PRESIDENT REAGAN’S PROGRAM TO SECURE U.S. LEADERSHIP INDEFINITELY:

How All Americans Can Participate and Reap the Benefits

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Chapter 4

The Footrace to the Next R&D Breakthrough is a US Treadmill

The Socrates team constantly encountered the R&D obsession of US decision-makers as the solution for just about everything. This obsession is another illustration of thought leaders stuck in a flawed belief system about finance-based planning and market-focused practices.

There is a widely accepted belief in the US that competitive advantage is a constant footrace to the next breakthrough, and winning the footrace automatically results in achievement of financial objectives. This belief has led to misuse of R&D and further illustrates a naive understanding of technology, strategy and competitiveness. The resulting normalized behaviors about R&D have been, overall, counter-productive to US competitiveness. Socrates disrupts this accepted practice that pervades US planning and decision-making.

The fact is that R&D, a potentially powerful competitive tool and process in which our country has demonstrated raw talent, has been a disappointment through misguided purpose and ineffective application. The result has been squandering of our massive investments in R&D for decades with relatively few results to show in achieving competitiveness.

US Leaders Equate Financial Investment in R&D with Competitive Advantage

Regardless of what organization or institution in America is measuring our competitiveness, we always go back to technology and innovation as being one of our strongest attributes. But because we use finance-based planning as the foundation for all planning, our technology and innovation capability is measured by the amount of money we spend on it annually, relative to other countries.

Individual US businesses, operating from a finance basis also measure their ability to perform by how much money is allocated to technology, R&D and/or innovation. From this basis conclusions are drawn about performance and a level of competitiveness is assumed.

However, when it is obvious we are losing, as clearly evidenced in our country’s steady economic decline, the connection to our method, finance-based planning, is simply overlooked. Even though we may win the “footrace to the next breakthrough” while our overall economic health declines, we conclude irrationally that we simply need to do more of the same only faster and harder to improve the overall economy. One very popular result is to spend more money on R&D and innovation to win the footrace to the
next technology breakthrough that will propel us ahead of our competitors. Socrates research found this approach to be full of baseless assumptions.

Measuring competitiveness by the amount of money we spend on R&D is considered accepted practice without question. US organizations, think tanks, education institutions and government agencies all use this measure to judge the competitiveness of our rivals at all levels. From this finance-based planning perspective, outspending one another in R&D on a country or organization level equates to competitive advantage.

As we will see later in this section, the finance-based community has developed various methods to ostensibly measure R&D effectiveness using complex mathematic equations, which attempt to measure R&D ROI but obviously miss the mark on competitiveness.

The false conclusions that our leaders parade around the world through these purely finance-based methods simply boil down to false conclusions summed-up as:

“Because we spend much more money on R&D than any other competitor, we are by far the best innovators. And because we are the best innovators, through R&D, we have competitive advantage.”

In the conventional definition of innovation it may seem true at first glance that we have historically been the best innovators in the world. But even that conclusion is even being challenged today. One fact remains absolutely true. Even if we are the best innovators, we are without a doubt one of the world’s weakest competitors. How can that be?

The irrational thinking of US decision-makers is not just limited to decisions about R&D, innovation and competitiveness. This irrational way of thinking may be so embedded into our culture that it impacts just about everything we do.

A Culture of Illusions

A retired FBI special agent and supporter of our Operation US Forward explained to us similar experiences he encountered over the years in his profession. His explanation provides further evidence that the irrational thinking we have encountered through Socrates research into the finance-based planning thought process is not isolated.

Our FBI friend’s unique skills for complex investigation keep him active today with the agency beyond retirement. In his current capacity, he requests anonymity, which we will respect in relating his experiences.

Over his long career, our FBI special agent’s unique investigative and problem-solving skills have led to assignments of the toughest cases. He led special agency operations in crimes of violence and resolving cold cases that were otherwise at a dead-end and filed away. As we discussed his experience in leading such FBI programs, his comments
reinforced what we see as *irrational thought* in routine US planning and decision-making. In this irrational finance-based thought process conclusions are frequently prematurely deduced from a superficial view from the marketplace.

At the surface, which is what is visibly happening in the marketplace, is where US decision-makers seem to operate, come to conclusions and take action. Our FBI special agent refers to these surface conclusions simply as *illusions*. These illusions are deduced from preliminary observations without analysis and produce counter-productive results. His job, as he describes it, is to get past *illusions* and to the *foundation* of the real cause where a clear path logically unfolds to rational conclusions.

The Socrates team observed this common tendency of US planners and decision-makers to reach conclusions based on the surface view of competition at the marketplace level. The process is *superficial*, the observations are *symptomatic* and the conclusions are not *causal*. Or as our FBI special agent calls these conclusions, *illusions*.

There are deeper implications to this US behavioral characteristic. News media pick up the stories and without question repeat the illusions as reality, which the general public then accepts. The solutions that are claimed from these illusions create inappropriate emotional reactions that, one way or another, prolong and aggravate the symptoms.

Universities operate at the superficial level, as we have already seen in the discussions on *disruptive technology*, the *innovator’s dilemma* and *open innovation*. A result of operating at the superficial level are countless false conclusions like, *our ability to out-R&D and out-innovate the rest of the world will take care of our loss of jobs and failing economy*.

**Facts Disrupt Conventional Thinking About R&D**

The truth is though that these illusions are not solutions at all now and have never been since the US adopted finance-based planning and market orientation decades ago. Socrates and our world competitors disrupt this embedded characteristic of US planners, decision-makers and educators.

The amount of money that Japan, South Korea and China, all examples of technology-based planning countries, spend on R&D and so-called “innovation” is a secondary factor in their overall global technology strategies. Yes, to these countries innovation and R&D are very important, but both are precisely planned, funded and conducted in the context of an overall technology strategy for achieving competitive advantage. In their holistic technology strategy approaches, these competitors properly treat R&D as just one factor in the process of achieving competitive advantage and do not measure it in terms of *spending*. These competitors, as a general rule, consider R&D a last resort in acquiring technology. For these competitors, money spent is simply a resource for acquiring
technology through R&D as part of executing a technology/competitive strategy, not a foundation around which to coordinate a financial plan, as is the illusion in the US.

US misuse of R&D not only fails to make us competitive, but the way we address R&D in the US, does not support the widely held illusion of US decision-makers that R&D equates to innovation. A recent Booz & Company annual Innovation 1000 survey states:

“When it comes to innovation, spending doesn’t correlate with success.”

...“Booz & Company found that the most innovative firms outperformed the top 10 R&D spenders across three key financial metrics over a 5-year period — revenue growth, EBITDA as a percentage of revenue and market cap growth — consistent with last year’s findings. Just three of this year’s top 10 (R&D) spenders also ranked among the top 10 innovators: Microsoft, Samsung and Toyota Motor.¹

Note that all measures are financial indicators that attempt to make the case for innovation. It would be hard to believe though, that they did not consider competitiveness somewhere in the discussion about R&D and innovation. The Socrates team would ask, “What objective is more important than achieving and sustaining competitive advantage because without competitive advantage financial performance cannot be maximized and sustained?”

The findings of this study reinforce Socrates research of many years ago. First Socrates concluded that it is about competitiveness not R&D or innovation. Yet innovation and other superficial factors like manufacturing, a current misdirected US obsession, are typically the focus for finance-based planning initiative based on the amount of spending to be allocated to R&D.

Secondly, an authentic technology strategy executes precise maneuvers in the entire technologyspace to acquire and utilize worldwide technology required for competitive advantage. R&D is never the proper foundation for competitive strategy planning and may or may not even be appropriate as a coordinated maneuver within a technology/competitive strategy. In the same context innovation, in and of itself, may or may not be a critical factor in achieving competitive advantage and again, certainly not the proper starting point for any business plan.

Also note that two of the three top innovators in the Booz & Company study are strong technology-based planning competitors of the US: Samsung of South Korea and Toyota of Japan.

The study also mentioned Microsoft as a top innovator. Microsoft is historically an “intuitive” technology-based planning company, as was Apple under Steve Jobs. In the case of these two US companies, they executed the technology-based planning approach informally as an art, not a science, as Sekora has perfected in Project Socrates. But both Apple and Microsoft are good examples of success through the art of technology-based planning.

