

Gheorghe Gabriel Văcaru¹

Under mentoring of Col. Kazimierz Kowalski, Ph.D.

THE FUTURE OF PERSONAL PROTECTION EQUIPMENT IN THE ARMY

Summary: *In the world where armed conflicts seem to be an inevitable part of the environment we inhabit, technology is rapidly advancing and asymmetry dominates these conflicts, the main focus of the armed forces is to manage conflict situations and crisis, as much as possible, with no casualties. Thus, to achieve this primary objective, defense industry has to develop and provide superior and sustainable integrated clothing and equipment as well as provide soldiers with state-of-the-art protection to defeat threats associated with ballistics, blast overpressure, fragmentation and heat, and, at the same time, to increase their mobility and allow them to operate in any conditions. Either if we talk about projects like carbon nanotube reinforced polymer based on nanotechnology, hydraulic exoskeleton or liquid body armour, armies have to keep up with this fast changing environment.*

Keywords: *personal protection equipment, body armour, future soldier, soldier protection system, liquid armour, nanotechnology, multi-functional equipment, exoskeleton*

INTRODUCTION

Serving in the military is a duty that can be very rewarding, but also very dangerous. If you serve in the military, it is important for you to be able to protect yourself properly from dangerous situations at any time.

Unlike civilians, military personnel do not have the option of simply avoid the danger. Military members sometimes must face dangerous circumstances head on. Having the proper military body armour can help ensure that soldiers are as safe as possible, regardless of the impending danger.

Armour, according to Dictionary of United States Army Terms², is a covering that is used to protect an object, individual, or vehicle from direct contact weapons or projectiles, usually during combat, or from a dangerous environment or action.

Throughout recorded history, there was an obvious concern for people about protecting themselves against any kind of danger they could face, so they improvised all kind of body armour which was made from various materials: from rudimentary leather protection, personal armour evolved to mail and full plated suits of armour, which also became ineffective at the moment when gunpowder and firearms were invented³. Armour mostly influenced the development of firearms, which revolutionised warfare.

Nowadays, armies declared target, in a potential armed conflict, is to protect their resources, especially their main resource – human resource, to reduce casualties to a minimum level and, at the same time, to become more efficient.

¹Gheorghe Gabriel Văcaru – Cadet from „Nicolae Bălcescu” Land Forces Academy, Sibiu, Romania.

² <http://fas.org/irp/doddir/army/ar310-25.pdf>, [downloaded on 12.05.2104].

³ <http://iarmor.org/about.php>, [downloaded on 12.05.2014].

Regarding that, as you can see in Figure 1, in the last century army expenditures increased, a big part of those amounts go for developing new body armour for soldiers. The results were an increase in spending per each soldier personal equipment, but with less army personnel to spend on, being possible to accomplish the same kind of mission with less soldiers, and the most important, and also the main objective, they have reached a huge decrease in number of casualties, from 41% in World War I to 12% nowadays (ratio of wounded in action to killed in action)⁴.

