EDITORIAL

Looking Back, Looking Forward – the View from a 45-Year Vantage

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This American publication was born into the explosive world of the late 1960s and has ridden the crest of the U.S. technical and economic shock wave ever since. Surfing through these decades has been a wild ride, one frequently filled with excitement and national pride, less often with fear and occasionally with collective shame. In 1967, electronics, nuclear physics, aircraft development, space exploration and the medical sciences were in high gear, both here and abroad. The United States remained firmly mired in the Vietnam War, and racial unrest and war protest continued to erupt all over this country.

Still, we found it possible to move forward on many fronts and even have a little fun in the process. *S&V* shared its birth year with the maiden flight of the Boeing 737, China's first hydrogen bomb test, Thurgood Marshall's confirmation as our first black Supreme Court Justice, two decent Beatles albums (*Sergeant Pepper's Lonely Hearts Club Band* and *Magical Mystery Tour*) and the off-Broadway introduction of *Hair*. In South Africa, Christiaan Barnard performed the first human heart transplant; Israel successfully prevailed in the Six Day War; Mohammad Reza Pahlavi was crowned *Shah of Iran*; Britain enjoyed its first color television broadcast and retired the *RMS Queen Mary*; the British/French-developed supersonic *Concorde* was unveiled; France launched its first nuclear submarine, *La Redoubtable*; Charles de Gaulle vetoed Britain's entry into the European Economic Community for the second time and alienated English-speaking Canadians with his deliberately rude "*Vive le Quebec Libre!*" remark in a Quebec city address. We saw Elvis get married; filmed Evel Knieval failing a 146-foot motorcycle jump over the fountains at Caesar's Palace; saw heavyweight champion Muhammad Ali arrested for draft evasion; and adopted the 25th Amendment (presidential succession) to the U.S. Constitution.

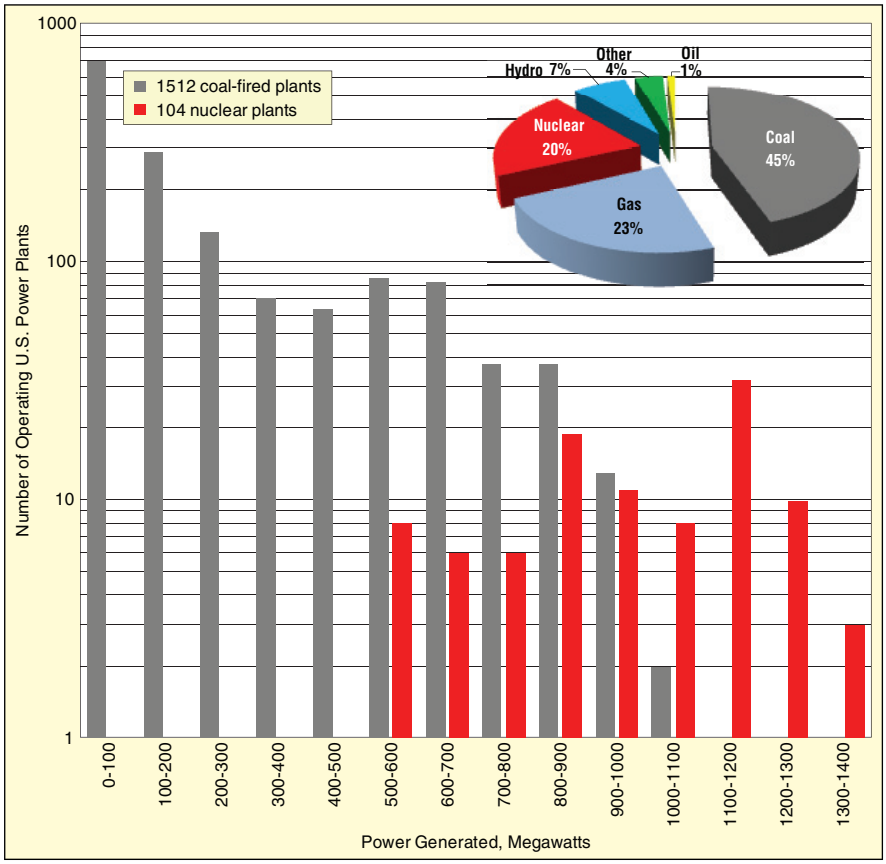
NASA enjoyed many hard-won yet brilliant successes during the '60s – *S&V* bootstrapped on these starting with the cover photograph of our very first issue. NASA has no greater collection of fans than the people who produce this magazine. We remember these events from our starting year: the X-15 set a speed record of Mach 6.7; Lunar Orbiter III & IV were both successfully launched; the probe Surveyor III launched to a successful moon landing; Mariner V made a successful fly-by of neighboring Venus; and a Saturn V rocket took an entire (unmanned) Apollo command module aloft to verify in-orbit ignition of the huge thruster's third stage and to test the entire re-entry process from atmospheric entry to splash-down recovery. The launch was the first from the John F. Kennedy Space Center and ended successfully when the command module was brought aboard the carrier *USS Bennington* (CV-20) waiting for it in the North Pacific ocean near Midway Island.

