

**SUSTAINABILITY - THE CHALLENGE OF 21ST CENTURY -
REFLECTIONS ON THE ROLE OF SCIENCE AND TECHNOLOGY**

- On the occasion of honoring Professor Fray's scientific lifetime achievements -

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ABSTRACT

Sustainability is a term that is used so frequently today in every field of life. You hear it everywhere; especially in political gatherings. Various serious risks that face our planet are frequently and rightfully stated if we do not become sustainable. These include the evaluation that not enough food and water will be available by 2050 for the forecasted 9 billion people living on the planet or that an increase of the global average temperature of the planet above a tipping point will itself be destructive. Many ways are proposed to make the world sustainable however not the right attention has been concentrated on the role of science and technology. The purpose of this lecture is to assess the primary role that science and technology play in the noble quest to make the world sustainable, to highlight the role of scientists, technologists and engineers as silent stars of our society, to stress the need for much better societal recognition for them and better funding to their work while suggesting better coordination among various fields of life and science and technology. This paper contains some extracts from the book “**Silent Stars of Society**” by the same author that is in print and will be available soon.

Key words: sustainability, environment, economy, society, definitions, sciences, engineering, technologies, coordination, silent stars.

INTRODUCTION

Ecology and sustainability have become frequent prerequisites for projects in every field of life especially in evaluating their objectives and outcomes. In a recent global survey of 8000 people aged 18-35, living in 20 countries, including 400 in Canada and USA, the respondents listed 3 various priorities as the modern world's challenges. They are shown in Figure 1.

As can be seen, environmental degradation or ecology is chosen by about 60% of people as one of the top priorities. However, ecology is only one priority among others. Nevertheless, ecology and sustainability are so very popular terms, especially among politicians, that are often used intermittently substituting one for the other without proper context. In fact, both terms have very different meanings.

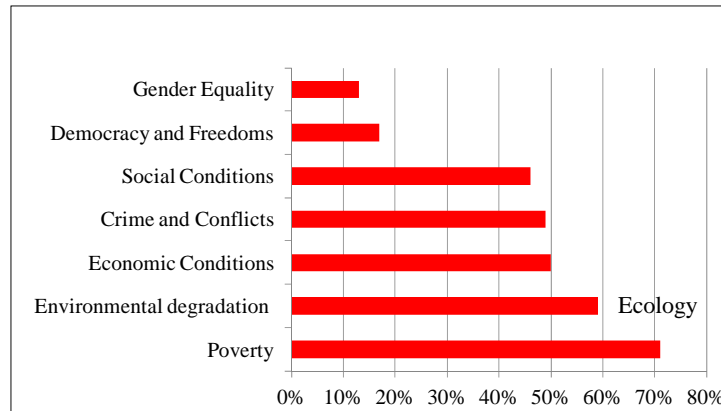


Figure 1- Survey results on 3 major priorities of today's world challenges

Ecology is the relationship that living organisms have with respect to each other and to their natural environment.

Sustainability is a specific way of using the world's resources that aims to meet present human needs without prohibiting future generations from the same opportunity.

There are many graphical definitions of sustainability but the best one is given in Figure 2. It consists of 3 equal dimensions: Social, Environment and Economic. Ecology falls within Environmental.

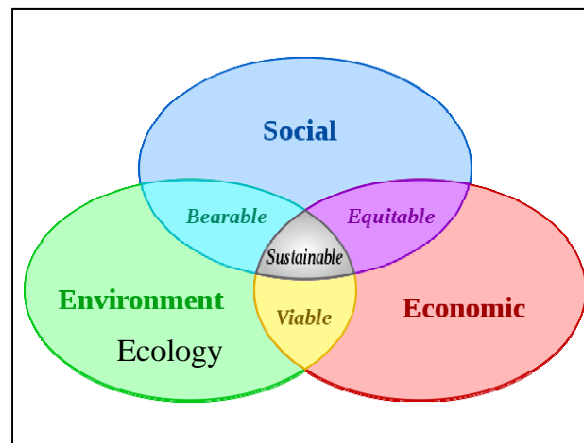


Figure 2 – Graphical representation of sustainability [2]

Equitable Development is the common ground between Economical and Social Development

Bearable Development is the common ground between Social development and Environmental Protection

Viable Development is the common ground between Economical Development and Environmental Protection

Sustainability is the common ground between the three of them: Economy, Society and Ecology

However, there are several definitions of the above terms. According to various language vocabularies the definitions of each term are as follows:

Economical: Careful, Sparing, Cautious, Cost-conscious, Frugal, Parsimonious /// Prosperity, Affluence, Capital, Treasure, Fortune, Means, Assets, Possessions, Goods, Funds, Resources, Holdings

Social: Communal, Community, Common, Societal, Public, Shared, Collective, Group

Environment: Ecological, Conservational, Eco-friendly, Green

The challenge for the sciences today is to better clarify and define these terms as they relate to sustainability.

