

"Our Reach Should Exceed Our Grasp"
by G. Steven Colyer-Sivco

How Should Humanity Steer Itself?

"Ah, but a Man's reach should exceed his grasp, or what's a Heaven for?"

... Robert Browning

Humanity will steer nothing; humanity, for the greater part, reacts rather than acts. Those few in a position to do so will steer us, the same who have always steered, those who have the ear and advise the wealthiest among us. Sometimes, the wealthy themselves, such as Thomas Jefferson, at other times, Rasputin.

To steer means therefore to command or take orders from those who do. Scientists feel this very deeply, but often also feel powerless when they see funds flow to Engineering, which provides wealth, which is Science, known science, applied for the profiteers. Every now and then however the recipients of profit direct funds to those in a position to increase the greater good, which includes themselves and future descendants, not in the short term, but in the long. Louis Bamberger and Carolyn (fuld) bamberger at The Institute for Advanced Study in Princeton, for example and there have been many others. To rely solely on ever-changing governments is risky, those far-sighted individuals among the wealthy must be engaged. We see that happening today among folks like Branson, Musk and bigelow. We need to see more.

The challenge then should be how to apply scientific achievements already in the can, so to speak, Science that is already known, in such a way as to build a better rudder, a better steering wheel, and to let that other side of Science other than the applied, that is to say, Research, breathe. Breathe, and in so doing, advance Science further yet.

We live in a world and on a planet of limited resources. There is plenty of money, known as funding, to go around, but too often the funding is misapplied, either overfunding some projects or underfunding others. Shrug, this involves politics. Advise those who control the purse strings. Who will advise? Will it be the profiteers, or the researchers? Given that research requires, more often than not, less funding than applications, with beautiful applications such as the Large Hadron Collider being an exception, who then among those to whom the funds are distributed will receive the scant resources out of a very big pot to advance that which is supremely fundamental, has always been fundamental, to the advancement of our species?

It should seem rather random to the young scientist how these funds are distributed. That is because it is random. A lone scientist gets a terrific idea and convinces others of its worth, and gets funded, then increasingly so as the idea catches on. He or she succeeds in this quest for a wide variety of reasons, sometimes without veracity, without being true, simply because the idea is unique, or has a powerful mentor or organization supporting it, or because a roadblock has been met, and colleagues are thirsty for an advancement, and so what the heck, let's try that.

And sometimes the idea is right. And so Albert Einstein, flummoxed and in stalemate with his competitor David Hilbert the Mathematician, seeks the advice of a former classmate and head of Gottingen Math, Marcel Grossman, to break the stalemate, and Grossman breaks young Albert's mental logjam by introducing him to the non-Euclidean geometry of Gauss and Riemann and Levi-Civita and Ricci, and General Relativity is born. And not without Einstein bragging to Hilbert as he gets close, and Hilbert taking up the challenge and getting closer yet for a bit, and voila, from competition, from the sheer desire of wanting to be first, Einstein wins the day. Hilbert, in more gracious times than we currently find ourselves, concedes defeat. It would be hard to see that happening today in the current cutthroat atmosphere, and that goes double in the life sciences, for legal reasons involving the big pharmaceutical companies supporting the research not just in medicine and chemistry, but in Physics as well.

Life Sciences, which in a gentler time we called Biology, is important. It tends to attract funding. It promises much; it has delivered much, and it is why a 70-year-old person today looks and is as healthy as a 40-year-old person a generation past, and Life Sciences will continue to provide life extension.

But what of the night sky? What of the stars? What of the galaxies, filaments and voids? And what of the planets? Are these no less important in pushing aside the veils of ignorance that are the bread and butter of researchers everywhere? Of course they are. But those who fund, who control the purse strings, do not see that. We have to make them see that these too should be studied. And here is why.

Of all the great fields of study, of Biology, Zoology and Botany, of Psychology and Anthropology, and of Chemistry and Physics itself, we owe a great debt to those who decided to stop looking at the bank accounts and the soil for a change, and look up and wonder, what if? To physician, lawyer, and economist Mikolaj "Mik" Kopernik of Western Russia and Eastern Poland, for example, better known as Nicholas Copernicus, who had the wild idea that the Earth revolved around the Sun rather than the other way around, and the other planets as well, around the Sun, not the Earth. Such a radical idea. It flew in the face of the thousand-year-old textbook by the Egyptian Ptolemy, known as The Almagest. The old guard would not accept it; Nicky knew this, but still he persevered. Perseverance. It is important. It is how you steer, holding the wheel against the storm, when the winds blow hard. And if you believe the ship should be steered in such a way, you never give up; you never surrender; you persist.