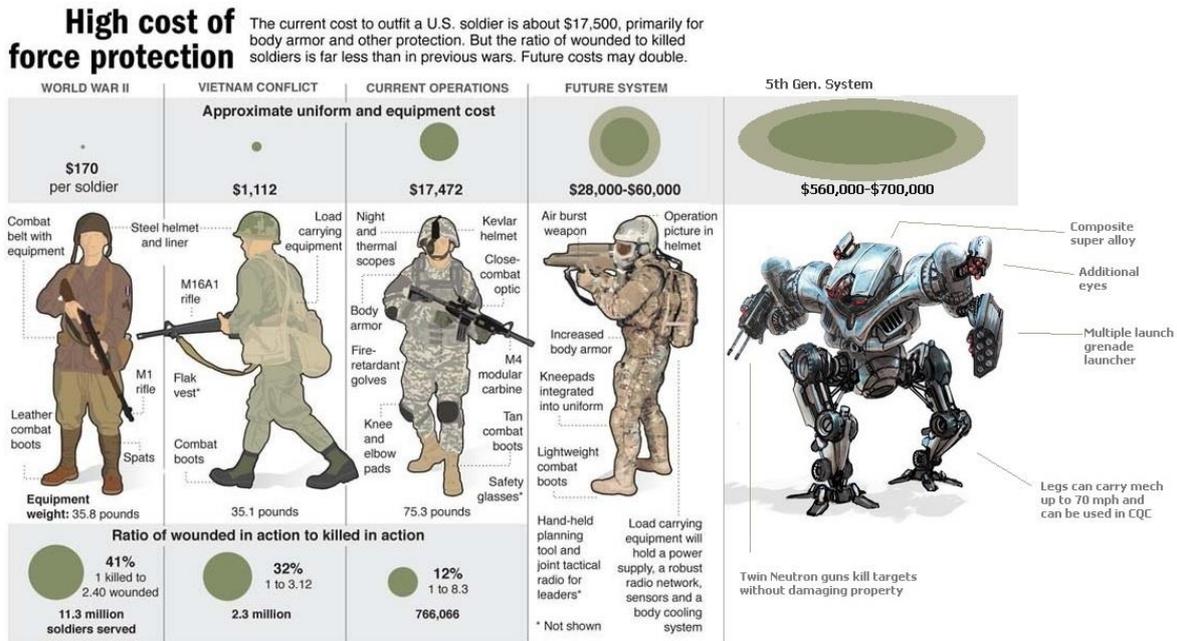


Fig. 1. High cost of force protection

Source: <http://3.bp.blogspot.com/-ATILFkh98Ag/TcHuZfOWiwI/AAAAAAAAAGpc/AqsYvLHZmVk/s1600/force-protection.png>, [downloaded on 12.04.2014].

With advances in ballistics, armies must develop better body armour. One type of modern body armour, first developed in the 1960s, is made out of advanced woven fibres that can be sewn into vests and other soft clothing⁵. More commonly known as Dupont Kevlar, this is one of the many body armour solutions currently employed by armed forces, but with time passing and technology evolving, this kind of composite material will become ineffective too, so, scientists need to find a solution for this matter.

Personal protection equipment today has to keep up with the new weapon system technology, and also with all the nowadays asymmetric threats. Designing military body armour is like a race without finish line: weaponry will always advance, so armour must constantly evolve. Between these two, throughout history, there was always an interdependency relationship, with each of them trying to be a step ahead from the other.

Now, scientists are working on different future protection equipment projects, which are parts of bigger programs, for near future and also for a longer period of time, to compete with the new threats.

⁴ <http://wweapons.blogspot.ro/2011/05/click-image-for-larger-view-as.html>, [downloaded on 12.05.2014].

⁵ <http://science.howstuffworks.com/ffw3.htm>, [downloaded on 12.05.2014].

1. SOLDIER PROTECTION SYSTEM

Soldier Protection System is one of this programs, to be developed and implemented in the following years, by PEO Soldier (Program Executive Office), which is an American governmental organization responsible for rapid prototyping, procurement, and fielding of equipment for U.S. soldiers⁶. This program is in development with the U.S. Special Forces and allows them to test new technology of modular protection equipment and eventually to come with suggestions based on their experience.

The aim of the SPS initiative is to provide head-to-toe coverage that is lighter and more interoperable as a personal protection equipment (PPE) ensemble. To achieve this, SPS is broken out into six product categories: Integrated Head Protection System, Transition Combat Eye Protection, Torso Protection, Individual Soldier Sensor System, Vital Torso Protection and Extremity Protection⁷ (Figure 2).

