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A Million Miles A Day...

Speaking for The Worst Case Scenario

The Existential Threat: Once upon a time there was a Big Bang... Cause/Effect - Cause/Effect - Cause/Effect and fifteen billion years later we have this chunk of cosmos weighing in at a couple trillion tons, screaming around our solar system, somewhere, hair on fire at a million miles a day, on course to the subjective center of the universe. Left to its own fate, on impact this Rock would release the kinetic energy equivalent of one Hiroshima bomb for every man, woman and child on the planet. Game Over... No Joy... Restart Darwin's clock... again. No happy ever after.

There is simply no empirical logic or rational argument that this could not be the *next* asteroid to strike Earth or that the next impact event could not happen tomorrow. And as things stand we can only imagine a handful of dubious undeveloped and untested possibilities to defend ourselves with. There is nothing we have actually prepared to do in response to this event.

From an empirical analysis of the dynamics and geometry of our solar system we have come to understand that the prospect of an Earth/asteroid collision is a primal and ongoing process: a solar systemic status quo that is unlikely to change in the lifetime of our species. And that the distribution of these impact events is completely aperiodic and random both their occasion and magnitude. From abstracted averaged relative frequency estimates we can project that over the course of the next 500 million years in the life of Earth we will be struck by approximately 100,000 asteroids that will warrant our consideration. Most will be relatively small, 100 to 1,000 meters in diameter, millions of tons: only major city to nation killers. 1,000 or so will be over 1,000 meters, billions of tons and large enough to do catastrophic and potentially irrecoverable damage to the entire planet: call them global civilization killers. Of those, 10 will be over 10,000 meters, trillions of tons and on impact massive enough to bring our species to extinction.

All these asteroids are out there, orbiting the sun... now. Nothing more needs to happen for them to go on to eventually strike Earth. As individual and discrete impact events they are all, already, events in progress. By any definition this is an existential threat. Fortunately, our current technological potential has evolved to a point that if we choose to do so we can deflect all these impact events. Given a correspondingly evolved political will, we can effectively manage this threat to the survival of our species. But since these events are aperiodic and random we can not simply trust that any enlightened political consensus will someday develop spontaneously before we are faced with responding to this reality. If we would expect to deflect the *next* impact event a deliberate, rational punctuated equilibrium of our sociopolitical will is required *now*.

The averaged relative frequency analysis described above or any derived random-chance statistical probabilistic assessment, in itself, would be strategically meaningless and irrelevant (just how many extinction level events can we afford?). However, they can be indirectly constructive in illuminating the existential and perpetual nature of the threat. Given that the most critically relevant strategic increment can be narrowly defined as the next “evergreen” 100 years, it would follow that the strategic expression of the existent risk of asteroid impact in its most likely rational postulate would be for one and only one large asteroid to be on course to strike Earth in the next 100 years...

If we do eventually choose to respond to this threat, clearly there is no way we can address the dynamics or geometry of the Solar System so there is no systemic objective we can respond to here. We can not address 'The Threat of Asteroid Impact' as such. We can only respond to this threat as these objects present themselves as discrete impending impactors: one Rock at a time. This leaves us the only aspect of this threat we *can* respond to - a rationally manifest first-order and evergreen tactical definition of this threat,

The Next Large Asteroid on its way to strike Earth.

Which unfortunately, as a product of random-chance, includes the prospect for our extinction. Asteroid impact is a randomly occurring existential condition. Therefore the next large asteroid impact event is inevitable and expectable, and that inevitable expectability begins... *now*.

The Probability is Low: As a risk assessment: “The probability for large asteroid impact in the next century is low”... is irrelevant. Say the daily random-chance probability for large asteroid impact is one in a billion. And because in any given increment of time the chance that an impact will not happen is far greater than it will, the chance that it will happen can be characterized as *low*. However, if we look out the window and see a large asteroid 10 seconds away from impact the daily random-chance probability for large asteroid impact will still be one in a billion... and we must therefore still characterize the chance of impact as *low*... When the characterization of the probability can be seen to be tested to be in contradiction with the manifest empirical fact of the assessed event it then must also then be seen to be empirically false. Worse: true only in the abstract and as such, misleading. If we are going to respond to these events, when it counts the most, this method of assessment will not be relevant. If information can be seen to be irrelevant ex post it must also be seen to be irrelevant ex ante. This assessment is meaningless.

