

NON-WASTE CIVILIZATION: Utopia or Reality?

O. Figovsky*, Yu. Magarshak**

*Israel Research Center "Polymate", Migdal Ha'Emek, olf@borfig.com
MathTech, Inc., New York, USA, ym4@nyu.edu

- Mankind is disposing to environment 2000 more biological wastes that the rest of biosphere.
- 10 billion tons of natural raw materials are excavated annually from our planet entrails.
- Geomechanical resistance limit has been already achieved in some regions due to Earth exposure to resource consumption.
- Currently one biological species is put to extinction every two hours.

UNO data

Be fruitful, and multiply, and replenish the earth, and subdue it: and have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that move upon the earth.

Gen. 1:28

INTRODUCTION

One may think that human civilization went astray after the First World War. In 19th century everybody believed that the technology progress ought to serve general weal. Regretfully, the situation has changed significantly over the last 90 years. The feeling is spreading that human society is governed not by Homo Sapiens, but by completely different species: Homo agressivus, Homo insanus and Homo chilloutus. Differences not alliances more and more come to foreground. In the context of 20th century devastating wars and 21th century terrorism a statement of growing affect of reason on civilization calls in the best case a skeptical smile. Regretfully there is not much to say on world ethic basis concert; contrariwise, globalization in communication and broader everyday ethnic contacts lead to deeper cleavage of the mankind in religious, cultural and so called patriotic issues.

And it is difficult to name an area where civilization's bias from its destination is seen to such an extent as in Man's attitude against his environment, the planet given to Man to subdue and against living nature given to Homo Sapience to have dominion upon. Replenish the Earth can be scarcely interpreted as replenishing it with garbage. However, the mankind is rapidly replenishing the Earth, as well as water and air, just with its activity wastes already threatening the mankind itself with irreversible habitat change. Natural resources are taken our so quickly that some of them will peter out in few dozen years. Thousands of species - species, not individuals - are extinct from Earth every year. Is it having dominion, and is it possible to have dominion upon something, which is no more, is a question of philosophy, but the answer both in economical and social sense is obvious. "Today the phenomenon called "ecology" is comprised by two problems melted together: devastating of Earth and devastating of Human. Modern ecology is neither scholarly subject nor way of thinking; it's our destiny, the event bringing us to *eventlessness*". (F.Girenok). "Mankind has not fulfilled its mission." (Andrey Bitov). Human civilization took really dangerous route, which is to be dramatically changed, at least for the survival sake of mankind itself. But can it still be done? The question is not "Is it not too late to do it?"; it is a different problem needing comprehensive study; what we ask is "Can it be done even in principle?" Is it possible for a civilization to develop but not generate or almost not generate any waste, keeping its environment untouched or, desirably, optimizing it? Is it possible at least in theory, let it be not today but in fifty, five

hundred or five thousand years? And is it possible to our human civilization to switch to stationary non-waste mode before we cross the line of no return? This is an attempt to resolve those problems.

I. CONSTRUCTIVE DESTRUCTION

We traditionally believe that construction is much more important kind of human activity, than destruction. Moreover, destruction is understood as something bad. Such an approach was justified until certain stage of civilization development. All funds and resources are invested to TV set development, but 0.0000% is invested to their recycling. When new generation computer or cellular phone appears, the old ones do not evolve, they are thrown out. Nobody, except for villains, terrorists and janitors, does not specialize in destruction of something constructed or in destruction as such. Plane or car creators are not interested what will be done with outdated products; those are simply thrown on the scrap-heap. However, in our era when product and technology generations come and go so quickly (as generations of living creatures come and go in Nature), it is not simply a short-sighted approach but a deadly menace to human civilization to produce goods just for consumption not giving a second thought to what will become of them upon consumption or what and when has to be destroyed. This was not important yet one hundred years ago. Civilization wastes were so negligible in hundreds or thousands years, that archeologists can hardly find the remnants being at least suitable for any decoding. Similarly, the effect of humans on biogeocenosis was infinitesimal. Even extinction of mammoths and sable-tooth tigers by man is no more than an assumption. Just one century ago the Man was not any threat to his habitat.

The situation has changed dramatically in 20th century. Homobiocenosis and homogeocenosis have started to play tremendous and constantly growing role turning “binary” living-nonliving interaction to “ternary”. The day when garbage weight exceeds the weight matter in Earth crust, which can be eventually turned to human activity products, is closing rapidly, and even now those two weights are comparable. We have to think about what to do when there is no more resources in Earth crust before our civilization goes over the point of no return. Destruction of anything created merits no less attention than creation itself. Destruction technologies have to an integral part of creation process. Destruction has to be included to any product design. Else it will be the end of human civilization. When exactly the end may come? Unfortunately, this is the question of not only scholarly interest; and even the most optimistic forecasts tell us that in current situation there will be none to celebrate the third Millennium when it comes.