It took a while for Nicky's good and correct idea to catch on, long after his passing, but experience, experiment, and further math would advance the truth of this man who, simply as a hobby, asked, what if?

What IF our ship is being steered in the wrong direction? What IF all these epicycles and deferents, while interesting mathematically, are overly complicated regarding what is in fact, a much simpler situation? What would God do? Would he build such an unnecessarily complicated Universe when a simpler solution is possible?

We know what happened then. University of Pisa and Padua Mathematics Professor Galileo Galilei took up the cause of Copernicus by building a telescope based on the spyglasses of the time, and pointed his super spyglass straight up. He concluded Copernicus was not only right; he discovered four new worlds now named after him in the process, the four large satellite planets of Jupiter.

His contemporary, the old guardsman Tycho Brahe, was not convinced. He proposed a compromise, which seemed at the time to make as much sense, that yes the planets revolved about the Sun, but the Sun revolved about the Earth. Tycho was wrong as well, and after a night of partying, passed away, to be replaced by the young buck Johannes Kepler, who agreed with Galileo and would advance our knowledge, our slaying of the ignorance, most significantly yet.

And this set the stage for the greatest scientist of them all, Isaac Newton, to tie it all together, and with his Laws of Motion, and Gravity, based partly on incorrect assumptions, that Mass is conserved and lightspeed is instantaneous, and Science took off like a shot. It had a strong mathematical base now; it thirsted for more. A Swiss named Leonard Euler, and many others, would provide such in the 1700's.

Better Mathematics led to better Science, a better base of experiments to get better results, which would lead to better applied Science, better Engineering, better Medicine, and better results. Physics would use Mathematics and feed it as well, and Math would return the favor, and a lovely dance ensued. Enter the 1800's, and the birth over the better part of that century of Thermodynamics, the Statics and Dynamics of Newton, the advanced Analysis known as calculus

which changed everything and was hyper-developed by Leonhard Euler, and the need to profit from those advancements by ambitious young men such as Peter the Great and the King of Prussia with Euler, which provided the incentive, and the Age of Steam was born, and with it, railroads, and ships at sea without sails.

But not just steam. Stephen Gray and Benjamin Franklin experimented with lightning and thus electricity; Volta created the first battery in modern times, and Clerk-Maxwell brought it all together as civil wars broke out in China and the United States in 1864 when he combined those experimental results with humankind's ancient fascination with lodestones, and Science took off exponentially

The money to be made, that was made, from either Thermodynamics or (but not "and," not yet) Electromagnetism, created great fortunes in the late 1800's such that the amazing advances led Lord Kelvin to proclaim that Science had maximized its greatest potential, and there was nothing left of significance to be learned! If only Max Planck and a teenager at the time named Einstein had accepted that, and they didn't, we might still be living in a world of steam locomotives. But they didn't; they asked first of themselves and then of the equations why some niggling problems were going unresolved. And they resolved them, and nobody noticed at the time, save an elite few in their field of theory. But momentum and inertia build, when those who have a correct idea persist and ask: "You don't believe me? Prove me wrong!" And many, especially Hans Lorentz, tried and could not discount them, and could not. Hermann Minkowski came on board, and Niels Bohr working in Ernest Rutherford's lab, and great discussions and understanding of these new ideas in those un-transistorized pre-Internet days spread.

Let us break and review what happened in between the years 1543 of Copernicus and the 1913 publication of the Rutherford-Bohr model of the atom, in less than 400 years, among a species 200,000 years old at the time.

During that time, Modern Science developed, and it began with thinking about, and looking up to, the night sky.

It ends with a stalemate, but one in which Special Relativity is known, and General Relativity is about to be developed, and the base of Quantum Mechanics is born. Still, yet, only known to theorists. But those theorists persist; they are persistent cusses, and ask questions, are diverted off course, and are fed by, the incredible experimental results coming out of not just Rutherford's own lab, but those of Roentgen and Pierre and Marie Curie as well. It is the age of Chemistry to the general public and in commerce, so very important in advancing Science. Chemical industrialist Ernst Solvay decided to hold a "meeting" of the finest minds in Chemistry and Physics in 1911, and the first of many, some would say too many today, Physics conferences are born.

So much to take in, so many new discoveries, so much chemistry, who can keep up? Europe explodes in war; there is a delay. Not the last great war of the century, unfortunately, but the theorists ponder on.

