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Science and Technology



Technological developments and challenges

Perspectives between fiction and reality

Maison d'Ailleurs

Marc Atallah
Director and curator
of the Maison d'Ailleurs



Dear reader,

These days it is clear that our relationship with science and technologies is not mainly conditioned by advances in actual research, but that it is also steeped in images and scenarios derived from science fiction that are part of our everyday exposure. Reflecting on science and technologies thus always entails reflecting that they can never be dissociated from the scenarios that confer upon them meaning as well as the values referenced by such scenarios.

For this reason, the Maison d'Ailleurs is very enthusiastic about this original collaboration with armasuisse S+T: the science fiction museum has worked for forty years on collecting and analysing futuristic narratives with a view to elucidating our complex relationship with science and technologies. Without such elucidation, one might argue that it is difficult to be free. Happy reading!

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Dr. Thomas Rothacher
Head of Science
and Technology S+T



Dear reader,

While technology is not the only driver of developments on the battlefield, it may certainly be seen as a catalyst, if not the trigger for most changes that take place between generations.

At armasuisse S+T, we test and evaluate the operational availability, functionalities, and efficiency of current and future Swiss army systems. We are committed to enabling our clients to take technologically enlightened decisions while minimising investment risks and guaranteeing that the highest levels of safety are adhered to.

Anticipating technologies in order to have better control over them, to understand the boundaries between science fiction and reality, we work tirelessly for a safer Switzerland.

Dr. Hansruedi Bircher
Director of research



Technologies are developing at a hitherto unknown rate. They are one of the important design components for modern armies and a key factor in the successful conduct of operations. However, an overall approach of societal, political, economic, military, and technological developments is required in order to grasp, in all its complexity, the context in which decision makers are called upon to take action.

Responsible for managing the various technological challenges, the research management and operational research unit is based on research programmes in the followed fields: reconnaissance and surveillance; communication, cyber-space and information; impact, protection and security; autonomous systems; technology prospective.

Observing in order to predict better, understanding in order to take action better, we contribute actively to the technological future of Switzerland for its defence and its security.

Dr. Quentin Ladetto
Research Director -
Technology Foresight



The mission of the scientific prospective programme at armasuisse Science and Technology is to acquire the knowledge necessary for the understanding of emergent technologies that can provide opportunities or threats for the military domain in general, and for the Swiss army in particular.

These different technologies that exist at the heart of interactive ecosystems materialise in new systems or make possible new levels of capabilities. What could be more appropriate therefore, than science fiction, to describe and communicate these emerging realities and concepts?

Using an innovative format and content in which imagination and actual developments interact, we hope to raise the reader's awareness of technological subjects that have come to play fundamental roles in aspects of our future.

We wish you a pleasant journey.



12 technology domains

Robotics

Human performance

Augmented and virtual reality

Additive manufacturing

Artificial intelligence

The internet of things

Hypersonic missiles and vectors

New materials

Electromagnetic spectrum

Quantum computing

Space technologies

Synthetic biology



Efficiency...distributed

Conduct...instantaneous

Information...validated

Resilience...unlimited

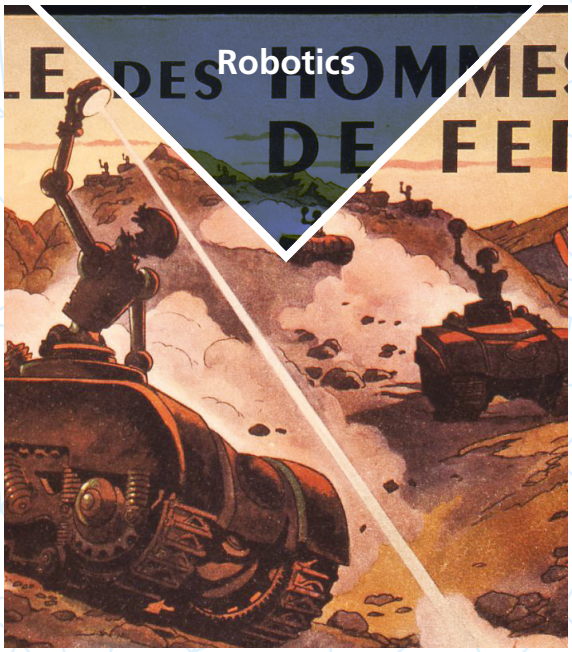
Mobility...ensured

Protection...enhanced

6 challenges to be faced

The robot in science fiction: a metaphor for man

The term "robot" was used for the first time in a play written in 1920 by the Czech writer Capek: R.U.R. this play invented two fundamental elements: the robot is a metaphor for man without a soul (in other words a pure body, automated, and without an individual identity); and if the robot were to rebel, it would not be because machines rebel, but because men refuse to be reduced – alienated – to the status of anonymous machines. Perhaps this is why we are so often concerned about the robots that proliferate in our day-to-day lives: they remind us that we were in fact the first entities to be robotised.



