

Part XXXI

Future of Informatics - Chapter 10

Chapter 10: LONGEVITY - LIFE OVER 100 (TILL 150)

Should and can we try to live (much) longer?

Can we fight death? How?

- Wisdoms.
- Is longevity a natural, achievable and desirable goal?
- Can we fight death?
- Should we try to fight death?
- If both answers are positive, are there some good reasons to believe it is now a proper time to do that?
- History of longevity.
- How science and technology could help to increase life span?
- Centenarians.
- Does living longer will mean living better?
- The Earth's ability to handle longer-lived humans.
- Family life during longevity.
- Economical and financial implications of longevity.
- Religions in the age of longevity.
- From human body version 1.0, to human body versions 2.0 and 3.0.

- Death was natural in the past, but so was the instinct to fight it. The future has room only for one of them.

Anonymous

- Immortality first! Everything else can wait.

Corwyn Prater

- The time has come for death to die

S. Arrison, the author of "100 +", 2011

- Death has never made any sense to me. How can a person be there and then just vanish just not to be there?

Oracle founder, who gave large part of his wealth to antiaging research

- The future is not determined. We cannot (or should not) outsource our own lives. In whatever capacity we can, we must take ownership of the future. In order to win we must fight.

P. Thiel, 2011

- The net effect of nanomedical interventions will be continuing arrest of biological aging, along with the reduction of current biological age to whatever new biological age would be desirable to the patient, severing forever the link between calendar time and biological health.....using annual checkups and clean-outs, and some occasional major repairs, your biological edge could be restored once a year to the more or less constant physiological age that you select. You might still die of an accident, but you will live at least ten times longer than you do now.

Robert A. Freitas, 1999, first issue of "Nanomedicine" journal

- Human life without death would be something other than human; consciousness of mortality gives rise to our deepest longings and greatest accomplishments.

Leon Kass, chair of US Presidential Commission on Bioethics, 2003

FEYNMAN'S OBSERVATION

It is one of the most remarkable things that in all of biological sciences there is no clue as to necessity of death.

If you say we want to make perpetual motion, we have discovered enough laws as we studied physics that it is either absolutely impossible or else the laws are wrong.

This suggest to me that it is not at all inevitable and that it is only a matter of time before the biologists discover what it is that is causing us the trouble and that this terrible universal disease or temporariness of the human's body will be cured.

HOW DESIRABLE and FEASIBLE IS LONGEVITY?

Comparing with goal to fight death, that touches some basic issues of humanity, drive to longevity is different.

- Desire to live better, healthier and longer has been a collective dream of humanity for ages and so the current tendency to put extension of our health and life spans and such longevity on our urgent research and development agenda is understandable and desirable.
- It is quite clear that progress in science and technology, medicine and health care makes this goal not only feasible, but one that is on our agenda.
- Some of the richest people of the world, especially from ICT area, are spending currently a large portion of their wealth to support antiaging research.

LONG LIVED PERSONS

By Bible: Methuselah - 969; his grandson Noah - 950; Adam - 930; his son Seth - 912 and his grandson Eros - 905.

Modern times (and verified): Jeane Calmet (France) - 122 (1997).

Austrian mathematicians Leopold Vietoris died at age 111 and wrote his last paper at the age 104.

In 2010 in developed countries 0.01% of persons lived over 100 years.

Recent statistics concerning the number of people over 100: US - 72,000; China - 43,000; Japan - 45,000; Brazil - 23,000; France - 17,000; Czech Republic 625 (2011)

An estimate has been publicized that around 2050 US will have between 800,000 and 4,000,000 of centenarians, 8,000,000 of those over 90 and 20,000,000 of those over 80.

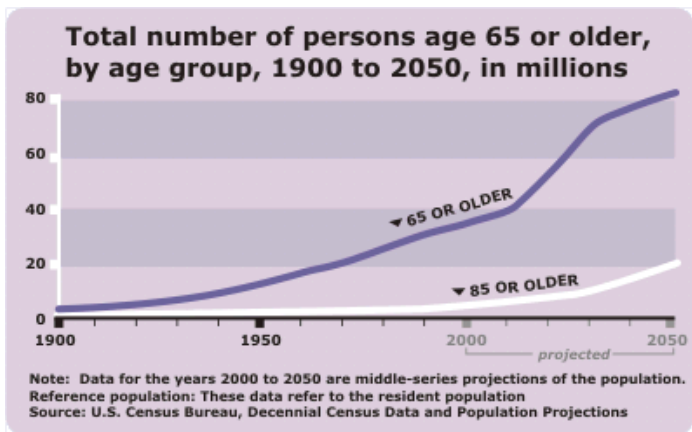
UN estimations for 2050 expect 2.2 million of people over 100 years.