When an entire society operates in a bubble of illusions, natural occurrences frequently appear as surprises. The article suggests a “surprising” result that innovation and R&D expenditures do not correlate. This “surprising” result though, supports a natural conclusion of Socrates findings decades ago. R&D expenditures do not naturally and automatically result in advancement and the expenditures themselves have no logical connection to innovation. To think otherwise, as is normal in US conventional thinking, is an illusion.

Measuring the value of innovation based on amount of money allocated or actually spent tends to distort its use and effectiveness. Without a process to guide the innovation process in capability improvement opportunities and needs, innovation spending has been made mostly irrelevant.

Because of this distortion in conventional thinking and application, innovation has been defined in various ways depending on whom you ask. Most definitions agree that innovation means a new idea, method or product. All are examples of innovation results but do not define or address the process required to achieve innovation. To effectively utilize innovation to achieve and sustain competitive advantage, we first need to agree on the definition of what it is.

Since Socrates operates at the foundation level, i.e., technology is the source of all competitive advantage; Socrates defines innovation at the process level where innovation occurs to produce specific desired results. In Socrates innovation occurs through and is therefore defined as – technology cross-pollination:

“Innovation is technology cross-pollination that increases product or service capability to satisfy needs better than competing products and services. Cross-pollination is the integration of two or more technologies to create a new technology that satisfies customer needs better than competition. The technology can be low-, mid- or high-tech and the function the technology is applied to can be mundane or highly sophisticated.” - Michael Sekora
As you can see, the technology-based Socrates definition does not limit innovation to R&D, as suggested by the article in its “surprising” finding that R&D spending does not equal innovation. Note also that the Socrates definition transcends the popular descriptions of innovation: New ideas, methods and products.

In technology-based planning innovation, cross-pollination of technologies, can occur absent of R&D and does occur more often than not in this way. Technology can be acquired for cross-pollination through alliances, licensing or purchase of technology. But you must first know what technologies are needed for competitive advantage, where these technologies are in the technologyspace, who has them and how others are using them before you can decide how best to acquire them. Finance-based planners in the US are blind to the technologyspace, where this information exists, and therefore, absent of factual information, make irrational assumptions that ostensibly justify jumping straight to R&D. Then they call it innovation and allocate massive amounts of funds. It’s an illusion and waste of resources in most cases.

A posting on Entrepreneurism and Innovation Today agrees with the Booz & Company survey that spending on R&D does not lead to success whatever measures is used. But even more telling in this posting is the statement that, “no one knows what the data means.” This statement suggests that the analysts are also stuck in conventional thinking while encountering the predictable discontinuity inherent in their thinking, which they then cannot understand.

The conclusion is that the practice of equating amount of spending on R&D to determine a company’s competitiveness does not compute. IEEE Spectrum research shows the disconnect reinforcing the fact that spending volume, associated with so called Brute Force R&D, is an accepted US practice and standard measurement for success. This excerpt from the article summarizes their findings:

Evidence that spending isn't everything comes from Toyota, which last year passed General Motors to become the world's top-selling automaker. Neither now nor at any time in the past six years has Toyota spent more than GM on R&D as a percentage of total revenues. This percentage, called R&D intensity, is what industry analysts look at when judging a company's focus on future technology and products.

The same pattern can be seen in many other industries. Apple, one of the companies most highly regarded for its innovative work, doesn't spend enough on R&D even to show up on the top-100 list. Google, another very innovative firm, doesn't spend unusual amounts on research, either.

Our data confirm a study (apparently an earlier Booz Allen annual study) by the consulting firm Booz Allen Hamilton. It found that firms among the top tenth of
their industry in R&D spending did no better than the average for that industry, although those in the bottom tenth did do worse.

Nobody knows what these findings mean, says IEEE Spectrum. Perhaps you need a certain amount of R&D but no more than that. Perhaps those companies that slight R&D do so because they have problems. Perhaps those that come to dominate their markets tend to slacken off on spending.²

One important finding of Socrates decades ago about R&D and innovation is summed-up in this one statement from the article, “This percentage, called R&D intensity, is what industry analysts look at when judging a company's focus on future technology and products.” This practice of industry analysts and those who go along with their findings is another gross example of flawed but institutionalized US decision-making practices that rationalize superficial data to get to an illusion of objectivity. In the case of Toyota vs. GM, Toyota consistently has a lower R&D intensity percentage than GM (spends proportionately less on R&D than GM) but consistently outmaneuvers GM competitively in the technologyspace to win in the marketplace.

Everything in the IEEE Spectrum article supports Socrates findings on the subject except the last paragraph that says, “nobody knows what these findings mean.”

On the contrary, we do know exactly what these findings mean – “finance-based planning and measures are irrelevant and misleading in determining operational capability, R&D effectiveness and innovation impact.”

The findings presented in this article also verify, what should now be obvious, that US companies are terminally blind to the technologyspace and its dynamics. If they were not blind to technologyspace, they would see the disconnect and be able to execute R&D for a precise purpose with exact results. Again, we must conclude that our decision-makers and planners do not understand technology-based planning and do not have the tools to conduct it.

One of the most important features of the Socrates solution was to provide a holistic technology strategy. This holistic strategy lays out the present, near-, mid- and long-term plan that enables decision-makers in all sectors of the economy to efficiently use R&D. See the Kodak example above in the section on MBA Schools Do More Harm than Good.

With the capability provided in Socrates, R&D becomes part of a series of coordinated technology maneuvers to acquire technology specifically needed for competitive

advantage. Where funds have always been a resource, funds, just like manufacturing, innovation and R&D, cannot be the starting point.

But winning the footrace to the next breakthrough is the objective of conventional US R&D. Because of finance-based conventional thinking the R&D footrace is more of a treadmill for US planners and managers, expending great amounts of energy and resources with no advancement in sustaining competitive advantage. Ironically, we seem to ignore the fact that achieving and sustaining competitive advantage is also essential for achieving and sustaining financial health for individuals and organizations, overall economic health of the nation and ultimately long-term viability for all of us.

The US consistently treats R&D as the centerpiece in finance-based planning. As the centerpiece, R&D is allocated funds based on market analysis. By spending more money US organizations have been able to “out-R&D” all other competitors. The mistake in this approach is the exclusive reliance on marketplace data to plan the R&D spending strategy, which as we have seen, is too late for competitive maneuvers. R&D allocations to win the footrace are, more often than not, lost to astute technology-based competitors.

The cycle continues. From current leadership across all sectors trained in the same mindset that got us into this crisis in the first place come the same programs to ostensibly get us out of this mess. Lost jobs and economic decline are actually symptoms as we have seen, of inability to compete. Meanwhile, leadership’s numerous so-called R&D and innovation initiatives, massively funded in the US to address manufacturing, for example, to stimulate general economic growth and job creation are neutralized before they even appear in the marketplace.

The Advanced Manufacturing National Program Office for interagency cooperation coordinates a high visibility government program focusing on innovation, R&D funding and collaboration across all economic sectors. Among other things, the program calls for a national innovation (industrial) policy for manufacturing. The Advanced Manufacturing Program, according to its website is:

...a family of activities that (a) depend on the use and coordination of information, automation, computation, software, sensing, and networking, and/or (b) make use of cutting edge materials and emerging capabilities enabled by the physical and biological sciences, for example nanotechnology, chemistry, and biology. This involves both new ways to manufacture existing products, and especially the manufacture of new products emerging from new advanced technologies.

The initiative’s Report to the President on Ensuring American Leadership in Advanced Manufacturing, dated June 2011, provides a closer look at our country’s government sponsored Advanced Manufacturing Program to create jobs and improve economic health.
You can view and download the full report from the President’s Council of Advisors on Science and Technology website.³

From the executive summary of the report we can see once again the continuation of flawed thinking leading to ineffective solutions for our nation coming from the highest levels:

As U.S. manufacturing leadership is waning, other nations are investing heavily in growing and revitalizing their manufacturing sectors and are crafting policies to attract and retain production facilities and multinational companies within their borders. Such policies include partnerships, physical structures such as science parks or technology clusters, tax and regulatory incentives, and concentrated investment in commercialization of promising technologies. Some of these policies amount to industrial policy—making clear bets on specific firms and industries—but others support precompetitive activities that would be regarded as within the scope of appropriate government action in the U.S.