It was also a year of severe loss: three Apollo astronauts, Gus Grissom, Ed White and Roger Chaffee, were lost in a ground-test fire; an X-15 rocket plane crashed, killing pilot Mike Adams. The nation mourned both incidents. NASA learned from them – two years later we landed Apollo astronauts on the moon and brought them home to safety and fame. The competitive USSR space program did good science in our birth-year as well, but not without cost. The Russians launched the Venera 4 probe to Venus. It performed the first *in-situ* analysis of that planet's atmosphere. Venera 4 required only one of its two planned course corrections and provided a treasure of measurements and insights. Our competitors lost their brave cosmonaut, Vladimir Komarov, when his Soyuz 1 re-entry parachute failed. Like the Chinese, the Russians found time for hydrogen bomb testing; their use of Kazakhstan as a proving ground drew some unfavorable international press attention.

Hope and Change

Now, four and a half decades later, we find ourselves in a brave new world. No, not quite the place of Aldous Huxley's novel, but a very different place nonetheless. It is a time and place filled with fewer hopes, greater fears and diminished expectations. This is not the America of my youth – not an improved nation but a severely wounded one. Some of those wounds were inflicted from without by people previously unknown to me – stupid, crude, animal-like sub-humans willing to fly airplanes and innocent people into buildings or strap explosives to the bodies of their children to express another man's hatred of me – people the world can and should do without.

Other wounds, unfortunately, have been inflicted from within by members of our own government – once-trusted Americans who have decided their own comfort is more important than the needs of the people they claim to serve. We now live in a complex and hostile "modern" environment and circumstances may force us to exhibit some old-fashioned common sense and inbred American independence to reclaim our nation once again. This is not a new circum-



Power generating plants in the United States as a function of output in megawatts

stance upon these shores. It is the reason the rights of free speech and arms retention were the first two items of attention in our Bill of Rights. Anyone who ignores attacks upon these rights in these times of strife from within and without is clearly taking a foolish personal risk – the circumstances of "We, the people" are clearly perilous – this would be a most inappropriate time to forget our history at the bidding of an enemy, be he a boldly identified or congressionally clandestine terrorist. We are at war.

Make no mistake – the first decade of the 21st century was stolen by Osama Bin Laden, the closest thing to evil incarnate since Adolf Hitler. That vile bastard's unprovoked criminal attacks upon this nation did damage us physically, fiscally and emotionally. We have done our level best to soldier on with brave faces, rebuilding and rising above the devastation in Manhattan, the tragic loss of brave life in Pennsylvania and the scars and death dealt within the District of Columbia. Our domestic transportation industry was grievously injured by his assault, as was our trust in one another.

American civil rights and freedoms have been seriously eroded in the name of homeland security. We have been forced to give up much of what once set us proudly apart from the rest of the world: our freedom to travel gracefully and comfortably within our own country without fear and without interrogation. Unexpected revelations in the banking and investment community compounded Bin Laden's felony. Brave American warriors finally exterminated Osama, but many felons involved in the 2008 financial holocaust (and their political allies) remain unpunished. I can only hope we learn of their incarceration as we rebuild the nation; national pride requires knowing that decency eventually triumphed.

What's New?

I had planned to characterize the time interval directly preceding 2001-2011 with the most significant S&V-related developments of the decade. But I find my memory frail in searching for these. I queried several trustworthy and more enlightened friends, asking them for the "10 most significant sound and vibration developments" in the era; to a man (and woman) they disappointed me. Between us, we could not find 10 truly significant S&V innovations in the decade. Yes, there have been some nice products from new (and old) manufacturers, but nothing strikingly new or excitingly different – just some modern repackaging of old ideas.