Calculation shows that among girls borned after 1997 about 50% will live over 100.

OLD STORIES ABOUT POTENTIALLY TERRIBLE IMPACTS of LONGEVITY

- Oscar Wilde: The picture of Dorian Gray.
- Dr. Faust story
- Vampires as immortal monsters
- Frankenstein story (Mary Sheley, 1818)
- Gulliver story (Jonathan Swift, 1716)
- The bisessential man (Isaac Anisimov)

STATISTICS CONCERNING LONGEVITY



OLD IDEAS TO ACHIEVE LONGEVITY

- Search for fountains of youth.
- **Tasks of alchemists.**
- Francois Bacon, around 1626, developed various ideas to achieve longevity, including organ transplants and blood transfusions.
- **First successful blood transfusion into dog was performed in 1650 and into human in 1667 (using lamb's blood). However, the idea was then abandoned till 19th century.**
- Several philosopher and scientists started to push the idea that diets are ways to longevity.
- **One of them was Elie Metchnikoff, who won Nobel prize for immunology, who advocated eating special Bulgarian yogurt. His ideas made New York Times to write "Elie Metchnikoff declares human life can be indefinitely extended."**
- Diets are also nowadays seen as a way to longevity. Another popular routes are hormone therapies.
- **Cryonics - "science" how to freeze humans or at least human bodies and defreeze them after a time, is still here.**

To summarize: To live very long in a healthy state has been the collective dream of humanity for ages.

- Discovery of ways to fight infectious diseases.
- Discovery of vaccines.
- Discovery of antibiotics.
- Improved cares for new born children - because for most of the history gains in life expectancy were made at the beginning, not at the end, of life.

- Time comes to see aging as plastic, as a foe that can be hobbled and potentially even beaten.
- The main question now is: How long science and technology will extend our lives and how that in turn will change our ecological, social, financial and religious worlds.

BASIC ROADS to LONGEVITY

- 1 More healthy life style.
- 2 More healthy food.
- 3 Better sanitation.
- 4 Dietary manipulations and caloric restrictions.
- 5 Development of much better diseases prevention measures.
- 6 Successful fights against main causes of death and aging, as infectious diseases, cancer, heart diseases,...
- 7 Development of ways to repair or replace worn-out body parts as well as re-engineer our bodies.
- 8 Much improved fight against viruses through their genomes scanning.
- 9 Much improved diagnosis of potential diseases due to nanotechnology.
- 10 Much improved personalized medical treatment due to nanotechnology.
- 11 Regenerative medicine.

- Development of nano(bio)technology.
- Bioinformatics a merge of biology and informatics.
- Neuroinformatics a merge of neurology and informatics.
- Medicalinformatics.

HISTORY of MODERN FIGHTS FOR LONGEVITY

- Great success of the Human Genome Project (3 billions of dollars) so the "genetic blueprint for human beings" is now available can be seen as a beginning of the vision of longevity as a feasible scientific goal.
- Start of a new huge project to make genome sequencing of 100,00 of bacteria.
- Once genetic code of humans and bacteria can be identified, then natural goal, that looks feasible, is to re-engineer it, - Improving quality of life and achieving longevity is the next natural goal.
- Start (2013) of huge European Human Brain Project to make a model of human brain. Start of similar projects in US, Japan,....
- Start of big National Robotics Initiative in USA, 2012, with goals (2 out of 4): (a) to help scientists to accelerate discovery of new life saving drugs; (b) to improve food safety by rapidly ensing microbiological contamination.
- Start of big project in USA (CMU) to design robots to take care for handicaped and elderly.

- Accelerating progress in biotechnology is expected to enable us to reprogram our genes and metabolic processes to turn off diseases and aging processes.
- Such a process will include rapid advances in genomics (influencing genes), proteomics (understanding and influencing the role of proteins), gene therapy (suppressing gene expression) and therapeutic cloning of rejuvenated versions of our cells, tissues and organs.
- Regenerative medicine has already remarkable successes in growing human organs and then implanting them successfully.
- Human tissues and organs printing.
- Biotechnology will extend biology and correct its obvious flaws.
- The overlapping revolution in nanotechnology will enable us to expand beyond the severe limitations of biology.
- Human life expectancy is growing steadily and will accelerate rapidly, now that we are in the early stages of reverse engineering the information processes underlying life and diseases.

