

Science and technology for personal defense in depth

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Summary

As a new topic for general discussion, this article describes how the principle of defense in depth could be applied on a planetary scale to assure personal security. The principle of defense in depth is used in many domains, in particular in the field of nuclear power. The basic idea is to have several lines of defense; if the first line fails, the second one takes over, and so on for additional lines. This article briefly discusses an example of personal defense in depth for a city or a state with advanced wireless communication systems in the context of international agreements favoring personal security. Emphasis is put on the personal defensive roles that the two rapidly evolving millimeter wave and drone technologies could play. These two technologies have the potential for dramatically improving personal security and for paving the way to new international agreements favoring personal security. Some desirable international agreements could be motivated by recent findings in genomics showing extensive kinship among all humans, a finding which could lead to more collaboration among different ethnic groups and constitute a fundamental contribution to personal defense in depth.

Section 1 : Introduction

The May 2014 issue of the popular science French magazine "*Science & Vie*" featured an article on the on-going revolution in drone technology and another one on the presence of Neanderthal genes within our genome. The drone article

described many new and wonderful peaceful applications, but it also mentioned that drones could carry explosives. The other article fell within a class of recent articles and books on genomics that describe the extensive genetic kinship of all humans, give new data on migration patterns of various ethnic groups over the last one hundred thousand years, and reach back about one million years to contribute to the genetic history of several species closely related to homo sapiens.

In these new scientific and technological developments one can see again the tension in the history of our species between technologies that could help us, or kill us, and scientific knowledge that could bring about better understanding and motivate more collaboration among humans.

Two important masterful French television series have recently informed the public on the history of World Wars I and II (WW1, WW2). In *Apocalypse WWI*, by Daniel Costelle and Isabelle Clarke, one learns how WW1 started and one sees the inferno that it imposed on millions of people, killing over 20 million of them. One of the root causes of WW1 was the alienation that people in various countries felt for people of other countries. In WW1 humanity was horrified by the killing power of newly developed machine guns and other weapons. Ever since that time, however, the commerce and the use of automatic firearms have proliferated in many countries and have caused countless losses of life.

In *Apocalypse WW2* by Isabelle Clarke and Daniel Costelle, one can see how Adolf Hitler acquired dictatorial power in Germany in the nineteen thirties and attempted to conquer the world by initiating World War II in 1939. Over 60 million people died in WW2. In his book "*Mein Kampf*", published in 1925, Hitler had revealed his

malevolent intentions towards numerous ethnic groups, notably towards the Jews and the Slavic peoples. The ominous warning signals in *Mein Kampf* had been ignored by most people. Hitler's attitude and actions, adopted by many of his followers, constitute the worst one of many horrible examples of ethnic alienation in history.

As far as technology is concerned, one can see that World War II was won by the Allies in great part thanks to the supremacy of their aviation and radar technology, thanks to breakthroughs in decrypting, and through their worldwide collaboration.

World War II ended completely after the United States dropped atomic bombs on Hiroshima on the 6th of August 1945 and on Nagasaki on the 9th. These bombings were along the line of the massive destruction of cities by aerial bombing in WW2. Since 1945 there have been many wars on the planet, but the nuclear powers have refrained from using nuclear weapons. But who can assert with confidence that at some point in the future a local war will not escalate to a nuclear war of unpredictable magnitude? Who can assert that no nuclear war could start by an accidental or a malevolent release of long-range nuclear-tipped missiles? A substantially new way of thinking about this problem may be what is needed now.

What are some important lessons to draw from the first two world wars? There are many. At the end of the 6th part of *Apocalypse WW2*, the film makers quoted words from General Douglas MacArthur on September 2nd 1945, on the occasion of a formal ceremony, aboard the ship USS Missouri, during which representatives from Japan signed the surrender documents (see web site

<http://bjmi.us/usa/macarthur-speeches.html>). Here is what the general said:

Douglas MacArthur: " We are gathered here, representatives of the major warring powers, to conclude a solemn agreement whereby peace may be restored. The issues, involving divergent ideals and ideologies, have been determined on the battlefields of the world and hence are not for our discussion or debate. Nor is it for us here to meet, representing as we do a majority of the people of the earth, in a spirit of distrust, malice or hatred. But rather it is for us, both victors and vanquished, to rise to that higher dignity which alone befits the sacred purposes we are about to serve, committing all our people unreservedly to faithful compliance with the understanding they are here formally to assume.