But is it possible? Is there any precedent of non-waste civilization? Absolutely. If we apply a little broader definition and number with civilizations all living organisms, including Homo sapiens not as creator or destroyer, but as a living thing whose body makes part of biosphere.

II. CREATION AND DESTRUCTION IN VIVO

One hardly realizes that all things and whole species living on Earth are non-waste, contrary to human civilization. It is seldom possible to find relics of ancient animals, and finding dinosaur or mammoth bones is an extremely rare case. Living turns to living. Even Man, despite producing garbage so painstakingly, is 99.999% “disposable” as a species in terms of substance comprised in him during his life. Our biological life disposes of wastes only in the form of carbon dioxide we exhale and stuffs we leave in the toilet, both latter being so life-giving, that harder product is used as fertilizer, and more fluent is sought, for instance, by polar dears and licked from upon snow to keep the necessary balance in their organisms. The bones? Unfortunately for Man, but fortunately for biogeocenosis, those return to the world too as chemical elements able to turn into life again. From biogeocenosis point of view, any man and even the whole mankind is almost ideal non-waste system. To our much regret, we cannot apply the above to products made by the Man.

The realm of living things is a perfect example of reversible civilization. It makes much sense to mankind to learn how it is achieved to try to copy this unique biogeocenosis achievement (having come into existence “just” as a result of evolution and selection). The Man is obliged to do his best to create non-waste habitat for his activity, similar to natural habitat comprising himself as a creature of flesh and blood, and also of DNA, proteins, lipids and so on.

III. SOME DESTRUCTION MECHANISMS IN VIVO

It is generally accepted, that creation and functioning mechanisms prevail both in living cell and in Metazoa organisms. It could seem so at the first blush. DNA and RNA, biosynthesis mechanisms (ribosomal complex) and action of most enzymes undoubtedly serve creation. Controlling genes in operons and human brain control dynamics of current processes and apparently serve mainly the same constructive goal. True. And destruction mechanisms are apparently of small account. But this opinion on creation dominating destruction is actually false. In vivo those are two sides of one process, as proteins and nucleic acids are able of begetting life together but never separately. It is just natural that at early stage of molecular biology development attention was mostly paid to macromolecule synthesis and cell structure creation in vivo. However, last years show more and more clearly to what an extent the mechanisms controlling destruction of anything created are subtle, sophisticated and filigree-like adjusted.

- **Biogeocenosis level.** All living things (except for plants) eat living things. Leaving practically nothing. When they die, they become (almost completely) somebody else's food. Plants, in their turn, are either eaten, or decompose to components used for creation of next living thing generations. How has it been achieved by the Nature? There was evidently many life arrangement options to choose from, mostly leading to irreversible accumulation of waste. How did evolution select those very molecules and mechanisms that provide for life reversibility in the sense of using of practically everything comprised in living body by other creatures? Was, so to say, the first attempt successful? Was there any struggle between reversible and irreversible forms of life at early stage of this life development? ¹ Can any material evidences of such a struggle be found? If DNA and aminoacids was different, could biogeocenosis have been reversible, or the choice made by Nature is unique in this sense as well? These questions are of not only theoretical interest, as human civilization goes farther on its way of endless accumulation of wastes not being processed to new products as the result of organic revolution, i.e. in the direction reverse to that chosen in vivo in evolution process.
- **Physiological level.** Every day millions of cells are synthesized in any animal (including human) organism. It happens on the levels of so-called stem cells, immune system, dermal cells etc. But, the fact that the weight of grown-up individual does not change means that approximately the same number of cells die every day. How is it determined which cells have to be substituted, and when? The answers are still unknown. But it is clear already that destruction processes have to be controlled very precisely to enable normal organism functioning.
- **Pre-programmed cell death.** About twenty years ago a phenomenon of pre-programmed cell death was discovered. As such, it is of no wonder, as it is necessary to distract exhausted or out-of-control cells to enable tissues functioning. But how this process goes, what is it governed by? The mechanisms controlling cell birth and death in tissues are being aggressively studied. But it can be considered verified fact that both birth and death of cells make part of normal tissue functioning. The same applies to the fact that pre-programmed death (at least at cell level) makes part of normal vital activity of most organisms, which can also be considered certain.
- **Protein Destruction Control.** It was found out several years ago that the cell system for used protein destruction and its renewal is extremely sophisticated. Recently, so-called ubiquinones, the molecules regulating controlled destruction of macromolecules, as well as proteosomes, protein complexes controlling protein degrading, were discovered. On the other hand, the mechanisms exist for "mass destruction" of biomolecule batches. For example, LYSOSOMES, membrane-bound vesicles having mostly spherical form which are sometimes been likened to "The Police Force of the Cell", contain proteolithic enzymes. If their shells are broken (which could be both under control and spontaneous), the cell is quickly destroyed. The mechanisms for vesicle interaction with other organelles, control over substances penetration into vesicles, their topology and geometry transformation are now under comprehensive investigation.