Then the stalemate is broken in 1924 by a grad student, Louis De Broglie of France, who asks if Einstein is right and light behaves as particles, then why can particles not behave as light, as waves? That did it. The accomplishments of Born, Pascal and Heisenberg, of Schrodinger and Pauli, would soon follow, and the world would never be the same. Wolfgang Pauli chipped in and solved three problems, inventing modern chemistry in the process with "spin," an accomplishment that would create untold fortunes; he suggested to Max Born that Heisenberg's Matrix Mechanics of Quantum Mechanics is the very same thing as Schrodinger's Wavefunction analysis, if only you would square the Wavefunction. Eureka! And of course, Pauli postulated the neutrino, the strangest known particle of them all, then and still, today. Quite a guy!

But the cherry on the topping of the whipped cream that is Quantum Mechanics on the fudge of

Special Relativity on the ice cream of Maxwell and Newton (which all starts with Miky Kopernik, lest we forget), is Paul Dirac, who united Special Relativity and Quantum Mechanics and voila, the primary rulebook of the universe, Quantum Field Theory, is born.

We have advanced beyond Dirac of course, but it still goes back to Paul. QED and QCD would be developed from Dirac's great discovery; Gordon Moore at Intel would make a fortune off it thanks to splitting from an irascible boss, William Shockley, co-inventor of the Transistor, and commerce, that commerce particularly, would change the world, and give us the technology so many take for granted today.

So many good men, so many giants, so many shoulders to stand on. Einstein, to his credit, didn't have to study Quantum Mechanics or Relativity; he invented them, with help. The students today are not as fortunate; they have to master what he mastered, and his contributions as well. It takes longer to get a PhD in Physics today. But Einstein published, and in so publishing changed so very, very much. That he was a humble man with an impish wit helped as well; he popularized Science like no other then or since.

Perhaps the lesson here is that as irrefutable as old Albert's math and physics were, we should laugh a bit more and stop and smell the roses to advance good and true ideas, lest we be labeled iconoclasts and our good ideas ignored for a generation. The ship of humanity has children aboard, and when you steer the ship, you steer the children, and you want to steer them correctly, don't you? They will after all, grow up and steer the big boat themselves, and as you relax one day in your rocking chair on the bow of the ship, staring out to sea content in reliving your past glories, they will take their breaks from the wheel, and tell you of new lands they are discovering, new lands because you brought them part of the way, and maybe, if you steered them wrong, they will report to you that all of us are about to fall off the edge of the earth, so to speak. So don't steer them wrong.

Back to Science. Which is truly only one Science: Physics. Chemistry is a branch of Physics, Biology, a branch of Chemistry, as it was for ages.

We now see all these fields merging, implying in ways both wonderful and spooky, that there is a greater, simpler explanation that will make the Lagrangian with its eight general terms with five, including the Higgs, Einstein's General Relativistic Field Equations, Wheeler-Dewitt, and Group Theory's $U(1) \times SU(2) \times SU(3)$ look overly complicated in comparison to some ... ultimate truth, and with Quantum Cosmology and the recent BIPOLAR2 results, the part-time musings of one Nicky Coppernick of Poland become united! But not completely. Not completely, but tantalizingly close. Physics theorists like Lee Smolin, Sabine Hossenfelder, Edward Witten, Juan Malcedena and many others speak lovingly of how so very close we are, but we seem to lack direction, a direction to steer in, all at the same time. How can this be? How and why did we hit this logjam, and how can we steer ourselves out of it?

In truth, theory has not advanced all that much since the early 1980's, and the beautiful Quantum Chromodynamics of Politizer, Wilczek and Gross form the last piece in the puzzle to give us the Standard Model of Particle Physics. There has been much speculation since, and may there ever be so, the worst you can be is wrong.

But in case it wasn't obvious, we need to tie the SMPP together with General Relativity, to firm up the very loose in comparison "Standard Model of Cosmology," and with BIPOLAR2, we are seeing a grand step, with many more advancements looming on the horizon. We have the charge-coupled device, the CCD, and with that not just digital photography on Earth, but crucially the stars, the galaxies, the filaments and voids are opening up to us. Oh, we'll get there! We are getting there. Astronomy is progressing very rapidly now, thanks to the computers born of Quantum Mechanics and Quantum Field Theory and Einstein and Planck and all the way back to an Astronomer, part-time, named Mik.

Have you not seen the connection that I do, that beyond academia lies commerce? That commerce is the engine that fuels advancement, that grants funding, to academia and yes, for profit, but so what? Not everyone in commerce seeks profits only; many wish to be Ernest Solvay, who after a lifetime of fretting over balance sheets and income statements and 52-week highs and lows in the stock markets and so on, ask themselves, as scientists have always asked themselves, what is it all about?