ROADS to LONGEVITY - II. GENE THERAPY

Gene therapy is a therapy through a process of modifying genes by adding new DNA or turning off parts of existing DNA.

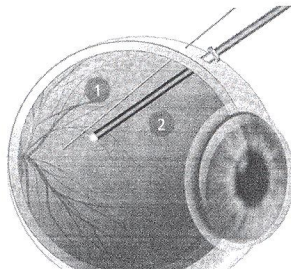
It is clear that if this can be done, then a very fundamental method would be available to deal with many health problem, but also to reengineer human body.

The main problem still to deal with is to achieve sufficient precision to introduce a new DNA exactly where it should go.

In spite of various successful treatments this very promising approach still nwaits for significant improvements.

How It Works

Using DNA, scientists create a functioning gene to replace the faulty one in the retina. Then they place the new gene inside a little "coat" made up of viral proteins (known as a vector). The type of virus researchers use



- The ability to rebuild body parts when people get injured or sick is something that human desired for millenia. A desire to do that has been motivated also by the fact that salamanders can grow back its legs.
- The goal of the regenerative medicine is to replace or to regenerate human cells, tissues or organs to restore or establish their normal functions.
- One way of doing that is to regenerate damaged tissues or organs by stimulating the body's own repair mechanisms to heal previously irreparable tissues and organs.

- Another way of doing that is to grow human organs in laboratories and then to transplate them.
- This is seen as a way to solve the shortage of donnors problems. This is also seen as a way to solve the problem of organ transplant rejection if new organ's cells are derived from the patient's own tissue or cells.

- Regenerative medicine is also seen as a way to change a course of chronic diseases and to regenerate tired or failing organ systems.
- Some forms of regenerative medicine made it already into clinical practice. It is estimated that 1 out of 3 Americans could profit from the development of regenerative medicine.
- Several proof of concept has been performed very successfully and quite a few success stories have been reported. It is seen as feasible to grow hearts, livers, kidneys, breast tissue, testicles, bones, bladders,... (for rats heart has already been grown).

- For example, in Wake Forest Institute for Regenerative Medicine they reported working on 22 different organs and tissues.
- **Regrowing a finger was another success story.**
- Stem cells are perhaps the most powerful tool for regenerative medicine.

PLAYERS in REGENERATIVE MEDICINE

US Army is perhaps the player with main interest and most money to support regenerative medicine.

DARPA (Defence Advanced Research Projects Agency) is the US Army main supporting platform for regenerative medicine.

One of its big projects was "Blood farming" - to secure large supply of blood that is readily available, universal, and has a long shelf life - large supply of blood is often needed to treat battle wounds.

Armed Forces Institute of Regenerative Medicine, with 250 millions is another extremely important player in Regenerative medicine.

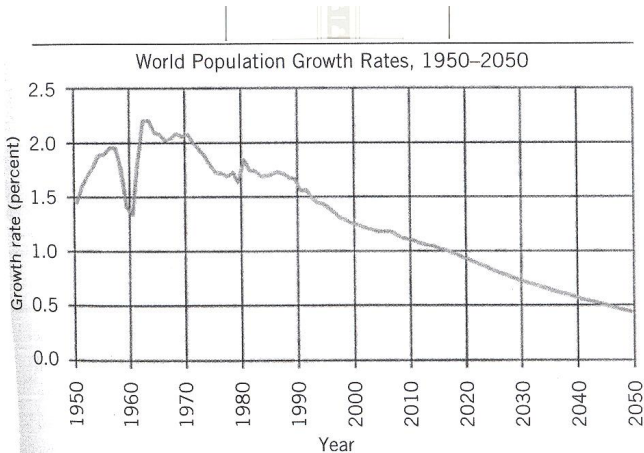
- In 2010 an organ 3D printer was announced, by a company called "Organovo" that gets on input a bio-ink (made of living cell mixtures) and then cells are printed on a biodegradable material, "pages" on top of each other to make 3D shape, that operates as a scaffold.
- State-of art: printing prosthetic limbs, hearing aids, dental fixtures.
- Under development: printing of human tissues
- Longer term goals: printing of kidney.