Consider the current threat of the asteroid Apophis. With its discovery we abandon the average relative frequency derived annual random-chance probability for a rational conditional-empiric probabilistic threat assessment derived from observing its speed, vector and position relative to Earth. The collective result is expressed in probabilistic terms due only to our inability to meter these characteristics accurately enough to be precise to the point of potential impact. As Apophis approaches this point the observations and resulting metrics become increasingly accurate and the conditional-empiric probability will process to resolve into a certainty of either zero or one. Whereas the random-chance probability is unaffected by whether Apophis strikes Earth or not.

These two probabilistic perceptions are inherently incompatible and unique, discrete and nonconstructive to each other. The only thing these two methodologies have in common is a nomenclature: probability/likelihood/chance, which has unfortunately served only to obfuscate their semantic value making one seem rational and relevant when it can never be so.

However, merely because they are non rational does not make averaged relative frequency derived random-chance probabilities worthless. They do have some psychological merit and enable some intuitive 'old lady' wisdom. When we consider the occasion of some unpredictable event that may cause us harm and there is nothing tangible we can do to deflect or forestall or

stop it from happening, we still want to know just how much we should worry about it. We need to quantify chance not only in case we can prepare or safeguard or insure against potentially recoverable consequences after the fact, but to also meter how much hope we should invest against the occasion of such events. Hope mitigates fear. And when there is nothing else we can do about it, only then is it wise to mitigate fear...

“The probability for large asteroid impact in the next century is low” does serve that purpose. It is a metric for hope. Fifty years ago, before we began to master space and tangibly responding to this threat of asteroid impact became a real course of action, hope was all we could do. Today we can do much more. Today we can hold our hope for when the time comes to successfully deflect The Next Large Asteroid on its way to strike Earth. And then, after we have done everything we can possibly do to deflect it, there will still be room for hope... and good luck. Until then, when anyone says that the probability for large asteroid impact or Extinction by NEO is low they are offering nothing more than a metric for hope. Not rational information constructive to metering a response or making a decision to do so or not. Here, the probability is in service to illusion... slight-of-mind... and is nothing more than comfort-food-for-thought.

We still need such probabilistic comfort-food-for-thought for things like Rogue Black Holes and Gamma Bursts where we are still imaginably defenseless. But if we expect to punctuate the political equilibrium and develop the capability to effectively respond to the existential threat of asteroid impact, we must allow a rational and warranted fear of extinction by asteroid impact to drive a rational and warranted response to this threat forward. Forward into the hands and minds of those who have the aptitude and training and experience in *using* fear to handle fearful things. Fear focuses the mind... Fear reminds us that there are dire negative consequences if we fail...

Fear Defines Necessity.

If we are going to concern ourselves with mounting a response and deflecting these objects and no longer tolerate and suffer this threat, would it not be far more relevant to know in which century the probability for large asteroid impact was *high* and far more effective to orient our thinking from when it *will not* to when it *will* occur? But this probabilistic perspective can not even pretend to approach providing us with that kind of information. As such, it can never be strategically relevant: contribute to the conduct of implementing a response. The same can be said when such abstract reasoning is used to forward the notion that the next asteroid to strike Earth will likely be small... This leads us to little more than a hope based Planetary Defense. If we are ever to respond to this threat *well* then we must begin thinking about this threat *better*!

Large Asteroid Impacts Are Random Events. Expect the next one to occur at any time.

Strategically speaking, this means being at DefCon 3: lock-cocked and ready to rock, prepared to defend the planet and mankind from the worst case scenario, 24/7/52... forever. Doing anything less by design, would be like *planing* to bring a knife to a gunfight.

If we expect our technological abilities to develop and continue to shape our nascent and still politically tacit will to respond to this threat: if we are to build an effective Planetary Defense, we must abandon the debilitating sophistry of “The probability for large asteroid impact in the next century is low” in favor of rational random inevitable expectation... and its attendant fear.