What IS it all about? What ... IS? Unlike the poor scientist, the wealthy industrialist has the money to make things happen, to fund that poor scientist, that brilliant graduate student whom like DeBroglie, asks a very interesting question and has the youth and vitality to answer it, and in so doing, advance the Science, steer the ship, not to the shoals but toward the open water and to wonderful lands yet unseen.

We need the corporations, not the governments, to get more involved. Seek out those who do not put greed above all else. Where are the Bransons, the Musks, the Bigelows, who see far? Hook them up with the bright and persistent scientists like Alan Stern, who dreamt of launching a probe to planets Pluto and Charon, and made it become a reality, in spite of the first five yeses being turned into no's. He persisted. He won. We will see Pluto and Charon next year, as we will see Ceres as well. New worlds, new worlds to learn about, the learning of which will help us understand our own, that much better.

We will do so because as previous generations, we will persist. We love our own planet. We love the stars and galaxies as well, and we will get there. But before we get there, the planets beckon; they have so much to teach us. We need not wait generations. We have the technology now to conquer them. Our technology advanced because we set a course to land on the Moon, and we did that. The engineering needed was unknown and tremendous, but it was done, because the engineers asked the scientists for help, who in turn asked the mathematicians for help, who know and knew who John von Neumann was, and so the Mathematicians turned to the computer people, who helped. And in so helping, by meeting the challenges put before them, the Computer Science people helped to advance their own field. It all came together for everyone. And it was all funded ... by government.

But that situation is no more. Corporations, for good or for bad, have taken over in terms of influence over governments, and we need their help. They will help, but first we have to ask. We have the computers; we have more data in those computers right now to crunch than we have qualified scientists to analyze it all, and we get loads of more data daily. Astronomy folk will not starve anytime soon.

Science and Math are close to merging, and both came from Logic, the fundamental backbone of Philosophy, which questions the assumptions. Question the assumptions. Please. We need more philosophers to learn more science to understand which assumptions to question, more people like David Albert and Tim Maudlin. It is not easy given all the competing theories, but we can do it. We are doing it. Computer programmers are the ultimate philosophers; they work with Logic almost exclusively.

So bring it all together; bring the Philosophy, the sense of wonderment that sets our sails in the first place and makes us question the very reasons for our existence; bring the theorists, the experimentalists and the engineers, the builders and makers, and yes the industrialists who stand to profit from it all. We reach for the stars, but the industrialists see what is in front of their face, and we know they will be richer for exploiting that which is readily available: the Planets and the satellite Planets that orbit them as well.

So tell them the Moon has tritium needed for nuclear fusion; that an astronomical observatory on farside would unleash wonders, that a lunar muon-muon particle accelerator would elevate our understanding of the quantum world, and a spaceport would send us out into the solar system at one-fourth the cost of launching from Earth; that dense little Mercury (second only to Earth in

density among the planets and moons) has valuable metals galore; that Saturn's satellite planet Titan is "The Gasoline Planet"; that Saturn itself has tritium in abundance, and there is water on Europa and Enceladus and perhaps on dozens of more worlds yet, there for the taking, IF they would fund the studies, then the engineering, and then the ships, we all will win.

From such a base we will then be in a strong position to explore the stars and break out of this cradle of a solar system which we should not live in forever. In spite of the recent news concerning the recently confirmed Earth's "twin", that world is hundreds of light-years away. Far more practical would be to focus on the closer stars and planets, six worlds found already by the Kepler spacecraft and the potential of many more, all within 75 light-years of Earth, and their stars' habitable Goldilocks zone, namely Gliese 667 Cc, Tau Ceti e, Gliese 581g, HD 50307g, Gliese 163 c, and Gliese 581 d.

Please ignore the naysayers, those of poor vision, regarding the future. Stand up to them, yes, but be polite and patient. Do not let the far left scream that Space is a waste, and money should be spent on the poor; of course, much should, but not all of it, as a mere five percent of the GNP will get us to the stars via the planets. Do not let the far right, with limited vision expressed as tax cuts and smallest size possible governments, de-fund Science; of course, we hate waste and unnecessary taxation, but we will always need some taxes. Look to the clear thinkers, the wealthy who care; they are rare, but they are there, and they will help.

And perhaps then, the heavens, perhaps Heaven itself, will open up to us, because as Browning said, and I close ...

"Ah, but a Man's reach should exceed his grasp, or what's a Heaven for?"