To my thinking, this was a technically disappointing decade. The inventiveness in our narrow field echoed the flat or declining character of the U.S. economy and spirit. In short, America is no longer working – we are not employing; we are not manufacturing; we are not exporting; we are not conserving; we are not energy-independent and we are not on a path to correct any of these shortcomings. We have severe problems in primary and secondary education, and our health-care system is a total bollix. Our federal government is now spending our dwindling gold reserves at an alarming rate with no observable return on their investment. We are engaged in declared wars on multiple fronts without clear exit strategies. We are losing an undeclared war at our border with Mexico. Illegal aliens are being handed the benefits and rights of citizens, while citizens are being handed the bill for their care. The United States is desperately in need of some enlightened leadership to permanently displace the *politically correct* talkers, spenders and thieves now inhabiting the nation's capitol as "professional" career politicians.

Five years hence I hope to author a far more positive and spirited editorial to mark *Sound & Vibration*'s 50th Anniversary. I hope to discuss the vital signs of a revived economy and a forward-moving nation. This, of course, assumes successful perpetuation of my mind and carcass and of this publication. While no promises or prognostications can be made for the former, it is clear that the latter depends upon the health of the United States economy.

Congress Manufactures Nothing!

We need to put Americans back to work conceiving, designing, manufacturing and refining high-quality goods from domestic raw materials and we need to purvey these goods at home and overseas. I do not look to the Congress to accomplish this; government cannot create real jobs or businesses. Yes, they could create another Civilian Conservation Corps to field thousands of men with shovels to build roads and repair bridges. No, the answer does not lie in having the federal government employ everyone – that would just create another socialist state and the world already has too many of these.

But Congress could do an afternoon's work to lay important motivations upon industry to accomplish this; they could simply change the U. S. tax code to redefine the taxable gross profit of any enterprise. While Line 4 of Schedule C (Form 1040) now reads, "Cost of goods sold," let it be changed to read, "Cost of goods sold overseas and cost of U. S. manufactured goods and American services sold in the United States."

That one line change would make "outsourcing" unprofitable, drawing domestic workers back into the work force. It would reduce the profit of selling imported goods domestically; this would immediately shift the game to favor U. S. manufacturers and would give them temporary incentive to market imported goods overseas as a survival stop-gap. Even our dullest senators and representatives should recognize this would let them collect *more taxes* in the short term as industry scrambles to play the game under the new rules. They would not need to concern themselves with any international treaties; no other nation has the right to dictate our domestic tax law. This small step might even temporarily silence the "let's tax the rich" versus "don't do that, you'll kill the golden goose" press diatribes while they try to figure out why they didn't think of this 1040 one-liner first.

Energy Independence

To move forward as an industrial nation, we must once again attain energy independence. We cannot afford to be the victims of Arabian (or American) oil extortion ever again. This freedom won't be won by wasting money and time on "energy bets" with known fool's payback. Politicians are placing this nation at serious risk while they "spout green" and line their election coffers with payback greenbacks. Windmills, tidal energy harvesters, ethanol fuel and photocell farms are interesting experiments and great "green" talking points, but they only offer the possibility of small power return for their extensive financial investment; they are clearly lousy technical gambits put forth by people who place their personal gain ahead of national interests. It is these types of activity that we members of the technical community must stop by exposing the claimed benefits as the hyperbole that it is.

There are activities that we should vigorously support, including oil/gas extraction from our own rich known untapped reserves and the renewed development of nuclear power. These are activities that can only be factually understood by technical people; as engineers it is our obligation to take a leadership role in explaining these options to the American people. We have sat silently for too long while the professional tongues of Washington have wagged nonsensical naysay about the only energy bets that make any sense. We owe it to our nation to stand up and weigh in on the "where do we get the energy from" debate. The lobbyists, politicians and lawyers have had their say for too long and they are leading the nation in the wrong direction.

The U.S. currently derives about 45% of its electricity from coal, 23% from natural gas, 20% from nuclear fission, almost 7% from hydroelectric plants, less than 4% from wind farms and other renewable resources and approximately 1% from petroleum. Clearly, our ability to generate electricity is *not* dependent on our ability to buy or produce oil; it is a separate problem. We are blessed with abundant natural gas deposits and have a functioning (and growing) infrastructure to deliver it. The current world coal reserve is estimated to last for another 118 years; the domestic U.S. reserve is 241 years. But these estimates assume the current rate of consumption, and it should be noted that the cost of mining and refining coal will increase as the quality and quantity of our reserves dwindle.

