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THE MISSIONS OF THE UNITED STATES AIR FORCE IN THE 22ND CENTURY

by

Julian M. Chesnutt, Lt Col, USAF

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Advisor:
Dr. Donald A. MacCuish
Air Command and Staff College

Maxwell Air Force Base, Alabama

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This study identifies global, environmental, socio-political, technological and military trends that may shape the USAF in the next 100 years. It employs the futures study tools of Environmental Scanning, Trend Analysis, Cross-Impact Analysis, a Delphi Poll, a State of the Futures Index (SOFI), a Coates Futures Diagram and Scenarios. The Scenarios present a Worst Case, Best Case and Most Likely Case of the world and their influence on the USAF at the beginning of the 22nd century. The most important trends potentially affecting one or more of these Scenarios are the preeminence of the cyber domain, the increasing importance of the high ground of space, fossil-fuel depletion and the pervasiveness and fusion of genetics, robotics, information technology and nanotechnology to bring about unparalleled machine and human performance. The study concluded that the most important USAF mission at turn of the century will be cyber-warfare, followed by information operations, space control, space force enhancement, surveillance and reconnaissance. The study provides nine recommendations focused on guiding the USAF toward the Best Case Future.

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Preface

As a first-time futurist, I have relied on the brainpower of others. I have been supremely humbled by the time, quality and effort of those who assisted me in completing this ambitious project. The idea for this research belonged to Dr. Mike Nelson, a true polymath and professor of communications, culture and technology at Georgetown University who also served as former vice-President Al Gore's science advisor. Dr. Nelson started a master's level course on "Predicting the Futures" and his enthusiasm for the subject infected me. Although excited by the prospect of a futures study, I had no experience in the field and thus sought the counsel of Dr. Tom Ehrhard at the Center of Strategic and Budgetary Assessments, a man who knows something about everything and a lot about a lot. He referred me to Lt Col Pete Garretson (USAF), who in turn introduced me to many of the concepts in this paper. He helped enlist the support of SIGMA, a group of top scientist and science fictions writers who volunteer their considerable talents to solving national security problems.

A major part of the research stems from a six month-long Delphi Poll in which "Oracles" provided the lion's share of insight into potential futures for the USAF. The Oracles are tops in their field (often multiple fields) and thus are busy people. Despite their busy schedules, 31 distinguished Oracles, ranging from Hugo, Nebula, Campbell and Locus Award-winning science fiction writer and astrophysicist Dr. David Brin, who authored *Earth, Foundation's Triumph, The Uplift Wars*, and *The Postman*, to US Air Force Senior Mentor Lt Gen Mike Short, who led NATO's air campaign in the Kosovo and Serbia without single NATO casualty in combat,

contributed to the project. Many of the Oracles command a high fee for their expertise, but all worked on this project pro bono out of a sense of patriotism, academic curiosity, professional interest, friendship or some combination of the above. In additions to those already mentioned, I would also like to thank the following distinguished Oracles: Dr. Vernor Vinge, professor of mathematics and Hugo Award-winning Author of *A Fire Upon the Deep, A Deepness in the Sky, Rainbow's End* and the seminal essay *The Coming Singularity*; Maj Gen David Goldfein, Deputy Director of Programs, Office of the Deputy Chief of Staff for Strategic Plans and Programs, Headquarters USAF; Mr. Joseph Coates, renowned futurist and author of more than 300 books and articles; Dr. Arlan Andrews, founder of SIGMA, author of over 400 stories, former White House Fellow in the Office of Science and Technology and Lifeboat Foundation panel member (Lifeboat Foundation is dedicated to encouraging scientific advancements while helping humanity survive existential risks and possible misuse of increasingly powerful technologies) Walter Jon Williams, science fiction writer and author of over 20 books including *The Praxis*, *Hardwired* and the Hugo and Nebula award-nominated *City on Fire*; Dr. Sage Walker, science fiction writer, medical doctor and author of the Locus Award-winning novel *Whiteout*; Mr. John Smart, futurist, author, founder and president of Acceleration Studies, a nonprofit community that seeks to help individuals better understand and manage accelerating change; Dr. Charles E. Gannon, Distinguished Professor of English at St. Bonaventure University, Fulbright Senior Specialist in American Literature and Culture and award-winning author of *Rumors of War and Infernal Machines*; Mr. Jay Wiener, lawyer, mountain climber and world Loppet champion; Dr. Tom Ehrhard, airpower strategist, military futurist and senior fellow at the Center for Strategic and Budgetary Assessments; Dr. Bill Morgan, US State Department Fellow, military historian and professor, Georgetown University; Col John P. Geis II, PhD, Director, Center for Strategy

and Technology, USAF; Dr. Regina Lewis, Vice President of Insights at Intercontinental Hotels; Dr. Silvana Rubino-Hallman, InterAmerican Development Bank analyst and former member of the Defense Committee on Women in the Services; Col Tom Feldhausen, Chief of the Strategic Integration and Analysis Branch, Joint Chiefs of Staff, Pentagon; Col Mark Weatherington, B-1 pilot and National Defense Fellow; Col William Eldridge, B-2 pilot and National Defense Fellow at the Woodrow Wilson Center for International Scholars; Col Craig Wills, F-15 pilot and National Defense Fellow at the Weatherhead Center for International Affairs, Harvard university; Lt Col Rory Welch, space operations squadron commander; Lt Col Alan Woodcock, F-16 pilot and political affairs specialist, French Defense Academy; Lieutenant Col Adam Kavlick, F-16 pilot and Chief of Rated Operations, HQ USAF, Pentagon; Lt Col Ricky Rupp, C-17 pilot and executive to the Secretary of Defense, Pentagon; Lt Col Kevin Rhoades, space operations officer and National Defense Fellow, Tufts University; Lt Col Michelle Clays, intelligence analyst, Joint Chiefs of Staff, Pentagon; Lt Col Bartz Sykes, F-16 pilot, Olmsted Scholar and Air Attaché'; Lt Col Pete Garretson, chief of Air Staff Future Technology division, Pentagon; Mr. Gaurav Mishra, Yahoo! Fellow, adjunct professor at Georgetown University and marketing analyst for Tata Motors; Mr. Nicholas Street, financial analyst for PNB Paribas; Lt Col Joseph Thill, Deputy Director, Joint Warfare Exercises, instructor at the USAF *Blue Horizons* Futures Study Group and Air Command and Staff College; and Maj Shelley Kavlick, maintenance officer and budget programmer, HQ USAF, Pentagon.

In addition to the Oracles, I would like to thank the Department of Defense's Office of Net Assessment and the Center for Strategic and Budgetary Analysis for including me in their Future Conflict 20XX series of wargames and workshops. Many of the ideas in this paper grew out of the scenarios presented in their forums. I would like to offer a special "thank you" to Lt Col Pete

Garretson for opening my eyes to all the material available on the subject. I would like to thank Ambassador Howard Schaffer, the Director of Studies here at the Institute for the Study of Diplomacy, for allowing me to veer off the diplomatic course and write an Air Force futures study. In addition, I would like to thank my 30 students who endured the "Future Conflict" portion of the "Military Instrument of Power" course I teach here at Georgetown University. Their lively debate of my theories helped sharpen my assumptions and predictions. Also, I wish to thank my colleagues at the Institute for the Study of Diplomacy, the Qatari students who traveled to Georgetown for the Doha Debates and my "brothers" at Delta Phi Epsilon Foreign Service Fraternity, three audiences who received my presentation and further honed my argument by asking many questions I could not answer. A special thanks to Col William Eldridge, Col Mark Weatherington, Maj Chris Claus, Mr. Jim Seevers and my brother Mr. Chet Chesnutt for their first-class editing skill…their inputs greatly improved the structure and readability of his paper, any mistakes that remain are solely my own. Their writing acumen, especially Colonel Eldridge and Mr. Seevers, made me wonder if the singularity had already occurred and they were sporting cortical implants! Finally and most importantly, I wish to acknowledge the keen insight and support from my advisor, Dr. Donald MacCuish at Air University. Dr. MacCuish also guided me through my previous thesis on radiological weapons, therefore I was pleasantly surprised (and a little shocked) when he enthusiastically agreed to once again shepherd a fighter pilot, scientist and engineer through the writing process. I was honored to have these wise and learned individuals' assistance and encouragement in this project.

