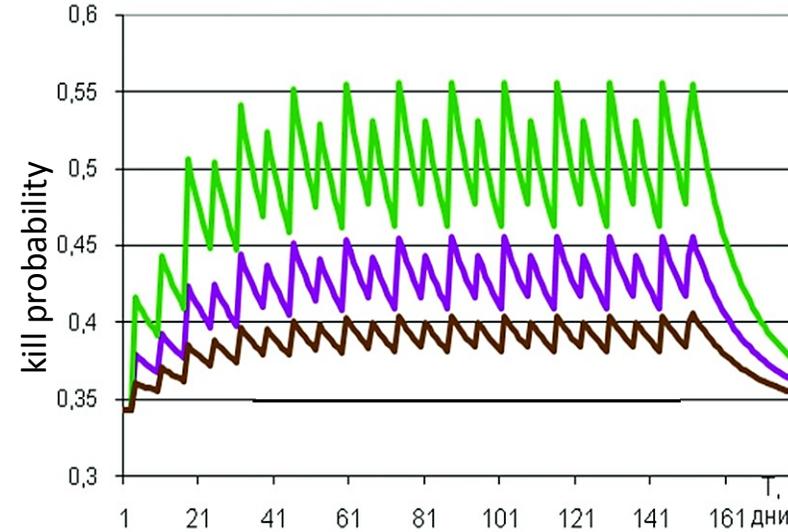
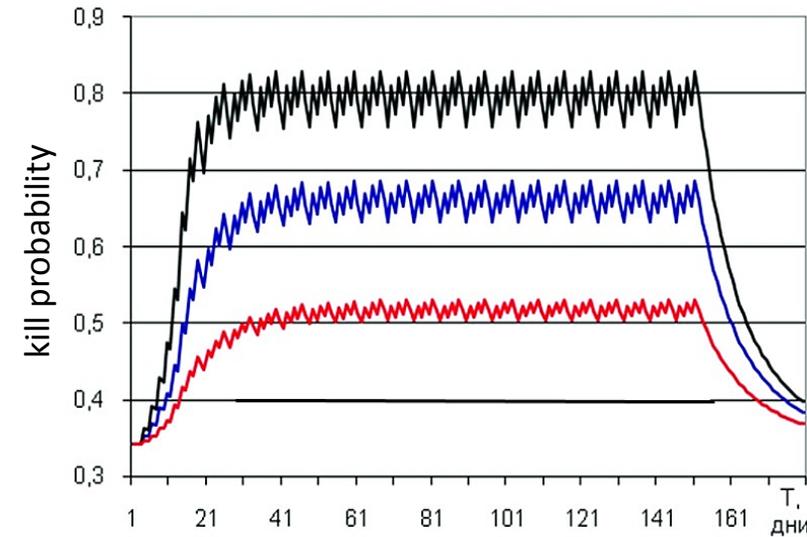
№	Gunner's operations	Allocation of preparation time to execute actions, close to rational		Random preparation time allocation	
		Pause between training exercises, days	Number of iterations during an exercise	Pause between training exercises, days	Number of iterations during an exercise
1	Assessment of ground situation	2	15	2	15
2	Search for targets	2	15	30	7
3	Taking decision on target engagement	2	15	39	4
4	Report to tank commander on detected target	2	15	26	1
5	Target identification	2	15	54	3
6	Selection of weapon, ammunition type, method of engagement and kind of fire	2	15	43	10
7	Target ranging	2	15	60	10
8	Weapon loading	2	15	28	4
9	Aiming mode selection	2	15	16	2
10	Aiming when stabilizer is switched on	2	15	58	5
11	Emergency mode aiming	6	10	59	2
12	Fire shot	2	15	54	20
13	Evaluating of firing results	2	15	34	20



Specialist's proficiency development and deterioration of skills dynamics

Changes in gunner's (ADAMS "Tunguska") skills level dynamics depending on structure of training process