False Hope... The Academic Threat: Now that we are looking for these objects to some degree, the principal strategically relevant question: what is essential to the conduct of implementing a response, becomes 'Is there *one* large asteroid on its way to strike Earth anytime in the next 100 years or not?' A simple, absolute binary problem: On/Off, Zero/One... Yes/No. The strategically relevant answer will necessarily also be absolute. There is no room for any random-chance probabilistic response. This is not about deflecting probabilities.

Yet NASA's Spaceguard Survey and its apologists have claimed that by finding 80% of the 1,100 estimated large asteroids and in also finding this discovered 80% to be safe (not 100 year threats) they think they have somehow reduced the probability and thereby somehow reduced the 100 year risk of large asteroid impact by 80% as well. Superficially this does *seem* to have some intuitive merit. Clearly, if their initial perception of the risk were that all 1,100 candidate objects could be on course to strike Earth in the next 100 years, then they have indeed reduced *that* risk...

However, the subjective and rational existential threat here is just one Rock: The Next Large Asteroid on its way to strike Earth. And

all that is required for the risk of one asteroid impact in the next 100 years to persist unmitigated is the mere possibility of one undiscovered asteroid.

The dice have already been cast here. Time to forget about the odds... Look at the result! Either show us the Last Large NEO or just say "we still don't know"! Anything else is little more than sophistry and/or some abstract academic slight-of-mind. Since our interest is no longer abstract or academic but rather strategic, the relevant question now is not what the 100-year probability for large asteroid impact is but rather is there or is there not one large asteroid on its way to strike Earth in the next 100 years *in fact*! This business has become empirical.

In the direction of establishing a more rationally insightful and appropriate intuition consider that this problem is not as if there are 1,000 Barbarians at the Gate: all equally dire in their prospect to rape, pillage and burn. And in dispatching 500 of them we would clearly be reducing the risk by half. Rather this problem is as if there are 1,000 Pilgrims at the Gate and one of them may be a Terrorist... with a Nuke. If we randomly select, search and rigorously interrogate half and fail to find any Terrorist with a Nuke, have we reduced the risk? Does the number of Pilgrims at the Gate have any constructive or implicative bearing on the threat or risk of a Terrorist at the Gate? The number of Pilgrims, and/or that they are Pilgrims, is irrelevant. The problem, the threat, the risk, is complete in the fact that there may be *one* Terrorist at the Gate... with a Nuke. We can only resolve the problem by finding a Terrorist or finding all to the *last* Pilgrim to be a Pilgrim.

Further, the Spaceguard Survey does not physically change anything: they are not beaming these objects to a galaxy far, far away as they find them. Which would reduce the random-chance probability but not the conditional-empiric risk. Nor are they finding anything different than they expected to find. So in terms of basic logic, at the onset of their survey the most rational understanding and initial perception of the threat and risk would be for one and only one large impact event in the next 100 years. Therefore, given their estimate at the time of 1,100 candidate objects, a reasonable mind would expect that in the next 100 years that if there were in fact either no impending impact events or if there were only one, any empirical analysis of the candidate population should reveal 1,099 objects not to be on course to strike Earth in the next 100 years. How can they change any initial understanding or rational perception of the threat or risk when they have found only what they expected to find? The fundamental and singularly relevant question here is "is there or is there not one large asteroid on its way to strike Earth in the next 100 years". To this question, finding 1099 large asteroids not on course to strike Earth in the next 100 years can not be considered new information. In the absence of new, relevant information understanding can not change. Therefore the initial perception the risk can not change?

If there are 1,000 Pilgrims at the Gate and you have an understanding that one of them may be a Terrorist with a Nuke, then through interrogation you should expect to find 999 of them to be Pilgrims. Therefore, finding 800 Pilgrims to be Pilgrims in fact can not in any way be taken as new information. How can it in any way change your understanding? Show me the last Pilgrim!

Yet these scientists and academics have already accepted the accolade that they have effectively Saved the World! They hold to the claim that, taken together with all their small asteroid discoveries, they have reduced the risk by 90% and as such, amounts to virtually eliminating the risk altogether. Therefore, there is little reason to continue looking for asteroids for anything other than for scientific purposes. It is apparently enough to seem to be deflecting the abstract *probability* of asteroid impact and the question of whether The Next Large Asteroid on its way to strike Earth will do so in the next 100 years or not is simply not scientifically interesting.