The best friend or the worst enemy of mankind ?

Military robotics is a reality in driverless vehicles (airborne, land, and water) that can be remotely controlled or totally autonomous, with, depending on the task to be fulfilled, a human in the decision-making loop.
The use of robotised systems makes possible access to zones that are inaccessible to humans, facilitates permanent surveillance, and assists the solider in the transport of equipment as well as in the existence of automated logistical convoys.

Is the cyborg of science fiction already here ?

The cyborg of science fiction, often characterised as a super warrior or super policeman, has the defining property of being a hybrid with technological prostheses: artificial limbs and consorts overcome human limitations and create a superhuman, an "enhanced" human. Science fiction does not conceive of cyborgs in order to delineate for us the contours of the future, but in order to place the emphasis on the evidence: we are already interfaced with machines and we have already delegated our powers to technologies. In other words, we are already cyborgs – and a question remains: what weaknesses do we refuse to accept?

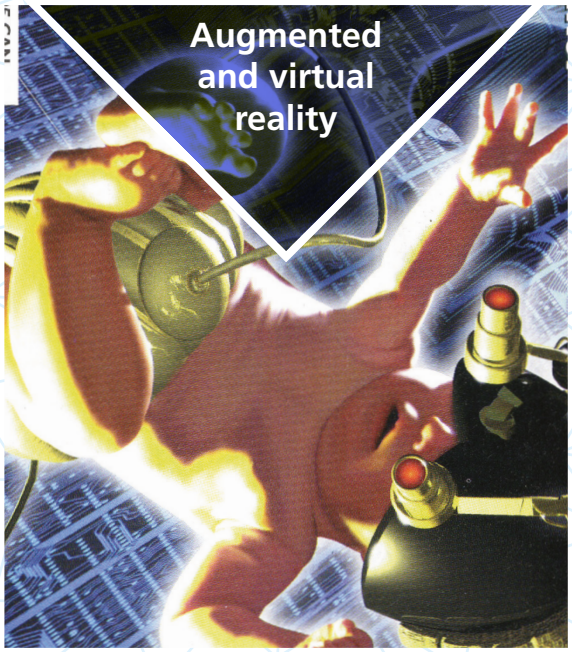


Is the cyborg the future soldier ?

The enhanced soldier is a soldier with enhanced capabilities, or capabilities that are stimulated or created from scratch with a view to reinforcing their operational efficiency.
These enhancements may range from physiological modification to a change in psychological state, to the use of resources, which, as a part of the entity, provide continuity in the enhancement of their physical, sensory, or cognitive capabilities.

The virtual world: an opportunity to reinvent ourselves ?

Virtual or enhanced reality technologies that were already used in science fiction stories since the end of the 1980s are now rapidly expanding. However, these stories do not use them to seek what they contribute in reality; instead, they tend to address the issue of simulation.
If, in fact, I can exist in a virtual world as well as in the real world, is this not a matter of creating an equivalence and reminding ourselves that our reality is a simulation, in other words, a contingent model? And, if this is the case, can I not modify this simulation, transform it so that is becomes worse …or better?

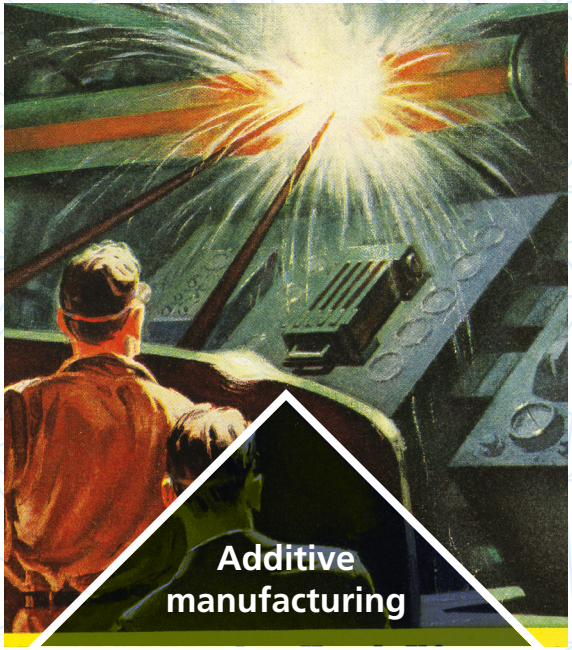


Virtual games, real effects ?

Enhanced reality is the fusion of real and virtual worlds in order to create new visualisation environments. In these, physical and digital objects coexist and interact in real time.
Applications designed to offer soldiers and pilots a better understanding of their direct environment, as well as the option of training in realistic contexts.
This superimposition of information facilitates remote learning and the provision of support in new tasks for people without prior training.

Constructing the world for a new start ?