Changes in gunner's training level depending on pause between training events

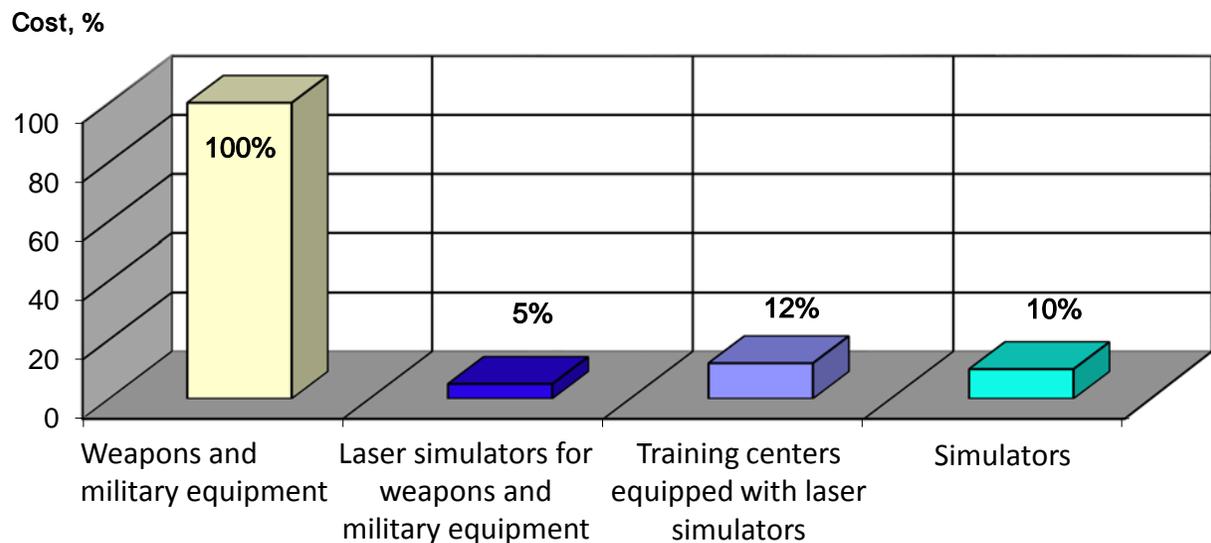


№	Ratio of gunner simulators ADAMS "Tunguska" usage	Training schedule					
		3 training events per week with duration 2 hours each			1 training events per week with duration 2 hours		
1	Number of gunner simulators, pcs.	1	2	1	1	2	1
2	Number of gunners to be trained, men	6	6	12	6	6	12
3	Total time to conduct training exercise by one gunner, hours	90	180	45	50	100	25
4	Total number of training exercises conducted by one gunner during training period	560	1119	250	147	294	79