By effectively retarding a strategic response to this threat, the rationalizations and critically flawed logics and interpretations of these 'expert's' pose a greater threat to mankind than the ignorance of the threat of asteroid impact in the first place. They look for the threat and dismiss it with nothing more than academic slights-of-mind. Only a rational fear ever defines necessity and what we have here is an

Irrational Absence of Fear.

No fear no funding. No funding no Planetary Defense... Despite all their good intentions, in their assessment of their efforts they have so far labored to produce little more than an equation for Suicide by NEO.

These are academics and do not really *do* things for a living, let alone manage or ever respond to risks... the same people who brought you the notion that: "The probability for large asteroid impact in the next century is low". But now it's time to *do* something. So now it's time to put the responsibility for addressing this threat into the hands of far more strategic minded 'experts'.

Two First-Order Executive Decisions:

Decision One: Should we endeavor to deflect asteroid impacts?

If no, perhaps you would believe we are somehow a Chosen Species or you just like the odds and would choose for us to continue this Cosmic Gamble. Then, the only tool at our disposal to achieve a desirable outcome would be hope. But hope alone is hardly a reliable survival tactic. We can only afford to hope for the best *after* we have prepared for the worst. We only willingly suffer the designs of chance once we have done all that we can to fix the race, stack the deck, load the dice... *cheat*. We The Species game the system... It's what we do.

If yes, consider that this issue has been merely talked about for far too long and we seem to have lost sight of the fact that ultimately we must deliberately *do* something here. And this something will be a wholly new way for mankind to address a Threat of Nature: an imposition of human will before the fact. If we are going to presume to overthrow and supplant the tyranny of the random-chance and seeming chaos of Nature and assume for ourselves the responsibility for the fate of our species in this, we must first come to the clear and unequivocal decision to do so. And if we would expect to succeed our decision must manifest and elicit the enthusiastic will of our species. The expression of our intent must be formal and bold... as if going to War. We can not sneak up on this like a thief in the night or afford to trust our will to somehow eventually evolve to meet the challenge ad hoc and extemporaneously... we simply may not have the time!

What is required then, is a codified expression of a Global Human Demand in response to this newly emergent Primal Fear of Death by Rock from Sky. A Global Executive Decision. A manifest Global Declaration of Intent, Global Policy Determination...a Global Resolution that:

“We the people of Earth will endeavor to deflect asteroids and comets as they are discovered to be impending Earth impact threats’.”

We can not leave this notion as a tacit assumption. It is both the conclusive expression of our collective resolve and the first fundamental political determinant compelling agency delegation, funding appropriation, strategy creation and ultimately executing an effective response. Without such a declaration we can never be on course to successfully defend ourselves from this threat.

Without a codified declaration of the political will of mankind in this, we will likely continue to only labor in some cheap and easy academic and abstract context... more plans and conferences and working groups and talk. It may not be certain that, as a matter of course, with such a deceleration all else will follow, but it is surely unlikely anything else will follow *without* it.

Consider that if you took a poll of every man woman and child on the planet and asked them if we should deflect The Next Large Asteroid on its way to strike Earth you would expect to get a virtually unanimous affirmative response. Such an expression of unity and consensus would be a great place to start any venture. This is a relatively easy but critical first step to save us all from Extinction by NEO...

If yes, then also consider that since all asteroid impact events are aperiodic and random both in their occasion and magnitude then from here and now we simply cannot derive any kind of rational certainty for either when the next event will occur or for how large it will be - until we see it coming. And with luck, that may be no more than decades before impact. Therefore...

Decision Two: Should we develop and build a means to successfully deflect The Next Large Asteroid on its way to strike Earth *before* we see it coming... or wait until *after*?

If *after*, then consider that when that day comes, not all the money - not all the hubris, not all the resolve, not all the hope, not all the genius, not all the 11th hour road-to-hell-paving political good intentions mankind can bring to bear, altogether in the world - will buy us more time. Time to select, design, develop, test, train personnel, build and stage an effective response that may have a mission mass of millions of tons in Low Earth Orbit.