- Cell therapy is the process of introducing new cells into a tissue in order to treat a disease.
- Cell therapy often focuses on the treatment of hereditary diseases with or without the addition of gene therapy.
- Cell therapy origin can be seen as rooted in blood transformation (1828).
- Today, cell therapy is the fourth (after drugs, biologics and medical devices) and most recent therapeutic pillar of healthcare.
- Current cell therapies: (1) The transplantation of stem cells; (b) the transplantation of mature functional cells (cell replacement therapy); (c) The application of modified human cells that are used to produce a needed substance (cell-based gene therapy).
- Therapy in development: Treating diabetic patients by introducing insulin producing pig cells into their muscles.

CASE STUDIES - IV. GENE THERAPY

- Gene therapy is perhaps main challenge of bioengineering. The goal is to enable us to effectively change genes inside the nucleus by "infecting" it with new DNA, essentially creating new genes.
- In particular, the main goal is to change our adult genes and this way either to block undesirable disease-encouraging genes or to introduce new ones that slow down and even reverse aging process.
- Animal studies that began in 1970s have been responsible for producing a range of transgenic animals (cattle, chicken, rabbits). The first attempts of human gene therapy were already in 1990.
- The main challenge that must be overcome for gene therapy to be applied in humans is proper positioning of a gene on a DNA strand and in proper time and monitoring of the gene's expression.

WORLD POPULATION GROWTH RATES



SOURCE: U.S. Census Bureau, International Database, December 2010.

R. Freitas estimated that by eliminating 50% [90%] {99%} of medically preventable conditions would extend human life expectancy to over 150 [500] {1000} years.

We can expect that the full realization of biotechnology and nanotechnology will allow us to eliminate virtually all medical causes of death.

Moreover, as we move toward a non-biological existence, we will gain the means of "backing ourselves up" (storing keypatterns underlying our knowledge, skills and personality), thereby eliminating most of causes of death as we know it.

Life expectancy:

Cro-Magdon era	18
Ancient Egypt	25
1400 Europe	30
1800 Europe +USA	37
1900 USA	48
2002 USA	78

LIFE EXPECTANCY

Top and Bottom Ten Countries Ranked for Life Expectancy, 2010

<i>Top 10 Countries</i>	<i>2010 Life Expectancy Estimate</i>
Monaco	89.78
Macau	84.38
San Marino	82.95
Andorra	82.36
Japan	82.17
Singapore	82.06
Hong Kong	81.96
Australia	81.72
Canada	81.29
France	81.09

<i>Bottom 10 Countries</i>	<i>2010 Life Expectancy Estimate</i>
South Africa	49.20
Guinea-Bissau	48.30
Chad	47.99
Swaziland	47.97
Zimbabwe	47.55
Nigeria	47.24
Afghanistan	44.65
Mozambique	41.37
Zambia	38.86
Angola	38.48

- The basic idea of mind uploading is to scan human brain, capturing all essential details and reinstating the brain's state in a different - better - computational substrate. That can be copied to another substrate again and again and we get a "weak form of longevity of mind".
- The above way of transferring mind to information and reinstalling it represents a form of Immortality that should be feasible in the middle of 21st century
- However, it is important to point out that data and information do not necessarily last forever: their longevity depend on its relevance, utility and accessibility.

- One can expect that during 21st century it will be an important ethical, philosophical and even political and legal issue whether the person based on my mind copy/file, who migrates across many computational substrates, and who outlives any particular thinking medium, will really be me.
- If death seems unavoidable, we have little choice but to rationalize it as necessary. However, if death is not unavoidable, is it desirable?

- The overall amount of information and knowledge also grow exponentially. That brings new hard problems:
 - How to make use of it?
 - How to store information and knowledge so longevity of it will be guaranteed?
- Big problem is that electronic media are getting so fast obsolete and information on them so fast unreliable that we have to realize that there is no set of hardware and software standards today, nor likely to come soon, that will provide a reasonable level of confidence that stored information will still be accessible (without unreasonable levels of effort) decades from now.
- Conclusion: **Information lasts only so long as someone cares about it.** Only when it is continually upgraded and ported to the latest hardware and software

The horror of that moment,
the King went on,
I shall never, never forget it.

You will, though,
the Queen said,
if you don't make a memorandum of it.