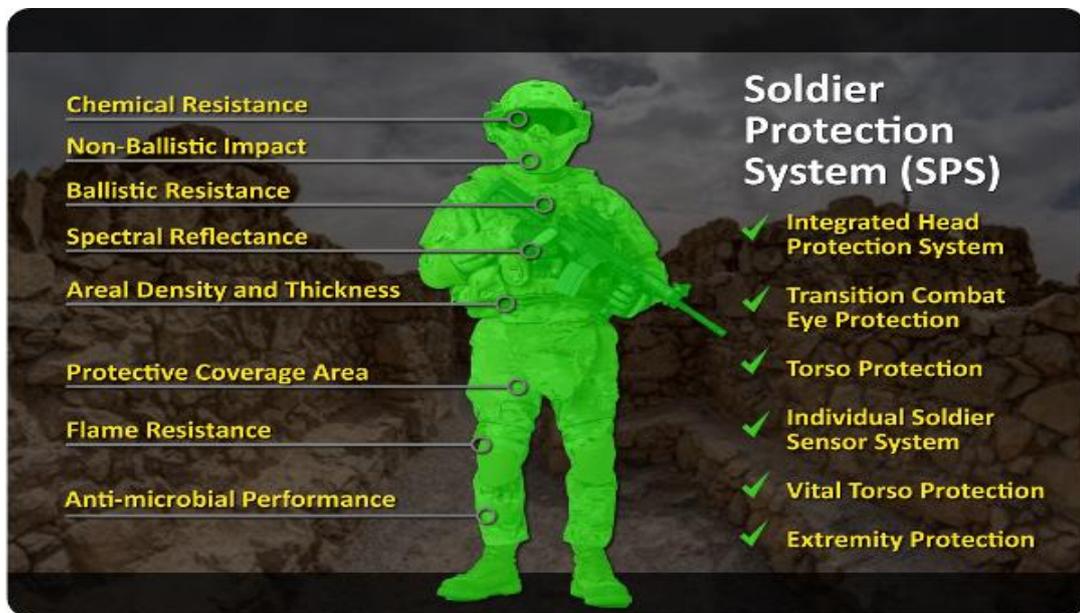


Fig. 2. Soldier Protection System (SPS)

Source: http://soldiersystems.net/blog1/wp-content/uploads/2013/04/Soldier_Protection_System.jpg, [downloaded on 12.05.2014].

The most revolutionary change brought by this program is the bulletproof vest made out of diamond particles. Scientists at DSM Dyneema, contractor for the U.S. Army, manipulated the molecules of diamonds to build better protection for soldiers. Dyneema employees have engineered diamond particles to grow so they form a flat shape that resembles a breastplate more than a diamond you may imagine on a wedding ring. The armour is light (15% less than current bulletproof vests), wearable, up to 10 times stronger than steel, better able to blunt the sharp points of bullets and will supposedly begin in few years to replace Kevlar, the material the military has used in its helmets and uniforms for decades now. This type of vest is expected to be used by the U.S. Special Forces within two years from now⁸.

⁶ <http://usarmy.vo.llnwd.net/e2/c/downloads/310291.pdf>, [downloaded on 12.05.2014].

⁷ <http://www.peosoldier.army.mil/docs/pmspie/sps-industry-day-16oct2012.pdf>, [downloaded on 11.06.2014].

⁸ <http://mashable.com/2013/12/31/military-armor-future/>, [downloaded on 12.05.2014].

