Neural and Biological Soldier Enhancement: From SciFi to Deployment

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ABSTRACT

We discuss selected highlights of future human performance enhancement and their potential impact as for example envisioned by authors of Science Fiction and Fantasy literature, coming into reach of man now. With reference to a new taxonomy of ergonomics as introduced by Kenneth R. Boff, we discern "technointegration" and "stimulated bioenhancement" and allocate these to the realms of neural respectively biological ergonomics, i.e. ergonomics of generation 3 and 4. Tools of knowledge generation including the Disruptive Technology Assessment Game approach are addressed. A brief comment on the perceivable shift in human-machine-boundary by society is included.

1.0 INTRODUCTION

In recent years we have seen substantial evolutionary or even disruptive advancement in and interaction of various disciplines of science. Referring to this contribution, they are the likes of nanoscience and -technology, medical analytics and diagnostics, neurosciences, pharmacology, drug targeting, genetic engineering, microsurgery or replacement and regenerative medicine. In succession, a rapidly extending comprehension of psycho-physiological processes and underlying biochemical and electrical patterns increasingly allows for manifold directed interaction either with body and brain itself, or with advanced technology. Thus, humans with supernatural abilities like pre-eminent hard and soft tissue resilience and force, extra- and ultra-sensory perception, side-effect free 72-hours unbowed alertness, or brain-based

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We discuss selected highlights of future human performance enhancement and their potential impact as for example envisioned by authors of Science Fiction and Fantasy literature, coming into reach of man now. With reference to a new taxonomy of ergonomics as introduced by Kenneth R. Boff, we discern technointegration and stimulated bioenhancement and allocate these to the realms of neural respectively biological ergonomics, i.e. ergonomics of generation 3 and 4. Tools of knowledge generation including the Disruptive Technology Assessment Game approach are addressed. A brief comment on the perceivable shift in human-machine-boundary by society is included.

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augmented reality perception, become conceivable and increasingly within reach. A lot of these extraordinary abilities have been anticipated and described in non-scientific literature during the last 100+ years, esp. in science fiction. By this, they have turned from being unthinkable to being imaginable, and have inspired generations of researchers.

According to Boff, we see the emergence of two new fields in human factors and ergonomics research [1]. Asides the two classical generations “Physical Fit”, i.e. adaption of equipment, workplace and tasks to human capabilities and limits, and “Cognitive Fit”, i.e. harmonious integration of humans, technology and work to enable effective systems, he identifies the new generations “Neural Fit” and “Biological Fit”. Neural fit investigates into symbiotic coupling of man with technology to amplify human physical and cognitive capabilities. Biological fit addresses non-technological enhancement by biological modification of physical and cognitive capabilities to maximise human effectiveness.

These innovations might, medium-term as well as in the long run, necessitate a RMA 2.0 (RMA = revolution in military affairs), i.e. reconsideration of operational structures and strategies, deployment and command, armament planning and so forth. They will change the rules of the game, as they are disruptive in character. In the short to medium term, they significantly might enhance individual capabilities of the deployed soldier, like for example in MOUT or DDD missions. Thus, the R&D progress in these topics mostly still perceived as visionary or exotic, might severely impact NATO forces´ future performance.

In addition, a shift in society´s perception of the parting rule between human and machine, the so called human-machine-boundary, as well as concerning associated ethics can be observed. This phenomenon can at least in part be ascribed to the self-perception and self-conception of younger generations that grew up embedded in a virtual gaming environment, with a surplus of high-tech SciFi movies and books at hands, and completely new ways of interaction and communication with humans and computers. Beyond this, subcultures emerged from the technoids and piercing scene that feature “functional” extremity implants like screws, pushbuttons or the like to “modify”, i.e. dress up themselves according to mood or theme party events. As vivid example from the scientific community may hold Prof. K. Warwick, University of Reading, who already performed several “upgrades” on himself that may be of generation 3 ergonomics, i.e. neural fit [2]. On the other hand, progress in replacement medicine and prosthetics added to the shift in perception by demonstrating a significant quality gain in life through high-tech support, e.g. by cochlear implants, pacemakers or deep brain stimulation. This in turn does not only provide for the impaired or disabled, but is of substantial interest for ageing societies.