From the emergence of nanotechnologies in the 1950s to the 3D printers of today, the fantasy of being able to construct objects part by part has never been so powerful, to the extent that being human feels like being a demiurge, capable of constructing the world around him/her, in order to exploit it at his/her convenience.
However, this all-powerful fantasy also hides an unseen aspect: that the desire to recompose everything entails acceptance that reality is imperfect if not constructed in our image. It also means passively accepting that man should be manufactured rather than born: do we really wish to escape from ourselves?



All possible forms ?

Additive manufacturing is a process that involves the layer by layer manufacture (addition of material) of a solid object obtained from a digital model.
This technology makes possible the creation of almost any shape, unlike traditional extrusion and machining (the removal of material). Additive manufacturing is used for rapid prototyping, repairing deployed military equipment, the creation of bespoke parts and unique elements.

From the robot to AI: science fiction as a mirror of our evolutions

Three fictional figures were used in the 20th century by science fiction: the robot (1920), the cyborg (1970), and artificial intelligence (1980).
These figures, although described in terms analogous with real technologies, should in fact be treated as metaphors: the robot is man without a soul, the cyborg expresses the hybridisation of man and technology, and artificial intelligence is man disembodied.
What is troubling is the perspective and reflection: does our desire to imagine that the machines we create could overtake us primarily evoke our (unconscious) desire to disappear?

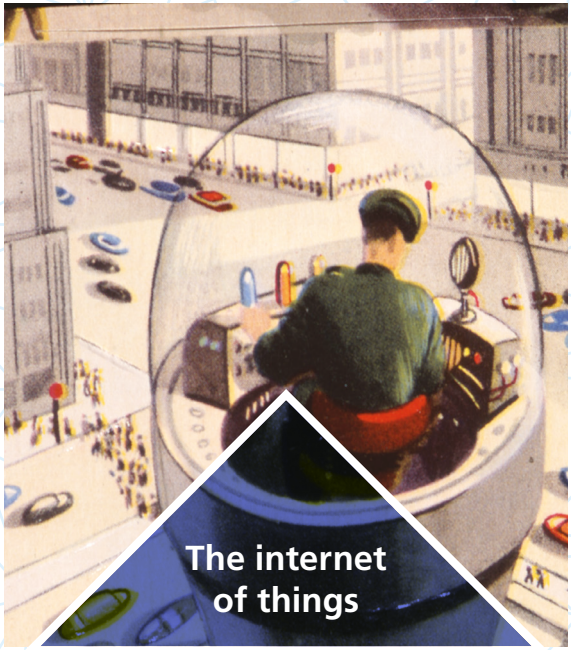


The machine more intelligent than the human ?

Artificial intelligence refers to the capacity of machines to behave like humans in terms of learning, reasoning, planning and action.
This technology is implanted in a growing number of domains. Whether in aids to decision-making, voice recognition, or artificial vision, enabling a machine to understand its environment, the algorithms developed are capable of incrementally improving as processing is implemented.
This technology is at the basis of all autonomy in future products (physical or computerised).

What drives us in the pursuit of utopia ?

It is astonishing to see how far we have come in seeking to develop a hyper-connected society, and thus a hyper-surveiled one: this utopia of modern times, where information has become the most important commodity for our societies, does have its downsides. In fact, we have imagined devices that are increasingly powerful, that collect our data – in other words the traces that we agree to entrust to digital networks.
We protest, however, when third parties exploit them without our consent. The digital utopia we hoped for transforms into an alienating dystopia: do we really want things to be different?



How can we hide ?

Sensors are now everywhere. Coupled with increasingly significant computational power, they offer the scope for detection, tracking, analysing, and even acting remotely, using real time data processing as well as data transmission, for decisions and actions taken.
The presence of a processor combined with the necessary connectivity make such objects the target of choice for cyber attacks.

A fascination that we should question

Science fiction writers have always enjoyed describing space wars where ultra-sophisticated craft were equipped with weapons of devastating power. But while this type of exaggeration is understandable from the narrative perspective – wars become epic or the disproportionate scale of objects accentuate how small humans are in comparison – it is more complicated to understand that this seems to have contaminated reality.
Science fiction, and this aspect may be useful to us, seeks, above all, to critique, in the noble sense, the negative aspects of our current actions: and what if we were to contemplate the image of our humanity constructed by our objects, rather than the objects themselves?

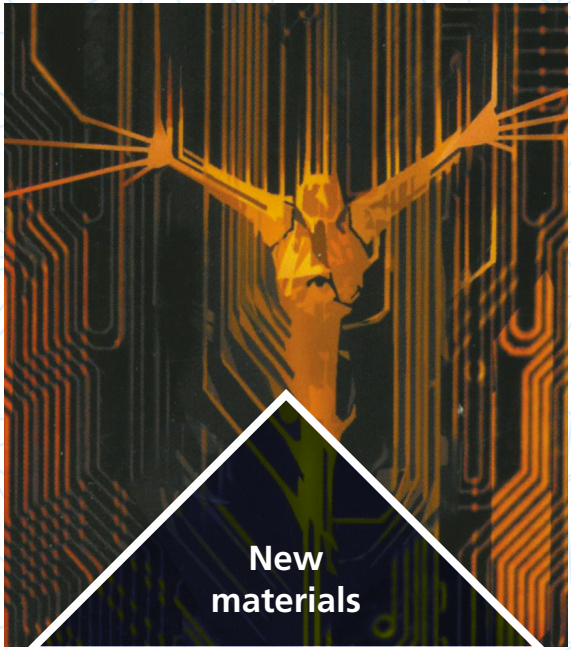


Too rapid to react ?