And once you sit down and think this all the way through well it gets worse! We not only do not know when the next asteroid will impact, we do not know when we will see it coming or how large the detection-to-impact window will be if we do, or if impact dictated deflection mission launch schedules will coincide with relative orbital launch window opportunities. If any. We also do not know how large the asteroid will be. The larger the threat the larger the mission (more launch windows) and the less likely the coincidence. To afford a 1 km asteroid 10 cm/sec of deflection would require 10,000 Deep Impact kinetic type missions. Not counting all the political and economic and technological subsections of Murphy's Law that can apply, from here and now that sounds like a plan counting on a whole lot of very good luck... The extemporaneous ad hoc character of *after* makes Decision One look like a crap shoot either way we choose.

Therefore, if *before*, then *before* begins... *now*! And we have all the time left in the world... And all luck great and small considered, we should not only be building a Planetary Defense before we see it coming but we should be deploying it to circumstellar orbit as well and be

Projecting of Power to the Orbit of Mars.

Given that the next large asteroid on its way to strike Earth may well result in an extinction level event, we should endeavor to do so at any cost. A rational and comprehensive response to this threat should not only be on mankind's list of things-to-do, it should be at the very top.

The Strategic Advantages and Tactical Flexibility in Using Nuclear Ablation

Nuclear Ablation: In a nutshell, the Nuclear Ablation approach to deflecting asteroids would be to cross the orbit of a target asteroid with a nuclear explosive device and at the point it crosses the asteroid's path and detonate the device at some predetermined proximity to the target. The radiation generated from the device would explosively volatilize a thin layer of the asteroid's surface generating a high velocity thrust distributed over some portion of the asteroid effectively altering its speed. Over time, this change in speed would serve to displace the asteroid from a collision point with Earth.

If we were in a position to observe this process, if the light were just right we might see the streak of the device approaching ahead of the asteroid. Then, at the target point where the device would cross the asteroid's path we would see an extremely brief but extremely bright flash of light. Then, if we don't blink, we may be able to just barely discern a nearly simultaneous puff of gas from the asteroid's surface and... that's it. Asteroid deflected. Not even any sound effects! Certainly not the stuff Space Operas are made of.

In March of 2007, NASA's PA&E released the results of their Congressionally ordered study to provide alternatives to divert impending impact threats. Their finding concluded that the use of a Nuclear Explosive Device (NED), in an ablation approach would be ~100 times more effective than the Second Best Alternative. Effectiveness here is principally a product of the relative mission mass between a NED and the Second Best Alternative. The lighter the mission the faster we can respond. The faster we can respond the less force it will take and/or the more force we can respond with to ensure mission success... and as the man said: "Failure is not an option".

In the direction of considering this differential, since there was no discrete appropriation of funding by Congress for this study the PA&E was justified in limiting the scope of testing its considerations to categorically small asteroid threats under 1,000 meters which was the dedicated scope of The Brown Act conveying the request. When you extend the scope of the consideration to the categorically large asteroid threat (over 1,000 meters) we can see that in contrast to the conservative one radius proximity used by the PA&E, the greater mass and cohesion of larger asteroids would tolerate a near surface detonation (tens of meters) possibly increasing the yield to work ratio by a factor of ten. And a NED becomes ~1,000 times more effective.

Further, if we then speculate where the PA&E can not, we can contrast the off-the-shelf example of using a 30 year old Cold War designed B-83 tactical device with a 1 ton mass to 1 Mt yield as the specific NED referenced in their analysis with a conceptual modern ad hoc design. Removing the superfluous variable yield and penetrator capabilities and setting aside the Cold War 'clean yield' restrictions and affording a 21 Century device design and upgrade yield efficiency, we could fairly expect to see an increase of the mass-to-yield ratio of the device by a factor of ten as well. Effectively compounding the optimal mission effectiveness of a NED over the Second Best Alternative to ~10,000 times.