To imagine new and amazing capabilities, SciFi may provide ample inspiration. However, only supported by elaborate methods of correlation of visionary capability requirements and emerging or prevalent technologies, inspiration will stand a chance to systematically turn into innovation. Thus, we introduce two methods from the innovation management set of tools that are notedly suited to enable visions turn reality. Finally, in order to assess visionary ideas in terms of military pros and cons, we allude to the recently developed NATO Disruptive Technology Assessment Game (NATO DTAG).

2.0 INSPIRATION: SCIENCE FICTION

Quite frequently, the birth of todays literary genre “Science Fiction” is allocated to the book “Cinq Semaines en Ballon” by Jules Verne, first published in 1862. Its foundation lies in science and technology of the industrial age. However, there is ample evidence for much earlier SciFi, like Kepler´s novel “Somnium” (finished around 1610), that we just do not recognise as such due to our contemporary cultural background. From the 1930s, the term Science Fiction had been established, and soon next to literature bound in books also trashy dime novels and comic strips appeared. At that time, supernatural characters like Superman, The Fantastic Four, Hulk or Elongated Man were sketched. But also loads of exotic technologies like Joystick and Remote Displays (1903) [3], Telemedicine (1909) [4], the Toughtscreen to visualise thoughts (1931) [5], an electronic Invisible Cloak (1931) [6], a HMI Tactile Sensorium, directly projected to the brain (1932) [7], or the SERT-helmet to control space ships by simultaneous emotions and reactions transfer (1968) [8] were anticipated long before the enabling technologies appeared on the scene.

A set of visualised concepts arrived in the 1960s with movies and television series like 2001: A Space Odyssey, or Star Trek, again presenting new technologies and abilities. Eamples are the laser gun Phaser, emotion-responding technologies like the computer HAL-9000 or the Tricorder medical diagnostics scanner.

A new quality was gained with the rise of Cyberpunk in the early 1980s, the name being a portmanteau of cybernetics and punk. The time frame of the story is usually near-future, the settings are often dystopian. Common technological themes include advances in information and communication, especially the Internet which visually is abstracted as cyberspace, artificial intelligence and neural as well as biological enhancement. Protagonists live and act part time in the virtual worlds of the cyberspace, but also feature implanted real-world upgrades like plug-and-play augmented reality interfaces to the brain, retractable mini-daggers under finger nails, high-resolution digital camera systems as eye replacements or biochips to enhance mental capabilities (1986) [9]. A first impressive visualisation of acting characters in the cyberspace was the movie “Tron” (1982).

With respect to modern military equipment, the novel “Starship Troopers” (1959) [10] popularised a number of concepts and innovations. The novel's most noted innovation is the powered armour exoskeleton used by the Mobile Infantry. This suit is controlled by the wearer's own movements, but significantly augments a soldier's strength, speed, weight carrying capacity, thus allowing much heavier personal armament, jumping ability - including jet and rocket boost assistance. It provides the wearer with improved senses via infrared and night vision, radar, and amplified hearing, a completely self-contained personal environment, sophisticated communications equipment, and a tactical map display.

3.0 INCUBATION: HUMAN ENHANCEMENT

Technointegration, or neural fit, investigates the symbiotic coupling of humans with technology to amplify human physical and cognitive capabilities. Major stimulus still is restorative medicine and prosthetics, ranging from limb replacement to communication support for patients suffering locked-in syndrome. Within the last two decades, enablers like nanotechnology, advanced materials or microelectromechanical systems (MEMS) technology started to facilitate contacting soft and hard tissue on the scale of living cells permanently without destructively intervening biological processes.

Stimulated bioenhancement, or biological fit, investigates methods and measures of non-technological enhancement by biological modification of physical and cognitive capabilities to maximise human effectiveness. Also here, within the last two decades major progress in R&D was and still is enabled by knowledge acquisition in disciplines like nanoscience and -technology, biochemistry, medical analytics and diagnostics, neurosciences, pharmacology, drug targeting or genetic engineering.

These developments address physical, physiological, psychological and perception capabilities. They affect all four domains of the HFM panel, i.e. Human Systems Integration, Human Effectiveness, Human Protection and in part Operational Medicine.

3.1 Technointegration

Technointegration comprises all possibilities of a man-machine-communication without involving extremities. Information exchange options between man and machine can either be established invasively by directly contacting nerves in brain or body, or non-invasively by using indirect signals.