Nuclear is the Answer

Unquestionably, we could produce electrical power at higher efficiency with fewer atmospheric gaseous emissions using clean nuclear plants in lieu of coal-fired generation stations. But the haunting images of

Fukushima, Chernobyl and Three Mile Island hang in our memories. In 2012, we operate 104 nuclear power plants residing in 31 of our states. These are large power generation facilities; each nuclear plant generates from 482 to 1,317 megawatts, with the average plant producing 973 MW. Some 69 of these plants are pressurized-water reactors, pioneered by Westinghouse, while 35 are boiling-water reactors developed by General Electric. Within each type of reactor, there are significant design variations among installations. It has been said that we run 104 prototype nuclear plants in the United States!

France took a different approach to nuclear power. In 1973, they adopted the "Messmer Plan," their prime minister's vision to free the nation from its dependence on imported oil by generating all electrical power using French-built nuclear facilities. After a brief flirtation with the UNGG (Uranium Naturel Graphite Gaz) reactor put forth by CAE (Commissariat à l'énergie atomique), they settled upon the PWR design as superior and licensed Westinghouse's designs and technology. Framatome (now Areva) engineered and built all of the French plants and EDF (Électricité de France) runs them. To date, a total of 58 plants have been commissioned in France, and they are all in operation.

The French plants are of three power classes. There are thirty-four 900-MW, twenty 1300-MW and four 1450-MW installations. Plants of a given class differ only by site engineering – the basic plants of a class are virtually identical to one another. An operator trained at one 900-MW facility is completely at home in the control room of a plant hundreds of miles away. This has provided major cost savings and enhanced safety. France generates more power than she needs, exporting power to neighboring Belgium, Britain, Italy, Germany and The Netherlands. She has also built the 900-MW design on foreign soil: two in South Africa, two in South Korea and four in the Peoples Republic of China (with 13 more to follow). The first of a larger 1750-MW plant called the EPR (*European Pressure Reactor*) is under construction at Flamanville on the Cotentin Peninsula and export sales to Finland, China and the U.S. are expected.

While France was intelligently developing Westinghouse technology into a government-directed national treasure, we allowed our commercial nuclear industry to disintegrate. Save a skeletal engineering group or two, both General Electric and Westinghouse are out of the commercial nuclear power reactor business. Westinghouse has retained a small and dedicated technical cadre at their Bettis facility to serve the highly classified needs of our nuclear-powered Navy. The (former GE) Knolls Atomic Power Laboratory (KAPL) supports this same important effort. But the sad truth of today is that when we need a new large nuclear power plant, we must now buy it from France. That small European friend is also rapidly becoming the place we will need to call for service on our aging 104 prototype plants. This is a sad reality, one that a long line of politically correct tree-huggers from both political parties needs to recognize and take responsibility for.

Is the U.S. techno-political nuclear circumstance entirely dismal? I think not. Once we put aside the dated notions that nuclear power plants must be huge to be economical and that they must be capable of breeding weapons-grade plutonium, there are other answers available. One of the best has its roots in American research circa 1954 to 1976. While the Chinese (and others) claim to be working on this solution, I see no reason we couldn't beat them to it. We won't need to involve our CIA, since we already own all of the original design documents and significant test reports.

Molten-Salt Reactors

Various U.S. national laboratories were involved in developing atomic reactors using solid uranium fuel and a water-filled primary cooling loop to extract the heat. But interesting alternatives using molten thorium as the fuel and dissolving it in molten lithium fluoride and beryllium fluoride salts used as the primary cooling-loop fluid were also investigated, prototyped and tested. This really productive alternate-technology nuclear work was initiated with the Aircraft Reactor Experiment (ARE) of 1954, performed as the precursor to the Idaho National Laboratories. This effort focused upon a 2.5-MW reactor of light weight and segued into the INL Heat Transfer Reactor Experiment (1, 2 & 3). In turn, this led to the ARE effort at Oak Ridge National Laboratory (ORNL). The ARE was a molten-salt reactor (MSR) built and tested at ORNLs University of Tennessee facility. It ran without incident for nine days while generating 100 MW of thermal power.