It is my earnest hope, and indeed the hope of all mankind, that from this solemn occasion a better world shall emerge out of the blood and carnage of the past -- a world dedicated to the dignity of man and the fulfillment of his most cherished wish for freedom, tolerance and justice."

It is interesting to note this first idea that "*.... divergent ideals and ideologies* " have led to the battlefields, and the second idea about the need "*.... to rise to that higher dignity*".

Following up on the first idea, seven decades after 1945, what is new on the horizon of battlefields? Literally, drones. So far, the world has largely tolerated the commerce and use of conventional weapons. The danger that lethally armed drone technology development now presents, is that almost all nations, many small groups, and even malevolent lone individuals could acquire the means of killing people at a distance and destroying vital facilities. Drones are already fairly inexpensive and their potential for hostile actions grows every day. Equipped with cameras that can see in daylight or at night time with infrared, drones can be remotely controlled or they can be autonomous through the use of on-board computers. In a word, drones threaten to bring battlefields into homes and into buildings where people work. Given the fact that small malevolent groups could

acquire and master armed drone technology, it is clear that this technology could potentially lower the threshold for war. Moreover, in peace time, malevolent groups or individuals could kill chosen victims with great ease and sometimes possibly with impunity.

This fearsome situation creates an incentive for looking at a substantially different choice for humanity, namely the application of science and technology to guarantee defense in depth to every person on the planet, and the adoption of international agreements favoring personal security. That may seem like a tall order, but the rapid evolution of science and technology makes it possible to envisage that such a choice is technically feasible. I will argue that such a choice may even be psychologically and politically possible in the near future.

Following up on Douglas MacArthur's second idea "*to rise to that higher dignity*", we can look at the new findings from the rapidly developing science of genomics. Genomic science has revealed that all mankind can be seen as forming one extended family. Genomics is a science that studies all genetic information in DNA stored not only in living organisms but even in the bones of persons and animals who were alive as far back as 130 000 years ago. Genomics teaches in a new and inspiring way the deep-time history of the human species and of closely related species. Important and excellent books on genomics have been recently published. Examples are: in 2000 "*Genome, the Autobiography of a Species in 23 Chapters*" by Matt Ridley; in 2001 "*The Seven Daughters of Eve*" by Bryan Sykes; in 2007 "*Deep Ancestry, Inside the Genographic Project*" by Spencer Wells; and in 2014 "*Neanderthal Man, In Search of Lost Genomes*" by Svante Pääbo.

The 2000 book by Matt Ridley is very informative and presents in its subtitle an idea that transcends the usual time boundary of an individual life: by reading the DNA information in our cells, by "*sequencing*" the DNA as scientists say, one can read many important aspects of the history of the human species over hundreds of thousands of years and even over millions of years. Also important is that Matt Ridley and other authors make use of what can be called "*a diachronic we*", that is the pronoun "we" used across time to include our ancestors very far into deep time, into millions of years and more. On page 2 of his preface Matt Ridley writes:

Matt Ridley: "As I have tried to show, the genome contains secret messages from the distant and the recent past – from when we were single-celled creatures and from when we took up cultural habits such as dairy farming."

Single cell organisms evolved on Earth for more than two billion years to finally give birth, about one billion years ago, to multicellular organisms. Single cell organisms are already in themselves a miracle of evolution.