In the following sections, the three components of sustainability will be analyzed in a special point of view that, without denigrating other aspects of sustainability, will stress the important role of the sciences and technology as well as the special irreplaceable role of scientists, technologists and engineers for the sustainable future of society.

EQUITABLE DEVELOPMENT = ECONOMIC + SOCIAL

Various language dictionaries define the word *equitable* as follows: “reasonable”, “impartial”, “just”, “unbiased”, “evenhanded”, “justifiable”, “rightful”, “fair”. It can be seen that various meanings of the word are sometimes confusing.

However, in terms of sustainability, equitable development is the one which always assures economic development and social development simultaneously. In this viewpoint both economic and social development are equality important and none of them should be overlooked because of the other.

Poverty is one of the issues related to this dimension of sustainability since it is closely related to economic and social development. As shown in Figure 1, this was a pressing issue for about 70% of the participants in the survey. Actually, there are two different aspects of this issue in close relation with science and technology.

Poor people versus rich people within a country

Closing the gap between the poor and rich within a country is not an easy task. Many good activities have been proposed and are underway to reach this very difficult goal. The challenge is to distinguish among them the most sustainable one.

Charity is an honorable activity. It includes feeding and sheltering the homeless and other similar activities. This is a very good and admirable activity if we are able to exclude several abusive charity organizations which use more than 75% of the donated money for administrative expenses. Nevertheless, the issue is how we can achieve economic and social development this way in the long term. Since we cannot eliminate this gap by this type of activity other more sustainable methods need to be used. The only long term sustainable solution for this issue is *creating the conditions in which the homeless can work and earn their living for themselves*. Science and technology can give a prime contribution in this field with new products that can train the homeless and make them useful and productive members of society.

Poor countries versus rich countries

Closing this second gap between the poor and rich countries is also not an easy task. Again, helping poor countries with money is simply charity and not necessarily sustainable. Money coming from charities does not close the wealth gap between countries. The only sustainable solution, especially in the long term, is *channeling the help in order to create conditions in which poor countries can help themselves to get richer*. Science and technology can play a big role here. Developing new technologies that are affordable for poor countries and commissioning them in these nations along with training of the local population to efficiently use them. Business models can be drawn to equally share the profit between the technology developers and users respecting patent and copyright laws.

BEARABLE DEVELOPMENT = SOCIAL + ENVIRONMENTAL

Various language dictionaries define the term *bearable* as “manageable”, “tolerable”, “endurable”, “acceptable”, “sufferable”, “supportable”. It can be seen that various meanings of the words are sometimes confusing.

Nonetheless, in terms of sustainability bearable development is one method which always assures social development and at the same time protects the environment. In this viewpoint, both social development and environmental protection are equally important and none of them should be overlooked because of the other. There should be no contradiction between the development of society and humans as social beings and protecting the environment. Unfortunately, there are several examples in which this link is ignored and sometimes in an extreme way. In a high level political meeting in February 2012, one of the panelists coming from the field of social science academia expressed her opinion that the only way to be sustainable is to return 800 years back in time since that would be the only way a proper equilibrium with nature could be achieved! Well, it is not a fictional story. It is real. When my 11-year old son Davis by chance heard this he said that if some extremist environmentalists win the elections:

- There would be no more toilets. Instead everyone will go in the backyard to make it natural
- Parliament would be a huge tent in an open field
- There would be no more e-mails, just handwritten letters which extremist environmentalists would run as fast as possible to deliver.
- There would be no more TVs, just wooden boxes and marionettes

It is clear that the sustainable development goal is not to sacrifice current social developments and achievements just to fit environmental concerns. Sustainable development's goal is to preserve these social achievements and to continue to further them in a better way while protecting the environment. Is this possible? I was asked this question in a recent TV interview. “Absolutely,” was and is my reply. Science and technology play an important role in achieving these goals along with political framework and education.