Hypersonic vectors may be planes, missiles, or spacecraft travelling at a speed greater than Mach 5, or five times the speed of sound.
The speed reached renders obsolete current capacities for interception, offering a very responsive strike capacity, regardless of the distance of the target.

What is science fiction capable of ?

Science and technologies are continually seeking – which is after all their raison d'être in a consumer-oriented world – to create new objects and new materials, in order to modify our world and to give birth to new applications or to new products.
Science fiction too, although in a different register, seeks to modify our world by creating new "products". These – the metaphors, the points of view, the exaggerations – are very useful for reinventing what we sometimes consider to be set in stone. Can one in fact change the world without changing our view of it and our way of talking about it?

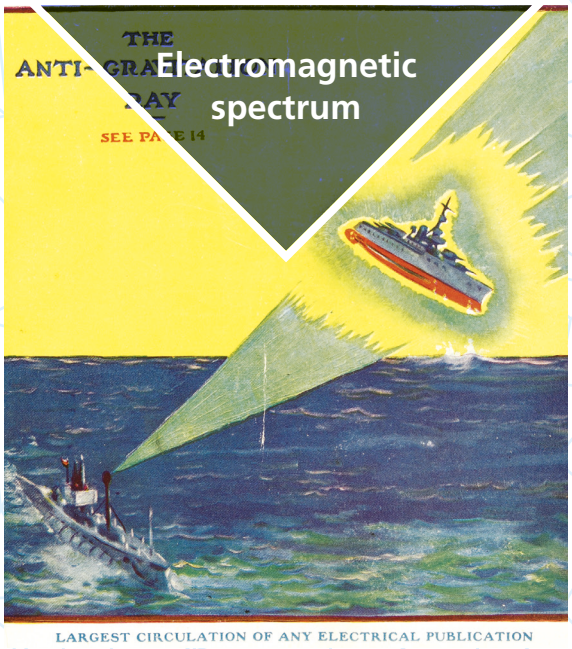


What is this material capable of ?

New materials are characterised by unique and exceptional properties.
They are manufactured using, in particular, nanotechnologies and synthetic biology.
More hard-wearing, lighter, more conductive; changing form, colour, and properties, according to a specific stimulus, these materials open the door to new products and more innovative applications.

Towards humility in discovery

The principle way in which Science fiction works is to draw upon the scientific discoveries of its time, on the one hand, in order to establish the effect or reality in its narratives, and, on the other hand, to reflect the hidden symbolism in these discoveries. The idea of the electromagnetic spectrum is interesting in this context where one can reveal colours – or entities – which do not form a part of the spectrum…!
This is how the science fiction laboratory reveals its riches: rather than emphasising the cognitive power of human intelligence, the narratives play the humility card, and remind us that man is an ignorant being, seeking reassurance.

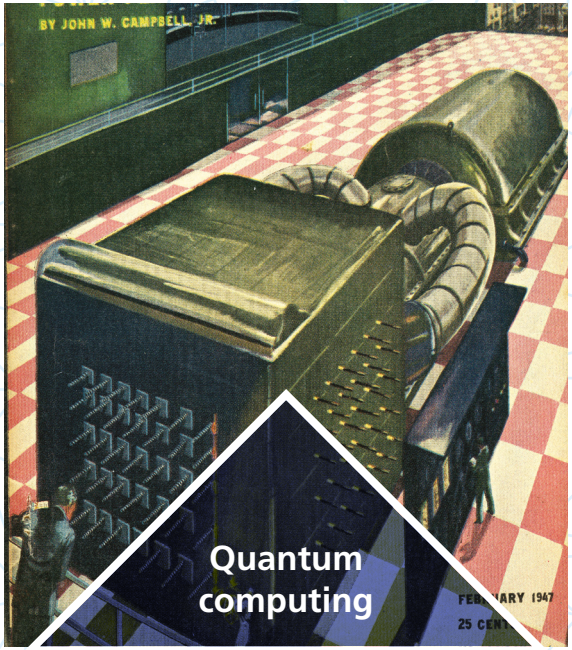


Information: everywhere, and all the time ?