Each person's body is made up of biological cells that multiplied and evolved from the mother's egg cell after incorporating the father's nuclear DNA at conception time. Along with the mother's cell, everyone inherits little organelles called mitochondria, which are the energy converters for the entire body. The mitochondria have their own DNA, about 16 500 bases (or "*letters*") in length. Since the mitochondria are part of the mother's egg cell, they were also part of the grandmother's cells, and before that they were part of the great-grandmother's cells. And so on, until millions of years ago. Mitochondrial DNA thus neatly traces the maternal lineage of every person and animal.

By sequencing the mitochondrial DNA of thousands of persons scientists have been able to conclude that all men and women presently living can trace their extended

maternal family tree to one woman who lived in central Africa about 130 000 years ago. By studying the male Y chromosome, which is part of the 6.4 billion letter DNA in the nucleus of each cell, scientists have drawn the conclusion that all men can trace their paternal family tree to one man who lived in central Africa about 60 000 years ago. Moreover, the degree of genetic similarity in the individual genomes of any two same-sex persons is about 99.9%. One can see in all the books mentioned above that these new findings from genomics are creating in large numbers of people an intense interest in the newly revealed extended human kinship and in the genetic history of our species.

This new awareness of our deep-time relatedness allows one to think that many types of ethnic and other alienation that have historically led to wars, and killings in peacetime, can be transcended. Science is thus opening yet another door for a substantially new way of thinking that transcends the usual borders in space and time often set by one individual life. This paper will develop the idea that personal security could be immensely improved thanks to the diachronic species-wide awareness newly facilitated by genomic science, and thanks to new lines of defence-in-depth made possible by new technology.

Section 2 : Combining drone and millimeter wave technologies

Let us look briefly at what modern drone and millimeter wave technologies could do to protect a person. Already drones are extensively used for surveillance by means of cameras operating in visible and infrared light. Millimeter waves are electromagnetic waves whose wavelengths fall in the range from one to ten millimeters, the corresponding extremely high frequencies (EHF) ranging from 300 to 30 gigahertz (GHz). Millimeter waves can be formed into beams that serve as line-of-sight links for communication networks hosted on building roofs, telephone poles and on airborne drones. Because of their large available bandwidths and

their extensive frequency re-use feature, it is possible that millimeter wave networks could be designed so that they would never fail because of overload due to heavy traffic. That would be a significant advantage of such networks from the point of view of personal security. Frequency re-use is possible because in point-to-point millimeter wave communication between buildings A and B by means of directional antennas and receivers, the same wavelength (or frequency) can be re-used between a different pair of buildings C and D, even when they are close to one another.

Existing military radars employing millimeter waves can "see" objects as small as bullets and trace out their path. Millimeter waves can go through clothing. Taking advantage of this property, millimeter wave scanners are already employed in many airports and allow security personnel to see through clothing and detect hidden weapons such as firearms or knives. Millimeter wave radars used for security would offer the advantage of detecting hidden weapons from a distance of up to several hundred meters.

When two terrorists exploded home-made bombs at the Boston Marathon on 15 April 2013, the usual surveillance cameras had recorded very good pictures of them moments before the bomb explosions, but had not been able to see through their backpacks. If they had been in place, millimeter wave radars or cameras could have detected the metal casings of the home-made bombs inside the backpacks. Immediately after the two explosions, the enormous public demand on the cell phone networks in Boston caused them to become overloaded and people could no longer communicate.

Detection of hidden weapons is a first step, but what about intervention? In New York City in the USA, large numbers of surveillance cameras are in operation around the clock. Surveillance is carried out in real time in a central location where security personnel watch hundreds of scenes on television screens. Should a situation arise where the centrally-located security personnel detect hidden weapons in a given location, police forces could be dispatched to the site in order to question potential aggressors and take their arms away.

But even better, and safer for police personnel, would be to immediately send drones for closer inspection, for interrogation via a drone-mounted speaker phone, and for rapid forceful intervention by means of millimeter wave emitters if such a need were to arise. The US military have been experimenting for years with a so-called "*active denial system*", or ADS. This system uses a millimeter wave emitter at a frequency of 95 GHz. At this frequency the electromagnetic wave has a wavelength of 3.2 millimeters and it can be formed into a fairly directional beam. The US military have observed the effect of a medium-power beam (about 50 kilowatts) on volunteers hundreds of meters away. This beam goes through clothing and is absorbed within a depth of about half a millimeter in the skin, thereby causing rapid heating and some level of pain. The volunteers have had the reflex of immediately running away from the millimeter wave beam. The US military refers to this medium-power millimeter wave beam as a "*non-lethal weapon*".