Women with largest number of their children

- 69 Wife of Vasiljev, Russia 1725-1765, 16 twins, 7 triplets, 4 quadruples, 67 survived
- 39 Elizabeth Greenhill, UK, 7 sons and 32 daughters
- 25 Lapa Pigenti
- 21 Olivia Guinness, Ireland,
- 21 Anna Crocker, Canada - 17 children lived to adulthood
- 20 Rose Alma Letendre (Quebeck, 1920)
- 19 Michelle Dugar (USA) - family was the subject of a reality show for 10 years

- Retirement was first established in 1880, in Germany, as the idea of Otto Von Bismarck
- Retirement age was set to 70 and in 3 years later to 65 - at that time very few people lived to that age (Otto von Bismarck was 71 and 74 at that time).
- Retirement was established in USA 55 years later in 1935 as 65. Life expectancy was at that time 61.7.
- Maximal current retirement age in Europe is 68 (????).

EARLY HISTORY of RETIREMENT

- Main motivation for Otto von Bismarck for declaring that he will pay those who retire after 60, was danger of communist ideas that was spread out over Europe.
- In US in 1905 physician William Osler developed a theory for necessity of retirement: Men are good workers only between 15-40, they are uncreative when 40-60 and useless after 60.
- In 1935 popular were ideas of Francis Townsend who suggested that government pay after 60 200\$ what was at that time average salary.
- Roosevelt came with idea that people pay social security and then get retirement pay. The main reason was that workers did not want to retire though they stopped to

LONGEST LIVED MATHEMATICIANS

- 1 110 - Leopold Vietoris (Austria , 1891-2002), last paper he wrote at age 104
- 2 107 - Sergey Nikolsky (Russia, 1905-2-12), at 99 he was running a weekly seminar and intensively published scientific papers
- 3 104 - Henri Cartan (France, 1904-2008)

THE EARTH'S ABILITY TO HANDLE LONGER-LIVED HUMANS

One of main worries of society is whether nature can handle much more people - what seems to be the consequence of radical life extension.

Related worry is whether societies will be able to handle much more "old" people what seems to be a natural consequence of radical life extension. Will that lead to a radical shift of retirement age? Or what?

There are reasons to believe that such worries are not justified because:

- Heavy population growth comes from more births and not from fewer death.
- Calculations showed that would humans become immortal Swedish population would increase only by 22% in 100 years and that without any life extension it would decrease from 9 millions to 6 millions in 100 years.
- In spite of the fact that overall population is still growing, the rate at which it is growing is slowing down.

WHY MALTHUS WAS WRONG

- In 1798 Thomas Malthus predicted society disaster because of overpopulation since number of people grow exponentially but potential of nature to feed them only linearly.
- **Bill Gates** Malthus was wrong because his math did not take into account influence and power of human mind.
- That is, more ideas lead to new ways of producing the things we need, which is why we are not facing scarcity even in the face of population growth.
- We can look also at this issue from the genius perspective. In a population there are about only 2% of brilliant people. Therefore, more people produces more innovative ideas and we have improved conditions.

Basic observation:

- Longer people live and more wealthy they are more they take care about environment.
- New technologies are on the horizon the promise to make the Earth a cleaner and healthier place.
- For example, it looks increasingly likely that society will be able to turn a lot of its waste into fertilizers or energy.
- A lot of effort goes into finding ways to create cleaner fuels and to deal with carbon emission problems.
- In addition nanotechnology brings new possibilities to make solar energy more efficient.

DOES LIVING LONGER MEANS LIVING BETTER?

There having been also opposition to pursue longevity. For example Dr. Kass, chairman of the Presidential Council on Bioethics in US (2001-2005), strongly in anti-aging camp, had three concerns:

- Using technology to extend healthy life should be seen as unhuman - as "incompatible" with human nature.
- Mortality makes life better - would Immortality be possible one day, life would not carry the same meaning because there would be too much of it.
- Death promotes "virtue and moral excellence" - without impending death, it would not be possible to be noble because nobility requires "spending your precious part of your life time".

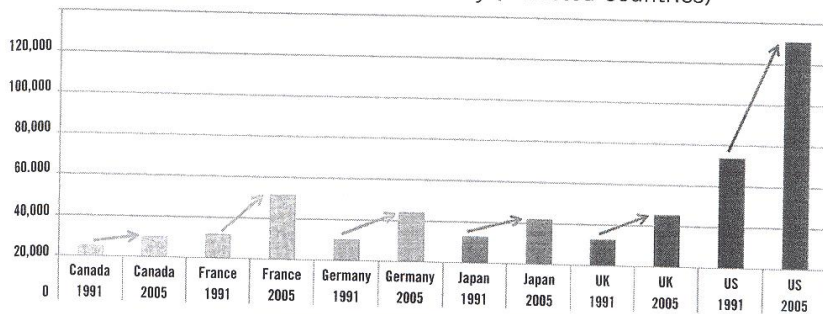
Some important questions:

- Can biological fertility be extended along with life expectancy?
- What will be impact of longevity on such institutions and activities as marriage, family, profession, education, hobbies?
- For example, can we see as likely a tendency to have several distinct carriers, one after another, and each requiring some longer education?
- Will redefinition of retirement be needed?