The capacity to use the largest possible part of the electromagnetic spectrum while sharing it efficiently has the objective of guaranteeing the use of these resources in the case of a conflict, while denying it to the adversary.
Considering the importance of the digital world and the growing exchange of electronic information, guaranteeing their security, reliability, and the overall resilience of the system are essential foundations for the conduct of any operations.

When computers go mad

Information technology has revolutionised the world, it is a fact, in particular because the management of this world has been removed from humans, to be entrusted to computers. In order to optimise calculation processes and to be able to manage an ever-larger number of dimensions, it is necessary for computers to evolve. For this reason, science fiction very often exploits the computer as a metaphor for the human: in science fiction narratives the computer dominates the world, evolves, manages power and… goes mad, before consulting with the psychologist! And why do we write this? Perhaps in order to remind ourselves that our machines are only the nightmares of what we would like to be.



Cryptographic disruption required ?

Breakthroughs in quantum computing will enable the creation of much faster processors (a million times or more) than those that we use today.
The calculation power thus released will instantaneously render obsolete all traditional methods of cryptography, calling into question data security and increasing the pressure of cyber-attacks.
Cognitive computing, simulating human thought processes, will be one of the winners in this quantum revolution and will thereby open the door to a new generation of artificial intelligence.

Space in science fiction: a place of refuge ?

Science fiction has very often projected its intrigues into the cosmos: humans colonise other solar systems, terraforming other planets or seeking to discover other intelligent beings.
Many of these stories tentatively remind us that if humans set out into space, it means that earth has been condemned; it has even become generally accepted. In effect, why would we seek to leave our planet if it were not dying?
Therefore, rather than seeing in the conquest of space a sign of human genius, science fiction invites us to reflect: what if this conquest were a resignation?



Everybody's space ?

Developments in the field of space technology render accessible multiple services at the lowest cost. The launching of satellites, telecommunications, and the observation of the earth in very high resolution are no longer services only available to governments.
This dynamic offers great possibilities, but also creates a need for control and coordination in order to ensure the viability of all the objects populating a limited circumterrestrial volume.
.

Manipulating living things to compensate for our fragility ?

Many science fiction stories incorporate in their plots the manipulation of living things: biotechnologies or nanotechnologies are exploited in order to produce new organic beings, viruses, or solutions to solve the issues of hunger in the world.
However, and unlike real world technologies, it is the alienating symbolism of these manipulations that is given prominence in the narratives: they are the mark of man's self-destructive power. Science fiction is in fact a distorting mirror that should not be interpreted at face value: it communicates to us the image of our weaknesses, rather than of our inventions.



Towards a synthetic reality ?

The purpose of synthetic biology is to manufacture biological components and systems that do not exist in nature, and to modify existing biological elements.

Making soldiers more robust, biologically producing certain components, modifying or eradicating certain viruses; the opportunities are infinite, but what are the long-term consequences and dangers?



Multi-sphere attacks,
dual use technologies,
cyber-security,
social networks

Efficiency... distributed

Efficiency must now be guaranteed simultaneously in the various spheres of engagement. Whether in cyberspace, on the ground, or in airspace, in the infosphere, electromagnetic space, or space itself, how can one guarantee the efficiency of an engagement against a potential attack that could be so sudden and diverse, and which could be physical, or software based?



« The 1920 man would have looked upon the audacious being as upon a sorcerer, who, simply clad in his light metallic suit, aspired to raise himself up, cross the seas, and defy the birds with a motor no bigger than a book, with wings no bigger than those of an archangel... » Bruno-Ruby, Celui qui supprima la mort , 1921

Submerging the adversary

Objective :

How to benefit from the new possibilities offered by the simultaneous use of a multitude (swarms) of low cost systems ?

Technology domains :

Robotics ; Artificial intelligence

Making our soldiers more effective

Objective :

What new equipment or training should be offered to soldiers in order to enhance their physical and cognitive capacities in engagement ?

Technology domains :

Human performance ; Synthetic biology ; New materials

Optimising human-robot collaboration

Objective :

How can one optimally interact with a machine in order to benefit from the intrinsic qualities of each (human: perception; machine: speed of calculation) ?

Technology domains :