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Abstract

This study identifies global, environmental, socio-political, technological and military trends that may shape the USAF in the next 100 years. It employs the futures study tools of Environmental Scanning, Trend Analysis, Cross-Impact Analysis, a Delphi Poll, a State of the Futures Index (SOFI), a Coates Futures Diagram and Scenarios. The Scenarios present a Worst Case, Best Case and Most Likely Case of the world and their influence on the USAF at the beginning of the 22nd century. The most important trends potentially affecting one or more of these Scenarios are the preeminence of the cyber domain, the increasing importance of the high ground of space, fossil-fuel depletion and the pervasiveness and fusion of genetics, robotics, information technology and nanotechnology to bring about unparalleled machine and human performance. The study concluded that the most important USAF mission at turn of the century will be cyber-warfare, followed by information operations, space control, space force enhancement, surveillance and reconnaissance. The study provides nine recommendations focused on guiding the USAF toward the Best Case Future.

Chapter 1

Introduction

I think there is a world market for maybe five computers.

—Thomas Watson, chairman of IBM, 1943

Airplanes are interesting toys but of no military value.

—Marechal Ferdinand Foch
Professor of Strategy, Ecole Superieure de Guerre, 1904

We shall one day travel to the Moon, the planets, and the stars with the same facility, rapidity and certainty as we now make the ocean voyage from Liverpool to New York.
— Jules Verne,
From the Earth to the Moon, 1865

In less than twenty-five years . . . the motor-car will be obsolete, because the aeroplane will run along the ground as well as fly over it.

— Sir Philip Gibbs
The Day After Tomorrow: What Is Going to Happen to the World, 1928.

The future is not set, there is no fate except that which we make for ourselves.

—Sergeant Kyle Reese
Character from the 1984 movie *The Terminator*

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One hundred years ago, the Aeronautical Division of the US Army Signal Corps had one mission—to observe artillery fire and the battlefield. To perform this mission, it had three Airmen, one dirigible, and one airplane. That small organization grew into today's modern USAF which now performs over 22 operational missions and consists of over 330,000 Airman and 4,000 aircraft.[1] In the 22nd century, the USAF will likely be as radically different from today's Air Force as today's Air Force is from the old Aeronautical Division.

Using accepted techniques employed in a futures study, this paper will identify potential trends that could shape the missions of the USAF 100 years from now. The USAF of the 22nd century, just as the Air Force of today, will be forged by the military, technological, economic, sociological, political and even ecological conditions present 100 years from now. This paper will explore several aspects of a possible 22nd century USAF and the types of missions it could perform. By discerning the missions of a future USAF, it is possible to infer how the service might be organized and equipped. While this paper was written, the USAF issued a draft document describing the core missions, further evidence that Air Force missions are continuously changing.[2] While future mission changes in the USAF are certain, their exact form and extent are unclear.[3] In the course of the research for this paper, ten trends were identified that are shaping the global, national and military landscape. These trends are:

1) Increasing prominence of the cyber-domain in all aspects of military operations

2) Relative decrease in economic and military power of the United States

3) Declining Department of Defense (DOD) purchasing power and increasing cost of modern weapons systems without a relative and corresponding increase in cost of systems to counter those modern weapons systems.

4) Increasing drive toward a pilotless or nearly pilotless USAF

5) The growing importance and reliance on genetics, robotics, information and nano technology (GRIN)

6) An increasingly pressing need to develop and eventually transition to non-fossil-fuel-based vehicles

7) Increasing potential and importance for directed energy weapons

8) Growing importance of the space environment

9) Increasing the number of missions the USAF performs while decreasing the overall number of personnel

10) The consolidation of immense destructive power in the hands of small groups or individuals

If leaders heed these trends, then they will be more prepared to ride the waves of change versus getting bowled over by them...and they may be able to direct or even generate those waves. The fact that cell phones today bear an uncanny resemblance to the communicators envisioned in the 1960s television show *Star Trek* could be coincidence, but it is more likely that the *Star Trek* vision of hand-held communicators influenced cell phone designers. Other trends of the 1960s, such as miniaturization of electronics and a desire for individual autonomy, led to the ubiquitous spread of the cell phone. *Star Trek* aside, a futures study is far from science fiction. Using quantitative and qualitative tools such as Delphi Polls, Coates Futures Diagrams, Trend Analysis, State of the Futures Indexes (SOFI) and Scenarios, it becomes possible to discover, to identify and to predict organizational trends and possibly surmise if those trends will continue, fade or fuse.

The US military in general and the USAF specifically have conducted and are conducting futures studies, but none have examined the dawn of the 22nd century. Most futurists claim that

looking forward over five generations stretches predictive methods beyond reliability; however, they also agree that the effort could pay significant dividends. Undoubtedly, the 100-year look is the scientific equivalent to a Hail Mary pass at the end of a football game, but occasionally the Hail Mary is caught—this is the hope for this study. If this study helps the USAF co-opt, direct, influence or invest in one trend that will pay dividends 100 years from now, then this effort will have been worth it. The next chapter will examine the theory and methodology of this Hail Mary look forward to the year 2109.

Notes

[1] In this paper, the term "missions" is used in place of the doctrinal term "functions." Air Force Basic Doctrine AFDD-1 listed 17 functions and one mission. For the purposes of this study, I included five emerging missions for a total of 22. Several Oracles suggested three other missions during Round One of the Delphi Poll. During Round Two, several Oracles suggested another four missions, bringing the total to 29. Appendix A lists all the missions and gives a brief description of each. Air Force Basic Doctrine, Air Force Doctrine Document 1 (Maxwell AFB, Ala.: Air Force Doctrine Center, 17 November 2003), 39-58 and US Department of Defense Directive 5100.1, Functions of the Department of Defense and Its Major Components (Washington D.C.: Department of Defense, 1 August 2002), 11-12, 21-23.

[2] During the writing of this paper, the USAF released a statement defining which mission the USAF would concentrate on going forward. Appendix A contains a list and brief description of the "new" missions.

[3] Peter Schwartz, *The Art of the Long View: Planning for the Future in an Uncertain World* (New York, N.Y.: Bantam, Doubleday, & Dell, 1996), 5.

Chapter 2

Theory and Research Methodology

> *Fleets of air-ships, hiding themselves with dense, smoky mists, thrown off by themselves as they move, will float over cities, fortifications, camps or fleets. They will surprise foes below by hurling upon them deadly thunderbolts*
>
> —John Elfreth Watkins, Jr.
> From the article *What Will Happen in the Next Hundred Years*, published in 1900

This study adopts the assumptions and follows the theory and methodology regarding futures research posited by furturists Jerome C. Glenn and Theodore J. Gordon, namely:

1. You cannot know the future, but a range of possible futures can be known.

2. The likelihood of a future event or condition can be changed by policy, and policy consequences can be forecasted.

3. Gradations of foreknowledge and probabilities can be made; we can be more certain about the sunrise than about the rise of the stock market.

4. No single method should be trusted; hence, cross referencing methods improves foresight.

5. Humans will have more influence on the future than they did in the past.[1]

Utilizing Glenn and Gordon's first assumption, this study will investigate how three possible futures could shape Air Force roles and missions. This study also makes the same assumption outlined in item two—humans are not subject solely to the hands of fate—we can make changes that influence our future. It also supports assumption five that mankind's ability to influence the

future is increasing. In addition to these assumptions, this study applied seven futures research techniques to identify and examine the trends shaping the USAF's future. Ironically, a futures study by no means purports to predict the future. If that were possible, all futurists would be earning fortunes on Wall Street. A futures study explores the trends that could shape possible futures. In that sense, a futures study is about the journey, not the destination.

To discern potential futures, this study employed the techniques of Environmental Scanning, a Coates Futures Diagram, a State of the Futures Index (SOFI), a Delphi Poll, Trend Analysis, Cross Impact Analysis and Scenarios. Each method will be explained, but Watkins's epigraph that opened the introduction provides examples of a few of these techniques.

Watkins's prediction in 1900 about beginning of the 20th century is interesting because of what he got right and what he got wrong, and most importantly, why. His prediction highlights some of the advantages and disadvantages of futures research methodology:

> Giant guns will shoot twenty-five miles or more, and will hurl anywhere within such a radius shells exploding and destroying whole cities. Such guns will be armed by aid of compasses when used on land or sea, and telescopes when directed from great heights. Fleets of air-ships, hiding themselves with dense, smoky mists, thrown off by themselves as they move, will float over cities, fortifications, camps or fleets. They will surprise foes below by hurling upon them deadly thunderbolts. These aerial war-ships will necessitate bomb-proof forts, protected by great steel plates over their tops as well as at their sides. Huge forts on wheels will dash across open spaces at the speed of express trains of to-day. They will make what are now known as cavalry charges. Great automobile plows will dig deep entrenchments as fast as soldiers can occupy them. Submarine boats submerged for days will be capable of wiping a whole navy off the face of the deep. Balloons and flying machines will carry telescopes of one-hundred-mile vision with camera attachments, photographing an enemy within that radius. These photographs as distinct and large as if taken from across the street, will be lowered to the commanding officer in charge of troops below.[2]

Watkins did not have to wait 100 years for his prediction of long range artillery and fleets of airships and submarines to come true…a scant 15 years later during World War I all these weapons appeared in vast quantities. His prediction of high-magnification reconnaissance flying

machines appeared 60 years later. Watkins could not envision the electronic transmission of images even though the telephone had been transmitting sounds for over 25 years. Nor did he predict space travel even though Jules Verne quite remarkably predicted the event 35 years earlier in *From the Earth to the Moon*.[3] The "deadly thunderbolts" (directed energy weapons?) have yet to be fielded 109 years after his time. However, he predicted a tank-like vehicle which appeared in World War I. But he got the huge mobile land fort wrong. Why was Mr. Watkins so prescient in some areas yet off the mark in others?