Note the terms, Industrial policy and precompetitive activities. The context within which these terms are used indicates that this operation is either severely hobbled, misrepresented or both from its very inception.

First, is the reference to industrial policy – “making clear bets on specific industries.” This inaccurate definition of industrial policy is misleading and serves as a major constraint to US government involvement on which the entire success of the program is built. US obsession with this inaccurate and misunderstood concept, industrial policy in this case, is a classic example of how conventional thinking from an improper foundation can evolve into irrational decision-making at the most critical policy levels. Our country’s self-inflicted issue with industrial policy is discussed in detail later.

Second, the phrase precompetitive activities is basically manufactured terminology used throughout US conventional thinking to rationalize collaboration between organizations that must work together temporarily but in real life actually compete against one another. In this case, the otherwise legitimate role of competing is deemed not to exist in the part of the process where the US government participates calling this part of the process, precompetitive. The assumption can be made that this declaration of no competition in the activities of the US government is necessary to uphold the bizarre US industrial policy interpretation. It is deemed then that no competition in the process exists and therefore there is no industrial policy, i.e., “making clear bets on specific firms and industries.”

³The President’s Council of Advisors on Science and Technology, Report to the President on Ensuring American Leadership in Advanced Manufacturing, Advanced Manufacturing Program, June 2011.
Conventional thinking consistently distorts and confuses critical survival concepts such as competitiveness in this case. In fact the issue that this particular government program was specifically built to address is a fundamentally a classic competitive situation – “restoring US manufacturing competitiveness.” In an otherwise rational world our intent and ability to achieve our competitive goals would be viewed as a strength not something to distort and minimalize. Most will agree that restoring US competitiveness is simply a matter of survival so why try to circumvent the natural need to aggressively address it?

In summary, the basis for this program is convoluted and inaccurate from the very beginning and destined to fail.

The term precompetitive is a grossly misused term originally concocted to justify collaboration among organizations that traditionally compete against one another but must now come together around a common issue to jointly develop a solution for mutual benefit. In conventional terms collaboration efforts are typically confined to the early stages of development and testing and deemed, precompetitive activities. But the early stages of solution development are where competitive advantage is achieved or not and there is always a competitor. Where there is a common issue around which traditional competitors can collaborate for mutual benefit, there is also a common competitor. This common competitor can easily be identified and must be jointly addressed. The logical way to handle collaboration opportunities is to simply identify the common competitor and conduct the entire process as a naturally competitive situation. In the real world vs. the world of illusions that occupy conventional thinking there are absolutely no precompetitive activities.

In Socrates this important collaborative process is achieved in a formal system function called Symbiotic Deployment discussed in detail toward the end of the book.

So instead of redefining the real competitor common to collaborators, conventional wisdom attempts to redefine the process by simply deeming it a set of noncompetitive activity euphemistically referred to as, precompetitive.

In this government sponsored Advanced Manufacturing National Program the important competitive process is unfortunately deemed noncompetitive to accommodate US government participation. This self-restricting act of accommodation is necessary to comply with a formal, but selectively practice US industrial policy. This self-excluding restriction from a process critical to our nation’s survival – competitiveness – is another clear example of US institutionalized self-destruction.

So many things are wrong with how our leaders make decisions that it is hard not to mention items that may seem at first off-topic. Since this section is about the R&D footrace to the next breakthrough, a mention of the way industrial policy is included in the report could be considered off-topic. But the continued obsession with industrial
policy, as denied but simultaneously practiced in Washington, is pervasive, and the connection made here is relevant. Industrial policy is discussed at length later in the section on *Challenges to Project Socrates.*

This obsession with industrial policy though, continues to be an unnecessary factor in the general workings of our government and specifically to the effort required to address economic health. At the same time, as the writers of the report take pains to declare that their Advanced Manufacturing Program is *not* industrial policy, they include as one of the program pillars, a recommendation for an “innovation policy” to address manufacturing. An innovation policy for US manufacturing is a form of industrial policy. From the proposed *innovation industrial policy* of course comes another sanctioned R&D footrace to the next breakthrough while attempting to unnecessarily skate around industrial policy. Is this not the makings of yet another illusion resulting in massive amounts of spending on R&D with little advancement in competitive advantage? And to top it off we have an overt attempt to rationalize a taboo of Washington, *industrial policy,* as a primary ingredient.

These innovation initiatives, with or without US government policy, are generally more R&D from a market-focused, finance-based plan with the promise, in this case, to achieve world leadership in advanced manufacturing. Making this flawed approach to innovation a government policy from the conventional mindset is a huge concern, since that means our government will widely encourage and support this ineffective initiative. The website description further states:

> While the United States should avoid industrial policy—making bets on particular companies and industries—we should be unabashed in pursuing an innovation policy. Specifically, the Nation requires a strategy for supporting innovation in advanced manufacturing. The objectives of an innovation policy should be to ensure (i) that the U.S. provides the best overall environment in which to do business, (ii) that powerful new technologies are developed here and (iii) that technology based enterprises have the infrastructure required to flourish here.

The continued confusion over industrial policy and obsession with a misdefined concept only reinforces the magnitude of the problems we face for getting our country back on track as a world leader. But as distracting as industrial policy is for US planners, it is minor compared to the more fundamental problem in the thinking that guides initiatives like this. A complete summary of the recommendations is in Appendix Two.

In the summary of recommendations from the report to the president we can immediately see that it is finance-based and R&D is, in lieu of an authentic technology strategy, viewed as the centerpiece for achieving the goals of the advanced manufacturing initiative. A group of “experts” will identify technologies that “merit focus” and then
blast them with R&D funding without any knowledge of what is occurring in the technologyspace, where competitors are already tying up constituent technologies required for advanced manufacturing processes.

An example of how these initiatives consistently result in disappointment comes from the A123 battery experience. A123 Systems, LLC, later known as B456 since a Chinese company took over ownership from the original US owner, manufactures lithium-ion batteries. In 2010, A123 received a $249 million federal grant to build battery production facilities in Michigan for the development of advanced batteries, which in large part would serve the green transportation industry. (By the way don’t be misled; this is US industrial policy at work picking winners and losers.)

In 2011, the United States Advanced Battery Consortium (USABC) contacted A123 in collaboration with the Department of Energy to develop advanced lithium-ion battery systems to meet USABC’s target application for a Power-Assist Hybrid Electric Vehicle. In typical US fashion, R&D funds were subsequently plunged into the initiative to win the footrace for battery-powered vehicles. In October 2012, the company filed for bankruptcy, and Wanxiang, a Chinese automotive supplier company eventually purchased it.

Today this event is still publicized as a win for the US in many circles, as the 3,000 employees in Michigan plants now owned by China’s Wanxiang continue to be employed. Of course that is important for the 3,000 employees, but is a drop in the bucket compared to the total potential that this technology was expected to generate. Now the potential of that technology stands to be used against us by the Chinese.

What we are missing is that China, an astute technology-based planning competitor, is not concerned about the 3,000 US workers taking the jobs of 3,000 Chinese workers. They will make money on the Michigan operations, but even if not, the win for China is the acquisition of key technology itself without one Yuan spent on R&D. They are now in control of one of the most, if not the most, advanced battery technologies in the world to use across several industries including national defense. Whatever the total market for lithium-ion batteries, China has taken a major step forward in competitive advantage.

But the US plows ahead in taxpayer-funded initiatives like the countrywide Advanced Manufacturing Program, following traditional planning methods not based on achieving competitive advantage. This current US initiative bases its plan on the allocation of funds for R&D with the assumption that competitive advantage will automatically occur through R&D breakthrough, i.e., innovation. Yet even after numerous disasters like A123, proponents of the Advanced Manufacturing Program will argue that there is a technology strategy to achieve breakthroughs in “technologies that merit focus” (hot technologies) and that these breakthroughs represent competitive advantage.
US technology-based competitors are licking their chops. Our program planners have little if any understanding of competitor strategies and what their strengths and weaknesses are. We will simply apply brute force R&D and expect to own the breakthrough technologies, and in this case, assume worldwide advanced manufacturing superiority.