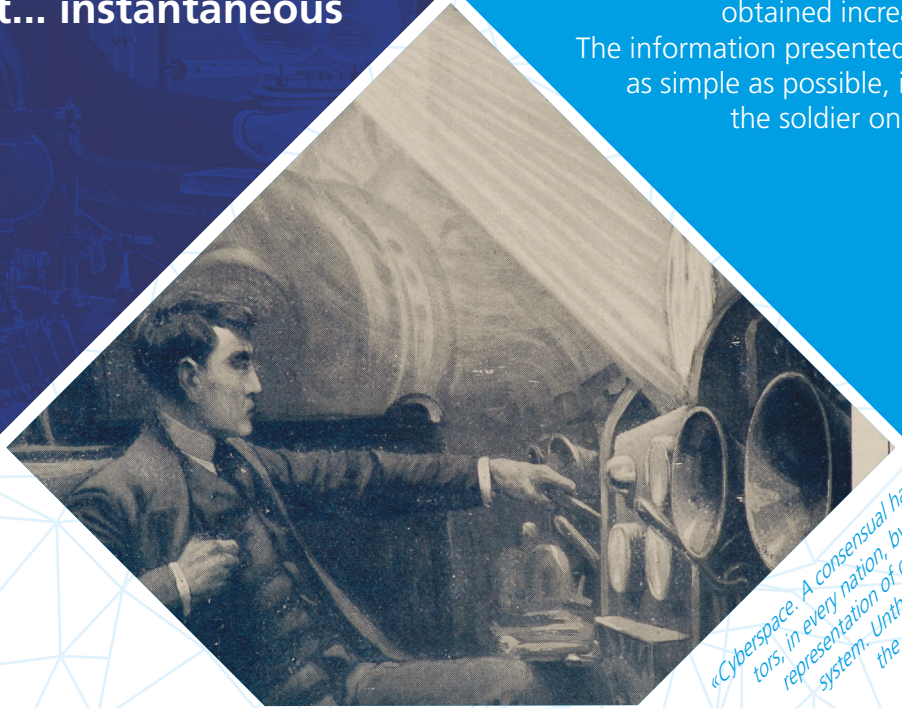
Robotics ; Human performance ; Artificial intelligence



Interoperability,
real time,
communication,
reliability

Conduct... instantaneous

The planning of operations, like decision-making and the communication of an order on the ground, needs to be implemented in a way that takes into account an increasing volume of data and parameters obtained increasingly rapidly.
The information presented to the individual must be as simple as possible, in order not to distract the soldier on their mission.



«Cyberspace. A consensual hallucination experienced daily by billions of legitimate operators, in every nation, by children being taught mathematical concepts... A graphic representation of data abstracted from banks of every computer in the human system. Unthinkable complexity. Lines of light ranged in the nonspace of the mind, clusters and constellations of data. Like city lights, receding...»

William Gibson, Neuromancien, 1984

Decision-making in consequence and knowledge

Objective :

What indicators and algorithms enable optimisation and reduction of risks of a decision, taking into account the many parameters to be considered simultaneously ?

Technology domains :

Artificial intelligence ; Quantum computing

Presenting relevant information

Objective :

How to present information in the most relevant possible way, while allowing the individual to remain focused on their task ?

Technology domains :

Augmented and virtual reality ; Artificial intelligence

Communicating orders at all costs

Objective :

How to guarantee reliable communication throughout the chain of command, and independently of location, atmospheric conditions, and enemy interference ?

Technology domains :

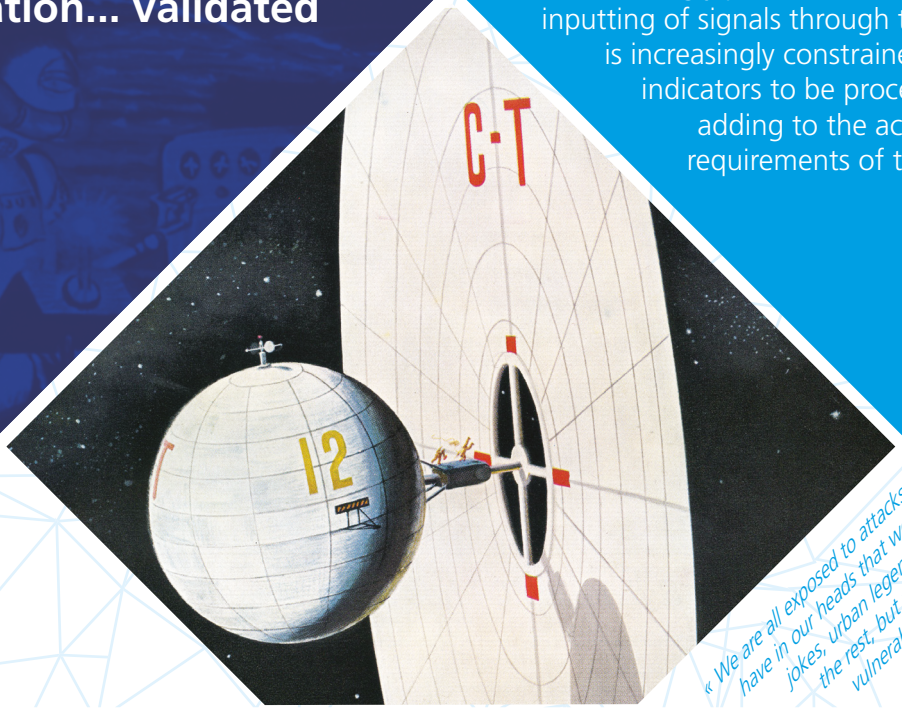
Augmented and virtual reality ; Artificial intelligence ; Electromagnetic spectrum ; Quantum computing



Big data,
visualisation,
indicators,
reliability

Information... validated

The challenge of obtaining reliable, precise, and up to date information, is increasingly difficult to face. With the quantity of data available, making the choice of the right sources and content is increasingly perilous. The time available between the inputting of signals through to the analysis of information is increasingly constrained, due to the variety of indicators to be processed simultaneously, adding to the acceleration of the requirements of the decision cycle.