Watkins looked at what was happening around him in terms of technology—in short, he performed an Environmental Scan. When Watkins made his prediction of directed energy weapons fired from aircraft, it is very likely he read about just such possibilities from the stories of marauding aliens in H.G. Wells's classic *War of the Worlds*, published just two years before in 1898.[4] Additionally, the construction of the first zeppelin began the year before in 1899.[5] Watkins's environmental scanning probably included the current events such as the construction of the zeppelin, attempts to build aircraft and tanks, as well as the increasingly modern submarines like the US Navy's first gasoline-battery powered vessel, the *USS Holland* (SS-1), which set sail the same year.[6] Perhaps he overlooked orbital satellites and space travel because he did not scan back 35 years to the *Earth to the Moon*. Failure to environmentally scan in the present and the future and not backwards is a common fault in futures studies. While the present must be thoroughly examined, the past must also be tilled for ideas whose time had not yet come.

The electronic transmission of images certainly seemed the next logical advancement from the electronic transmission of sound, so why did Watkins predict the photographs would be "lowered," presumably mechanically, from the high-flying, telescope-toting aircraft? Watkins, who was a civil engineer, likely would have been comfortable with mechanical devices, but

perhaps less so with ethereal ones such as the electromagnetic spectrum. One method of combating this limitation is to use experts, preferably with some variations in background and training, to more broadly explore the topic. Delphi Polling employs this technique by drawing ideas from a variety of experts.[7]

Watkins also employed Trend and Cross-impact analysis while constructing a Scenario. He took the present state of the technology of submarines, the nearly completed zeppelin and the nescient attempts to fly heavier-than-air craft and extrapolated those trends forward. He likely multiplied and combined them until the machines of his day—a single *USS Holland* and a single Zeppelin—became entire fleets. Additionally, he predicted that the odd flapping contraption could be transformed into bomb sight-equipped bomber squadrons common in WWII or the targeting pod-equipped F-16s of flown in Operation Allied Force. Unknowingly, Watkins employed established futures study methodologies by using his own imagination. His predictions also illustrate many of the concepts in Glenn and Gordon's five axioms of futures study.

Trend Analysis

Today, futurists have a substantial toolkit, no less than 26 "accepted" techniques to investigate the likelihood of events happening tomorrow, next week, next month, next year or even the next decade. In this regard, futurists are similar to weather forecasters. A weather forecaster can look at an existing hurricane, ascertain its vector, and predict when it will hit a city 20 miles away with a high probability of accuracy. The vector is the "trend" of the hurricane—the direction it is going. Most simply, any study of a trend is a Trend Analysis. The same forecaster can use mathematical models of pressure, winds and sea temperature to predict the likely formation of hurricane. If pressed, the forecaster can provide the approximate number of

hurricanes next year, maybe even 10 years from now, or if feeling particularly prophetic, 100 years from now. However, that forecaster would be foolish to predict which day a hurricane would form next year, much less 100 years from now. Trend analysis points to the direction, but rarely to the exact destination.

While the likelihood of accurately predicting the day of a hurricane 100 years from now is exceedingly low, it is more likely that a hurricane will form during the historical hurricane season. The hurricane season is determined by analyzing all the applicable meteorological trends. Despite these historical models, the forecaster cannot predict how "wildcards" could change what would otherwise be a safe assumption that most hurricanes will occur in the official hurricane season a 100 years from now. How might the variables of sea temperature, ocean currents and wind patterns interact and influence each other to completely alter the official hurricane season 100 years from now? Predictions by long range futurists are subject to the trappings of similar wildcards. The toolkit is more restricted—it is more aptly described as a toolbelt, and even those tools are highly susceptible to divergent and convergent trends, wildcards and game-changers.

All futures research techniques begin to lose accuracy the longer the time horizon. This is due to the difficulty of discerning the cross-impact of variables, some of which are defined, but many of which are undefined or not even in existence today. Adding further complexity to the long-range futurist's task is the reality that some of these variables display a high degree of sensitivity on initial conditions (chaotic behavior) while others progress linearly, logarithmically or exponentially. The final complication is *how* the variables respond when they interact, converse, diverge or fuse—a linear variable could behave exponentially when interacting with another logarithmic variable.

Cross-Impact Analysis

Cross-Impact analysis attempts to discern how two or more trends will affect each other. Physicist and futurist Dr. Stanley Schmidt expertly delineates how the engineering trend of miniaturizing engines combined with the educational trend of greater understanding of the physics of flight converged to yield the first airplane.[8] Overlapping trend effects do not always yield positive results. For example, the cross-impact of the urbanization trend and the skyscraper trend, coupled with the air travel trend and the terrorism trend, enabled the events of 9-11 when hijackers were able to kill many people using civilian airliners as an "unconventional" weapon.[9]

When major trends converge to yield new trends and those new trends also converge, it is called metaconvergence.[10] There are several possibilities for metaconvergence of modern technologies with genetics, robotics, information and nanotechnology (GRIN) being the one most likely to cause paradigm-shifting change. GRIN cross-impact was detected frequently in the Environmental Scan and incorporated in the other futures techniques employed in this project.

This study began with an Environmental Scan. Just as Watkins relied on past and present environments, this research looked at past trends leading to the present day environment and projected them into the future. After a thorough Environment Scan was conducted, a Coates Futures Diagram was built in an attempt to model the future of the USAF. The Coates Futures Diagram offered a clear graphical depiction of the key components that would drive the future USAF. After the Coates Futures Diagram was completed, three distinct Scenarios were built. An important method for this study was a Delphi Poll, which consisted of two rounds. Each focused on the future missions of the USAF. A SOFI was built simultaneously while conducting the Delphi Poll. The SOFI was designed to predict whether the USAF would "improve" or

"decline" in the future. Cross Impact and Trend Analysis were conducted during all these techniques. While all these methods were complementary, the most successful was the Delphi Poll due entirely to the exceptional team of Oracles. The SOFI proved to be the most problematic due the requirement to combine variables, find appropriately predictive mathematical equations and make sequential assumptions.

Admittedly, in the art and science of futures studies, the methods used here fall more on the side of art. However, the value of long-range futures research is less in forecasting accuracy and more in opening minds to consider new possibilities, anticipating opportunities and negating threats, for it is a wiser strategy to anticipate rather than just respond to change.[11] The research was conducted in this spirit.

Environmental Scanning

Environmental Scanning is a must for any futures project and simply put, consists of looking to the left, right, back and forward to assess the current environment, how we got here, and where we are going in the future. Common techniques for an Environmental Scan include participating in expert panels, literature reviews and key-person tracking.[12]

Two expert panels contributed to this project: a Delphi Poll and the Future Warfare 20XX Group. This latter group consisted of over 50 experts in defense and GRIN. The Future Warfare 20XX Group held a series of workshops and wargames in 2008 and 2009 at the behest of the Office of Net Assessment in the Pentagon.[13] The group wargamed conflicts in the 2030-2050 time frame, but made an effort to determine which trends would continue past 2050.[14] The order of battle in the wargames consisted of current systems, such as the F-22, augmented by weapons systems currently under development, such as the F-35, and included systems envisioned for development in the next 20 years, such as directed energy weapons.[15] The wargamers focused

on technology and force structure, but also discussed social and moral issues in future warfare, such as the justification of cyber attacks or the lethal use of force when decisions are made by machines without humans in the loop.[16]

Most contemporary futures literature covered broad topics and peered forth only a few decades. This literature included such works as the Bestseller *Hot, Flat and Crowded*[17] and the USAF-focused writings of the *Blue Horizons* study.[18] Some literature focused on developments purported to influence the world of 2100. Of these, Ray Kurzweil writings, especially *The Age of Spiritual Machines: When Computers Exceed Human Intelligence*,[19] along with Dr. Vernor Vinge's groundbreaking paper *The Coming Technological Singularity: How to Survive in the Post-Human Era* proved to be most beneficial.[20] Only a few works looked well past the 22nd century, one of which was *Year Million: Science at the Far Edge of Knowledge*.[21] In all, the information and opinions from 18 books, 40 articles, two workshops, three wargames and 17 lectures were consulted to support the Environmental Scan.