Brute force R&D is expensive and represents what Socrates calls frontal offensives. In this case and many to follow, the US is unconsciously executing brute force R&D frontals against competitors with greater resources. This is patently suicidal.

Further recommendations in the report to the president call for a permanent tax credit of 17% and an overall investment goal for R&D of 3% of GNP per year. The questions are, “On what are we basing these numbers? What is the thinking that gets us to these illusions?” The answer is a misguided, but embedded, flawed finance-based planning approach.

Without a clear view of technologyspace, US companies make assumptions and arrive at a number, e.g., 3% of GNP investment in R&D, then rationalize and publish recommendations. The number, the rationalization and the ultimate measure come from a retrospective market view where assumptions are made to provide future projections that become illusions. Keep in mind that everything that happens in the marketplace is a symptom, result or absence of, planning and maneuvering in the technologyspace based on facts not assumptions. If we are not participating in the technologyspace, our competitors are calling the shots for us in the marketplace.

Because finance-based, market-constrained planners see only the marketplace, they cannot see the actual competitive maneuvers that are already taking place or being planned against them in the technologyspace. A clear view of the technologyspace as a basis for planning would otherwise guide precise use of R&D and other resources.

This kind of planning is engrained in US institutions and is based on a time, well in the past, when the US had no competition and lots of financial resources. As Team Socrates walked through this unusual time in US history it was easy to conclude that the only way finance-based, market-constrained planning ever worked was when the US had no competition at all. Unfortunately our methods and practices designed and put in place in that other time continue today in a radically changed competitive environment.

Throughout history, the ability to effectively compete has been the source of improved economic health and generation of jobs. The required starting point is the capability to achieve competitive advantage, naturally leading to improved market indicators such as economic health and generation of jobs.
Project Socrates’ ten findings (Appendix One) provided the thinking and process for that thirty years ago. Project Socrates was subsequently built and successfully deployed with incredible results such that, Congressman Frank Wolf (R-VA) introduced and Congress passed legislation in 2011 to revive Socrates. The legislation is to be the government’s vehicle to address the very issues these new government programs are now fumbling.

In the meantime, while Congressman Wolf’s legislation sits unexecuted in the Department of Commerce, new initiatives like the Advanced Manufacturing Program are requesting $500 million that will progressively increase to $1 billion to fund its execution.

The program, coordinated by the Advanced Manufacturing National Program Office, steeped in the same thinking that got us into trouble in the first place, is destined to revert back to the same old flawed practices. Those flawed practices are based on the premise that R&D equals innovation and that this combination will automatically result in competitiveness, grow the economy and create jobs. On the program’s website the Advanced Manufacturing Portal further explains:

America’s ability to make things underpins America’s ability to innovate, compete, and create good jobs. U.S. manufacturers perform 70 percent of all private sector R&D and account for 60 percent of U.S. exports and the majority of U.S industry patents. Over the last six decades, innovation — in new products or new processes — was central to three-quarters of the nation’s economic growth. American manufacturers have been major drivers of this economic progress.4

The sponsors of this program actually seem to believe that the US has done well over the past six decades. And the economic growth we have experienced has come from innovation — new products and new processes — (as defined in conventional terms).

The statement should read:

America’s ability to acquire and utilize technology better than competitors underpins what America used to do before WWII to innovate, compete and create jobs. We must shift back to technology-based planning.

First of all, it is appropriate to remind readers at this point that through the kind of thinking that is going into the design and execution of this initiative, the US has steadily lost industry after industry and job after job over the past six decades. Secondly, we have built up a seventeen-plus trillion dollar and growing debt to maintain a false sense of economic growth and status. Our ability to innovate has been impressive at times but has not led to sustained competitiveness and ability to make things that are competitive. What we have been doing though by innovating to become competitive, as first presented

in Project Socrates findings and confirmed in our continued economic decline, has been anything but successful. The remarks in the above excerpt from the initiative’s portal are obviously more illusions.

Conventional thinking has turned rational thinking upside-down. The goal has become to achieve *breakthroughs and sustain innovation* rather than achieve and sustain *competitive advantage*. These are very different perspectives, and the former has not succeeded. The fact is we have been achieving R&D breakthroughs for decades, yet losing competitively, industry after industry and job after job.

Total spending on R&D in the US has generally been in excess of $400 billion each year for the past several years. Some estimates for the most recent year surveyed are $600 billion. Even the conservative figure of $400 billion is double our nearest rival. The exact numbers reported by various sources are different, depending on how the statisticians calculate and allocate expenditures, but the $400 to $600 billion figures are generally accepted.

From the Battelle and R&D Magazine 2012 Global R&D Funding Forecast, the US will account for 31.1% of all global R&D. By comparison, the next closest in R&D spending are China and Japan, 14.2% and 11.2% of global R&D funding respectively.5

Although China and Japan are steadily increasing their spending on R&D, they are doing it wisely. Systematic application of R&D in support of their “grand technology strategies” drives their spending, as opposed to the US practice of allocating R&D money from a market-based financial plan. These are two very different approaches, and we are losing.

From the *Science and Engineering Indicators 2012*6, US businesses conduct 62% of our country’s R&D. The balance of investment in US R&D comes from government, academia and non-profit organizations. Other reports indicate that government *funding* for R&D, conducted by government, business, academic or not-for-profit organizations may account for as much as fifty percent of all R&D funding, but for the purposes of this writing, it is immaterial. The point is that R&D spending in the US is huge, and the obsession with R&D as the basis for competitive advantage permeates all US sectors and dwarfs all other countries, while at the same time the US remains non-competitive.

The Socrates grand technology strategy for competitive advantage should guide all R&D initiatives. Technology strategy for competitive advantage dictates funding for R&D. This is a major disruption to conventional thinking, methods and practices.

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The Socrates team used this graphic (Figure 2) to illustrate what was actually happening as a result of the shift to finance-based planning. Unfortunately, because of the absence of Socrates, what the *pumps and buckets* graphic illustrate continues today to an even greater extent, nullifying the majority of expected benefits from US R&D initiatives.

![Figure 2: US approach to R&D](image)

Figure 2 illustrates Socrates findings on US R&D practices. In a logical system, R&D is part of a systematically deployed technology strategy to create a competitive advantage in achieving a specific objective. In Socrates, *competitive advantage* applies to every objective from curing cancer, where the competitor is the disease, to GM achieving greater market share, where the major competitor has been Toyota.

In practice though, execution of R&D in the US is almost always a *frontal offensive* to win the footrace to the next breakthrough. That process is something like this: A market analysis determines the “hot technologies” that are expected to win in the marketplace based on market trends, probabilities, statistical analysis, expert opinion, etc. The current obsession targets manufacturing in this process, and the Advanced Manufacturing Program is an example. The list of “hot technologies” becomes the focus for allocating R&D resources to win the footrace. R&D initiatives are planned and executed. This represents a *frontal offensive* without even knowing the full range of competitors and
their individual competitive strategies and capabilities. It is like deploying an army against an enemy about which our commanders know nothing about where the opposing army is, its capabilities, size, strengths, weaknesses, etc. A military commander would call what we do in business, academia, financial markets and government insane.

But we continue to plan and blindly execute full frontal attacks no matter what the situation. In lieu of knowing anything about competitors, US planners deploy resources directly into the marketplace as brute force frontal offensives to achieve the goals of their marketing plans. By then it is too late. The battle is over and all our finance-based planners can do is shuffle assets around to make the best ROI while the organizations they manage deteriorate and eventually fail.

The typical US approach is a blind and foolish attempt at shock and awe that may have worked when we had massive resources and no competition, but with a $17.5 trillion debt and a competitive environment teeming with sophisticated technology-based planning competitors, we can no-longer expect to win with these practices. This approach, originally described by Sekora as brute force R&D, is common in US thinking.

From the Advanced Manufacturing Program Report to the president, here is the list of “hot technologies” for investing in R&D to win the footrace. The list according to the writers of the report aligns with their “hot technology” selection criteria also provided below:

The following technologies represent potential areas that would align with the criteria PCAST (President’s Council of Advisors on Science and Technology) has outlined for public private investment to support advances in manufacturing:

- Advanced robotics
- Nanoelectronics
- Materials by Design
- Biomanufacturing

As the program progresses, it will likely target more technologies. From the report, the criteria for selecting technologies with merit were as follows:

Opportunities should be selected based on the merits of the proposals, and based on the below criteria:

- The technology area has a high potential payoff in employment and output.