2. FUTURE SOLDIER 2030 INITIATIVE (FIGURE 3)

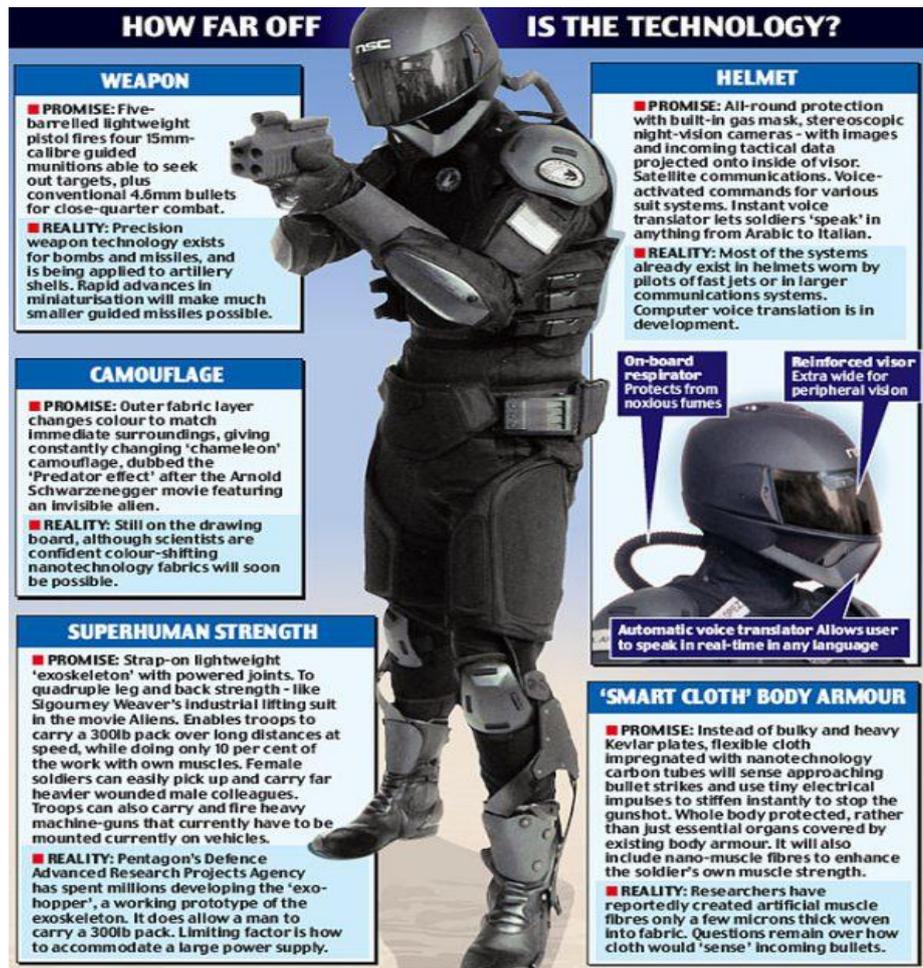


Fig. 3. Future Soldier 2030 Initiative

Source: <http://www.yaplakal.com/forum2/st/75/topic759528.html>, [downloaded on 12.05.2014].

Another U.S. program, the one for a longer period of time, is „Future Soldier 2030”. To better equip its soldiers, the U.S. Army is developing an advanced infantry uniform that will provide superhuman strength and greater ballistic protection than any uniform to date. Also, using wide-area networking and on-board computers, soldiers will be more aware of the action around them and of their own bodies. We may have seen it all before in science-fiction movies but the bionic warrior is in fact a vision of real-life warfare in the 21st century.

In 2030, the U.S. Army will roll out a suit that integrates nanotechnology, exoskeletons, the protection will be fully made out of liquid body armour and carbon nanotube reinforced polymer, the outer layer will be self-camouflaging that adapts to changing environments and the helmet system will be able to translate a soldier's voice into any foreign language, all of which exist only in concept now⁹.

Among the most important changes that the new project will bring, we encounter:

⁹ http://www.wired.com/images_blogs/dangerroom/2009/05/dplus2009_11641-1.pdf, [downloaded on 12.05.2014].

Liquid Body Armour – the fluid used in this type of armour is a shear-thickening fluid (STF) also called dilatant, which is an example of non-Newtonian fluid¹⁰, and behaves like a solid when it encounters mechanical stress or shear. This is the opposite of a shear-thinning fluid, like paint, which becomes thinner when it is agitated or shaken.

Before impact, the particles in shear-thickening fluid are in a state of equilibrium. After impact, they clump together, forming solid structures – Figure 4.

The fluid used in body armour is made of silica particles suspended in polyethylene glycol. Silica is a component of sand and quartz, and polyethylene glycol is a polymer commonly used in laxatives and lubricants. The silica particles are only a few nanometres in diameter, so many reports describe this fluid as a form of nanotechnology¹¹.

Liquid body armour is used together with Kevlar fibre and, in laboratory tests, four layers of STF-treated Kevlar can dissipate the same amount of energy as 14 layers of neat Kevlar and they do not stretch as far on impact as ordinary fibres, meaning that bullets do not penetrate as deeply into the armour or a person's tissue underneath, being effective in avoiding blunt traumas¹².

Helmet – will be equipped with mounted display that has a computer screen in order to view all the available digital maps and will also include a global positioning system for precise navigation and for providing commanders with exact positioning data on their troops. This element is very important because you can see exactly where everyone is located avoiding friendly fire and also any soldier can point out on the map where enemy is located so every team mate can be aware of this.

Another vital component of a battle is communication between soldiers. The future soldiers will use sensors that measure vibrations of the cranial cavity, eliminating the need for an external microphone. This bone-conduction technology allows soldiers to communicate with one another, and it also controls the menus visible through the drop-down eyepiece. The helmet has 360-degree situational awareness and voice amplification¹³.

Warrior Physiological Status Monitoring System – this layer of the suit is the closest to the body, lies against the soldier's skin, and contains sensors that monitor soldier's core body temperature, skin temperature, heart rate, body position (standing or sitting) and hydration levels. The suit relays the information to medics and field commanders (Figure 5).