The primary advantage of a comprehensive literature review supporting an Environmental Scan is to discover trends and ascertain why different experts believe those trends will or will not continue. Additionally, it provides ideas on how the trends may cross-impact and fuse in the future. The information from the Environmental Scan informed all the other methods used in this study. The major findings of the literature review were integrated in the Scenarios and centered upon military, technological, environmental and socio-political trends.

Coates Futures Diagram

Futurist Joseph Coates developed a simple yet powerful futures research method for analyzing an organization using graphical techniques. The Coates Futures Diagram dissects a system into component parts in order to discern which plans and policies would most likely lead

to the desired future.[22] Combined with the Environmental Scan, construction of a Coates Futures diagram provided a necessary launch point for the study. During the diagram's construction many vital factors were defined which affect on the future of the USAF, namely: Key Elements, Driving Forces, Key Actors and Stakeholders, Trends in Driving Forces, Wildcards and Potential for Change.

Key Elements

The key elements of the USAF system are the mission, people, hardware and budget. These key elements mirror most systems or organizations along the lines of purpose (mission), personnel (people), hardware (inventory) and money (budget). Each one of these key elements would provide ample material for a separate USAF futures study. This project concentrated primarily on how these elements influenced the missions of the USAF in three different future Scenarios. Hardware was constrained mainly to the inventory of aircraft, spacecraft and bases. After the Key Elements were identified, the next step was discerning the Key Actors and Stakeholders.

Key Actors and Stakeholders

Who cares about the USAF and who can do something about it? Those are the questions used to determine the Key Actors and Stakeholders. The most important actors and stakeholders are the people who care *and* have the authority to influence. The obvious people in this category are the executive branch leaders such as the president, vice-president, secretary of defense and congressional leaders, especially members of the armed services committees and appropriations committee. Next in influence, and probably the highest in caring, are the military and USAF leaders such as the chairman of the joint chiefs, secretary of the Air Force and the Air Force

chief of staff. Sister Service leaders also have a stake in the development of the USAF, both in as a supporting service and as a competitor for limited funds.

Industry leaders and their lobbyist also "punch above their weight" in terms of influence. Alliance and adversary leaders also influence the direction of the USAF. For example, if the Russians build an advanced fighter that outperforms the F-22, then the USAF would likely respond by developing a counter. A similar case can be made if an alliance leader like the NATO Secretary General lobbies for additional commitments or for new weapons systems. Individual US citizens cannot be considered key actors, but as a group, they can hold tremendous power. For instance, citizens wield influence when they band together to prevent the closure of a base or the shutdown of a weapons factory. The next step in building the diagram was identifying the driving forces.

Identify Driving Forces

The driving forces that shape the USAF include money, missions, conflicts/contingencies, adversaries and technology. Undoubtedly money is a driving force. Dr. Tom Ehrhard once quipped that the primary reason the Pentagon exists is to spend money.[23] Missions are the *sine qua non* of the USAF and are listed both as a key element and a driving force. Missions and money also present a circular logic loop for the USAF organizational system. Does the mission drive how much money Congress apportions and authorizes for the USAF, or does the USAF accomplish missions based on available funds? Maj Shelley Kavlick, a USAF budget officer, firmly believes the latter. The fact that the USAF's share of the DOD budget has not changed significantly in the last decade supports her conclusion.[24] So while missions are important, cash is still king.

The amount and intensity of conflict and contingencies also drives and shapes USAF missions, technology, people and budget. Key actors rarely call for a "peace dividend" when combat or contingency operations are ongoing. Similarly, adversaries also act as key drivers. If an adversary possesses advanced technology, then the USAF attempts to match or best that technology. The drive for technological superiority has led to the replacement of the fleets of bombers flown in WWII with small formations of stealth fighters employing highly accurate munitions. Extrapolation of this trend may envision artificial intelligence replacing pilots in those fighters. Technological advancement permits the USAF to do more with less and is poised to have significant influence on future missions.

Identify Trends in Driving Forces

Greater reliance on technology and information systems is a trend that is shaping the USAF as well as the developed and developing world. The geometric growth of information technology such as "Blackberries," FaceBook and Twitter are changing the way people interact. The century's long trend in miniaturization of electronic components continues, as does increasing the development and use of robotic systems. The USAF and DOD fund research for directed energy weapons such as the Airborne Laser, PHASR and Firestrike. The trend toward directed energy weapons likely will continue because the advantages of operating at the speed of light with a strong immunity to gravity make this class of weapons incredibly accurate.[25] Once developed, these weapons will likely be more affordable than current "projectile" systems and capable of repetitive engagements.[26] The US Army's anti-missile THEL laser cost an estimated $8,000 per shot compared to $3.8 million for a Patriot missile.[27] Finally, many of these weapons will be able to function in lethal and non-lethal modes and vary from attacking a single target to attacking multiple targets or entire areas.[28]

Decreased purchasing power is a defining trend in USAF procurement as well as in operations and maintenance. Today's F-22 is literally worth its weight in gold while the F-18E is worth its weight in caviar.[29] During WWII, the P-51 Mustang fighter program unit cost was $51,000 ($630,000 in 2006 dollars), while the Government Accounting Office estimates the F-22 tops out at $363,130,000 program unit cost.[30] This means the US Government is paying nearly 600 times more today for its top fighter than it did during World War II.

Not only is the USAF paying more to buy aircraft, the organization is paying much more to operate them as well. The cost-per-flying hour has increased 31 percent in the last two years, which has necessitated a cumulative 10 percent cut in flying hours each year until 2013.[31] The driving force in the cost increase is petroleum, with the USAF spending over four billion dollars last year on aviation fuel.[32]

The USAF is also paying more for its people, with personnel cost rising 50 percent in the last decade.[33] To counter rising cost, the USAF began cutting personnel and replacing many of the functions performed by those people with automated or web-based programs. Both these trends will continue—people will continue to become more expensive and more of their functions will be outsourced to computers, artificial intelligence, or machines.

The trend of the expanding USAF mission likely will continue. The USAF (and its predecessors) has grown from one operational mission 100 years ago to 22 doctrinal missions today. The USAF still performs that first doctrinal mission, but it has added missions at the rate of approximately three per decade. The reasons for this ostensibly include the ability to successfully engage a widening diversity of threats and conflicts in the 20th and 21st centuries.

Long-term conflicts, often involving religious or ethnic disputes between non-state adversaries, seemingly have increased in the new millennium. In the last decade the USAF has

fought a short but relatively high-intensity air campaign in the Balkans and two long but low-intensity campaigns in Iraq and Afghanistan. These conflicts highlight the need for the Air Force to be prepared for action anywhere along the spectrum of conflict. While all these trends will likely continue, the exact path and rate will inevitably be affected by other factors.

Explore Potential for Change

Some changes in the coming century seem certain. For instance, continued natural resource depletion, continued technological advancement and population growth are safe bets. Most estimates suggest that all the Earth's commercially viable oil will be extracted by 2080. However, the development of alternative sources and recycling efforts can certainly drastically slow the rate of depletion.

Moore's law governing the doubling of the number of transistors that can be placed on a integrated circuit, and hence processing power and speed, also seems likely to continue. Other likely changes include variations in national power status and the amount and type of conflict. One or more of the following wild cards could certainly become "game changers:" a devastating natural or cosmic disaster, a deadly pandemic, a serious political upheaval, a severe economic depression, a paradigm-shifting discovery or a nuclear war.

Completing the Diagram

Once the Key Actors and Stakeholders, Driving Forces, Trends in Driving Forces and Potential for Change were identified, then three possible Scenarios were built to fulfill the requirement to "Develop Images of Alternative Futures." The completed diagram is depicted in Figure 1 (below).