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7 The President’s Council of Advisors on Science and Technology, Report to the President on Ensuring American Leadership in Advanced Manufacturing, Advanced Manufacturing Program, June 2011.
8 Ibid
• There is a prospect of sustainable competitive advantage for the U.S., including through first-mover advantage.

• Identifiable market failures impede adequate private investment.

• PPPs (public and private partnerships) include industrial partners willing to co-invest with the government.

• PPPs include some industrial partners with sufficient size to invest at scale in the fruits of the pre-commercial research, as well small and start-up enterprises.

• Investments will help anchor subsequent manufacturing in the United States—for example, through shared labs, pilot plants, technology infrastructure and creation of clusters.

• Shared infrastructure will help existing firms and industries compete globally by increasing the quality and performance of their products.

The selection criteria further illustrate the flaws inherent in US thinking and the subsequent inability to compete adding to our economic decline. Notice how the Advanced Manufacturing Program criteria for acquiring and utilizing technology starts with selecting the “hot technologies” visible in the marketplace and then attempts to find ways to use them for competitive advantage. The process is exactly backwards. First of all, “hot technology” does not automatically point to a market need that must be satisfied. Even if a need exists, investors in R&D are still blind to how the technology must be utilized to achieve competitive advantage. Answers to these questions, “need” and “utilization”, are essential before selecting and then effectively guiding the application of technology for competitive advantage. This is a very good example of how US R&D consistently fails to achieve competitive advantage by prematurely investing in technology development without understanding the need, how to satisfy the need and the competitive situation.

Because Socrates is the authentic technology-based planning system, you may expect the Socrates process to begin in the technology space but if so you would be mistaken. In the early planning stages of a Socrates technology strategy, establishing the most impactful and quickest economic payoff that fits that requirement is important. At this point in the process, it is not about the technology, it is about focusing on the area where we will get the most economic, social and/or political impact from industry, education, finance and government.

Typical of conventional finance-based planning though, as illustrated in the Advanced Manufacturing Program, the process starts with a technology focus and then works backwards. This approach interjects a technology bias up-front that corrupts the rest of the planning process, severely limiting technology innovation – the ultimate source of sustained competitive advantage, economic health, job creation, balanced trade and
national security. This engrained approach is accepted and applied without question. Is it any wonder what the US is declining?

Project Socrates’ methodology to achieve and sustain competitive advantage remains technology neutral in the beginning steps of the process. Sekora refers to this as *completely technology unbiased*. The Socrates planning process purposefully ignore any reference to technology at this stage for two reasons:

1. First, and this is most relevant here, we do not want to bias the selection of an industry or sector that would then become the focus without knowing potential for job creation, economic growth, capability to expand into other areas and the full range of human needs that define competitive advantage. The advanced manufacturing initiative starts with technology biases based on assumptions from blind market projections or *expert* conjecture. As a result the planning process is guided by the requirements to acquire (usually through R&D) the selected technology rather than to satisfy human needs.

2. Second, selecting technologies prematurely establishes bias toward technology paths routinely and historically applicable to targeted industries. This bias tends to constrain the scope of the technologyspace configuration causing planners to ignore technologies in other areas of technologyspace that provide competitive advantages out of reach of other competitors, i.e., restricts technology innovation.

The next step also remains technology unbiased as the Socrates Automated Innovation process continues to focus on human requirements. In this step the full range of all customer requirements are identified and defined (regardless of the technology involved) that must be excelled at for competitive advantage.

After we have identified the focus area that will provide the greatest job creation, economic growth, expansion potential and human requirements for achieving competitive advantage, the technologies that impact each of these human requirements can be precisely identified. Notice that the human requirements drive technology selection (acquisition and utilization) in authentic technology-based planning but not in finance-based market-oriented planning.

The Socrates system capability and supporting process that identifies the full range of human needs for a target end item (in this case advanced manufacturing) is the essence of a major breakthrough in all planning, decision-making and operational management. This system capability differentiates Socrates from all other planning, decision-making and execution systems and positions Socrates as the underpinning for total organization management at any scale from national, organizational to individual.

Here is how it works:
Every human action involves the laws of physics. Technology is the result of human interaction with the laws of physics. Human interaction with the laws of physics results in development and refinement of useful tools, material and knowhow, i.e., technology. Technology is found in every human activity and is therefore the natural and universal foundation for all planning, decision-making in every society. Every action by human beings across the world in every situation involves the laws of physics and related technology. The acquisition and utilization of technology by humans and their organizations leaves an audit trail of activities that can be identified, tracked, analyzed and coordinated. Technology is then a “homing device” for all individual and organization actions that vividly expose all maneuvers for advancement, which in a world of limited resources, are maneuvers for competitive advantage. The ability to see all actions of all players enables precise counter maneuvers, offensive and defensive, to achieve and sustain competitive advantage in any situation. Socrates subsequently built, tested and deployed a complete system based on automated technology-based planning to control and manage the technologies of the world for competitive advantage. The ability to control and manipulate the technologies of the world, technologyspace, determines precisely and dictates what occurs in the marketplace where finance-based planning operates after the fact.

In this way, Socrates identifies competitive threats as well as opportunities providing the basis for maneuvering to gain and sustain competitive advantage. With this map of the technologyspace users of Socrates know the technologies to acquire, where competitors are, competitor capabilities and what must be done to acquire and utilize those critical technologies for competitive advantage. R&D and the list of “hot technologies” that form the starting point for conventional planning may or may not factor into the resulting technology strategy in technology-based planning. But it is certain that users of Socrates will have and maintain competitive advantage indefinitely. In the process, the most useful and impactful technology advances for human benefit will enable previously unimaginable products and services to become available at astronomical speed.

In the Advanced Manufacturing Program approach, as you can see in their list of criteria above, the starting point is with technology without a sound basis for economic impact, job growth, what is required from a customer’s perspective to achieve competitive advantage and anything about the competitive landscape. Instead they determine these critical factors through assumptions if considered at all. They reason that by identifying and selecting the hot technologies, becoming the leaders in those technologies through
R&D, regardless of competition capability, or assumed customer needs, everything else will fall into place. This is not so without the proper foundation and technology strategy, as we have seen time and time again. This is a weak frontal offensive that US leadership continues to use without success. The US frontal offensive is further weakened by our decline and our adversaries’ growth in strength. Our traditional obsolete approach is basically uninformed, therefore presumptuous, and comes from the wrong foundation.

Going forward with the Advanced Manufacturing Program frontal offensive as described, based on their financial planning approach and R&D foundation, has little chance of succeeding any more than the lost opportunities listed on Page 5 of the report:9

Research and innovation are essential, but alone they do not ensure a successful manufacturing sector. This is a sample of technologies and products with both commercial and defense applications invented in the United States and now produced primarily abroad:

- Laptop computers
- Solar cells
- Semiconductor memory devices
- Semiconductor production equipment such as steppers
- Flat panel displays
- Robotics
- Interactive electronic games
- Lithium-ion batteries

The report explains exactly what Socrates warned of and solved 30 years ago.

The nation’s loss of manufacturing leadership is not limited to factory jobs; there are also concerns that we are losing leadership in R&D employment and investment related to manufacturing. R&D activity linked to manufacturing is moving offshore to access emerging global markets, and to respond to global competition for talent and the growing supply of scientists and engineers abroad.10

In a nutshell:

In today’s marketplace, an R&D focused US frontal offensive against technology-based planning competitors with far more resources than the US, i.e., China is insane. Brute force R&D frontals though, are generally the only competitive maneuver exercised

9 The President’s Council of Advisors on Science and Technology, Report to the President on Ensuring American Leadership in Advanced Manufacturing, Advanced Manufacturing Program, June 2011.
10 Ibid
throughout the US. This approach has succeeded many times for the US in winning the footrace, but US organizations consistently fail in achieving and sustaining competitive advantage. Competitors with fewer resources like Japan, South Korea and Germany systematically execute a range of offensive and defensive maneuvers that render our frontal offensives ineffective and costly.