ORNL followed this success by building and running its Molten-Salt Reactor Experiment (MSRP) from 1965 to 1969. This was followed by gestation and operation of the 3 MW Molten-Salt Breeder Reactor (MSBR) from 1970 until 1976. Though all of these thorium-fueled MSRs worked successfully and demonstrated some unique advantages, they lacked one property of the uranium-fueled PWR: they couldn't produce weapons-grade plutonium for nuclear weapons development. While Edward Teller and other eminent nuclear scientists of the age championed the MSR, the U.S. government moved ahead with the PWR as its undersea and on-the-shore power solution. These near-ancient American experiments demonstrated a host of important nuclear truths:

- An MSR has a *negative* reactivity-versus-temperature coefficient, ensuring intrinsically safe operation, because if it heats up, the reaction slows down. The MSR operates at atmospheric pressure (but at high temperature); reaction ceases when the fuel/coolant is drained from it. A deliberate "drain plug" formed from the coolant material can be maintained solid by cooling it with a fan driven by the reactor's electrical output. Should this power be disrupted, the plug melts and the coolant drains into a holding pan and solidifies; the reactor is shut down and the situation is stable.
- A uranium-fueled PWR only burns about 5% of the uranium in its fuel rods; the "spent" but highly radioactive rods must be removed and stored. In contrast, a thorium MSR is very efficient; it burns virtually all of the thorium supplied; one pound of thorium produces about as much power as 300 pounds of uranium or 3,500,000 pounds of coal.
- An MSR can be refueled and waste products extracted "on the fly," eliminating costly fueling outages. An MSR can be used to burn the waste products from a uranium reactor. The waste products of a thorium-fueled reaction have a 300 year half-life; a spent uranium fuel rod's is 10,000 years.
- Thorium is several times more plentiful than uranium and is much easier to mine. We currently have a large stockpile in the scrap diggings from rare-earth mining operations.
- An MSR is air cooled; it does not have to be built near water and needs no cooling towers.
- A thorium-fueled, molten-salt-cooled nuclear reactor design lends itself to a *small* electric power generation station.

That final item is really important. I noted earlier that 45% of our domestic electrical power is currently generated from coal. There are some 1512 coal-fueled power generation stations in the U. S. Most of these are 30- to 35-year-old small plants. How small? Better than 46% of them produce 100 MW or less; nearly 79% are smaller than our smallest existing nuclear station (482 MW). Why is that important? Because of the wiring. Small fossil power stations are near the markets they serve and they have an existing conductive conduit to those customers. If you replace a collection of these outmoded stations with a large-to-huge PWR reactor, you must also build a new power grid distribution backbone from the PWR to all of the old distribution points. The routing of towers and high-tension cables is never cheap, pretty or politically simple. Consider the advantages of dropping in a series of small *nuclear replacement* stations of similar power output to their fossil predecessors at each antiquated site of generation. If we are producing such plants as standard items, we will see the economic, safety and longevity advantages of production scale. I propose we, a knowledgeable engineering community, need to consider and analyze the technical worth and challenges of small mass-produced, intrinsically safe atomic power plants and then publicize them as the American solution to our electrical shortfall.

Technical Support

A related thought in closing; there is one domestic product that we now export far too much of: American technical education. We

are being our own worst enemy by training engineers and scientists who plan to return to other countries in support of their competing economies. I fully believe in extending our support and resources to our allies worldwide and to developing nations in particular; it is only right and proper that a strong world leader extend a helping hand to the less fortunate. But, when that leading nation has been wounded, the world can no longer expect the same degree of help from it until strength is regained. We must exhibit the common sense to reduce the scope of our aid and charity while we rebuild our economic strength; if we don't, we will eventually be able to aid no one, including ourselves.

I feel the government needs to initiate immediate strong discriminatory immigration quotas; this is not the time to absorb more unemployed, unskilled and untaxed. I'm not advocating closing the door forever, but we need to close it for a while. Further, our universities need to place immediate voluntary restrictions upon new alien student enrollment in our technical schools and graduate centers. If we are going to rejuvenate American industry, we are going to need American engineers and scientists to guide it. Universities and colleges might try to keep their books in balance during this transition by exporting more lawyers and MBAs – we presently have more than a domestic sufficiency of both.