To summarize this exceedingly brief review, we can conclude as follows:

¹ This seems to be incomprehensible at all, as complete usage of organisms lost competitive struggle and absence of biogeocenosis activity waste apparently could not grant any evolutionary advantages for quite a long time.

1. Destruction and creation mechanisms make part of the same process in living nature.
2. Destruction control is an integral part of normal functioning of living cells and organisms.
3. In vivo study of controlled destruction mechanisms seems to be advisable from the point of view of development of the technologies functioning in a similar way.
4. The question, whether the areas of human activity exist where irreversibility is inadvertent and no destruction can be constructive, is a key issue for civilization future.

IV. PRACTICAL ISSUES OF CIVILIZATION MOVEMENT TO REVERSIBLE TECHNOLOGIES

Let us consider the possibility of movement to the technologies corresponding to the above principles. First and the simplest is to switch to biodegrading materials. Such polymer materials are already developed but still expensive. Here we can foresee different inventive approaches, e.g. polymer packing materials can be readily replaced by composite materials having paper as the main layer and biodegrading aqueous dispersion polymer as water- and oil-resistant coating. “Long-living” polymer sausage skin is already being replaced by “edible” protein skin. Ecologically unsound technologies should be swapped to alternative technologies as soon as possible and without any hesitation. If we need polyurethanes (porous plastics, coatings etc.) we should replace current technologies based on use of extremely toxic isocyanates (made in their turn with the use of phosgene being a chemical warfare agent) by non-isocyanate processes based on cyclocarbonate oligomers and aliphatic amines that can be obtained by means of efficient and non-waste biosynthesis. It should be remembered here that tiny silkworm obtains silk thread using cybernetical “bioassembly” and spending millions times less energy for thread extrusion that is spent in synthetic fiber (nylon) production.

In the last 100 years the mankind switched to synthetic materials in many areas. However, currently we return to technical use of renewable bioresources (alcohol as fuel in Brazil, plant oil use for lacquers and paints, biosynthesis of water-resistant adhesives from wood-processing wastes etc.). Even a special science called “Green Chemistry” came into being. But those are still single-point breakthroughs. A real progress will be achieved only on global switch to new technologies.

High-temperature technologies using plasma, high-energy lasers, autopropagating high-temperature continuous synthesis are the most promising for inorganic materials. Ecologically more sound physical and biological separation methods should substitute for chemical methods. It will enable processing separately all materials of an annual volume of cars thrown out to numberless throw-heaps while spending energy produced by only one middle-range power station.

It should be noted that biological methods are efficient for inorganic materials as well. For instance, high consumer value of Chinese china is achieved due to nanoparticles of clay raw materials in their turn generated in the soil owing to vital activity of certain species of worms.

- Another example: reinforced concrete, the principal construction material in modern world, can be recycled completely: upon fragmentation and separation metal is remelted and silicate component finds various usage, e.g. as chips for road building or even as raw material for stone molding.

Now to organics. Practically every organic material can be processed to gas (biogas) by bacteria or to liquid carbohydrates (like fuel oil) by high temperature (like cracking). It is interesting to remember recent studies showing that in natural conditions crude oil is (or at least may be) generated by brief thermal process in organics-containing rocks. This explains for instance oil traces in geysers.

V. NON-WASTE POWER ENGINEERING

If, as it was shown above, material revolution is possible even with current technologies, the problem still to be solved is power essential both for modern society vital activity and for material revolution itself. Much has been done already here. Power production will more and more wind, water and sun emission energy-based. Even menacing nuclear power engineering will be transformed to fusion power engineering, and nuclear wastes will be gradually processed and their quantity minimized. The solution will be found alternative to transmission lines. Energy distribution among local and

global sources is necessary at least to prevent global power system disasters like one happened in North-Eastern USA. Let us recall that in living world the energy is accumulated and transferred locally and only locally². Local energy sources (sunlight and literally each other) suffice to provide vital activity of all organisms within a habitat. Human civilization will undoubtedly make more and more use of local energy sources along with global electric power nets. In particular, development of hydrogen motors may lead to next generation systems where power is not transmitted by high voltage lines but “shipped” in containers or produced on site, whereas consumption of energy is not accompanied by hazardous discharges as on fuel burning in combustion motors (when hydrogen is burned only very pure water is generated). Vehicles will be propelled by electric energy or use combined propulsion systems based on accumulators and other alternative fuels. Further generation technologies may see the systems based on reversible molecular energy depositories (similar to glucose as the universal energy transmitter *in vivo*, and ATP being a versatile depository and reversible “coins of energy”, which is able both to deliver energy turning to ADP and to accumulate it during reverse reaction very efficiently and without any hazardous side effects).