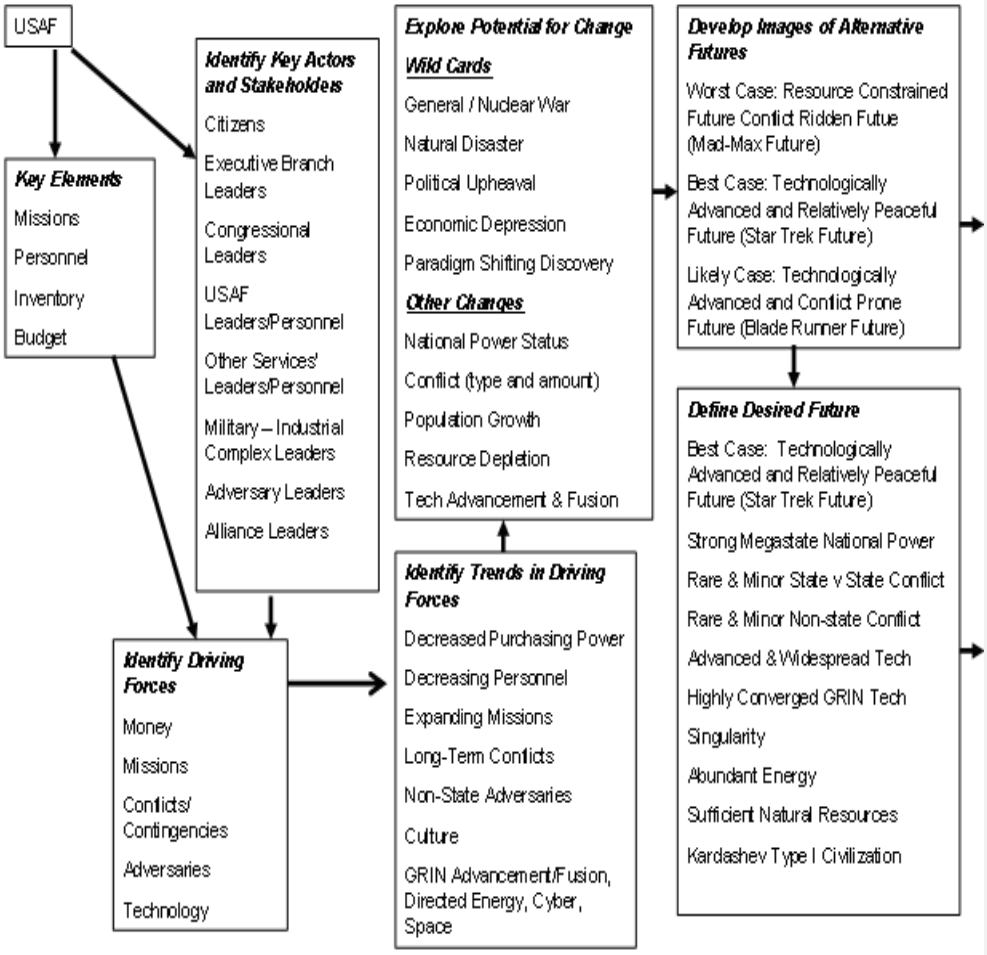

Figure 1. Coates Futures Diagram Part 1 (From LtCol J.M. Chesnutt, 2008).

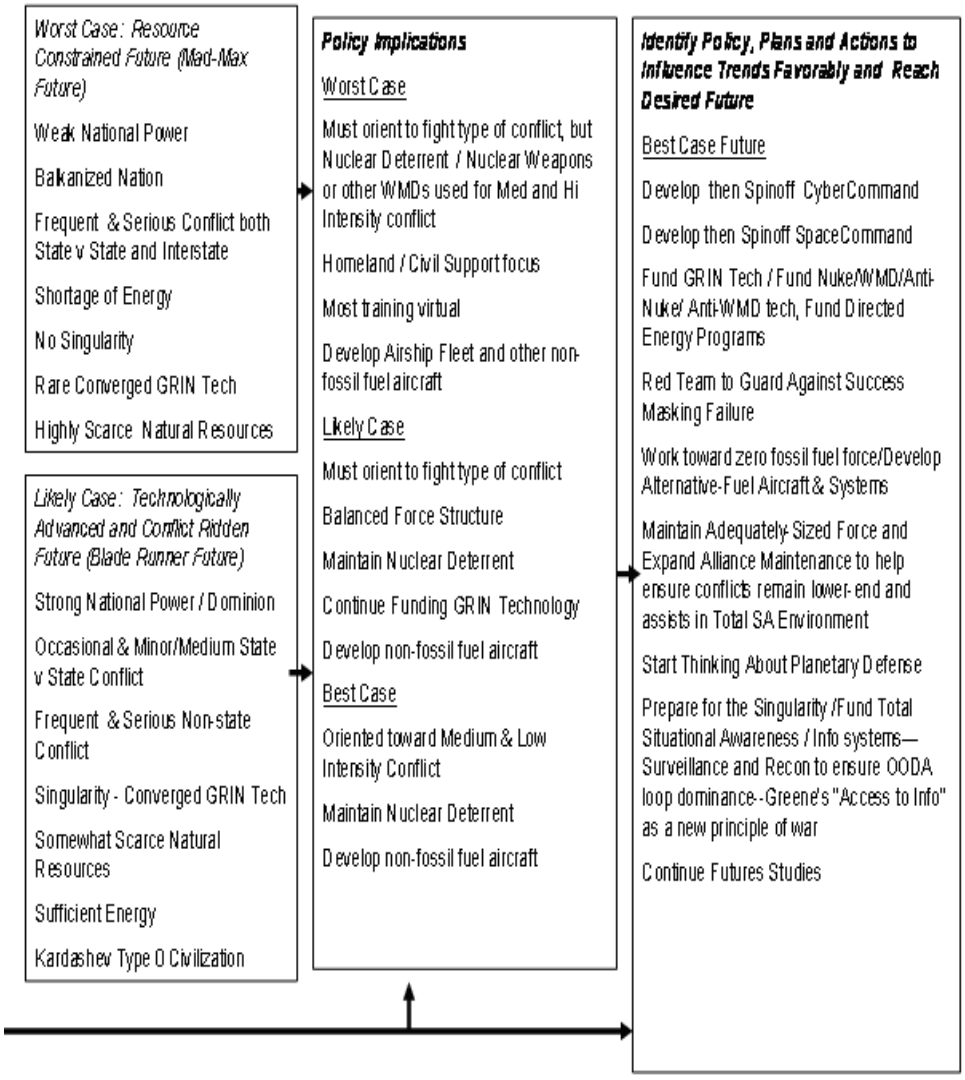

Figure 2. Coates Futures Diagram Part 2 (From LtCol J.M. Chesnutt, 2008).

Figure 2 of the diagram is oriented toward the specific Scenarios. The task of "Define Desired Future" involved simply duplicating the Best Case Scenario. Once the Scenarios were constructed, the "policy implications" for each were explored in chapters three, four and five,

respectively. The final task was to "indentify policies, plans and actions to influence trends favorably and reach desired future." These results will be covered in chapter six.

State of the Future Index

Theodore Gordon developed the State of the Futures Index (SOFI) methodology in 2001, making it the most modern futures research method.[34] The SOFI Methodology aggregates qualitative and quantitative techniques, fuses historical data and future forecasts, and employs mathematical derivation as well as human judgment to determine a future state.[35] The value of a SOFI is two fold. First, it clearly and easily presents information on whether a system is increasing (getting better) or decreasing (getting worse).[36] Second, the details of the study, such as assumptions, judgments, debates, inter-relationships and cross-impacts can provide other analysts with useful ideas.[37]

The consumer price index (CPI) is similar to a SOFI index in that combines rather disparate variables to give a single indication on whether prices for goods used by an average family are getting higher or lower. However the CPI does not provide an estimate of a future state, while this is the expressed purpose of a SOFI.

The allure of the SOFI index is also its weakness—by combining variables into a single number, important relationships between the variables can be masked. The results of this method may be precise; however, the precision should not be confused with accuracy.[38] Admittedly, the exercise of determining the number of variables, weighting the variables, combining the variables and judging the level of cross-impact proved exceedingly complex. That said, the value of the USAF SOFI lies in those assumptions and weightings and the level of debate they inspire. The ramifications of the SOFI index are discussed in later chapters.

Combining Variables and Key Assumptions

The key assumptions are vital in determining if the USAF will be "improving" or "declining" in the future. For this SOFI, 20 variables were considered and ultimately 12 were chosen. These variables were categorized under four factors: budget, personnel, mission and inventory. Next, a subjective weight was applied to each variable. The variables were then combined to form the four factors. Once the four factors were determined, then each factor was assigned a subjective weight related to the perceived importance and normalized.

The next step was to define exactly what is meant by "improving" vice "declining" in terms of the four factors. This determination was made subjectively and considered the current trends and possible cross-impact of both the factors and the variables which comprised the factors.

The normalized budget factor was deemed improving if it increased in value. This assumed that more money and a larger share of the defense budget for the USAF would translate into more capability. While this seems obvious, a bigger budget may actually indicate that the USAF is less efficient or just too expensive. An expensive USAF may not be good for the nation or the DOD. However, for the purposes of this USAF SOFI, it was assumed that bigger was better, with the "optimum budget" getting the highest value.