Success of frontal offensive maneuvers is a matter of attrition. The side with the greater resources wins. US resources are certainly not enough to overwhelm China, our chief competitor. This will continue to be a critical mind shift for the US as we go forward in the economic war with China.

To recap, superior technology acquisition and utilization is the foundation for all competitive advantage. Competitive advantage is essential for economic growth, jobs, trade policy and national defense. Therefore technology strategy is the foundation for all planning. A list of R&D “hot technology” targets is not a technology strategy, but typical planning methods of US organizations are nothing more than that. By their own analysis (see above list of “lost opportunities”) the Advanced Manufacturing Program approach does not work but US leaders, across all sectors, continue to plan and execute the same approach harder and faster apparently expecting success.

How US R&D Frontal Offensives Consistently Lose

Figure 2 above illustrates how our competitors simply draw off technology from our R&D, without much investment of their own, giving them an immediate cost advantage. They bring the technology into their buckets to support overall technology strategies while they isolate constituent technologies needed in the extended process of product and service development, manufacturing, deployment and marketing.

Constituent technologies are the vertical and horizontal technologies within a core technology. Core technology is the target technology for producing an end item such as telecommunications systems or nuclear power plants or something as mundane as a loading dock or a web-based order and payment system. Vertical constituent technologies are those technologies integral to the core technology, identifiable in a "drill down" or walkthrough of the core technology production thread.

For example: A core technology may be a steering system for an automobile. A simple walkthrough at the basic level-1 (top level with no drill down) would start with the steering wheel, then the steering shaft to the rack and pinion to the tie rods, ball joints and steering arm to the wheels, tires and road. Each step in the level-1 technology thread from steering wheel to the road is a separate but vertical constituent technology of the steering system. Each constituent technology can become a core technology and further drilled down into exposing its own constituent technologies and so on.
**Horizontal constituent technologies** are those technologies that enable cross application of core technologies. For example, the steering system for an automobile may also be conceptually applicable for trucks, earthmovers or even an airplane’s taxi steering mechanism. Or one constituent technology within the core steering system such as the rack and pinion, which converts rotating action to linear action, could be used in the horizontal market for automatic door opening technology.

This explanation helps to further understand the need for remaining *technology unbiased* in the early stages, so that the broadest *slice* of the technologyspace is scaled from the beginning to ensure that the resulting technology strategy considers all potential threats and opportunities. On the other hand, the R&D driven US brute force approach starts with a core technology from a list of “hot technologies,” which automatically filters out a significant part of the technologyspace as well as the competitor landscape which otherwise would expose additional threats and opportunities that must be addressed to achieve competitive advantage.

But our technology-based competitors have a holistic view that produces a complete technology strategy including the full range of all constituent technologies, vertical and horizontal. The related technologyspace and the vast number of all opportunities are exposed.

Our competitors can see well in advance where to maneuver in the constituent technologies to literally control the market with or without the core technology. As a result, US R&D sponsors and investors are subsequently left at the mercy of competitors in acquiring both vertical and horizontal constituent technologies to produce and market their end products. With only limited participation in the overall competitive process, expanding a product’s application horizontally may be even more difficult for US companies than simply competing in the vertical market with the original product.

After putting themselves in this situation the easiest way out for US companies, driven by a financial focus, is to have the ultimate products that must be delivered, manufactured by the competitors who have all the technologies needed except the latest version of the core technology. The core technology will be supplied by the US company or consortium that sponsored the original R&D if they expect to have any market impact at all.

This scenario has played out time and time again for over fifty years and we cannot seem to make the connection that our basic approach is broken. In addition to losing the expected benefits of winning the footrace to the next breakthrough with massive investments in R&D, the fact that we are consistently out maneuvered strengthens the positions of our competitors. In their improved positions of strength our competitors are able to further negotiate with US manufactures for actually acquiring the US R&D core technology itself or by innovating around it if need be. If they choose to innovate around
it their investment in R&D, unlike ours, is part of a total technology strategy for a specific opportunity to gain competitive advantage in a proven, lucrative market. Their risk is minimal. This is an ongoing tactic of Chinese, Japanese and South Korean companies who are expert in these competitive maneuvers. See the A123 Battery example discussed earlier.

US finance-based planners will license, or in some cases even sell, the R&D core technology to competitors to make their quarterly numbers, and the Board of Directors is satisfied. As this scenario takes place, our competitors eventually end up owning the annual billion dollar ongoing markets for the products containing all the technologies including those breakthrough technologies from US R&D. But we won the footrace and that was our objective.

**R&D is Only One of Many Factors Dependent on Technology-Based Planning**

Operating at the level above the technologyspace, finance-based planning by design dumps the entire organization planning process into the middle of a myriad of marketplace factors that are dependent on what is actually happening in the technologyspace.

Factors like marketing, manpower, operations, finance and R&D as well, are all important factors in the planning process but not the starting point because they are all dependent on what happens first in the technologyspace. Finance-based planners and decision-makers though, argue that because financial allocation is common to each factor, it seems logical to assume that finance-based planning is the starting point for all other factors. As a result finance-based planning continues as the accepted basis for all planning in conventional thinking and practices in US institutions.

The problem as discussed at length above, is that proper resource allocation, e.g., financial planning, requires a basis or foundation that precisely dictates where resources are required for competitive advantage. That basis is found in the technologyspace. Ignoring the technologyspace as the starting point, finance-based planning has only the marketplace for determining what resources are required to address business planning. But in finance-based planning competitive advantage is the overlooked requirement for achieving the primary objective, profit.

In the absence of an authentic technology strategy from a technology-based planning foundation, finance-based planners simply pick the appropriate factor currently getting attention in the marketplace as the place to begin. That factor then becomes the resource allocation starting point or centerpiece, serving improperly as the *foundation* for all planning that follows. Today it is manufacturing because manufacturing has visibly declined in the marketplace. Tomorrow it will be R&D or innovation because we have
always been leaders in winning those footraces so that must be the place to focus. Next week, it will be a marketing tactic like branding or Blue Ocean or an operational solution like productivity improvement or quality. It is never-ending.

US companies following this pattern expend many resources on communication, orientation, training and even complete re-organization to support the projects required to execute these initiatives. Frequently, new technology, which must be licensed and integrated into the operation, supports these programs. Sekora refers to the programs that emerge from this superficial approach as tricks of the month because they are deceptive, creating a false sense that they are somehow enhancing competitive advantage.

Ever-present academic studies to find magical solutions to enhance organization performance also distract US planners. Typically, these researchers conduct their studies on 1000, 2000 or more companies. They expect the size of these sample groups to establish veracity. Keep in mind, as a comparison, Socrates research looked at all competition worldwide and studied it from the beginning of time. The Socrates research findings got us to the root that determines the starting place for all planning required for performance improvement of any kind to be technology acquisition and utilization for competitive advantage.

Based on the relatively small samples in academic studies, by comparison to Socrates research, the conclusions that follow from these studies are ostensibly the identification of that one critical factor of all market factors studied that will then be used to address the particular performance issue targeted. This critical factor was determined by the number of votes received from the sample respondents, e.g., sixty-three percent of the 1000 respondents selected Factor #9 as most important. They publish a whitepaper, and that becomes the trick of the month, as Sekora would say.

Because we are operating at the superficial level where finance-based planning from a marketplace view prevail, everything and anything can become a starting point, centerpiece and foundation for planning and decision-making, which actually means nothing is the foundation.

The conventional approach is a never-ending intellectual exercise to select one or a set of key factors that will ostensibly improve financial results. In this mishmash of superficial factors, R&D and so-called innovation have become favorite rallying points for achieving ROI and profit objectives. This is happening even as experts continue to struggle with actually measuring R&D ROI without much success, as we will see in the next section.

The footrace to achieve the next R&D breakthrough results in vast amounts of financial resources allocated for R&D and innovation with the expectation that winning the footrace will achieve financial/economic objectives. The allocation of financial resources for R&D then, in finance-based planning, is nothing more than a cosmetic measure of
financial capacity to innovate through R&D spending as defined in finance-based planning. The footrace is on for the next market-based breakthrough, and that is the extent of technology planning from a finance-based planning perspective.