Research is going on all these issues and it seems to converge to view that much larger diversity in all aspects are likely to emerge.

FIGURE 5.1

Live Births to Women over Forty (Selected Countries)



Basic questions:

- If the average person could expect to live a healthy 150 years, how would that change economy?
- How would extending our economically active life span alter our financial world?

Some observations or findings:

- Health makes wealth. If two countries are identical in all respects, except that one has a 5 year advantage in life expectancy, then the real income per capita in the healthier country will grow 0.3 - 0.5% per year faster than in the less healthy country.
- Economists at U. of Chicago calculated for US that "gains in life expectancy over the century were worth over \$ 1.2 million per person to the current population" and that "from 1970 to 2000, gains in life expectancy added about \$ 3.2 trillion per year to national wealth".

An important feature almost all religions is an offer of an Immortality in the afterlife and ways one can make his/her afterlife happy.

Since religions are very important for most of humanity, it is of large importance to ask how would religions develop in case of longevity.

Some observations

- The world as a whole has now more people with traditional religious views than ever before and they constitute a growing proportion of the world's population.

- Some of the scenarios for radical life extension involve re-engineering and rebuilding the systems and subsystems that our bodies and brain comprise.
- In taking part in this reconstruction, do I lose my self along the way?
- This issue will transform itself from a century old philosophical dialogue to a pressing practical matter in the next several decades.
- So who I am? Since I am constantly changing, am I just a pattern? Am I the original and/or the copy?
- Whom am I? Why I am me? Why are you you?

- At Canadian Master Swimming Championship they have category 100-104 years old. Jaring Timmermann made in 200? four world records in that category - he started to do competitive swimming at age 80.
- Marathon. The oldest man who was able to run marathon in England claimed to have 101. However he had no birth certificate - born in India.
- The oldest recorded man running marathon, in 1975 was 98 and did it in 7 hours and 33 minutes. The oldest woman was of age 90 and did it in 2002, in 11 hours and 34 minutes.

What is death?

- A fact of life?
- A purpose of life?
- A sense of life?
- A punishment of humanity for their sins?
- A necessity, because

Other questions

- Must die all what lives?
- Are we the only animals that have knowledge of death?
- Have science and technology developed to such a point that time came for death to die?

What is the goal of mankind?

- To grasp *Tree of knowledge*?
- To grasp *Tree of life*?

Would triumph over death mean the end of science?

What is more important: to get as much knowledge as possible or to beat death and aging as much as possible?

How to extend life expectancy?

To extend life expectancy was always one of the main goals of science since the modern science was borned.

For a long time in history number of young people was much larger than that of old people and so the clue to an extension of life expectancy was to do that for new borned children and young ones.

Success in fighting infectious diseases was the first big step to extend life expectancy.

Success in taking cares for healthy birth giving and for children in first two yeas has been another big step.

However, taking care for cancer, heart diseases, brain diseases and aging looked for long to be not only a very different and much harder task, but as an impossible goal.

Luis Dublin, one of those believing in limits for longevity, calculated in 1928, when US life expectancy was 57 that it would never be greater than 64.75.

Several other limits for life expectancy, that got fast broken, were set by such prominent organisations as UN or World Bank.

de Grey's plan to fight aging

In 2005 Aubrey de Grey, a computer scientist originally, now gerontologist, offered a compressive road map to fight aging - a 7 ways to deal with main damages that aging inflicts in our bodies.

Already in July of 2005 The MIT Technology Review offered 20,000 to anyone who could demonstrate that de Grey's "plan is so wrong that it is unworthy of learned debate' - the challenge is still open.

de Grey's belief in his plan made him to claim that the first humans to live to 1,000 may have already be borned.

- Ray Kurzweil (1948-), whose father died at age 58, and who developed Type 2 diabetes when 35, is also an expert on living long and published two books on his own approach to life extension.
- Personally, to follow his own advices for living long and healthy, he takes more than 200 pills and supplements a day.
- Kurzweil also belong to those singulatarians that take seriously the belief that many people who are alive today will end up being functionally immortal.

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