A similar assumption was made for the normalized personnel factor. The larger the personnel factor, the more capability for the USAF. The converse could be argued as well. A large personnel factor certainly means increased cost and perhaps decreased efficiency. However, in the final assessment it was decided that the USAF is better off with more people with a good education, however, the highest value was assigned to the "optimum number" of personnel.[39]

The true test of measuring USAF improvement is in how well it performs its missions and in how many missions it can accomplish. It was assumed that the more missions assigned to the

USAF, the more capability it has—all leading to an improving force. However, the mission effectiveness was weighted 90 percent in the computation for the normalized mission factor. It was assumed that if the USAF was performing well when it was successful 80 to 95 percent of the time—this was the normative (best) value.

Table 1. SOFI Variable, Weights, Factors, Set Weights and Normative-Dystopic Range

Variable	Variable Weight	Combined & Normalized Factor & Factor Set Weight	Scenario	Normative to Dystopic Range %
Budget Amount	**0.7**		**Worst**	**30-60**
Percentage of Real Growth	**0.2**	**Budget Factor**	**Best**	**80-95**
USAF Percentage of DOD Budget	**0.1**	**.25**	**Most Likely**	**65-75**
Personnel (Active)	**0.6**		**Worst**	**30-60**
Personnel (ANG & Reserves)	**0.2**	**Personnel Factor**	**Best**	**80-95**
Officer Masters Degrees	**0.1**	**0.15**	**Most Likely**	**65-75**
Enlisted AA Degrees	**0.1**			
Effectiveness of Missions	**0.9**	**Mission Factor**	**Worst**	**50-60**
Number of Missions Assigned	**0.1**	**0.4**	**Best**	**80-95**
			Most Likely	**65-75**
Number of Aircraft	**0.4**		**Worst**	**30-60**
Number of Satellites	**0.4**	**Inventory Factor**	**Best**	**80-95**
Number of Major Installations	**0.2**	**0.2**	**Most Likely**	**65-75**

Source: LtCol J.M. Chesnutt (2009)

The USAF was performing poorly when it was only accomplishing the mission 50 to 60 percent of the time—this was the dystopic (or worst) value. A normative and dystopic value range was subjectively assigned to each factor and varied depending of the Scenario.

It was initially assumed more was better in the computation of the normalized inventory factor; however this too proved a dubious supposition. Periodically, The USAF asks the Base Alignment and Closure Commission to close facilities to improve efficiency and save money. Additionally, the USAF attempts to retire aging aircraft. Despite the downside of having too much inventory, it was decided that having a "more "of aircraft, spacecraft and bases defined "improving." However, the factor was also weighted the "optimum" number of inventory as "improving" as well.

Computing the Data

There were five data points selected. The first was 2013 because it is the furthest point in which reliable projected data existed for budget, personnel and inventory. Second was 2030 because it is the projected year of the singularity (explained in chapter 4) and where the Worst, Best and Most Likely Case Scenarios could begin to diverge, as well as the peak oil consumption. Third was 2050, the year when the United States fully transitioned to renewable energy in both the Best and Most Likely Case Scenarios. Finally, 2080 was the year when all viable oil and most coal were depleted.[40]

The first computation combined the variables (i.e. Budget Amount, Percentage of Real Growth, USAF Percentage of DoD Budget) to form the Factors (i.e. Budget Factor).[41]

Equation 1:

$$F(t) = w1 * v1(t) + w2 * v2(t) + w3 * v3(t)$$

Where F(t) = Factor at time t and w1 is the first variable weight, w2 the second variable weight, w3 is the third variable weight and v1 is variable 1 at time t and v2 is variable 2 at time t, v3 is variable 3 at time t.

Note: the Personnel Factor combined four variables, the Inventory and Budget had three each, and the Mission Factor had two (see Table 1).

The second computation normalizes the Factor F(n,t) using Equation 2

F(n,t) = (Vn(t)–dystopic value of Vn)*100/(normative value of Vn–dystopic value of Vn)

Where F(n,t) is the normalized value of the Factor n at time t that is the percentage of the range between the highest and lowest values of Vn

and

Vn(t) is the value of the Factor at time t.

The next step computes the Index using Equation 3

Index (t) = W1 * F(1,t) + W2 * F(2,t) + W3 * F(3,t) + W4 * F(4, t)

Where W is the weights and F(n, t) are the normalized values of the Factors

W1 = Set Budget Factor Weight

W2 = Set Personnel Factor Weight

W3 = Set Mission Factor Weight

W4 = Set Inventory Factor Weight

The next step used the graphing software program *LAB-Fit*[42] to determine W(n,p), the Weight of the Factor n at p percentage of its range using the Index(t).

An ellipse function was the best fit out of a possible 27 mathematical functions for the Worst Case Scenario.

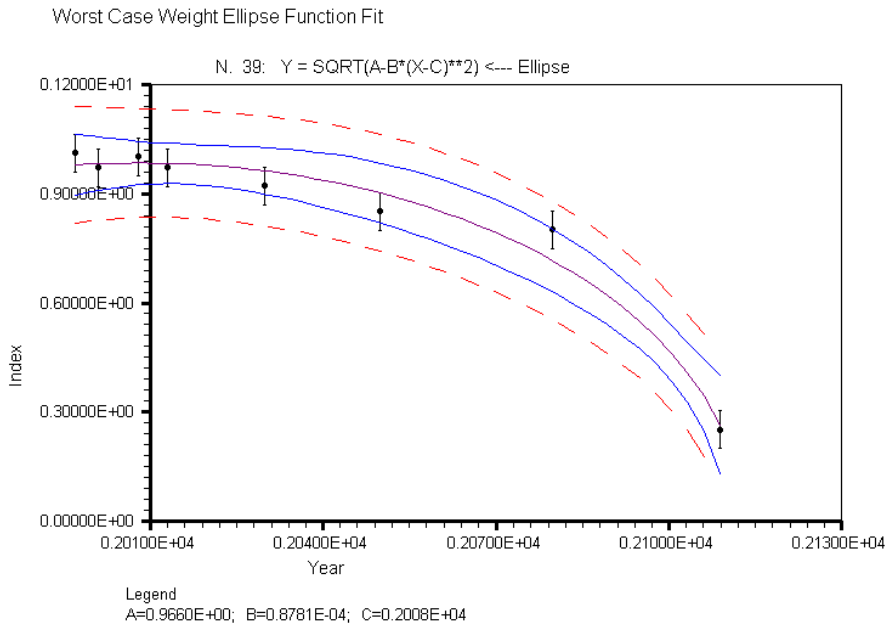

Figure 3. Ellipse Function used to fit the Worse Case Scenario curve (From Wilton and Cleide Pereira da Silva, *LAB-Fit Software Program* version 7.2.45, Campino Grande, Brazil, 2009)

The best fitting curve for the Factor weights in the Best Case Scenario was a Cauchy Function; there were 31 mathematical functions that were approximate fits.

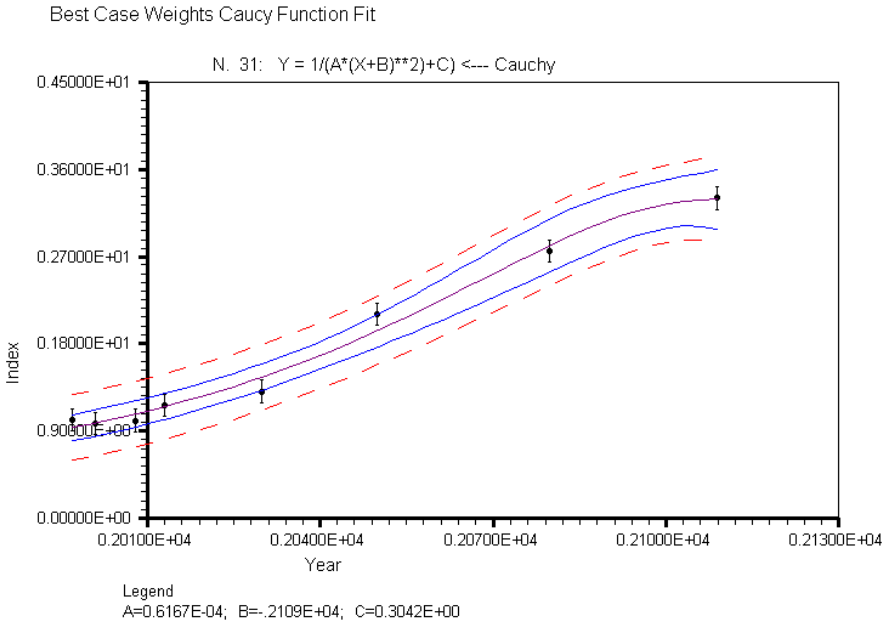

Figure 4. Cauchy Function used to fit the Best Case Scenario curve (From Wilton and Cleide Pereira da Silva, *LAB-Fit Software Program* version 7.2.45, Campino Grande, Brazil, 2009)

For the Most Likely Case, 33 mathematical functions provided an approximate fit with the Gaussian function proving the most accurate.