A thumbnail for the relative differential between tactically optimized missions for a 10,000 meter Chicxulub class impactor would require one million tons of payload delivered on target for the Second Best Alternative as a kinetic impactor tactic for each centimeter of deflection. Whereas for the same effect, with Nuclear Ablation the optimized mission mass would be only 100 tons. Or, in real world terms: 1,000,000 Deep Impact missions vs 100 Deep Impact missions. Money is proxy for human endeavor so at \$333m each... let's take a moment and do the math.

However, when the time comes to deflect the next large asteroid on its way to strike Earth the real metric will not be in dollars or human endeavor. When that day comes success will be determined by just how much good luck mankind has left: Launch Windows...

Then, which is more likely to be available when we are likely to need them: 100 launch windows for a Nuclear Ablation mission or 1,000,000 launch windows for a Second Best Alternative kinetic impactor mission? A product not of quantitative economic industrial capability but rather random chance. Note that these deflection capabilities have been for only 1 cm/sec and based on best case assumptions for a 10 year interdiction. In rational real world terms and all things-of-chance considered, projecting applications that accommodate margins of error and ensure a reasonable expectation of mission success we should multiply everything here by a factor of ten.

vs Second Best Alternatives: Even in a Nuclear Ablation approach, aside from being seen as Politically Incorrect, critics of the application of Nukes to deflect asteroids hold that such an approach would incur a high risk of inadvertently 'Blowing It Up'. That may indeed be possible if we narrowly see this process manifest as using One Big Fat Super Nuke ten inches from the surface of the object... if we do it stupid/wrong. Easy fix. Don't actually do it stupid/wrong...

The conceptual risk of disrupting the integrity of an asteroid presents itself in their argument not so much with monolithic and highly cohesive asteroids but rather in loosely bound/rubble pile threats. However, regardless of their cohesion, even if you want to it is difficult to actually blow up anything from the outside-in... particularly in Space where you lose the transmission value of having an atmosphere to generate an initial shock that would strike the asteroid. And by blowing it up we must understand that to mean to impart sufficient velocity to the fragments to bring them all to escape velocity in order to overcome the extant center of gravity of the now disrupted asteroid. Absent a sufficient velocity, given time the fragments will simply fall back together.

If it were our intention to Blow It Up (apart), it would be far more effective to in fact use the Second Best Alternative nominated by the PA&E of employing a high relative velocity kinetic impactor! Note here that such a result, where all the fragments were dispersed, albeit randomly, beyond the initial escape velocity of the object, it is highly unlikely that with the random change in speed and/or vector that any of the disbursed fragments would remain on their previous unique 'collective' collision course with Earth. The problem with such an approach would be that the net energy requirements for such a distributed deflection would be orders of magnitude greater than merely deflecting the asteroid in the whole.

To some degree, in Nuclear Ablation the tactical risk of disrupting the integrity of a loosely bound/rubble pile threat is real. However, there are several ways to augment the One Big Fat Super Nuke approach suggested by the critics that combine to mitigate and likely eliminate this risk and still maintain a substantial margin of effectiveness over any Second Best Alternative.

A) Multiple devices: For many reasons, it would be strategically and tactically sound to design a response to any task as modular to better afford flexibility, accommodating some margin of error and afford proportional success in response to the many manifestations of Murphy's Law. If we calculate we need 10 Mt of yield to achieve a desired effect we would design its implementation in 10 discrete 1 Mt devices. And since even Cold War designs vary in yield down to fractions of kilotons (SADM) there is no realistic minimum to the yield and therefore no obstacle to any modular application for small asteroid threats. This may serve to increase the mass-to-yield ratio by a factor of something on the order of two and from a modern designed device reduce optimal mission effectiveness relative to the Second Best Alternative from ~10,000 to ~5,000 times.

B) Incremental execution: To avoid fratricide, and in the same direction of addressing the vagaries of device failure, we would address the problems of Murphy's Law in execution by delivering our devices over some reasonable short period of time: minutes/hours. This inherent aspect of implementation, by distributing the total force required for deflection over time, in and of itself would serve to decrease the potential for threatening the disruption threshold of any target asteroid with no effect to the net effectiveness relative to the Second Best Alternative.