In this point of view, several examples will be given below highlighting the important role of science and technology as well as the irreplaceable position that scientists, technologists and engineers have in bearable developments as part of sustainable development.

Water Resources

It is rightly asserted that by 2050 there will be not enough water for the forecasted 9 billion population of the world. The initiatives to educate people not let the tap water run in vain is somewhat important in the short term but the real challenge to remedy this situation lies in front of *chemists, technologists and engineers*. They need to develop new, efficient technologies that recycle water from any source (in Singapore, even the toilet water is cleaned and recycled to drinking water) as well as invent new and effective temperature or movement sensor taps.

Detergent contamination

The claim that most cleaning detergents pollute the water is correct. The initiatives to educate people to use less detergents, wash bed sheets less frequently in hotels and at home are not bad in the short term but sometimes, especially in some environmental journals, the tips go to the extreme such as suggesting that people wash themselves less frequently. As mentioned above, the social achievements on hygiene cannot be compromised and this can be achieved through bearable development. The real sustainability challenge lies in front of *chemists and engineers*. They need to develop new detergents that can clean dry, use steam instead of water or develop new methods of cleaning and disinfection without water.

Car pollution

The assertion that most private cars in circulation are a source of air pollution and have a noticeable carbon footprint is also valid. The initiatives to educate people to minimize this kind of pollution are not bad but they are short term solutions only. Furthermore, some environmental journals go to extremes suggesting for example to turn off car air conditioning or remove all the unnecessary objects from the car in order use less petrol and contaminate less the environment (A humoristic reaction to this was to remove all friends from the car! This is actually contrary to the other suggestions in other magazines that suggested for the same purpose to use car pooling and have more people in the car). Again, one cannot compromise the social achievement of comfort through air conditioning nor eliminate one of the big achievements of humanity to use private cars for their convenience or transport objects in them! The real sustainability solution stands as a challenge in front of *technologists, chemists and engineers* to develop new methods or types of air conditioning with less energy consumption as well as develop new types of light vehicles that spend less fuel or invent new kinds of vehicles that use new types of pollution-free fuels.

Airline Pollution

It is accurately asserted that the airline industry is a source of air pollution and has a noticeable carbon footprint. However, in some environmental journals you see suggestions that dictate people should fly less and less or book a direct flight instead of a connecting one in order to

decrease their carbon footprint. Again, you cannot compromise the modern achievement of something such as aviation nor restrict the rights and pleasure of people flying. This is a big social development. Furthermore, there are many poor people around the world that have never flown and still dream to fly on an airline. One cannot prohibit them not to fly. On the contrary, in order to have social development we need to make flying more accessible to more people. As a result the real sustainable solution to achieve both social development of airplane flights for everyone and protecting the environment lies as a challenge again in front of scientists, metallurgists and engineers to develop new types of light-weight airplanes causing less pollution or using a type of energy/fuel without emissions.

Video Games/TV Energy Consumption

It is presumed that videogame consoles and computers consume a lot of energy and increase carbon emissions. The remedy tip that some environmental magazines give is to educate people to play less and less videogames in order to conserve energy. Although this is a somewhat good short-term tip for energy saving, the earnings that result from it are not so considerable. Additionally, as mentioned earlier, one cannot again compromise the modern achievement that is the videogame and restrict poor people from dreaming of having one to play. As a result, the real sustainable solution in order to preserve this particular social development and make video gaming accessible to all and simultaneously protect the environment lies as a challenge in front of scientists, material engineers and engineers to develop new types of computers and gaming consoles that are energy efficient.

Electric Lighting

It is rightly asserted that electrical lighting is a major source of energy consumption. In order to sensitize the public, the “Earth Hour” event has been organized every year in various countries. It consists of switching the lights off almost every building and sometimes whole cities for one hour. It is a good activity but this is mostly a public sensibility issue. Also, it should never be understood as a need to use less lighting. Otherwise the modern social achievement of lighting is compromised. Furthermore, there are several hundred million poor people around the world that have not seen the electric light and no one can restrict those that dream to have electricity. The real sustainable solution to achieve both social lighting development and to make it accessible to all by simultaneously protecting the environment stands as a challenge in front of material and physics scientists and engineers to develop new types of low cost lighting that use lower levels of energy and have high energy efficiency as well as to produce highly efficient lighting sensors for dynamic savings of electrical energy when lighting is not necessary.