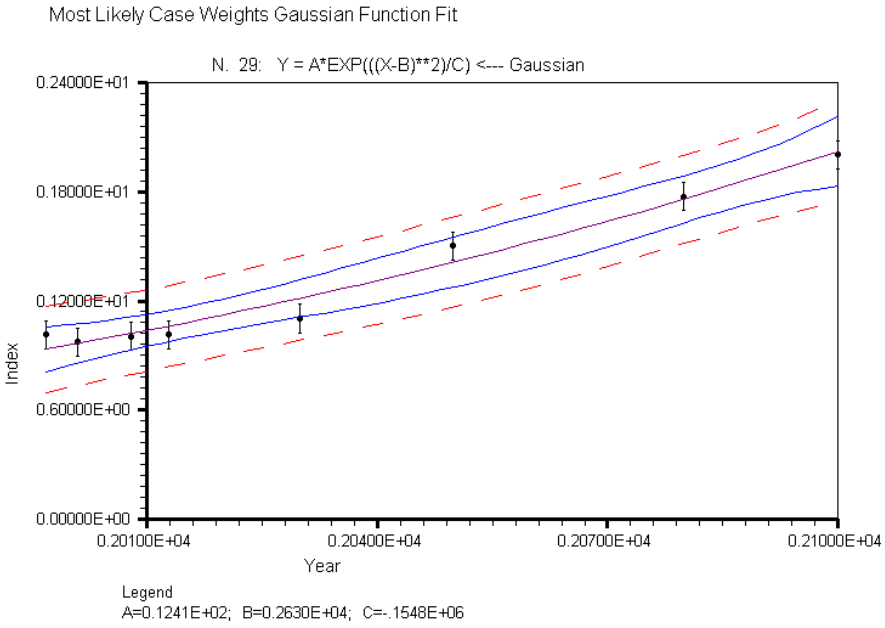

Figure 5. Gaussian Function used to fit the Most Likely Case Scenario curve (From Wilton and Cleide Pereira da Silva, *LAB-Fit Software Program* version 7.2.45, Campino Grande, Brazil, 2009)

The final computation produced the SOFI curve using Equation 4

SOFI = SUM (F(n,t) * (W(n,p)) / SUM (F(n,T) * (W(n,p))

Where T is the reference year (2008) for the SOFI.

The curve was then plotted via *Excel* Graphing Tool.[43]

Below are the graphical results of the SOFI for all three Scenarios, the details of which will be discussed in later chapters.

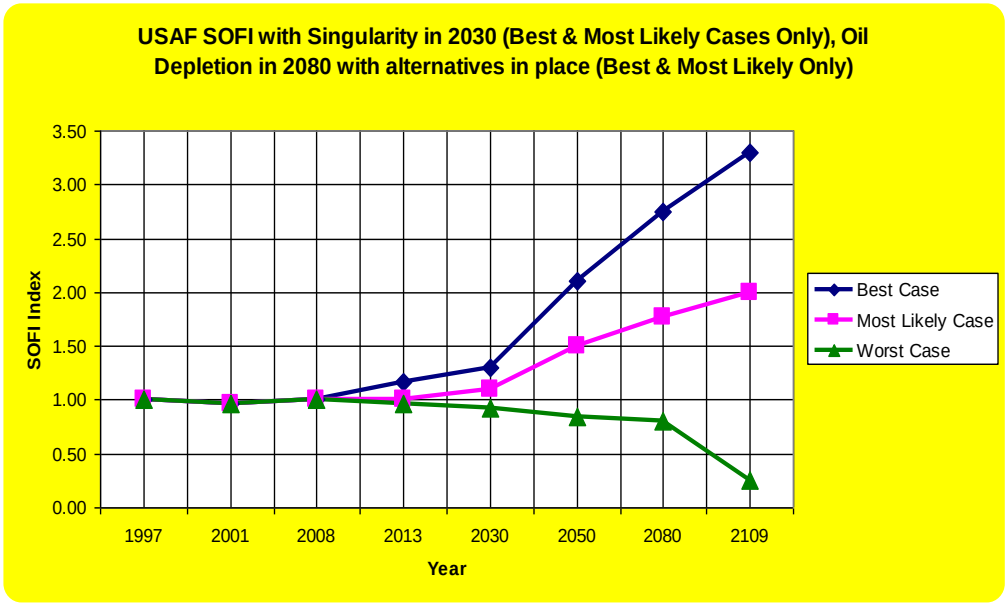

Figure 6. SOFI for comparing all three Scenarios (From LtCol J.M. Chesnutt, 2008)

Delphi Poll

The Delphi Poll, another technique developed in the 1960s at RAND, proved the most valuable research tool for this paper. A Delphi Poll is a controlled and anonymous debate conducted by subject matter experts.[44] The value of a Delphi Poll resides with the ideas it generates, both those that evoke consensus and those that do not, even "outliers" that argue for extreme positions.[45] The key component to a success Delphi Poll is assembling the correct mix of experts, dubbed "Oracles." A near optimum mix of professions was achieved for a Delphi Poll investigating future missions of the USAF, however Air Force officers, especially fighter pilots, were over-represented and women and sister service officers were underrepresented. For this poll, 31 Oracles participated to some degree (see the preface for a complete list); Figure 7 below lists the Oracles by expertise (some of which overlap).

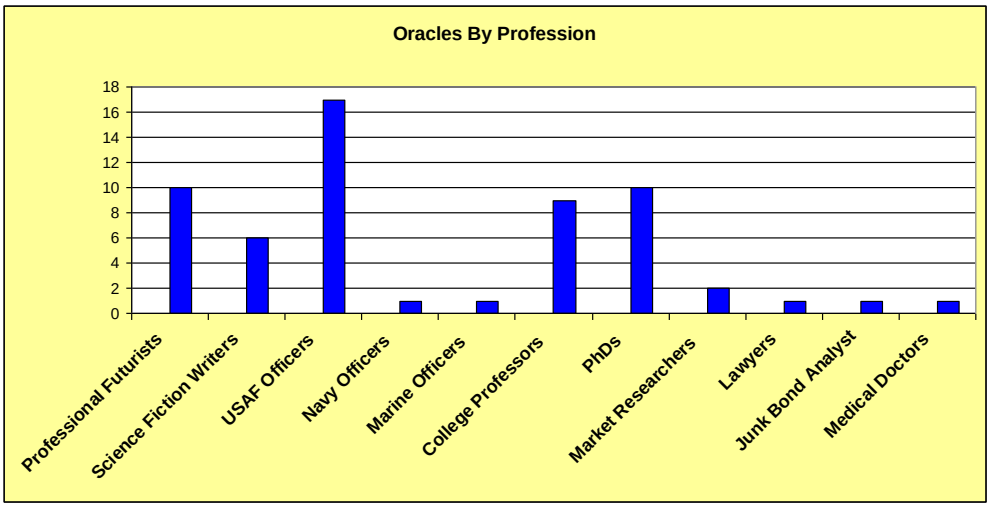

Figure 7. Oracle by profession and expertise (From LtCol J.M. Chesnutt, 2008).

The poll consisted of two rounds of guided debate focused on the missions of a future USAF and took six months to complete. There was vigorous discussion and debate between both rounds and further discussion after the final results were released. Round One asked the Oracles which of the 22 current operational missions would increase in importance, decrease in importance, stay the same, and/or change significantly. Several Oracles suggested new USAF missions. Round Two asked the Oracles which missions would be most important in the given Scenarios: Worst Case, Best Case and Most Likely Case. Most Oracles only listed their top five most important missions. Several Oracles also listed a couple missions they felt would be least important. In general, mission importance was not highly dependent on the Scenarios. For instance, there was an expectation that some missions to be very important in the Best Case Scenario but unimportant in the Worst Case Scenario. The only missions that showed significant Scenario dependence were special operations (not important in the Best Case Scenario but important in the other two) and surveillance and reconnaissance (twice as important in the Worst

Case Scenario as the other two. The study clearly indicated that over 80 percent of the USAF missions will change significantly in function. The following graph is representative of the results from Round One of the Delphi Poll.