C) Increase altitude: In the case of loosely bound/rubble pile threats, the proximity and therefore yield-to-work ratio can be varied to suit the tolerance characteristics of the target. Going from near surface (meters) to one radius would reduce the net effectiveness relative to the Second Best Alternative by a factor of approximately ten from the optimal multiple device approach of ~5,000 times to ~500 times.

D) Incremental increase: Further, in the case of loosely bound/rubble pile threats, since there is virtually no chance of actually disrupting the asteroid to the point of dispersal (Blowing It Up) as long as we avoid doing it stupid/wrong and vary the size of the individual device/yield employed as well as the proximity of its detonation, there is still the near certainty of some small degree of short term disruption of the asteroid if only in millimeters. To mitigate this effect in terms of being relevant to the objective of the mission, we need only to afford the target some period to settle and restore integrity by increasing the interval of the device delivery: weeks/months. Perhaps the term Gravity Bag would suit the effect here? And the greater the mass of the object the stronger the gravity, the stronger the force of the bag, the faster the fall-back and the shorter the restorative interval required. This variable would also have little if any effect on mission mass and therefore no bearing on the net effectiveness relative to the Second Best Alternative.

E) NEONet A: If we step outside-the-box, and if the target were large enough where the total available inventory of NEDs became problematic (for example) it may even be far more effective to employ a Net to contain any possible dispersal of a loosely bound/rubble pile threat and then abandon the optimal proximity for a maximal subsurface detonation and employ penetrator technology. Here we may see a trade off in mission mass between the increase of the yield-to-work ratio by perhaps yet another ten times with a subsurface detonation (effectively ~100,000 times greater than the Second Best Alternative) with the employment of the Net and in terms of overall mission mass still be equal if not favorable compared to a optimal Nuclear Ablation mission. However, added mission complexity would beg whole new sections of Murphy's Law so some degree of preparation and training would be required... as in any tactic.

F) NEONet D: The concept of Nuclear Ablation relies upon the advantage of distributing of the reactive force of the volatilized gas over the surface of the asteroid. So again, stepping outside-the-box, another means to achieve this effect could be to distribute many low yield NEDs over a portion of the leading surface of the asteroid by means of a Net. Detonated simultaneously such an approach would disperse the potentially disruptive reactive force while at the same time dramatically increasing the effective yield-to-work ratio to that of a surface detonation.

In short, the inherent flexibility of Nuclear Ablation, seen in a potential light of experience and expertise, would afford this tactic an optional ad hoc surgical character. Even tested by what may be the most difficult of deflection challenges - loosely bound/rubble pile objects – the margin of effectiveness of Nuclear Ablation over Second Best Alternates remains in the range of orders of magnitude. Given that Nuclear Ablation appears to enable an effective response to any conditional manifestation of this threat, taken in conjunction with the strategic infeasibility of any of the proffered Second Best Alternatives to be effective in addressing any asteroid threat over 500 meters,

the only reasonable course and commitment for any serious research and funding would be in support of developing reliable variations on the theme of Nuclear Ablation.

Modern Design: If we are going to employ Nuclear Explosive Devices in the effort to defend the planet from asteroid and comet impact we will need to develop, test and deploy a modern design upgraded to maximize its mass to yield ratio in the form of a space capable mines dedicated to this purpose. Starfish Prime was not even close to a test of the requirements here.

Such devices must be the product of a dedicated design and tested to be consistently reliable in Zero G, absolute vacuum, at -240°C and in ambient radiation outside Earth's magnetosphere for long periods of time after being accelerated to circumstellar orbital velocities for deployment. We are far from having a standing tested NED capability that could be considered reliable to this degree.

The above notions describing the variations on the application of NEDs are offered here only as back-of-the-envelope and require the formal attention of a dedicated Planetary Defense agency for any precision. But, as is, these notions are clearly not rocket science nor do they require the insight of a strategic genius. They are basic rudimentary principals of doing things. Common sense. What may be at work in the minds of the opponents of Nukes may simply be an absence of political courage to see and make the hard Real World decisions when the clearly best course of action is merely politically incorrect. The result is a convenient ignorance of what should be obvious to even the harshest of critics.