VIABLE DEVELOPMENT = ECONOMY + ENVIRONMENTAL

Various language dictionaries define the word *viable* as “feasible”, “practical”, “worthwhile”, “practicable”, “workable”, “possible”, “doable”. Again, it can be seen that various meanings of the word are sometimes confusing.

However in terms of sustainability, viable development is the technique that always assures economic development and at the same time protects the environment. In this viewpoint both

economical development and environmental protection are equally important and none of them should be overlooked because of the other. There should be no contradiction between the economical development of society and protecting the environment. Unfortunately, there are several examples in which this link is ignored and sometimes in an extreme way.

The goal of sustainable development is not to stop economic development just to fit environmental concerns. Sustainable development's goal is to further economic development while simultaneously protecting the environment. Is it possible to have this balanced approach? Absolutely! Science and technology constitute an important key to achieve this objective along with political framework and education.

Several examples will be given from this perspective below highlighting the important role of science and technology as well as the irreplaceable position that scientists, technologists and engineers have in viable development as a part of sustainable development.

Undeveloped rural Areas

There have been many suggestions/protests in the press and as well as in specialised environmental magazines from pure environmentalists to prohibit the development of undeveloped and rural areas especially through extraction and mining projects. Their idea is to keep them as the virgin environments they are (examples: North of Canada or Quebec, Alaska etc.)

Nevertheless, these undeveloped and rural areas have the same rights to be developed as the other developed regions. None can prohibit them from these rights. These projects can decrease unemployment in these regions which in turn is a plus-value for these places and their inhabitants. As written above, poverty is one of the big issues for a sustainable world and developing these regions with extraction and mining projects among others eradicates poverty. The real sustainability challenge is to do this in a balanced way while protecting the environment and this is a real challenge facing *chemists, metallurgists and engineers*. They need to develop new extraction and treatment of minerals and raw materials methods in order to protect the environment at the same time.

Food Depletion

It is rightly asserted by scientific studies that by 2050 the population of the world will reach 9 billion people and that current food production will not be able to feed all of them. Some proposed solutions such as a voluntarily controlled population growth based on education are good but are unlikely to have the extended, proper effect we need since, among others, the average life of humans will continuously increase. However, some other suggestions in some environmental journals will certainly have no long term effect. These suggestions include eating two times per day instead of three because three times per day is not needed or eating less meat and more vegetables etc. (all these suggestions are given by known social science panelists and some environmental magazines). The real sustainability solution that will solve this issue stands as a challenge in front of *scientists* to develop among others new types of grain or other products

with much higher productivity and shorter growing time in order to meet this challenge. The latter allows long term and simultaneous economic development and environmental protection.

Nuclear and Wind Energy

The assertion implying the tremendous risks of nuclear energy following the nuclear accidents of Chernobyl and Fukushima is also quite valid. The easiest advice given in the press and specialized journals is to close down all nuclear reactors. Some countries have in fact decided to close them down but confusion exists among their politicians on when their country will be able to replace all that nuclear energy with wind energy. Pronouncements of various politicians vary from plus/minus 5-10 years!

It should be noted however that nuclear reactors are currently a cleaner way for energy production compared to others. There is some risk associated with them but there could be no heavy industry without risk. Also the risk factor should not be the only one factor deciding on one type of energy production. Again, the creation of a sustainable solution here is the task of *scientists and engineers* who need to develop new types of nuclear reactors with much more improved safety and at the same time innovative and more effective renewable energy from wind or other renewable sources. This balanced approach does not prohibit economic development.

Oil, Natural Gas, Coal

The proclamation that the oil, gas and coal industries in their current states have high carbon footprints is also correct. As such, the proposals to close down these kinds of industries and prevent any new projects in these fields surface regularly in the press. It is suggested that they should be replaced by other renewable forms of energy. In principle, this is a very good suggestion and a proper solution. The issue, however, is that the renewable ways of energy production are not yet efficient enough today and not able to replace the current amount of energy produced by oil, gas and coal resources. Moreover, they constitute an important job provider. Closing them all down will stop economic development and will create a social crisis.

The real sustainability solution stands in front of *scientists, technologists and engineers*: they need to develop new highly effective technologies to produce renewable energy that will be able to replace the old ways of producing energy and at the same time to make the old energy production routes of oil, gas and coal carbon neutral. For example a new technology has been proposed to extract CO₂ capacity of oil before it is used thus eliminating the carbon footprint from the use of oil. If this and other technologies are developed and are efficient, then the old technologies of oil, gas and coal will also be clean types of energy.