Neuroprostheses, or neural integration, are characterised by a direct interface between the nervous system and electronic components. Communication between human and machine then uses the efferent, i.e. motor, division of the nervous system to transfer information to technology and the afferent, i.e. sensory, division of the nervous system to collect technology-generated input. Up to now, mostly uni-directional data transfer is employed.

In the first place, generation of electrical signals by the nervous system implies to use these for information transfer between man and machine. They can either be detected themselves or by measuring the corresponding electric or magnetic field. However, signalling via nerves involves electric impulses and chemical communication, the latter being rate limiting. Thus, two different kinds comprising four types of communication are possible. Up to now, chemical pathways utilising neurotransmitters and neuromodulators are not understood clearly enough to allow for directed communication purposes.

In the brain, mental processes come along with measurably increased physiological activity like higher oxygen consumption or slightly elevated temperatures. Also, the brain produces various types of waves in various states of coherence. This allows for non-invasive data transfer, though up to now on a very coarse level and mostly active, i.e. from the brain to technology.

To date, we are still very much in the infancy of neural integration. However, we can observe accelerated progress in all enabling fields of science and research, ranging from the understanding of the interplay of psycho-physiological processes and thoughts and emotions, to microsurgery, sensors technology and computer software, just to name a few. Today, invasive brain-machine-integration like Deep Brain Stimulation (DBS) and Cochlear Implant are “standard routines”, Auditory Brainstem Implant, Auditory Midbrain Implant or Retinal Implant in various states of clinical realisation. Also, additional benefits and functions of state-of-the-art implants are continuously revealed. For example, DBS aimed at relief for Parkinson patients, seems also to be beneficial in therapy of other forms of tremor (essential, multiple sclerosis), epilepsy, severe depression, cluster headache or obsessive-compulsive disorders like Tourette syndrome. Quite some of these “remedies” can be interpreted as measures enabling remote control of humans. Invasive BMIs allow for delay free information transfer.

Most non-invasive methods as EEG (Electro Encephalo Gram) or NIRS (Near Infrared Spectroscopy) still have the disadvantages of time delay, usually very low signal-to-noise ratio and compound nature of signals, of being very insensitive concerning accurate location of the signals origin, and so forth. However, for example fMRI (functional Magneto Resonance Imaging) can detect “decisions”, i.e. the initiation of intentional action, several milliseconds before the idea to act comes to consciousness and is transferred into brain impulses triggering physical action. Nevertheless, we already witnessed EEG-driven technology like wheelchairs, robots or artificial limbs.

NIRS, on the other hand, is at the moment the only non-invasive tool able to feed “information” into the brain. This is due to the functional principle of the NIRS interface. It emits sensor NIR-pulses into the brain tissue on a frequency that is not blocked by absorption through water. These NIR-pulses also could be used to selectively heat discrete areas of the brain e.g. by crossed beam method.

Since the entertainment industry discovered the opportunities of multimodal game controlling beyond plain “joystick” interaction, an additional acceleration of applied research into non-invasive technointegration can be expected. As example may be mentioned a game controller headset developed Emotiv Systems, called EPOC. Utilising 14 “strategically placed” sensors it detects neural signals (EEG) and signals from facial muscular movement. These signals are then narrowed down and interpreted in 30 possible ways. Asides actions in a way beyond the capabilities of a physical controller, they enable real-time intentions, emotions and facial expressions reflected in cyberspace avatars. This combination of signalling considerably accelerates information transfer and widens the spectrum of parallel communication signals at hands. Furthermore, it is a first step into a rudimental authentic interaction in cyberspace domains like Second Life.

Looking into the future, neural integration might quite soon enable functional coupling of the peripheral nervous system to advanced technology in a plug-and-play-like manner. According to experts interviewed in 2007, from then on in 5 to 10 years direct multifunctional coupling of nerves in extremities like an arm could be a standard surgery routine. Also, at that time all materials used in the respective HMIs should be substantially enhanced to provide at least one decade of smooth and failure-free service. The same holds true for BMI fixed on the surface of the cortex. Restorative surgery like technologically bridging lesions of the spinal cord or from there to the peripheral system could be routine in 10 to 15 years. With respect to multifunctional deep brain implant BMIs, the experts assumed a time horizon of 15 to 25 years to achieve standard routine status, depending on factors like robotic surgery assistance, visual high-resolution 3D-diagnostics of the brain and more precise allocation of brain functions to discrete regions (functional clusters of neurons). All these estimations did only account for technological and medical feasibility, free of ethical or political constraints.