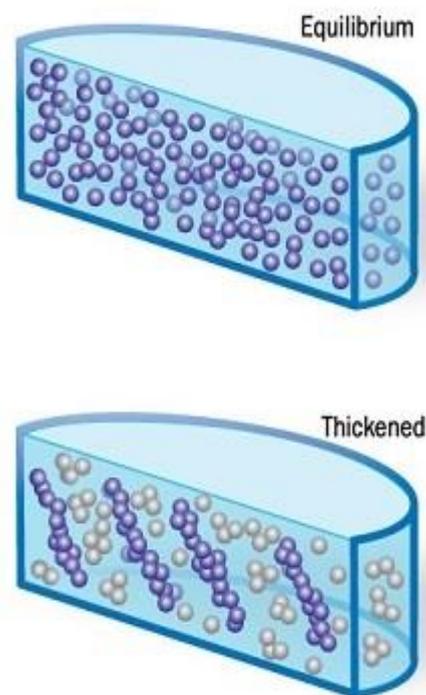


Fig. 4. Shear – Thickening Fluid

Source: <http://www.notalotofnews.com/shear-thickening-fluid-stf-for-body-armor/>, [downloaded on 12.05.2014].

¹⁰ <http://en.wikipedia.org/wiki/Dilatant>, [downloaded on 12.05.2014].

¹¹ <http://www.notalotofnews.com/shear-thickening-fluid-stf-for-body-armor/>, [downloaded on 12.05.2014].

¹² <http://science.howstuffworks.com/liquid-body-armor1.htm>, [downloaded on 12.05.2014].

¹³ <http://forums.cybernations.net/index.php?/topic/77302-the-republic-purchases-a-military/>, [downloaded on 12.05.2014].

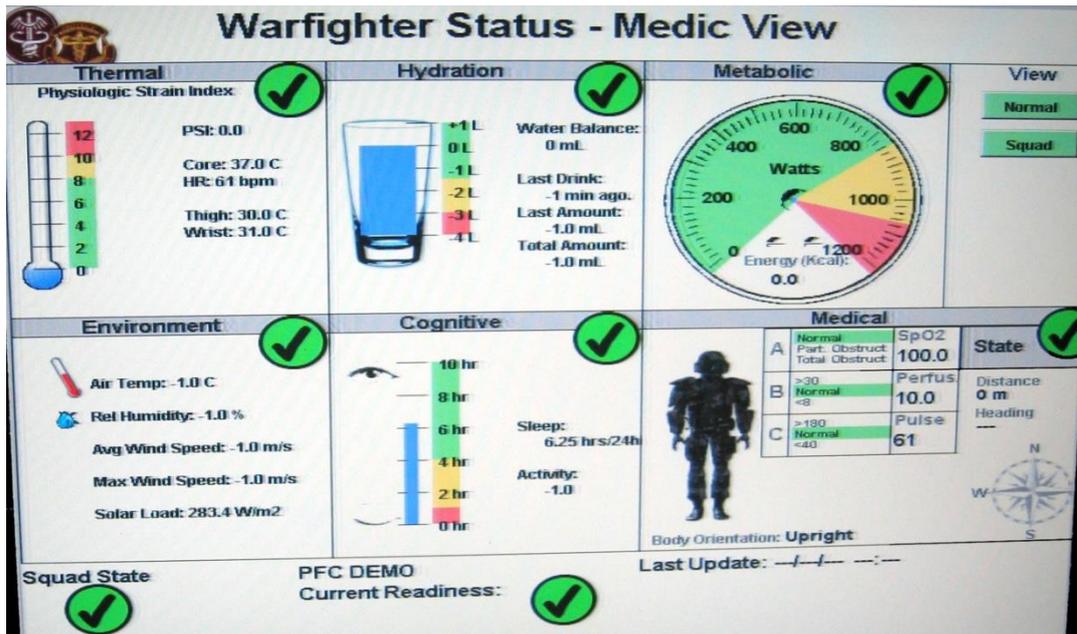


Fig. 5. Warrior Physiological Status Monitoring System

Source: <http://www.defense.gov/news/newsarticle.aspx?id=25636>, [downloaded on 12.05.2014].

