

Dear Professor Heuer  
Dear Carlo,  
Dear Colleagues and Friends,

After the fascinating talks of this afternoon, there is very little than I could add about the factual aspects of Carlo Rubbia's exceptional career.

Rather, I would like to reflect tonight about Carlo's intellectual attitudes, as a scientist basing his thoughts and acts on his own independent assessments of facts rather than consensus opinion or, even worse, preconceived ideologies.

In the field of fundamental physics, I need not insist: it is well known to all of you that embarking in the search of W and Z by transforming an existing accelerator rather than building a dedicated new one was a profoundly unorthodox view. The success of that bet is now History.

Therefore, I will concentrate my talk on that part of his activities concerning global issues: such as energy, resources, environment and population.

I have often heard him say: *using energy is not a sin and we need energy to satisfy the needs of a growing world population*. From that starting point, he proceeds to find solutions for producing energy in a sustainable way, brushing aside the prophets of gloom and doom who preach us poverty if we are to avoid the depletion of resources.

His proposals for a New Nuclear, based on Thorium and on Concentrated Solar Power are major steps in that direction. By contrast, those who describe themselves as ecologists, show themselves as opposed to progress and – according to me – contribute little, if anything to safeguard our planet and its inhabitants.

These ideologues can all be traced to Thomas Malthus who in 1798 put forward the famous thesis that, whereas the world population

grows exponentially, the food supply grows linearly. Therefore, unless the population is checked and people live at subsistence level, the world faces catastrophes (famines, war etc.. ).

We now know that Malthus was wrong.

Implicit in the “linear increase in food production” is the idea that growth is due exclusively to more land being brought to culture.

However, one detail is missing in the picture: the role of technology.

The use of high yield varieties, chemical fertilisers, irrigation, pesticides, mechanisation, has brought about an enormous increase in food production so that the world has easily caught up with a six fold increase in population since the days of Malthus.

In the ideological landscape, Malthus’s ideas still persist in a modified form, for instance the “Limits to Growth” predictions issued in the 1970’s by the Club of Rome.

These predictions were strongly opposed by Cesare Marchetti, an Italian Physicist and System Analyst that Carlo likes to quote.

Marchetti, who worked many years at IIASA, near Vienna made numerous contributions and the most important, according to me are

- 1) Based on historical evidence, growth is never exponential. Its logistic (S form) is never infinite but shows saturation.
- 2) The Dominant forms of Energy used by mankind show successive (logistic) growth and decrease. They substitute one to each other. Wood is followed by Coal then Oil, then Gas then Nuclear and Solar.

Let us remark that in this succession, our time is still marked by the dominance of fossil fuels with Nuclear and Solar still in their initial stages.

I find it very probable that Carlo's New Nuclear will come to the forefront with the next generation. As for CSP, which is particularly advantageous in African deserts, it is poised to outcompete the other forms of solar such as wind and photovoltaic.

Marchetti explicitly opposed the gloomy predictions of the Club of Rome who stated in the '70s that oil, food etc.. were going to run out shortly. In 1970, their estimate of oil reserves was 550 billions barrels. By 1990, after the world had burnt 600 billion barrels, proven reserves stood at 900 billions!

There were similarly wrong predictions about gas, silver, tin, aluminium, copper, lead and zinc. In all these cases, reserves have actually increased.

Another prophet of doom is Paul Ehrlich who predicted in his 1968 best selling book "The Population Bomb" that the world would undergo famines in the 1970's. Despite the world 's population having doubled since 1961, the food production per capita has increased by some 20% (even though, there is a persistent unequal distribution world wide).

India doubled its population in 37 years, but managed to increase its per capita food production, whilst maintaining its cultivated land constant within 5%.

At the opposite side to the doomsayers, there are optimists (sometimes called cornucopians), among which one can quote the economist Julian Simon. Simon believes that the ultimate resource is Man and his Ingenuity. When a resource is rare, prices rises, which causes an incentive to find more, or to find a substitute (e.g. Copper replaced by glass fibre for the transmission of data).

Let me now turn to world population, which is one of of Carlo's favourite topics.

According to Jeffrey Sachs, Director of the Earth Institute of Columbia University, there are three schools of thought about demography:

**Population Optimists**, among which Julian Simon, believe that since progress is led by the tiny minority of geniuses, the more the population increases, the more geniuses will be born. Resources are not really an issue, as technological progress will provide.

Similarly, Marchetti opposed the idea of limited resources and wrote an admittedly provocative piece showing that the Earth (based on nuclear power and concentrated mega cities) could support a trillion people for thousands of years, still leaving 80% of land uncultivated as a nature reserve.

I am not sure how I would (or Carlo would) condone such a vision, since it is such an extrapolation of actual engineering, political and other constraints. However, the idea that we should not be prisoners of arbitrary doomsday scenarios and able to look at real solutions to the real problems is certainly encouraging.

**Pessimists** counter that the world is too populated, that the threat of Malthusian catastrophe lingers on, with a possibility of exponential population explosion. They claim that our “soi-disant” technological progress just amounts to mining faster and faster finite natural reserves.

**Cautiously Optimist** is the category in which Sachs puts himself and I think Carlo would agree to belong. It implies the recognition of a slowing down of population growth through a demographic transition which will cause world population to peak at 9 billion humans around 2050. This does not deny worries about some regions of the world (such as Sub-Saharan Africa),

Carlo, in a Conference he gave us in Casablanca in 2005 described the broadly accepted demographic transition mechanism:

- 1) The first phase (say in 18th century Europe) sees a constant if fluctuating population due to an equilibrium between births and deaths,
- 2) In a second phase, due to better food and health conditions, mortality (particularly child mortality) declines, but the number of births is still high because people have not fully realized that the better conditions raise the probability of survival of children, and they still want a enough children to have adequate manpower on the farm and support for their old age. Therefore the population rises strongly.
- 3) After a certain interval, the population realises that persistently high birth rates have no good reason, and the fecundity decreases.
- 4) After the transition, births and deaths are in equilibrium and the populations stabilizes but at a much larger level than before the transition.

The demographic transition, which happened in France in the 18th century, is now taking place very rapidly, as shown in a recent book based on 2005 statistics by French historian and demographer Emmanuel Todd. A number of countries (from Maghreb to Iran) now have fecundity rates (number of children per woman), which are at or even below the replacement level of 2.1. The speed of the decrease (from one generation to the other) is striking. But because of the inherent inertia (for baby girls to come of age and have children of their own..) the actual stabilisation or decrease of the population takes 20-30 years.

It is interesting to note the factors that are driving the reduction in fertility:

–Alphabetisation (of men but also obviously of women) should pass the 50% mark.

–Increase in hygiene and health bringing about the corresponding drop in child mortality.

–Modestly affluent level of life leads to a better planning of estates.

Todd also notes that the decrease in fecundity has historically been linked to a decrease in religious practices.

Will this fact from Christian World also apply in the future to Muslim countries? And if yes, in which time frame? 10 years, 30 years? Only the future can tell.

The case of Iran is striking as the decrease in fecundity has actually been synchronic with the Islamic revolution.

At the onset in 1986, Iranian women had 7 children on the average. By 1995, this had fallen to 2.5 and now (2005) is 2.0, which is slightly below replacement level. It is hard not to interpret this as a sign of modernization and even rapprochement with the West.

From our Iranian colleague Hessem Arfaei, I learnt that the majority of PhD students in Theoretical Physics in Teheran are women (there were hardly any when he himself was a student). Women with a higher degree of education inevitably will be a transformational factor in Iranian society.

That may well be one of the significant contributions of CERN policy to the general movement of the world.

Thank You