Congress needs to free our public primary and secondary schools to produce more and better candidates for our colleges. It is time to admit that "no child left behind" is a dismal failure. If there is one place we *need* to discriminate, it is in our public schools. Graduating high school students who cannot read or do rudimentary arithmetic serves no one. The presence of such failures in the school system inhibits the education of young people who could learn far more and want to. We need to give our best and brightest students every educational opportunity to succeed, especially in the now poorly supported areas of science, mathematics and communication. To do this, we *must* separate motivated, parentally supported students from distracting problem children at the earliest possible time. Our public educational emphasis *has* to be on making the most of our mainstream children. We cannot continue the vain effort of trying to educate people who do not want to learn; we may have a societal obligation to these "early failures," but it should not be paid by children exhibiting appropriate deportment and a desire to learn who are being deprived of the opportunity to reach their full potential in life. It doesn't take a "village" (or an army of lawyer-whipped teachers) to raise a child; it takes caring and responsible parents (or appropriate surrogates).

This simple truth transcends both race and economic status. We are a nation of immigrants, primarily European immigrants. From our founding, people have arrived on these shores with virtually nothing but their pride and a small sack of possessions and found their place here to become productive Americans, citizens who value education as the path to a better life for themselves and their children. Let those parents have what they long for, what they have paid for. It is well past time to weed the disruptive children of irresponsible parents out of our public classrooms. Delinquents and criminals have no place in public schools – it's time to stop being politically correct and time to start doing the correct thing for *our* children, for ourselves. This is an era when the motto of my now-defunct military prep school seems very appropriate: *Rather be than seem.* SV

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Energy – A Necessity of Life As We Know It

Energy (ĕn-er-jē) *n., pl.,* -gies: *The ability to do work.* Like God, energy is a thing or concept that can only be defined in terms of its effects. I've always found that an interesting coincidence. Both defy man's best effort to precisely identify, characterize and understand. In essence, both are worshipped; the favor of each is shamelessly curried by species *homo sapiens*. Man tends to kill wantonly in the name or defense of either entity. These things have happened for as long as we have inhabited planet Earth and will probably continue until we manage to destroy it or to rise above our self-created differences of opinion regarding God and energy. One can only hope the latter course is possible.

As engineers and scientists, we tend to assign the simplest of characteristics to energy: *the ability to do work*. That is, we view it as an ultimate simplicity. We understand it takes many forms (mechanical, electrical and chemical, to name just a few) and is thus known by many names. Much of our professional lives have revolved around studying the "laws" of energy's many transactions. Most of us accept that energy can be released by the destruction of matter in accordance with Dr. Einstein's $E = mc^2$. The optimistic among us hope that this is a reversible relationship rather than the ultimate demonstration of entropy. Most scientists view energy as that most basic "building block" from which all existing things, including thought, have sprung.

As ordinary people, we tend to assign the most complicated of characteristics to our God, our Allah, our Krishna, our Rah. We blindly accept that our personified and worshipped deity is beyond personal understanding, beyond the scope of all human knowledge. We are willing to admit we will never fully understand that entity to which we implicitly entrust our soul and the lives of our children and loved ones. Our chosen deity is a complex entity, affecting and controlling all creatures and things of our world, understanding all of its complexities, yet *choosing* to deal most benevolently with only those few humans that understand and worship its true precepts. But, given the diversity of such understandings, how is any man to be certain he stands among this enlightened minority?

We cannot survive without energy – it is the stuff that supports all known forms of life. In my opinion, God and energy have long been confused. Could it be possible the ultimate complexity and the ultimate simplicity are really the same thing? Both confuse man. Both have driven him to acts of extreme cruelty and of kindness. In the grand plan, do zero and infinity actually converge? Does the radius of a straight line approach that of a point? Could it be that we simply worship what we need to survive? Could God and energy actually be synonymous?

I am not a religious person and I make no claim to unusual insight regarding our existence or the reason for it. I believe I am a rational and moral human being and I have spent many hours reflecting upon philosophical matters to form and test my own system of beliefs. Must we each fully understand the unfathomable to cohabitate upon this Earth? We accept ignorance in business and certainly in politics; why not demonstrate some slight tolerance for it in religion? Whether your worn bedside go-to book is a *Bible*, a *Torah*, a *Bhagavad Gita*, a *Quran* or the *Handbook of Chemistry and Physics*, let's cease killing one another over who has the fast-track to religious truth – none of us does, and such philosophical myopia is a poor thing to murder for or die defending.