Two key elements differentiating a millimeter wave beam from a firearm bullet, are the time scale and the level of harm inflicted. In one second or so, a bullet hits the victim and inflicts death or severe injury. Once fired a bullet cannot be called back. In sharp contrast, the millimeter wave beam can be interrupted within one second if the operator judges this to be appropriate, for example in case the

potential aggressors run away or drop their arms. In a time span of a few seconds some pain may be caused but without serious injury. If potential aggressors keep coming closer to security personnel or to a potential victim, and if they are threatening to shoot bullets or stab with knives, prolonged skin heating by the millimeter wave beam to the point of intense pain may be judged appropriate. A fundamental advantage of combining drone and millimeter wave technologies is that all of this defensive action can be carried out remotely and immediately, thereby rendering a forceful intervention much safer for both the potential victim and for security personnel.

At the present time only a few public places, buildings, airports, subway stations, etc ..., are under the protection of surveillance cameras and security personnel. How could a lone person defend herself/himself in some remote area far from security surveillance cameras? For personal protection, two teams of engineering students at Laval University have had the idea of using portable millimeter wave phased-array emitters to direct a beam at an aggressor, or at some aggressive animal, like a dog or a bear. The students are Daniel Lussier-Levesque, Louis Bourdages, Nicolas Marquis and Mathieu Garon who did creative theoretical work in Winter 2013, and Louis Bournival, Carl Nadeau, Guillaume Tanguay, and Jérémy Noël who did their creative theoretical work in Winter 2014. The idea is to heat up the aggressor sufficiently to make him/her give up or drop his/her weapon; this could be done when the aggressor is up to 10 meters away. The millimeter wave emitter could also be combined with existing cell phones to alert the police forces. The fact that the millimeter wave beam could leave a burn mark on the aggressor would act as a deterrent to committing a crime.

Portable millimeter wave emitters are now available for line-of-sight communications and for automotive radars at a power level of a few watts. For the

thermal repelling effect a power in the kilowatt range is desirable. Present military systems use gyrotrons, which are bulky high-voltage vacuum tubes and are typically mounted on trucks. These gyrotrons emit about 50 kilowatts of millimeter wave power which is formed into a directional beam by means of a curved reflector about one meter in diameter.

Semiconductor devices are very light and lend themselves to portable battery-powered equipment. Throughout history the semiconductor electronics industry has always been able to steadily increase emitter power at all frequencies. It is therefore reasonable to expect that semiconductor-based portable millimeter wave emitters will become available in the near future for the purpose of self-defense. These could also be mounted on drones. A medium-power semiconductor millimeter wave emitter mounted on a drone would not constitute a lethal weapon. It would be a repelling means, not a killing means, and it could be dispatched quickly to prevent a crime.

Among international agreements regarding the regulation of frequencies in the millimeter range, it is important to immediately take steps to negotiate and reserve adequate frequency bandwidths for personal security, and to develop standards.

Section 3: A third line of defense: genetic kinship.

What has been described above can be considered as two lines of personal defense in depth, namely real-time communication with security personnel and millimeter wave heating. For a veritable defense in depth at least one more line of defense is needed, one that is as universal and compelling as possible. Along the lines of

thought of the introductory section, I argue briefly in favor of a strong line of personal defense having to do with social factors impeding or motivating intentional killing.