SUSTAINABLE DEVELOPMENT = ECONOMICAL + SOCIAL + ENVIRONMENTAL

Economy, society and the environment are the three pillars of sustainability. If any one of them is compromised, there is no sustainability. Many cases can be given that satisfy these three important criteria of sustainability. However, what it is more important to stress here is the need for close cooperation between several fields of science and engineering and this is another key to efficiently achieve sustainability.

It is sad to notice that there are different, wide and sometimes abusive definitions of sustainability and many solutions offered as sustainable are unsustainable. Among others this is because these solutions deal with a narrow field of a particular science and do not make the relationship with other sciences and also do not properly define their applicability within the big picture. If there is no proper scientific definition of sustainability on a global scale only a vicious circle is produced. There might be very good ideas, projects and achievements in any particular field of sciences however in order to make them sustainable, they have to be applicable in practice and in the long term.

As such, a close link and better coordination is needed between all fields of science and engineering because engineering is able to put into practice the achievements of the sciences in fields such as the natural, environmental, agricultural, medicinal, health etc. and at the same time engineering is able to push new developments in the sciences such as economical, legal, social and political, by giving them new grounds and new horizons

SILENT STARS OF SOCIETY

As seen above, the scientist, technologists and engineers are such important people for a sustainable future. Essentially, without them the sustainability of the world cannot be practically achieved. It is unfortunate to notice that they are not known as they should be in society. The existing stars of society are those from movies, TV and socialite circles. As such it is not a surprise to see that the percentage of engineering degrees has fallen sharply during the years in developed countries. The overall number of bachelor degrees and engineering degrees presently constitute only 20% in Japan, 16% in Germany and 6% in USA. Also, in a recent poll in Italy, some teenagers were asked to choose their preferred professions for the future. 95% of respondents chose movie and TV star careers. Science and Engineering was not at all in the picture. This is totally unsustainable.

The causes of this situation are multiple. The fault can be placed first upon scientists, technologists and engineers themselves. Movie and TV stars are valuable members of society and they are able to distinguish themselves efficiently. This is not the case with scientists, technologists and engineers. There are also other important causes and several examples that will be given below.

The Role of Media

A couple of years ago, 33 miners trapped deep underground in northern Chile for more than two months were rescued. It was a happy ending to a particular disaster. Furthermore, TV & Media covered this event live for 24 hours per day and referred to the rescue process several times as a “miracle” or “divine”...The same reference was given multiple times by the President of Chile during that period (a former journalist and TV owner) who was himself onsite following the rescue and used the occasion very wisely to advance his public image (Figure 3). However, no mention was given to the new American breakthrough technology that made it possible to drill in hard rock so deep. At least 80% of the chances for the miners’ survival were due to this new technology that nobody mentioned!



Figure 3 – Rescuing of 33 miners in Chile: All TV coverage and the Chilean President at the time called it a “miracle” or “divine”...Nobody mentioned the technology that made possible their rescue.

CNN’s legendary Larry King (Figure 4) has interviewed during the 25 years of his career numerous celebrities such as actors, talk show hosts, boxers, singers, stylists, chefs, etc. However he has interviewed no scientists, technologists or engineers (with probably only one or two exceptions). Not even Nobel Peace Prize recipients in the sciences were in his list of guests. His new successor, Pierce Morgan, is continuing this trend. The question is: Why can’t engineers, technologists and scientists be celebrities?



Figure 4 - CNN’s legendary Larry King has interviewed no scientists, technologists or engineers in his 25 year long career with only a few exceptions.

CNN’s flagship program “CNN Heroes: Everyday People Changing the World” (Figure 5) has chosen many heroes of society featured in movie star staffed live broadcasts. The 2011 CNN heroes were 23 community crusaders and 2 people championing children’s causes. In 2010, the CNN heroes were 10 community crusaders, 3 people championing children’s causes, 4 medical marvels and 4 people protecting the powerless. There is nothing wrong with that since these people deserve to be honored. The issue is: they had no engineers, technologists or scientists as heroes who change the world! The question is: Aren’t engineers, technologists and scientists among the ones that *really* change the world?



Figure 5 – “CNN Heroes” has featured no engineers, technologists or scientists as heroes.