VI. ALTELVITAL CIVILIZATION: UTOPIA OR FUTURE OF THE MANKIND?

As soon as equilibrium between the Man and his environment is restored, new problems will appear, but it will go without saying that:

- (a) everything must be non-waste,
- (b) resource excavation must be decreased to possible minimum, and
- (c) all products must be recycled on their service life expiry.

Let us assume for a time being that non-waste civilization has turned to reality. What next? This very moment (maybe earlier) the problem will arise of self-improving products (similar to changes in infant organism when it grows). Elements of such technologies already exist. For instance, automatic download (in the background) of anti-virus programs online. The end-user continues to run the apparently the same program without any idea that it has been gotten better (evolved, self-improved). On the other hand, mutant bacteria are discovered in urban soil (in particular, in Moscow) able to process any civilization side-product (or almost any) that gets onto and farther into soil. If bacteria (or synthesized “enzymes) are able to dissociate quickly concrete or, say, computer chips to components (not necessarily to elements) fit to be used in next generation technologies, such “vesicles” could be envisioned as *allevital* product organs. As far as nano-technological scale is achieved, the difference between chemistry and human made device little by little will disappear, like it takes place in the molecular biology. It is still a way to go to self-developing and self-improving products (TV sets, computers, cars) able to change like growing organism, but it does not mean that it is impossible in principle to create such products. When our civilization sets such tasks, it will encounter the problem of constructive destruction (already solved *in vivo*) on a completely new level.

How could we ensure that an artificial allevital “bacteria” or “enzyme” able to “devour” a computer of its part when it gets “a word of command” would not break from under control and devour the user at the same time? Or that it would not mutate and eat everything in a row - from cars in the streets to skyscrapers? Apparently, if allevital (from Latin words *alter* - different and *vita* - life) civilization is ever to be created, it should be necessarily built of molecules not used in living nature, in order to prevent destroying life by allevital “bacteria” by the very physical principles of their “corner stones” structure. How is it possible to solve this problem? One option is: destruction by allevital mechanisms should be performed under conditions never achieved in natural environment (e.g. over 80° C). The question, if it is possible in general to create an allevital world, based on the molecules that differ from organic ones but operating (in the broadest sense) on the same principles that life, is justified. Is it enough to create “anti-organics” based on the molecules with chirality contrary to that of biomolecules or are more profound changes indispensable? Can *alter vita* be built, at least in theory, on some other basic element, or existing set of aminoacids, nucleotides and lipids *iw* unique and has no alternative?

Those are the fundamental questions, at present not to be answered by anybody in justifiable manner. We can just state that concurrent fulfillment *in vivo* of two completely different requirements, namely, life functionality and reversibility, would be extremely improbable should the life as such be able to satisfy only one of those.

² Energy transfer to big distances during migrations of birds, antelope etc. being kind of “migrating bearers of biological energy” is infinitesimal as compared to total mass *in vivo*.

CONCLUSION

Under condition of purposeful consistent efforts made by all developed countries, the civilization may move within next dozens of years to the status, marked by the following:

- 1) minimized wastes;
- 2) excavation of new minerals and other resources reduced to minimum;
- 3) almost everything produced is almost recyclable.

Development of new technologies, and only this task, should become a new standard, similar to issues currently regulated by the State, e.g. car exhaust. Such a strategic program could be for mankind not only a huge stimulant for new technology development in all sectors, but also a “highway” for development, different from all roads taken up to now by all technology revolutions. It could change people life completely.

Why the “Reversible Civilization” program is not being implemented already? Apparently, not only because this is a long-term and expensive way of radically changing all sectors of industry and economy, but also because it is generally considered impossible by default to create a reversible civilization. Another reason is the domination of military-oriented development of science and technology in 20th century.

Incomparably exceeding the arms race in late 20th century that stimulated development and transformation in many sectors far from military. In that process, the main course of the human civilization was lost.

Reversible civilization is possible. Moreover, it is absolutely necessary as there is no alternative. And we should start its extensive implementing as soon as possible, while the Man’s environment has not gotten over the point so well known from nonlinear system theory, i.e. the point of no return.