In 2013 the *United Nations Office of Drugs and Crime* (UNODC) published a comprehensive report titled "*Global Study on Homicide*". The report is available at web site

http://www.unodc.org/documents/gsh/pdfs/2014_GLOBAL_HOMICIDE_BOOK_web.pdf

In 2012 almost half a million people in the world died as a result of intentional homicide. The homicide rate, ie the annual number of homicide victims per 100 000 population, averaged close to 6 per 100 000 in 2012. The homicide rate varies enormously from one part of the world to another. In descending order, here are the annual rates for some countries, per 100 000 population : Guatemala 40, South Africa 31, Brazil 25, Mexico 21, Russian Federation 9.2, USA 4.7, Morocco 2.2, Romania 1.7, Canada 1.6, Poland 1.2, Ireland 1.2, China 1.0, Czech Republic 1.0, United Kingdom 1.0, Germany 0.8, Japan 0.3, Singapore 0.2.

In going from Japan to Brazil the homicide rate increases by a factor of 83. Between the extremes of 40 in Guatemala and 0.2 in Singapore the ratio is 200. Between the USA's 4.7 and Canada's 1.6 the ratio is about 3. These substantial ratios strongly suggest that *the social climate* is playing a key role in motivating or deterring intentional killing in a country. Taking as a working hypothesis that social factors can have a significant effect in motivating or deterring intentional killing, what new element, or elements, could be brought into the picture in this 21st century to improve personal defense in depth?

My reading of historical killings, during wars as well as in peacetime, is that a major motivating factor is ethnic or other type of alienation. In support of this well-known point of view, the *Canadian Broadcasting Corporation / Radio-Canada* has recently produced a television series titled "*Love, Hate and Propaganda*". The beginning of this series examines the root causes of World War 2. The series shows that in the nineteen thirties, in Germany and in Japan, government actions and propaganda were preparing their populations for war by seeking to convince them of their superiority over other ethnic populations. The web site is :

<http://ici.radio-canada.ca/ventesdarchives/fiche.asp?Client=&nSection=7&langue=2&IDcategorie=60&IDTitre=VINT-193A&btn=nouveautes>

Assuming that we draw the same lesson from World War 2 as general Douglas MacArthur did in September 1945, and that we accordingly seek "*to rise to that higher dignity*", I argue that part of a new attitude could be inspired by genomics, the scientific discipline that studies all genes in humans, animals and plants, alive or long dead. One important new result of genomics is to have brought out the close genetic kinship of all human beings. In the last decade scientists in genomics have sequenced hundreds of individual genomes and have been able to trace out the human family tree going back hundreds of thousands of years. Many articles and books have popularized important findings regarding our ancestry. The books mentioned earlier on genomics have presented convincing scientific evidence that we are all cousins. On page 22 of his book "*Deep Ancestry*" Spencer Wells wrote: "*Rather than belonging to discrete subspecies, humans are part of one big extended family.*"

There are more treasures yet in genomics. On 20 March 1989 *Time Magazine* had announced the birth of the human genome project under the sponsorship of the US government. By 2003, an extensive collaboration between scientists working in many laboratories in several countries had achieved a nearly complete sequencing

of the human genome's 3.2 billion base pairs, or "*letters*", in 23 chromosomes. Because each one of our cells has 23 chromosomes from the mother and 23 from the father, the DNA of each cell comprises approximately 6.4 billion base pairs or letters. The DNA alphabet has four letters: A standing for adenine, T for thymine, G for guanine, and C for cytosine. The copying of genetic information in going from two parents to a child is done with great accuracy, typically one letter in 100 million being changed by a copying error, this being called a *point mutation*. From one generation to the next very few DNA letters in our 20 000 genes are changed. What changes dramatically from parents to child is the *combination of inherited genes, and gene segments*; this combination is selected by random processes at the molecular level in each parent. In two humans of the same sex, no matter where they come from, the similarity of the genetic information in their DNA is approximately 99.9%.