On the one hand, technointegration faces new challenges in functional materials, miniaturisation, computing power, software and energy supply. On the other hand, novel challenges appear through direct information input from various sensors working outside of human perception abilities. When thinking beyond classical prosthetics, as a fully functional hand with tactile sensory may represent, there still is a major lack of knowledge on how the human brain would process and interpret data from artificial extrasensory sources like UV- or IR-vision, ultrasound or magnetic field sensors. Thus, asides experimentation in processing of technology-generated data towards human requirements, research in perception modes and cognitive/mental training is still due. According to the experience of K. Warwick [11], the output of head-mounted ultrasonic sensors as substitute spatial orientation device when blindfolded worked very well after few minutes of accommodation to the new sensory input. He also reported that the input pulses where not witnessed as one of the normal five senses. Though only a one-off self experimentation, the results seem quite promising for utile invasive human-technology integration.

Once invasive technointegration provides rugged bi-directional multichannel interfaces, human enhancement will range from imaginable upgrades like “extra-sensorial” perception, superhuman physical capabilities like superstrength, superfastness, or superprecision by direct docking to and melting with an exoskeleton, superior artificial organ and limb substitutes, to the yet inconceivable. However, also for non-invasive technointegration extraordinary accomplishments as mental capabilities like pre-cognition and faster data processing lie ahead.

3.2 Stimulated Bioenhancement

Already today, bioenhancement knows a plethora of ways to enhance physiological and mental performance. Next to health care related research and development, doping in sports can be regarded upon as a main driver in this field. Interestingly though, according to a recent online poll academia seems to be a major consumer, or beneficiary [12].

Predominantly, effective interventions tackle elemental levels of live - the genetic code and the body´s biochemical processes. A major change in quality of enhancement is about to be gained through personalised pharmacological products with none or neglectable side effects, on the other hand through opportunities provided by stem cell “technology” and genetic engineering.

Optimisation of body and brain functions by neuroactive substances is well known for centuries and has also been employed on the battlefield. Traditional stimulants comprise caffeine, glucose, nicotine, but also a wide variety of plants and extracts, like henbane, poppy, Labrador tea or wormwood. Usually they work by increasing the amount of neuron activity or by releasing neuromodulators. Deeper understanding of neuro-biochemical processes is leading to a broad spectrum of controlled pharmacological pathways to selectively address and enhance various physiological capabilities, i.e. mental, cognitive and physical performance parameters. Asides this, pharmacological agents will be helpful in unlearning phobias and addictions, i.e. for a highly selective modification of ones own personal memory. Thus, the combination of different pharmacological agents administered at appropriate times might allow future users a fine-grained control of their learning process.

To begin with, a rather unspecific goal is to pharmacologically induce a state called Flow, also know as Runner´s High. Flow is a mental state of operation in which the person is fully immersed in what he or she is doing, with the respective action executed at much higher performance levels as usual. Its physiological counterpart is cardiac coherence, an optimum synchronisation of respiration, heartbeat and blood pressure. It seems proven that Anandamide (after Sanskrit ananda for “Bliss”), the body’s endogenous equivalent to THC in marijuana, enables this physiological state by transporting endorphins through the blood-brain barrier. However, Anandamide triggers short term memory loss, which still is an obstacle to be overcome before commercialisation of “Flow-Pills”. The state of flow also can be evoked deliberately by experienced (Buddhist, Transcendental Meditation, etc.) meditators practicing regularly.

In recent years, several commercial drugs like Provigil/Nuvigil or Ritalin have found alternative markets with the healthy far off their original target. The pharmacological substance modafinil and its enantiomer armodafinil are stimulant-like drugs for the treatment of narcolepsy, shift work sleep disorder, and excessive daytime sleepiness associated with obstructive sleep apnea. With the healthy, they are in use to significantly reduce performance lessening due to sleep loss with apparently none or neglectable side effects and risk of dependency. Furthermore, modafinil has been shown to enhance working memory in healthy persons. This makes it very promising for use in military operations, as unbowed vigilance, attentiveness and concentration can be kept up over 24 hours and extended towards 48 hours. Ritalin, an analeptic drug too, is indicated in the treatment of Attention-Deficit Hyperactivity Disorder (ADHD). Its psychoactive agent is methylphenidate, a potent central nervous system stimulant closely related to amphetamines. The most frequent off-label use is the enhancement of cognitive and learning processes. These findings successfully initiated research specialised into development of “steroids for the brain”, so-called Smart Pills to improve long-term memory. In a first step agents are developed that permanently increase the concentration of the respective neurotransmitters.