« We are all exposed to attacks from viral ideas. It is like a collective hysteria, or a refrain we have in our heads that we hum all day, until we pass it on to someone else. Like good jokes, urban legends, crazy religions, Marxism. We can try to be smarter than the rest, but we always have an irrational basis that makes us potentially vulnerable to attacks by a fragment of self-replicating information.»
Neal Stephenson, *Snow Crash*, 1992

Observing to surveil better

Objective :

What sensors and what data should one analyse in order to enable a reliable and continuous understanding of the situation ?

Technology domains :

Artificial intelligence ; The internet of things

Anticipating events

Objective :

How can one anticipate and predict certain actions sufficiently early, in order to be able to react and take appropriate measures ?

Technology domains :

Artificial intelligence ; Space technologies

Encrypting to communicate

Objective :

How to guarantee that the information transmitted is not intercepted by the adversary and modified by them ?

Technology domains :

Electromagnetic spectrum ; Quantum computing ; Space technologies



Militia, instruction, redundancy, flexibility

Resilience... unlimited

Avoiding dependence on a given technology, as for the enhancement of resilience to natural disasters, to critical infrastructure failures, and to military attacks, all constitute an ever-growing challenge created by digitalisation and the urbanised mores of our society.



« Human beings can cope with big plain facts, like seasons or lunar night and day, light drought or a vacuum, like a pestilence among the game animals they feed off or a rocket going astray and crashing a load of provisions into a mountain side. What we can't cope with is seven billion competing members of our own species. You have too many incalculable variables to make a rational response when a crisis occurs. »

John Brunner, *Stand on Zanzibar*, 1968

Manufacturing on demand

Objective :

How to organise and optimise logistics in order to guarantee the usability and reparability of different military systems ?

Technology domains :

Additive manufacturing ; New materials ; Synthetic biology

Becoming invisible

Objective :

Do new materials, new forms, or other technical devices enable certain elements to be made invisible to future detection resources ?

Technology domains :

Additive manufacturing ; New materials ; Synthetic biology

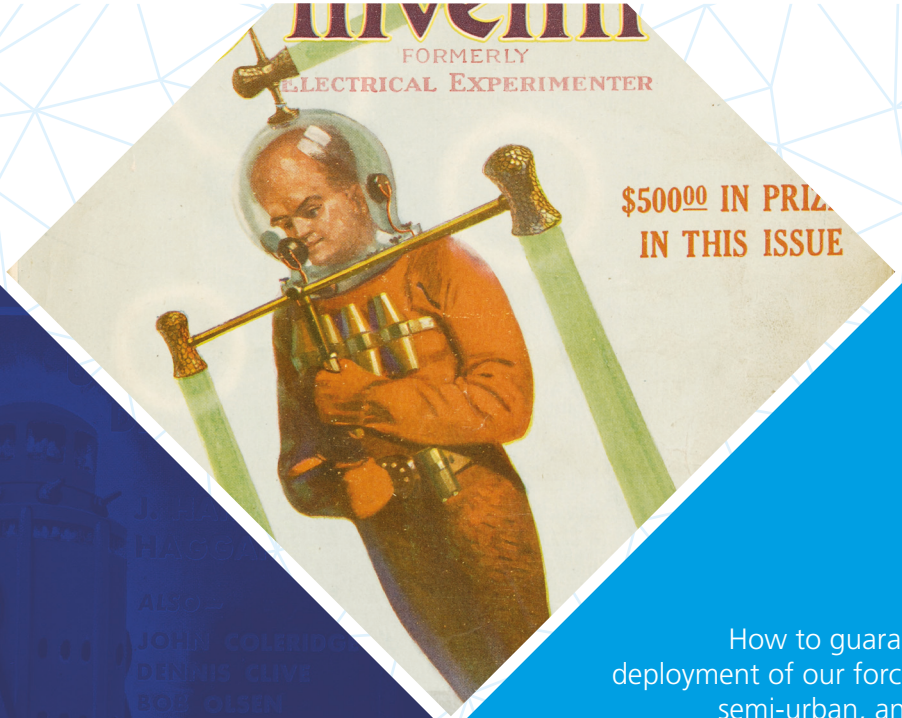
Deriving benefits from dual technologies

Objective :

What civilian technologies and approaches can be integrated in order to enhance the various military systems or procedures ?

Technology domains :

Robotics ; Enhanced and virtual reality ; Artificial Intelligence ; The internet of things ; Synthetic biology



Mobility... assured

Topography,
tracks, wheels,
electricity, agility,
air, robotised mules

How to guarantee the rapid deployment of our forces in all types of urban, semi-urban, and rural terrain, and regardless of topography? Do we have the ability to limit enemy mobility?