A very important consequence of the human genome project had already been expressed in 1989 by the late Leon Jaroff, Time Magazine's scientific journalist and editor. Leon Jaroff's article had an illustration showing a baby with a simplified drawing of the DNA double helix lacing its way through the baby's body. In this most remarkable illustration, the base pairs linking the two DNA strands represent the 6.4 billion letters in our individual genome, vividly showing that genetic information is part of what we are. In this article Leon Jaroff had written: "*Does it demean humans to have the very essence of their lives reduced to strings of letters in a computer data bank?*"

Jaroff's expression "... *the very essence of their lives* ..." itself carries meaning, thus answering his own question. This expression is justified by the fact that not only the structure of our bodies is expressed in our DNA but even the complex and still unknown structure of our brain also is. Studies of identical twins, who share

the same individual genome, indicate that a major part of our behavior is also determined by our genome. Leon Jaroff's chosen illustration and his sentence quoted above raise the following interesting question for the reader to ponder: "*What is your relationship with the human genome, and with your own individual genome?*"

James Watson, who won with Francis Crick and Maurice Wilkins the Nobel Prize for finding the double helix structure of DNA (with a key contribution from Rosalind Franklin), was one of the first individuals to pay to have his genome sequenced and published in 2007. This sequencing was carried out by the firm *454 Life Sciences* in Branford, Connecticut, USA. The current cost of human genome sequencing is a few thousand dollars, and is expected to soon drop into the multi-hundred dollar range. Personalized medicine will be one of the important practical benefits of having one's genome sequenced.

Another benefit will be to immensely augment the data base available to family tree enthusiasts. A forerunner bit of this can be seen in the book "*Seven Daughters of Eve*" by Bryan Sykes, a readable book that focuses on mitochondrial DNA to trace out a person's maternal ancestry tens of thousands of years into the past. On the basis of the mitochondrial DNA sequences obtained from thousands of persons, scientists are now able to describe the migration patterns of most ethnic populations over the last 130 000 years.

Since approximately 99.9% of the information in each person's genome is the same as the information in a different person's genome, the basic kinship of all human beings now finds a strong scientific basis. Each one of us has a genome built up from DNA information that has traveled through considerable time

intervals. Our species, Homo Sapiens, started splitting off from other primates about six million years ago. Some of our genes, the so-called "*ultraconserved sequences*", have traveled over much longer time intervals with little or no change, reaching more than 50 million years into our evolutionary past.

To the extent that kinship can bring out positive attitudes towards others, to that extent one may nourish the hope that the science of genomics will help foster more altruism and solidarity among all humans in all circumstances. Leon Jaroff's illustration can be taken as an incentive to include one's genome as part of one's self-identity. In this case, from the point of view of genetic information, we are all closely related. Each one of us can see himself/herself as part of the multifaceted human genome, a genome that has been evolving over millions of years. This is a strong invitation to transcend one's individual life and identify with all of humanity over millions of years. This diachronic transcendence could become an important part of life.

An important aspect of research in genomics in the last three decades has concentrated on our relationship with other subspecies of our Homo Sapiens species. The two known examples are the Neanderthals and the Denisovans. In the last decade nearly complete sequences of mitochondrial and nuclear DNA have been obtained for these now extinct subspecies. The 2014 book by Svante Pääbo "*The Neanderthal Man, In Search of Lost Genomes*" tells the story of these most remarkable achievements in sequencing ancient DNA preserved in bones under certain conditions. The genomic data indicate that we last shared a common ancestor with the Neanderthals and the Denisovans about one million years ago.

A recent reference (<http://en.wikipedia.org/wiki/Neanderthal>) mentions that in December 2013 a large team of scientists reported in *Nature* their sequencing the entire genome of a Neanderthal who had been living 130 000 years ago in the Altai mountains of Siberia near the border with Mongolia. The DNA had been extracted from a toe bone found in a cave. The Neanderthal's nuclear DNA differs from ours by approximately 0.12%. The Neanderthals left Africa about 500 000 years ago and populated Europe, central and Northern Asia. The Denisovans left Africa earlier and populated mostly central and South-eastern Asia. Later, Homo Sapiens humans left Africa about 60 000 years ago and populated the four other continents.