Turning towards physical body enhancement through pharmacological stimulation, as an outstanding example may hold the discovery of the growth factor protein Myostatin. Active Myostatin keeps muscle stem cells inactive as long as normal levels of physical load are applied to the body. Research in Bully- or Double-Muscle Whippets revealed, that with them Myostatin is switched off. These dogs show approximately doubled muscle mass as their regular siblings and, if trained properly, run close to the double speed of them. Myostatin-blocking agents already have been developed and successfully tested on animals. Their use by humans is assumed in isolated cases due to observed irregular gain in muscle volume. However, during the last decade also several human births with deactivated Myostatin were reported.

Stem cell therapy seems to introduce limitless therapeutic opportunities ranging from in-vivo regenerating or in-vitro grafting of individualised replacement organs, healing of cancer or neurological diseases to inversion of the aging process. Obviously, also the healthy body could be enhanced to perform superior, like by growing additional muscles, more resilient bones or enlarged lung volume. In theory, any human body may physically become prepared for or adaptable to specific tasks. Actual obstacles to progress are imposed by unsolved questions like how to reliably direct stem cells to their target region, how to fix them there, and how to activate them at the right moment to the desired expression.

Gene doping has in recent years come to public attention through doping related scandals in sports. Research is at the moment focused on treatment of degenerative diseases of the muscular system. Gene doping works by delivering a modified genetic code to the owner´s body through viral vectors. The modified code will activate a correct programme to restore or enhance physical body capabilities. Also here, the hows, whens and whys of code activation are not fully understood yet, but experts do not doubt a major breakthrough will happen.

4.0 INNOVATION: TOOLS TO GUIDE AND DIRECT R&D

Innovation and Technology Management has developed a broad variety of tools to guide, accelerate and render more precisely innovation processes from early stages of identification of customer needs to design and experimentation of prototypes, production, marketing, and sales. These tools also can be used or adapted to assess future needs in security and defence, identify options and evaluate chances and risks of evolutionary as well as disruptive developments. Of course, they enable to analyse feasibility of SciFi inventions, or at least of one or alternate cascades of enabling knowledge and technologies to approach SciFi-ctional capabilities. In this section, we briefly introduce and discuss two important toolsets: House of Quality and TRIZ.

4.1 House of Quality

The House of Quality (HoQ) is the central function within the innovation management tool Quality Function Deployment (QFD) and quite flexible concerning the correlation of any “Whats” to “Hows”. QFD is an important communications and planning method in early stages of the innovation process. According to its inventor, Y. Akao, it is a method to transform user demands into design quality, to deploy the functions forming quality, and to deploy methods for achieving the design quality into subsystems and component parts, and ultimately to specific elements of the manufacturing process. The main task of HoQ is to link customer demands to respective technological requirements and solutions, to facilitate the assessment of the interaction of all identified technologies, competitor evaluation etc. (see Fig. 1). However, a much broader scope of applications for this method is obvious.