**Finance-Base Planner’s Struggle to Measure R&D Effectiveness**

R&D is a major investment of the pharmaceutical industry, roughly $50 billion annually. Finding ways to measure its effectiveness is a constant pursuit. This makes the pharmaceutical industry’s R&D operations a good example to use in understanding the struggle in measuring R&D effectiveness as applied today in finance-based planning.

Bringing new molecular entities (NMEs), which translates into new products, to market is estimated to cost $1.8 billion in the pharmaceutical industry as of this writing. The greatest portion of this amount goes to R&D. Understandably; much has been done in this industry in an attempt to get a handle on R&D effectiveness.

*Nature Reviews Drug Discovery* focuses on drug discovery and development and is considered the leading journal in pharmacology/pharmacy and biotechnology/applied microbiology.

Nature Reviews Drug Discovery conducted an R&D productivity study consisting of a complicated academic approach attempting to measure R&D effectiveness. The study focuses on two dimensions of R&D productivity: R&D efficiency, inputs that lead to outputs, and R&D effectiveness, outputs leading to outcomes. This seems to make sense so far.

The measurement of R&D productivity in this study appears to be focused internally on the conventional R&D process flow mechanics. In this method of examining the end-to-end R&D process, the various factors impacted in R&D during the flow from start to finish are identified and become the *elements* of an elaborate equation for measurement of efficiency and effectiveness of the drug discovery and development process. An excerpt from the study states:

> R&D efficiency represents the ability of an R&D system to translate inputs (for example, ideas, investments, effort) into defined outputs (for example, internal milestones that represent resolved uncertainty for given project or product launches), generally over a defined period of time.

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The approach researchers have taken resembles the way process flows are typically assessed for effectiveness in any system process flow analysis. In this case, the conclusion suggests that the conventional R&D process in the pharmaceutical industry can be measured and improved through optimization of the numerous factors involved in the process. The R&D productivity study process then leads to a deduced conclusion about the correlation, as defined by the authors, of these process factors and their potential impact on effectiveness and efficiency of R&D.

The Nature Reviews Drug Discovery approach fits conventional thinking as described in the section above on “productivity” where we show how the conventional approach in productivity improvement initiatives consistently leads to expensive, but disappointing, process improvement initiatives. But, as discussed at length above, these productivity improvement initiatives are not effective because they are designed, developed and operate from the wrong foundation. As a result this pharmaceutical R&D effectiveness study will simply result in process improvement initiatives, in this case pharmaceutical R&D, more efficient at delivering the same or less desired output. The methods used to improve process performance in these conventional ways rely only on statistical models, probabilities, trends and extrapolations rather than finite absolutes from the proper foundation.

The conventional finance-based method of measuring process effectiveness addresses process flows that have been designed to produce a target ROI managed from a budget in a financial spreadsheet. But the real need and effective use of R&D, in this case Pharmaceutical R&D, is to address diseases first and the effective use of R&D in that process can only be determined in a Technologyspace Map® which dictates the precise R&D activities that must occur. In addition, the map dictates exactly how those activities must be executed to cure the targeted diseases. Without this solution map there is no foundation for a valid productivity measurement process. As a result the initiative of Nature Reviews Drug Discovery to study pharmaceutical R&D productivity becomes a never-ending process searching statistical models, probabilities, trends and extrapolations for something that resembles reasonable correlations.

In a follow-up posting, Nature Reviews Drug Discovery AOP published online, the article informed its readers of progress in the challenge of measuring pharmaceutical industry R&D effectiveness:

One strategy to tackle this challenge that has gained momentum in recent years is the establishment of precompetitive public–private partnerships (PPPs) to focus...
on issues that are too large for single organizations to effectively address alone, such as the development of biomarkers of drug toxicity.

The article focuses on the importance of evaluating the effectiveness of public-private partnerships (PPPs) as a strategy for conducting and measuring pharmaceutical industry R&D. The article proposed another measuring tool to assess the effectiveness of PPPs.

In a matrix format, each step of the pharmaceutical industry R&D process, Input – Process – Output – Outcome would be assessed in these areas:

- Networks
- Know-how
- Human capital
- Financials and operations

Across the top of the matrix were the evaluating factors under each process step for each assessment area. For example, the area of networks would be evaluated under each process step using the following factors for each data point:

Input – number and diversity of partners

Process – exchange of information between partners

Output – number of projects continued after PPP funding

Outcome – number and size of new partnerships inspired by PPPs

The idea of using PPPs to improve pharmaceutical industry R&D may be just an extension to the never-ending mishmash that develops when a single foundational element based on a precisely defined objective is missing. Without this foundation the specific R&D process and process activities involved cannot be isolated and precisely measured. In lieu of this precise focusing and engaging process, visible and executed from the technologyspace, conventional finance-based practitioners resort to complicated equations to find correlations so that measurement of R&D effectiveness and efficiency appears rational. This is an accepted approach in US conventional thinking and leads only to illusions.

Another method from Harvard Business Review that the author claims can fix the inability to accurately measure the effectiveness of R&D is called RQ, short for research quotient. The author explains it this way:

Essentially, the equation defines the relationship between a firm’s inputs (what it spends) and its output (its revenues). The formula typically considers two costs, capital and labor. Of course, those aren’t the only determinants of revenue, and most economists would accept that the equation could be expanded to include
another central input: R&D. Using standard regression analysis, the calculation tells us in a very precise way how productive each of the inputs is in generating output. It tells us, for instance, how much a 1% increase in R&D spending would increase a firm’s revenue.

My research—which includes a comprehensive analysis of all publicly traded companies in the U.S.—suggests that if the top 20 firms traded on U.S. exchanges had optimized their 2010 R&D spending using the RQ method, the collective increase in market cap would have been an astonishing $1 trillion.\(^\text{13}\)

In a traditional approach such as the “RQ” method, the process is again without the proper foundation. The subsequent framework of dependent factors cannot be absolute and without discontinuities. Because conventional methods, such as RQ, are not straightforward and based on the proper foundation; assumptions, probabilities and mathematic relationship quotients are made necessary in the mishmash of finance-based planning.

Purveyors of conventional thinking and practices continue to flail about in the universe of superficial market factors ultimately dependent on a technology acquisition and utilization foundation that they cannot see. They try to measure the effectiveness of R&D by juggling the marketplace factors, from a financial basis, to find a correlation with profit and ROI instead of simply measuring the impact of R&D on competitive advantage, which translates directly to profit, and ROI. Without a single foundation and operating system for determining and guiding actions, they continue to struggle in these myriad factors, probabilities and elaborate mathematic equations while tethered to their improper planning foundation and questionable premises.

In the pharmaceutical industry competition exists at two levels. First is the battle with the disease itself to find the cure and/or ways to relieve the symptoms. Socrates treats the need to battle disease as a competitive situation where the disease such as cancer is the competitor and the objective is to remove the threat. Simultaneously, there is another level of competition among pharmaceutical companies to be first to launch the product to remove the threat. Both competitions must be addressed coherently in a single technology strategy. Conventional finance-based R&D initiatives cannot effectively track and address the competition among pharmaceutical companies and therefore struggle to measure overall R&D impact.

The competitive strategy at both levels is to effectively acquire and utilize technology, of which R&D is an optional resource for achieving competitive advantage. To measure R&D effectiveness though, the impact of R&D on competitive advantage, at both levels, must first be established. In this approach, R&D is determined to be either clearly

required to achieve competitive advantage at one or both levels or it is not. There is no question. But conventional finance-based business strategy development is not capable of performing this step.

In lieu of the capability of conventional approaches to properly coordinate, track and execute technology strategy, with or without R&D, assumptions must be made up front. These assumptions, based on a market view not technologyspace activities, are severely limited because they see competition after the fact, not how competition is actually developing. Absent of viable technology acquisition options, otherwise provided in a view from the technologyspace, the need for R&D is typically nothing more than a knee-jerk assumption about “hot technologies” that bias the process from the beginning. This bias in conventional R&D planning, discussed in the earlier section on the *R&D footrace*, establishes artificial limits in technology acquisition that filter the field of viable options and adds significant financial risk to project.

Technology acquisition and utilization maneuvers in Socrates are precisely planned, funded, executed, monitored and measured based on capability to achieve and sustain competitive advantage. First we can accurately see how a particular acquisition maneuver such as R&D will impact competitive advantage at both levels. The laws of physics determine an R&D initiative’s capability to impact competitive advantage (achieve the R&D objective), not expert opinion, statistics, probabilities or conjecture.