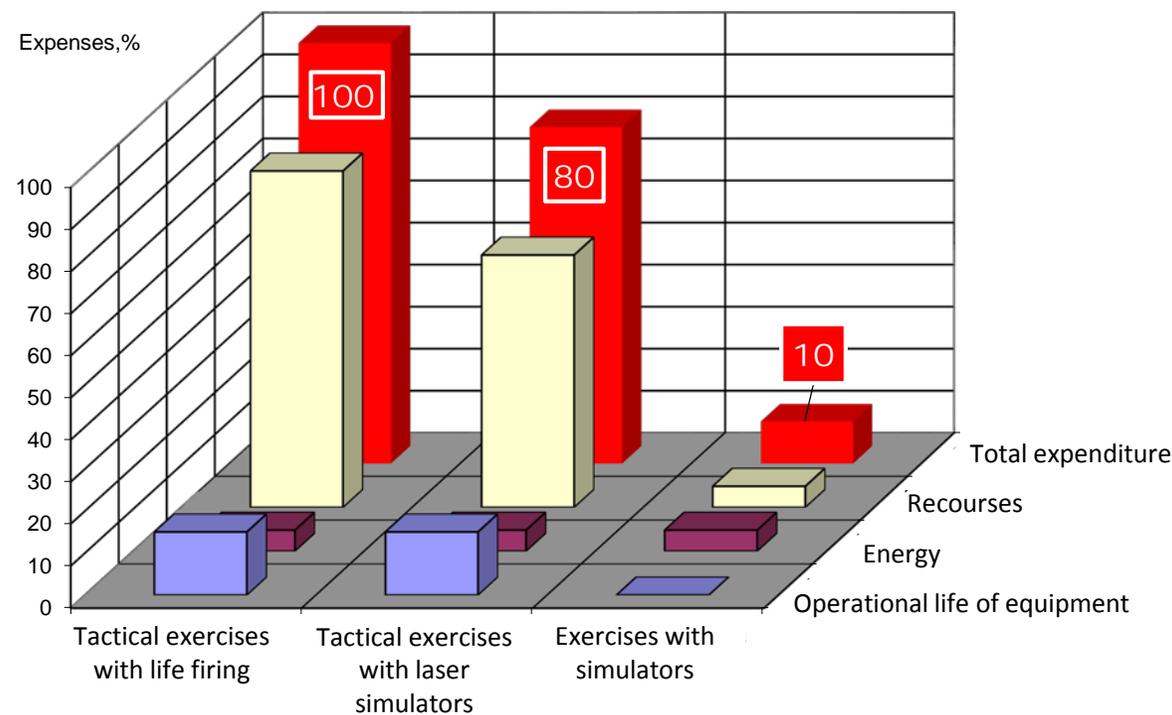
Shaping of skills Didactic model	Deprivation of skills Didactic model
$K_{jm} = 1 - (1 - K_{0j}) \exp(\alpha_j m)$	$K_i(T_n) = K_{0j} + (K_{jm} - K_{0j}) \exp(-\beta_j T_{ni})$
<p>K_{jm} – trainees' training status (timing or accuracy characteristics execution of operation or algorithm), that is achieved as result of training</p> <p>K_{0j} – entry level of training of trainee to execute i-operation (algorithm)</p> <p>i – serial number of operation (algorithm)</p> <p>m – number of iterations of i- operation (algorithm) during training event</p> <p>α_j – skill shaping index to execute i-operation (algorithm) during iteration</p>	<p>$K_i(T_n)$ – level of skill to execute i-operation (algorithm) after pause in training T_n</p> <p>K_{0j} – entry level of training of trainee to execute i-operation (algorithm)</p> <p>K_{jm} – trainees' training status, before the pause in training</p> <p>β_j – index of skill deprivation to execute i-operation (algorithm) when pause in training occur</p> <p>T_{ni} – duration of pause between two sequent training events to execute i-operation (algorithm)</p>

Economical indicators of simulators usage in units combat training system

Correlation of weapon systems and combat vehicles cost with the cost of simulators