The very successful high-rating “Celebrity Apprentice” show of Donald Trump on NBC (US) (Figure 6) has actors, talk show hosts, boxers, singers, stylists, socialites, chefs, etc. as celebrities competing for business management excellence. Donald Trump, a respectful figure of mine, is not himself a “standard” celebrity but a very special and “unusual” one. He does not come from any of the above professions. He is instead an economist and a very successful real estate entrepreneur. He became a celebrity through his successes in business. A rare case... Nevertheless, he has not selected at anytime any engineers, technologists, scientists or

economists to compete on his “Celebrity Apprentice” show. The question is: Can’t engineers, technologists and scientists be celebrities and compete for business management?



Figure 6 – Donald Trump, an “unusual” celebrity from economy and business has never selected engineers, technologists, scientists or economists to compete in his “Celebrity Apprentice” show.

American Idol (and Canadian Idol for sometime) is a popular TV show competition with spin-offs in over 40 countries with the winner becoming an “idol” in their respective nation (Figure 7). An idol? In what field? Although they are not called a “pop music idol”, it is in fact a pop music singing competition. Science, engineering and technology is not even in the picture.



Figure 7 – American or Canadian Idol TV shows feature only singers although they are not called “pop music idols”

Societal Perception

John Lennon’s tooth was recently sold for \$ 31,200. It was a gruesome, yellowy, brownish, cavity tooth from decades ago when he was still alive (Figure 8). It was not a rare object that scientists brought from another planet! It was a tooth.

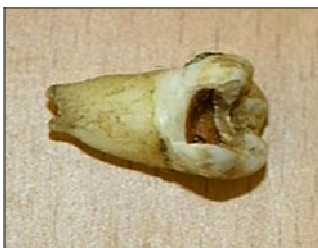


Figure 8 - John Lennon’s tooth was sold for \$31,200



Figure 9 - Justin Bieber’s hair was sold for \$40,668



Figure 10 – Justin Bieber’s right shoe was sold for \$1,450

Justin Bieber’s hair was recently sold for \$40,668 (Figure 9). It was not a rare organic material that scientists artificially created in the laboratory. It was a bunch of Bieber’s hair from a barber shop donated to Ellen DeGeneres to auction off for charity for an animal rescue organization.

Justin Bieber’s right shoe was sold for \$1,450. It was not a new breakthrough shoe technology that scientists invented. It was Bieber’s shoe that he autographed and donated to help raise money for his former high school’s broadcasting project.

At the same time, the usual grants that companies in some developed countries give to science researchers and technologists to develop new technologies are much less. In Japan for example it is about \$30,000 per project. Furthermore, it is rare that anyone from general society knows who invented the cell phone, the internet, the touch-screen or other tools that have changed and revolutionized the world we live in. Recognition is lacking big time.

Are all the above sustainable? Certainly not! Changing this reality is a duty upon all of us. The above is a call to action. As a bottom line, in the short term sustainability is making the world equally good for future generations. As shown above, science and technology plays ***a primary role***. In the medium-long term sustainability is saving planet Earth from the self-destruction caused by human activity. Science and technology play ***a primary role*** here also. In the long, long, term; in about 500 million years, when the life of our planet sun comes scientifically to an end for our planet; sustainability is to find another habitable planet for humanity. Here, science and technology has ***the primary role***.

CONCLUSIONS

Many ways are proposed to make the world sustainable but not the right attention has been concentrated on the role of science and technology. It has been shown that science and technology play a primary role in the noble quest to make the world sustainable along with political framework and education. It was also sadly illustrated that the role of scientists, technologists and engineers is not recognized and acknowledged as it should be on a societal level. The status of the world today is mainly because of the work of scientists and engineers. The future is created by scientists and engineers and without them the world cannot function. Yet, they are the silent stars of our society without the type of recognition that the other players in other fields of modern civilization have. Their work to develop new technologies is seriously underfunded. This is not sustainable since this seriously undercuts their capacity to produce future scientists, technologists and engineers. It is imperative to better recognize their role in society, to better fund their work and better coordinate various fields of life with science and technology. This role is also the mission of the non-profit organization, Flogen Star Outreach (www.flogen.org) and this article is an invitation to everyone to join and help.

ACKNOWLEDGEMENT

This paper contains some highlights from the book “**Silent Stars of Society**” (3) that is in print and will be available soon.

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