Secondly, the strength and weaknesses of technology acquisition maneuvers developing in the technologyspace are clearly visible *before they are executed*. Specific R&D maneuvers can be accurately calculated for the initiating pharmaceutical company as well as its competitors. Marketplace results then can be projected with precision from the strength and weaknesses of all competitive maneuvers executed by the initiating pharmaceutical company and its rivals, as calculated in Socrates. R&D’s effectiveness in creating and sustaining competitive advantage translates directly to marketplace results, including ROI and profit. The results immediately show up on the financial spreadsheet, but as we can see, the process does not and should not start with the financial spreadsheet.

The effectiveness of R&D as a factor in a Socrates technology strategy is straightforward. The question to answer is, “how does R&D remove competitor threats and exploit opportunities that provide competitive advantage?” We can see it clearly in the Technologyspace Map® and track the impact directly to profit and ROI. It is simple, straightforward and precise. No more guesswork.

Technology-based planning, given the proper process and tools, is extremely accurate. Beginning with the foundation for all technology strategy factors, technology acquisition and utilization maneuvers, every step from the foundation forward is based on absolutes and closed data sets. Because no discontinuities exist in technologyspace, the guesswork
required for gathering superficial factors that are then weighted according to their estimated impact on R&D effectiveness is eliminated.

To sum up this section, today’s experts are operating from very limited research data and built-in biases toward breakthrough R&D, innovation for innovation sake, market focus and finance-based planning.

Sekora likens this condition to the story of Copernicus. Until Copernicus established that the sun, rather than Earth, was at the center of the solar system, as was conventional wisdom of the time, the revered thought leaders in conventional wisdom were constantly surprised and frustrated when their equations on the revolution of the planets did not quite work. Time after time, they refined their equations, reevaluated and refined the weighting rules for superficial factors in attempts to make them work. But it was an impossible task because they were operating from and dedicated to the wrong foundation premise.

Their foundation for mathematically plotting the revolutions of planets was wrong and everything that followed from their conclusions was also wrong. This dedication to an improper foundation and false premise kept humankind in the dark for centuries.

Conventional wisdom about technology, R&D, competitiveness, planning and strategy keeps us in the dark today.
Appendix One

Project Socrates Ten Findings

1. The foundation of all competitive advantage is a matter of satisfying the customer needs better than the competition.
   - Any customer need if excelled at has the potential of providing a competitive advantage.
   - Needs defined from the customers' point of view—even if the customers' needs appear illogical or minor.
   - Must go beyond just meeting customer needs; excel at satisfying one or more customer needs.
   - Address holistically the set of customer needs.

2. Satisfying customers' needs is accomplished with technology.
   - Technology is any application of science to accomplish a function.
   - The science can be very leading edge or it can be well established.
   - The function can be very critical, high visibility or it can be significantly more mundane.

3. To satisfy customer needs better than the competition, an organization or a region must exploit technology more effectively than the competition.
   - Must acquire technology more effectively than the competition and/or
   - Must utilize technology more effectively than the competition.

4. Effectiveness of exploitation of technology dictated by four attributes inherent in all technology.
   - The definition of the technology by the laws of physics dictates which customer needs can be satisfied.
   - The capability level of the technology dictates to what level the customer needs can be satisfied.
   - The flow of the technology dictates how technology can be acquired and utilized to satisfy customer needs.
   - The evolution of definition, capability and flow dictates how the other three dimensions can be exploited.

5. Four attributes for all present and future technologies worldwide comprise four-dimensional "technologyspace".
   - Tech structure -- The interconnection between all technologies as defined by the laws of physics.
   - Tech capability -- The ability of all technologies to accomplish functions.
   - Tech flow -- The flow of all technologies internally and externally to all organizations worldwide.
   - Time -- How the other three dimensions evolve forward.
   - No discontinuities in the four dimensional technologyspace.

6. Traditional planning methods, only address limited aspects of some of the dimensions of techspace.
   - Traditional planning methods developed by experts viewing only a very narrow slice of competition.
   - Socrates Project had a view of all forms of competition worldwide.

7. Organizations or regions must out-maneuver competitors in one or more of the four dimensions of technologyspace to generate a competitive advantage.
   - Out-maneuvering in a dimension equates to using that tech attribute more effectively than the competition.
   - Dimensions orthogonal -- Movement in one dimension can be independent of movement in other dimensions.

8. Maneuvering in technologyspace same as maneuvering on the military battlefield; the science of military strategy can be used as the basis for strategies in technologyspace.
   - Technology behaves like military resources when it comes to their exploitation for a competitive advantage.
   - Thousands of years of experience of the science of military strategy can be drawn from.

9. Elements of military strategy are highly fragmented, must be consolidated into a logical structure.
   - Science of military strategy consists of writings of the lessons learned by the great captains of war.
   - Dissecting wide range of writings enabled universal truths to be extracted and a logical structure developed.

10. Combining logically structured military strategy elements with 4-D techspace produces a set of elements for technology strategies that enables an organization or a region to consistently out-maneuver the competition in the exploitation of technology for the maximum competitive advantage.
    - The set of elements for a technology strategy are a closed set.
    - Each tech strategy element is precisely defined in terms of one or more of the four dimensions of techspace.
    - The strengths of each tech strategy element is dictated by one or more of the four dimensions of techspace.
    - The technology strategy elements do not change with time.
Appendix Two

Advanced Manufacturing Program Summary Recommendation

RECOMMENDATION 1: LAUNCH THE ADVANCED MANUFACTURING INITIATIVE

The Federal Government should launch an Advanced Manufacturing Initiative for America’s Future (AMI). AMI should be a concerted, whole-of-government effort, spearheaded by the Department of Commerce, Department of Defense, and Department of Energy and coordinated by the Executive Office of the President (EOP).

The coordinating body of AMI should prepare a biennial report to the President on the most important needs for Federal investments, including:

• Coordinated Federal support to academia and industry for applied research on new technologies and design methodologies
• Public-private partnerships (PPPs) to advance such technologies through pre-competitive consortia that tackle major-cross-cutting challenges
• Development and dissemination of design methodologies that dramatically decrease the time and lower the barrier for entrepreneurs to make products
• Shared facilities and infrastructure to help small and medium-sized firms improve their products to compete globally.

The report should also identify the most pressing technological challenges that merit focused attention for these activities.

AMI should also report on the availability of financing for pilot plants and early-stage activities within these technology areas.

It is crucial that this whole-of-government effort be complemented by parallel initiatives in the industry and academia. AMI should develop mechanisms to involve these sectors and to draw on their expertise in identifying technological opportunities. An external advisory board that has access to advanced manufacturing expertise should help guide this work.

Funds to implement the programs recommended by AMI should be appropriated to the Departments of Commerce, Defense, and Energy to support the most promising opportunities, at the level of $500 million rising to $1 billion over four years. Some of these funds may be drawn from existing programs as appropriate.

AMI should work closely with industry and academia in identifying opportunities through an appropriate advisory board.

RECOMMENDATION 2: IMPROVE TAX POLICY
The Federal Government should:

- Reform corporate income taxes, to bring the marginal tax rate in line with other OECD countries, as advocated by President Obama in his 2011 State of the Union address.
- Extend the R&D tax credit permanently and increase the rate to 17%, as advocated in the Presidents’ Strategy for American Innovation and FY2012 budget request.

**RECOMMENDATION 3: SUPPORT RESEARCH, EDUCATION, AND WORKFORCE TRAINING:**

To ensure the health of the research enterprise that underpins innovation and national, and to ensure that the Nation has the highly skilled workforce needed to attract and maintain advanced manufacturing in the United States, the Federal Government should:

- Fulfill the President’s plan to double the research budgets of three key science agencies over the next ten years: the National Science Foundation, the Department of Energy’s Office of Science, and the National Institutes of Standards and Technology. Ensure appropriate research budget levels for other research agencies.
- Help fulfill the President’s goal that public and private investment R&D reach 3% of GDP.
- Strengthen science, technology, engineering and mathematics (STEM) education.

Expand the number of high-skilled foreign workers that may be employed by U.S. companies.