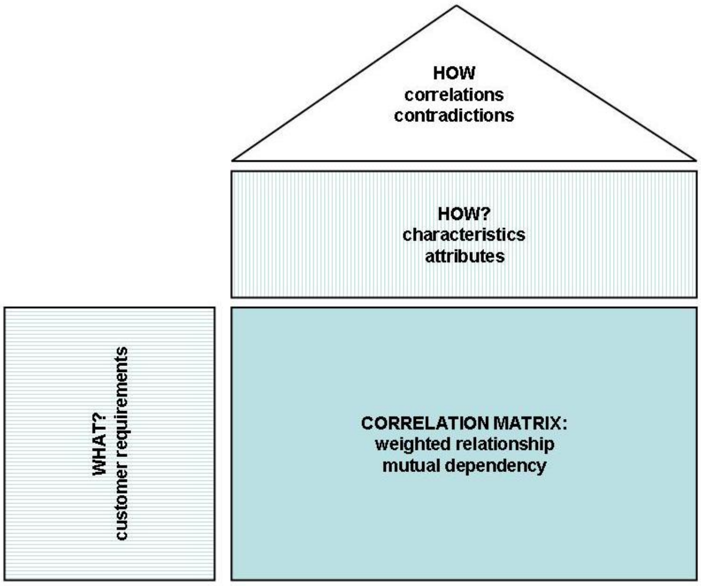

Figure 1: House of Quality, basic general building blocks. A fully expressed HoQ provides several more units like cellar, mezzanine, or attached rooms.

4.2 TRIZ

The theory of inventive problem solving, TRIZ (from Russian Teoriya Resheniya Izobretatelskikh Zadatch), is a method based on the systematic analysis of tens of thousands of patents for their underlying design patterns and principles. It provides tools and methods for use in problem framing, system analysis, failure analysis, and patterns of systems evolution. From a methodological point of view, it is a combination of intuitive (like brainstorming) and discursive (like Osborn´s checklist) creativity methods.

TRIZ is for example very helpful in answering to technological contradictions identified by the crosschecking process of the "Hows" in the roof of the HoQ. Over the last decade, lots of effort is put into transfer of TRIZ principles and approaches to other disciplines outside technology. TRIZ is made up of a broad variety of tools and methods to elaborate creative and effective solutions to all technology-based problems. It comprises four core elements: system, knowledge, analogies, and visioning.

The TRIZ process is initiated with a systematic analysis and the definition of the goal. Here, tools like the innovation checklist to collect all available information on the object/topic, including resources and prevalent knowledge, the Ishikawa diagram to identify causes of problems, the visualisation of the ideal state or solution, an analysis of the resources at hands, or the anticipating failure (mode and effects) analysis are employed.

Secondly, all available knowledge on the subject under investigation is collected. Tools like bibliometrics and patent analysis, but also managerial tools like an environmental analysis – what are the corresponding upstream, downstream, complementary and substituting technologies – are used.

The third element, creating analogies by abstraction, identification of typical solutions, and concretisation, is crucial core element and unique with TRIZ (see Fig. 2). Here, specific tools mostly developed by the inventor of TRIZ, G.S. Altshuller, are employed. These comprise the matrix of contradictions, the laws of technical systems evolution, the algorithm of inventive problems solving (ARIZ), the 76 standard procedures, or the four separation principles to solve physical contradictions.

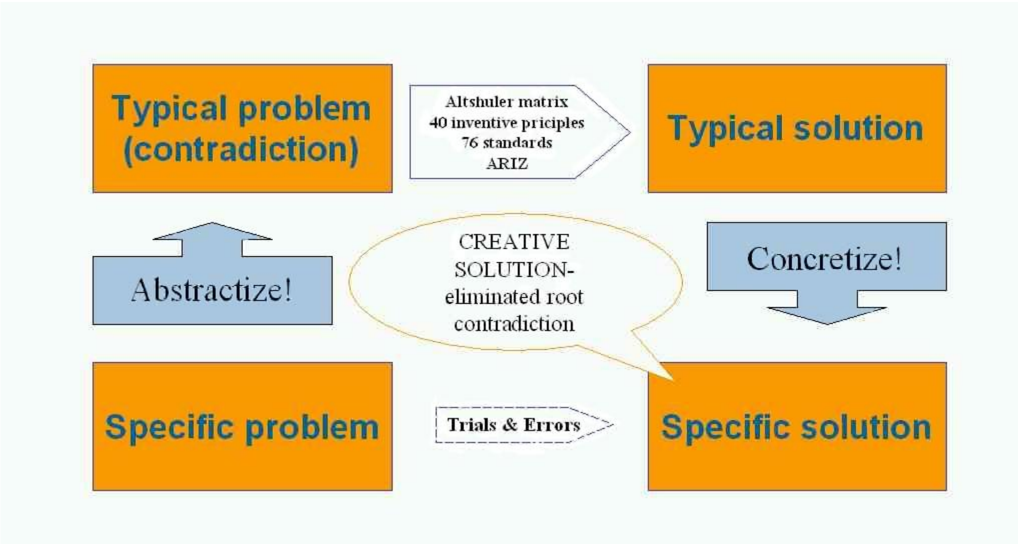

Figure 2: Core process in creative problem solving (http://en.wikipedia.org/wiki/TRIZ).