However, to directly address this nagging 'Politically Incorrect' argument against the use of Nukes: We should not allow our completely rational and warranted fear of global thermonuclear war to be used against us to coerce a completely unwarranted and irrational fear of employing nuclear energy to defend us from our Extinction by NEO. After all, sooner or later, when NEOPucker Time comes, and your children and grandchildren are at Ground Zero, will you settle for whatever powers-that-be using any Alternative that is Second Best by a factor of 10,000 times or even 100 times? How about Second Best even by a factor of 2?

The Silver Bullet/One Tactic Fits All Size Threats: From an imaginative buffet of Second Best Alternatives: Solar Collectors, Mass Drivers, Lasers, Gravity Tractors, Kinetic Impactors... soft critics of using nukes would offer a conciliatory 'basket of tactics' approach commensurate with all the conceivable variations manifest in this threat. It is said that a Good Strategist is a strategic genius while a Great Strategist is a logistical genius... as well. That said, strategically speaking, a Great Strategist never wants to *have to* have more than one tactic to employ to achieve the results he is responsible for. He understands that: if he needs only one tool to do the job, regardless how the challenge may present itself, it will be far more likely he will be able to have and even deploy that tool *before* he needs to use it; be able to rely on the tool being cheaper and afford some potential for a reserve beyond what he may exactly require to achieve his mission; be able to trust that, by volume and redundancy of production, this tool will become refined and tested to a higher degree of inherent reliability; and better prepare and train personnel in its effective use.

Great Strategists *like* Silver Bullets...

Tactical imperative: Even a strategic genius understands that to be able to craft any strategy: determine what is essential to the conduct of implementing a response, let alone manifest it, it is imperative that first there must be a dedicated tactic to respond with... The notion of having a 'basket of strategies', with their attendant economic, industrial and political infrastructures, would then insist on having a strategy of strategies. A formula for failure in complexity. All Strategists, Good or Great, like to keep it simple/stupid. It just makes their success easier to come to. It is only the engineers of tactics and the industrial complex that they service that like the idea of a 'basket of tactics'. But ultimately, they will not be the ones to be actually tasked with the responsibility for successfully deflecting these threats. Strategically speaking, the application of Nuclear Ablation in response to the threat of asteroid impact appears to be a universal hammer that does, in fact, turn all our asteroid impact problems into nails. The one tactical response with which to build a sound and effective strategy around. KISS IT.

Agency/Funding

The prospect of asteroid impact is forever. This is not something that will ever go away or can be eliminated. It must therefore be addressed and responded to... forever. In this sense this is not so much a threat as a newly discovered element of our existential condition and our response, a cosmic cost of living. This is not about Man in Space. It is about the Survival of Mankind. Not about Science but Security.

We The Species have already evolved and developed a dedicated human agency for addressing our Survival and Security problems. How much easier would it be to task the militaries of the world with a mission in Space than it would be to try and teach our scientists and academics to think like soldiers? And the best part, at a trillion dollars a year or more, is that our world militaries come with their own budgets dedicated to Survival and Security!

If we delegate this mission to the collective military agencies of the world and direct the funding of building a Planetary Defense proportionally from standing military budgets we could maintain current global balances of power while at the same time reduce our overall ability to kill each other over political, economic and religious principals. Win/Win... And when you consider that it should be far easier to sell mankind on the notion of going to Mars in order to defend the planet from asteroid impact at the expense of our collective ability to wage war on each other than it would be to go to Mars 'Because It's There' at the expense of our ability to feed our children...

Win/Win/Win!

Science and technology have advantaged the evolution of our understanding of our place in the cosmos. One product of this emergent awareness is the recognition of an inherent vulnerability to some concurrent and seemingly exigent threats. Since the credible and perpetually imminent threat of asteroid impact is a threat we can conceivably manage, and since it will always include the prospect for our extinction, which asteroid is The Next Large Asteroid on its way to strike Earth will always be the most important thing mankind will ever know. Deflecting it will always be the most important thing mankind will ever do. The Universe is a dangerous place. It does not suffer dilettantes gladly. The Next Large Asteroid on its way to strike Earth is coming... at

A Million Miles A Day...

<<http://Gaiashield.com/AMMAD/>>

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