A question of high interest to scientists is whether Neanderthals and Denisovans interbred with us. The answer is yes. Today people of European descent have approximately 2% of their DNA as a legacy from the Neanderthals, and some ethnic groups like the Papua New Guineans and the Australian aborigines have about 4% of their DNA that was inherited from the Denisovans. The ethnic populations that stayed in Africa do not seem to have any genetic legacy from the Neanderthals or the Denisovans.

Conclusion

An important lesson from the past is that the invention of new types of arms has often been followed by their use. This applies even to the atomic bomb. The use of lethally armed drones has already begun. As I complete the present article the shooting down of the Malaysian Airlines flight MH17 in Ukraine is all over the news; 298 persons are reported dead. USA experts think that a radar-controlled military missile fired from the ground destroyed the plane flying at an altitude of

10 000 meters (33 000 feet). In the future, if drones of all types are allowed to be armed with fire arms or with missiles, and if their control on the international scene is similar to what has been done with fire arms, then newscasts about shot down airplanes could become more frequent.

Each one of us is now challenged to make a choice regarding the use of drones. In the past, much killing in various situations was carried out because the individual had to make the simple choice between his/her own survival or that of the opposing party. Our instinct for survival, well rooted in our DNA, almost always chose our own survival. Killing in the animal kingdom goes on all the time.

But a new and more positive picture is now possible. The new millimeter wave and drone technologies are just two examples of areas where a broader policy could be adopted, namely a policy of applying scientific and technological progress to the defense in depth of every person's life on the planet. Forcing an aggressor to drop his/her arms or to run away could be considered to be sufficient, in the immediate moment. Later on, of course, judiciary procedures could be set in motion against aggressors.

In a far-reaching way, the positive wide-ranging benefits of science and technology could be made available to everyone on the planet and lead to nearly absolute personal security for everyone. This may sound utopian, but so was the decision taken in 1966 by the *World Health Assembly* to fund a program to eradicate the biggest killer of all times: the smallpox virus. Antecedents were these: in 1950 the *Pan American Sanitary Organization* had undertaken a wide-ranging smallpox eradication program through vaccination, then in 1958 the Soviet Union had proposed a global eradication program. In December 1979 the

World Health Organization officially declared that smallpox had been eradicated from our planet. This added enormous prestige to the legacy of Edward Jenner, the British physician who had developed the smallpox vaccine at the end of the seventeenth hundreds.

Another example of an apparent utopia that came true is the DNA sequencing of the extinct Neanderthal and Denisovan subspecies. Scientists have been able to extract and sequence their DNA preserved in bones found in caves in several countries. In the early eighties, when Svante Pääbo and others undertook to sequence ancient DNA, it didn't seem possible that DNA could have been preserved for 30 000 years (when Neanderthal became extinct) and up to 130 000 years, and that it could be read out. But such feats now continue to make the news. What does it mean for us?

In 1989 Leon Jaroff raised the question of meaning with respect to having in hand DNA sequences. Here is one of many examples given by the authors of the books mentioned earlier. On page 188 of his book, author Svante Pääbo sees the following meaning to the finding that about 2% of our genome came from the Neanderthal through interbreeding:

Svante Pääbo: "Neanderthals weren't totally extinct. Their DNA lived on in people today."

This diachronic awareness expressed by Pääbo also applies of course to the other 98% of our DNA. Each one of us is a mosaic of infinitely precious DNA information coming from countless ancestors and living in us.

In our modern era we can all look at the Moon in a different way compared to our ancestors: following the lunar landing of the Apollo 11 mission on the 20th of July 1969, men have walked on the Moon. Much else has been accomplished by humanity, and much else will be accomplished, hopefully according to our choices. When Neil Armstrong first stepped on the Moon, he said "*One small step for a man, one giant leap for mankind*".

One may legitimately ask whether swarms of lethally armed drones in the skies would be part of this "*giant leap for mankind*"? I think that a better leap would be for everyone to participate, each person in his/her own way, to the defense in depth of everyone's life on our planet, and to enjoy fully the presence of an extended human family on our planet.