Exoskeleton – is another vital part of this project because without this technology, future soldiers would not be able to carry all the equipment he is supposed to carry. The exoskeleton is made of lightweight, composite devices that attach to the legs and hands and augment the soldier's strength. In the shoulder of the Future Soldier uniform is a fabric filled with nanomachines that mimic the action of human muscles, flexing open and shut when stimulated by an electrical pulse. These nanomachines will create lift the way muscles do and augment overall lifting ability by 25 to 35 percent¹⁴.

CONCLUSION

Wars are evolutionary, with each new conflict bringing more powerful and advanced weaponry. Weapons that yield success on the modern battlefield today can quickly become outdated and ineffective in just a few years. The reality of the battlefield necessitates continuous change in the pursuit to stay a step ahead of the enemy. But, with all the new weapon technology, armies have to keep up with personal protection equipment, too. They need to focus on protecting their main resource: humans. Even if the technology gets to the point where the battles will be carried out by robots, this robots will still be designed, developed, built, controlled and, when needed, repaired by human beings. Thus every army priority is to protect and provide security for their own troops by investing in their safety and in developing new protection equipment.

Modern armies declared target, in a potential armed conflict, is to protect their resources, especially human resource, to reduce casualties to a minimum level and, at the same time, to become more efficient. U.S. Army Weapon System Handbook last issue motto was *The American soldier is our highest priority and most precious asset* and they stated that their mission is to *provide our soldiers a decisive advantage in any mission by developing, acquiring, fielding, and sustaining the world's best equipment and services*

¹⁴ <http://cobraithech.com/slides/Cutting%20Edge%20IT.swf>, [downloaded on 12.05.2014].

*and leveraging technologies and capabilities to meet current and future Army needs*¹⁵, and to fulfil that, the main focus of every army should fall on their own troops security and to provide them with the best protection equipment suitable for the mission they carry on.

REFERENCES

1. <http://3.bp.blogspot.com>
2. <http://cobraitech.com>
3. <http://en.wikipedia.org>
4. <http://fas.org>
5. <http://forums.cybernations.net>
6. <http://iarmor.org>
7. <http://mashable.com>
8. <http://science.howstuffworks.com>
9. <http://soldiersystems.net>
10. <http://usarmy.vo.llnwd.net>
11. <http://wweapons.blogspot.ro>
12. <http://www.defense.gov>
13. <http://www.notalotofnews.com>
14. <http://www.peosoldier.army.mil>
15. <http://www.wired.com>
16. <http://www.yaplakal.com>
17. U.S. Army Weapon System Handbook 2012

¹⁵ *U.S. Army Weapon System Handbook 2012.*

PRZYSZŁOŚĆ ŚRODKÓW OCHRONY OSOBISTEJ ŻOŁNIERZY

Streszczenie: *W świecie, w którym konflikty zbrojne są nieodłączną częścią rzeczywistości, gwałtownie rozwijająca się technologia determinuje asymetrię tych konfliktów. Głównym zadaniem sił zbrojnych jest radzenie sobie w powyższych sytuacjach konfliktowych oraz kryzysowych z jednoczesną minimalizacją ofiar w ludziach. Aby to osiągnąć przemysł obronny musi jednocześnie rozwijać technologie, a zarazem produkować najlepszej jakości oraz wytrzymałości umundurowanie oraz sprzęt wojskowy, jednocześnie zaopatrując żołnierzy w najnowocześniejsze środki bezpieczeństwa przeciwko zagrożeniom związanym z bronią palną, falą uderzeniową, odłamkami pocisków i wysoką temperaturą, zachowując jednocześnie ich mobilność i sprawność bojową w każdych warunkach. Do powyższych technologii zaliczamy: nanorurki węglowe wzmacniające polimery oparte na nanotechnologii, egzoszkielec hydrauliczny czy inteligentne kamizelki wykorzystujące do ochrony ciecz. Siły zbrojne muszą nadążyć za szybko zmieniającym się rzeczywistością.*

Słowa kluczowe: *środki ochrony osobistej, kamizelka kuloodporna, żołnierz przyszłości, system ochrony żołnierza, pancerz wodny, nanotechnologia, sprzęt wielofunkcyjny, egzoszkielec*