Finally, visioning should accompany the whole process of TRIZ to enable optimum efficiency and ideal solution finding during all stages of the process itself as well as with respect to the degree of maturity of technological solutions within a products live cycle.

5.0 EVALUATION: THE NATO DISRUPTIVE TECHNOLOGY ASSESSMENT GAME (DTAG)

The NATO DTAG is a holistic approach to assess all facettes of foreseeable impact of emerging technologies and anticipated systems (ideas of systems) enabled by them. Special focus is on so-called disruptive technologies.

The term "Disruptive Technology" was introduced to the business world in the context of innovations based on technological developments. It is aimed at sharpening the awareness of new technologies which could disrupt the economic context of a business, leading to the breakdown of companies [13]. The term Disruptive Technologies has also inspired other communities. One of these is the domain of international research and technology cooperation and technological forecasting for defence and security planning. In this context, a Disruptive Technology stands for a technology-based development that changes the conduct of operations including the rules of engagement significantly within a short period of time. Disruptive military technologies of the past are for example nuclear weapons, radar-stealth technology or precision-guided munitions. Technically and/or biologically enhancing humans as well is very likely to cause disruptions.

The question of how to identify and evaluate possible disruptiveness of technologies for defence is challenging. The standard bottom-up approach is based on monitoring of emerging technologies and their course of development. The alternative option is a top-down approach, where presumably disruptive capabilities are identified and analysed for their underlying enabling and therefore potentially disruptive technologies. These pathways are typically chosen in national foresight activities. However, they can at best identify "candidates" with disruption potential. A content-oriented analysis of disruptiveness has to be performed to reveal helpful conclusions and recommendations for decision makers.

The NATO-SAS subgroup 062 has developed and tested a promising methodology, a process involving military staff in a wargame-like setting. First step is the identification of interesting technologies, performed by the participating nations, mainly based on evidence (e.g. literature scanning) and expertise methods (using skill and knowledge of experts). The relevant information about these technologies is extracted, consolidated and given a common two-page format, known as the Technology Card or T-Card. These T-Cards provide information about the technology, its possible applications, readiness, drivers/actors and relevance to defence. In a second, creative step a number of higher aggregate level "Ideas of System" (IoS) are generated, based on the identified technologies and condensed into IoS Cards. The rationale behind this is that it is hardly possible to directly assess the impact of technologies, but rather of the systems and capabilities that they enable.

The third step and core of the methodology is the so-called "Disruptive-Technology Assessment Game" (DTAG) where the potential use of the IoS are explored in a military context, by interaction of military players, technologists and analysts. Every DTAG consists of a number of vignettes, each considering a different military task. The military tasks are placed within the same NATO scenario, but are independent of each other. For the game, military players are split into two teams, Red and Blue, with each team supported by technologists, an analyst, and a military controller. The DTAG activities demonstrated that relatively immature technologies still can be successfully assessed [14, 15].

6.0 CONCLUSIONS

Neglecting ethical and political issues, the future of human enhancement provides options that up to now at best can be imagined by inspiration from science fiction. Technological as well as bio-medical progress is on the way to acquire capabilities enabling permanent technointegration on the level of the nervous system as well as transient or permanent stimulated bioenhancement far beyond normal body functions and resources. This will change the rules and conduct of military conflicts and introduce a new quality of asymmetry to the battlefield. To prepare for this, anticipation of future capabilities of humans and human-machine systems as inspired by SciFi is necessary. As support, the tools House of Quality and TRIZ have been introduced. To evaluate the impact of the methodically derived future capabilities we referred to the recently established NATO Disruptive Technology Assessment Game.

As history proves, man frequently took advantage of novel technologies at the adversities of others. However, human enhancement has reached a quality affecting and conflicting with natural evolution. Thus it is on the verge to outbalance civilisation on a new level - as mankind is in a position whereby it has the potential to evolve its own destiny. Ethics and related issues will have to be discussed, probably against the interests of strong lobbying parties. Up to now, only actions to be interpreted as "preliminaries" have been taken, like the STOA workshop "A European Approach to Human Enhancement" in the European Parliament, 24th Feb. 2009.

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