Expenditure data comparison per 1 hour of training



Simulators in units combat training system

Simulator's role in combat training

1. The mean to shape weapons and combat vehicles operational skills
2. The mean to achieve crews and units cohesion

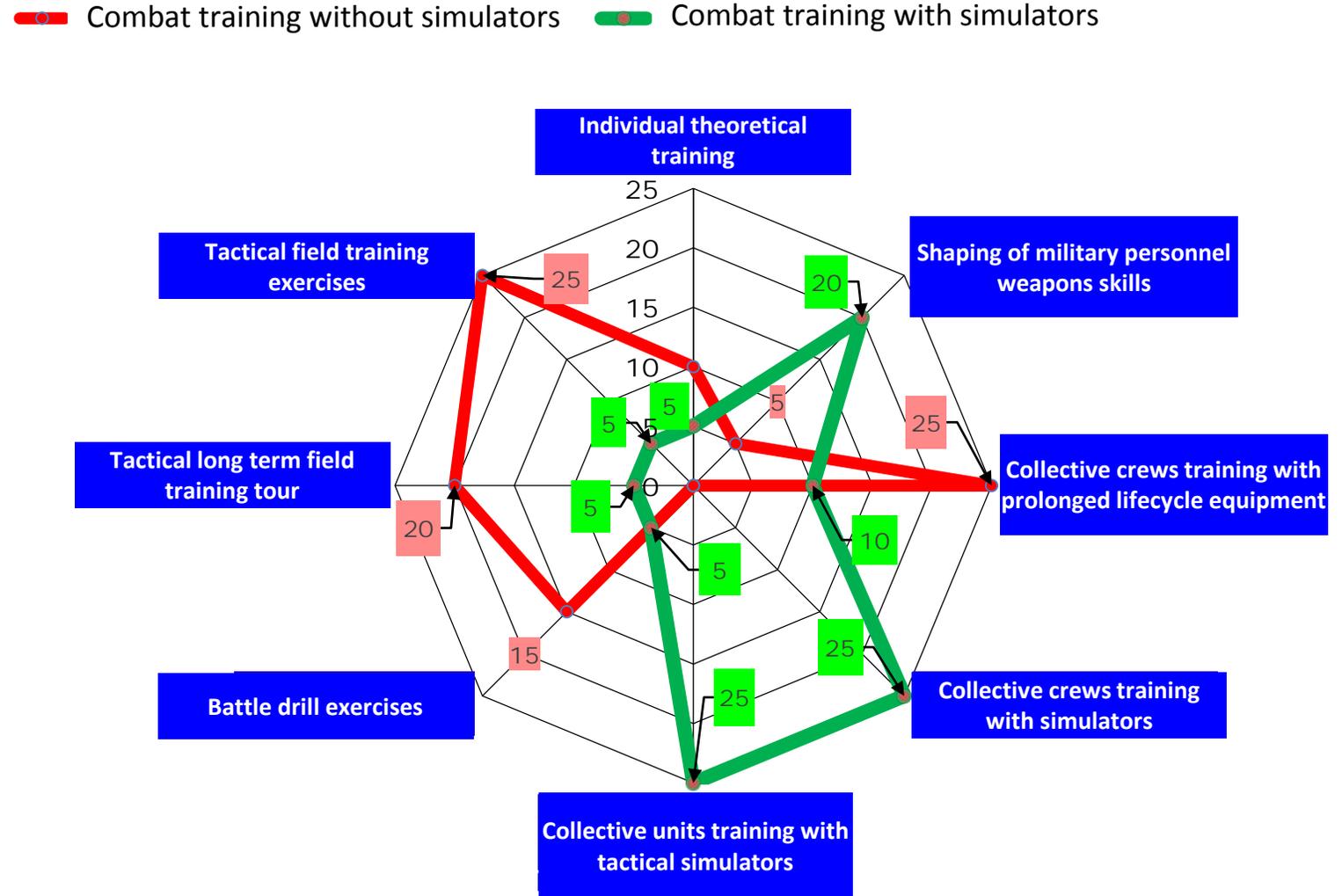
The place of simulators in combat training

1. Technical basis of individual training stage of military men
2. Technical basis of collective training stage of crews and units
3. Technical basis of unit commander's training

Effectiveness of simulators

1. Economy of fuel
2. Economy of ammunition
3. Economy of operational life of weapons systems and combat vehicles
4. Shortening of duration and promotion of quality of combat training of individual soldiers, as well as crews and units
5. Complete accomplishment of combat training tasks

Combat training time allocation (%) with usage of different types training aids



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Enterprise provides:

- ✓ Manufacturing, packaging and preservation, shipping of simulators to point of use
- ✓ Assembly works, operational commissioning tests and transferring to a customer
- ✓ Training of customer's technicians
- ✓ Warranted maintenance
- ✓ Post warranted maintenance (subject to separate agreement)
- ✓ Author's supervision and modernization of simulator's hardware and software during whole period of operations.