« I do not consider I would be going too far in saying that the time will come when trains of projectiles are established, in which one will be able to make the journey comfortably between the earth and the moon. There will be no impact, or jolts or derailment to be feared, and one will reach the destination rapidly, without fatigue, in a straight line "as the bee flies", to use the language of the trappers. Within twenty years, half of the people on earth will have visited the moon!»

Jules Verne, *From the Earth to the Moon Direct in 97 Hours 20 Minutes*, 1865

Facilitating individual travel

Objective :

How to enable an individual to move without fatigue, over long distances, while carrying significant loads ? Can they also maintain agility and responsiveness ?

Technology domains :

Robotics ; Human performance ; Additive manufacturing

Reinforcing lightness and agility

Objective :

By combining new properties of materials as well as the different types of propulsion, will we see the streamlining of vehicles, offering greater agility and flexibility ?

Technology domains :

Additive manufacturing ; New materials ; Synthetic biology

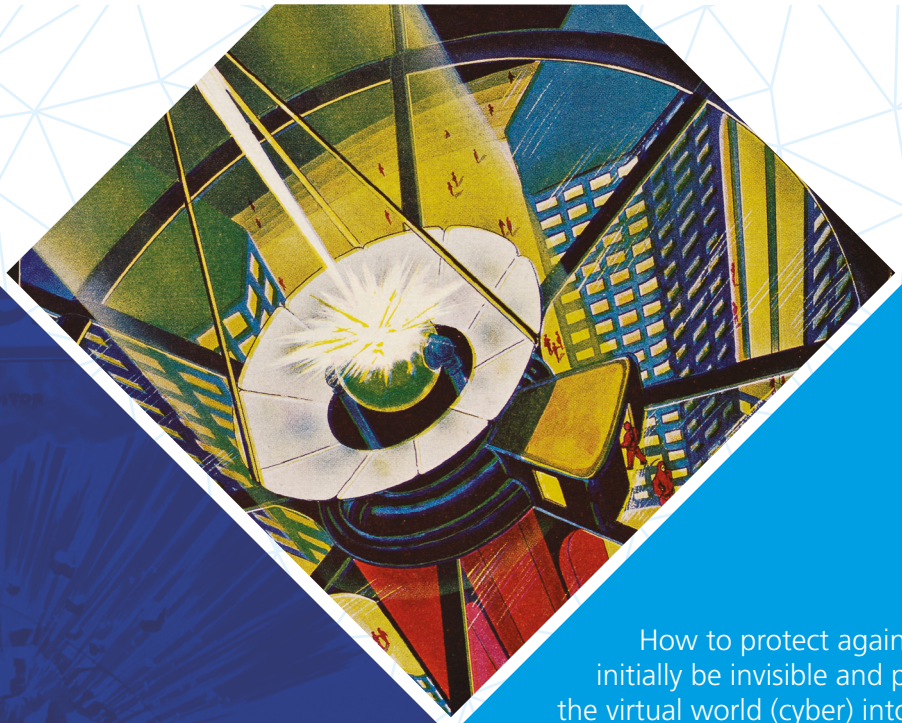
Revolutionising mobility

Objective :

To what extent can one benefit from the autonomy developed for vehicles as well as the changes in paradigms engendered in civil society ?

Technology domains :

Robotics ; Artificial intelligence





Protection... enhanced

How to protect against attacks which may initially be invisible and propagate themselves via the virtual world (cyber) into the real world? What new materials and systems will enable diverse threats to be resisted originating from systems and adversaries that are as mobile as they are varied?

Infrastructures, virtual vs. real, encryption, physical vs. cognitive

« Even "library" is a vague concept. Once upon a time, it was a place filled with books, above all, old, dusty ones. Then tapes, discs, and magazines were added. Then, there was all the data converted into a format accessible to machines, in other words, noughts and ones. As the number of media increased, materials become subject to the tastes of the times, and methods of exploration of data became increasing elaborate. After a while, there ceased to be any difference between the Library of Congress and the CIA. »

Neal Stephenson, *Snow Crash*, 1992

Combatting the multitude

Objective :

What strategies and technologies should be used in order simultaneously to combat a multitude of systems or a succession of attacks launched close together and that are of different kinds ?

Technology domains :

Artificial intelligence ; Quantum computing

Combat at high speed

Objective :

How can one protect oneself against a variety of threats travelling at hypersonic speeds or approaching their target almost imperceptibly prior to the action ?

Technology domains :

Robotics ; Artificial intelligence ; Hypersonic missiles and vectors ; Space technologies

Defending oneself in digital mode

Objective :

What are the vulnerabilities, and how can one protect the different physical systems from digital attack ?

Technology domains :

Artificial intelligence ; Quantum computing



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