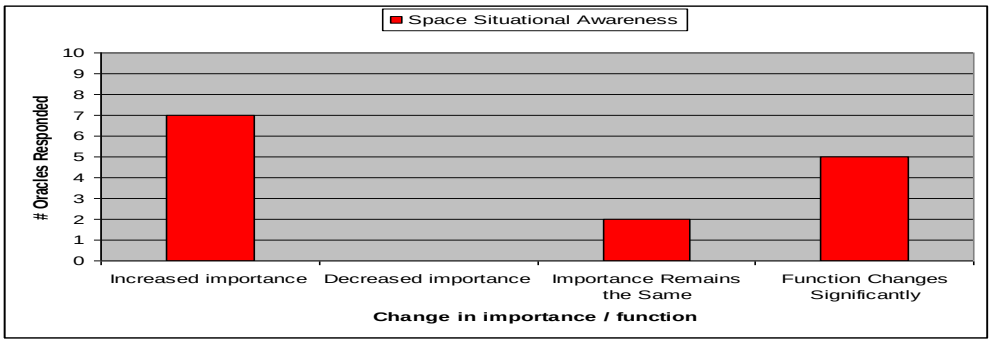

Figure 8. Delphi Poll Round One Results (From LtCol J.M. Chesnutt, 2008).

The following three figures show the Scenario-dependent results from Round Two.

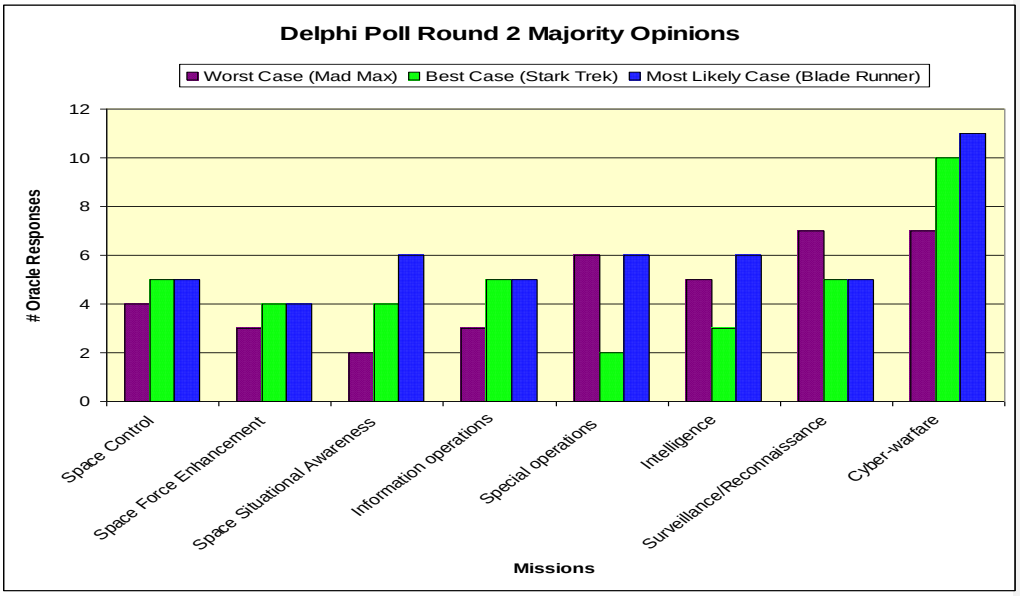

Figure 9. Delphi Poll Round Two Results—Majority Opinions (From LtCol J.M. Chesnutt, 2008).

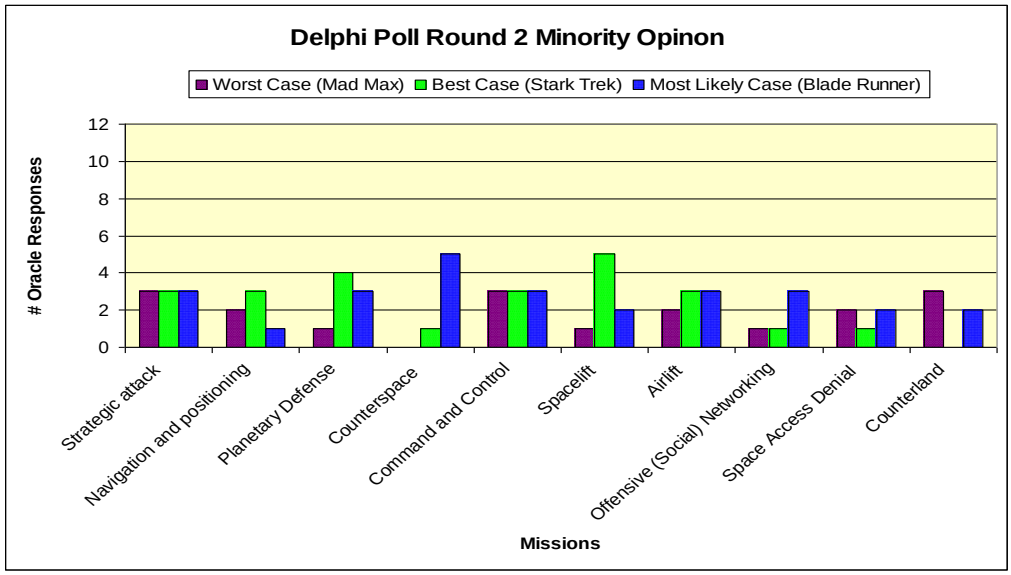

Figure 10. Delphi Poll Round Two Results—Minority Opinions (From LtCol J.M. Chesnutt, 2008).

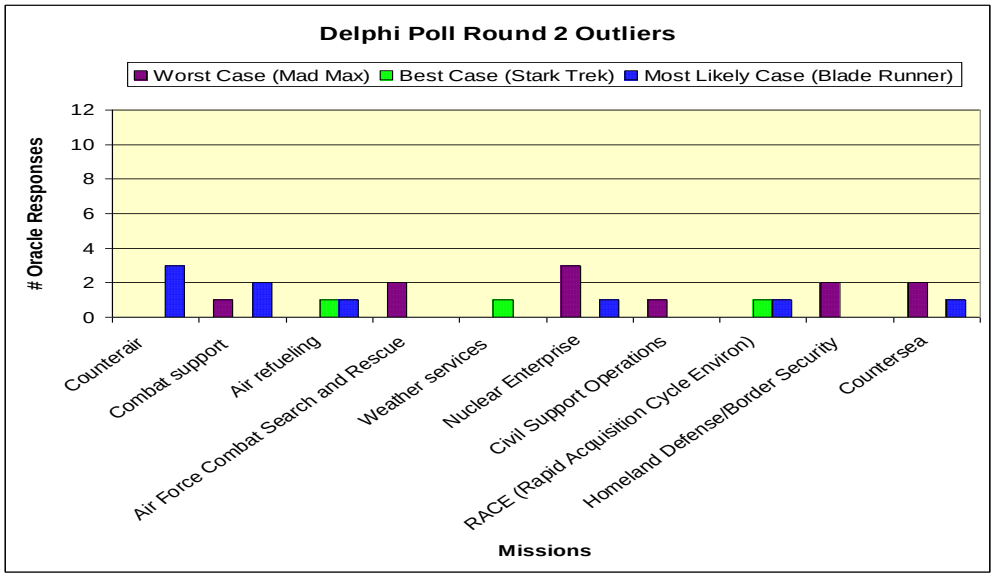

Figure 11. Delphi Poll Round Two Results—Outlier Opinions (From: LtCol J.M. Chesnutt, 2008).

The results of the Delphi Poll will be discussed in the context of the Scenarios in chapters three, four and five.

Scenarios

Scenarios provide one of the more accurate methodologies for exploring the "distant" future. Scenarios are not predictions—predicting the future, especially the future 100 years hence, is simply not possible. However, Scenarios provide "vehicles for learning" that frames the picture the trends are painting.[46] This technique, developed by Herman Kahn of RAND in the 1950s, constructs a story that connects a description of a specific future to present realities in a series of causal links that illustrate decisions and consequences.[47]

Oracle Col John Geis, one of the USAF's top futurists and expert Scenario builder, warned that while Scenarios are a powerful technique, the assumptions on which they are based can lead to vastly different results if those underlying assumptions are not valid or prove untrue.[48] The five Scenario variables in this study consisted of status of the nation, degree of technological advancement, the state of natural resources, the amount of conflict, and the intensity of conflict. These Scenarios were built explore the likely missions the USAF would perform. Each Scenario was approximated by a popular science fiction film to give the Oracles a frame of reference for answering the questions. In order to canvass a wide range of possible futures, this study used a Worst Case, Best Case and Most Likely Case Scenario at the beginning of the 22nd century.

The Worst Case was a heavily resource-constrained world that was rife with nation state and non-state conflict and thus roughly described as a *Mad Max*-like future. The Best Case was a technologically advanced future with very little state conflict and therefore similar to a *Star Trek*-like future. The Most Likely Case was approximated by a *Blade Runner*-like future that had advanced technologically but remained in conflict.

The theoretical basis of this study was Gordon and Glenn's assertion that a range of possible futures can be known, gradations of foreknowledge and probabilities can be made, and humans will have more influence on the future than they did in the past. It then follows that in theory, the likelihood of a future event or condition can be changed by policy, and policy consequences can be forecasted. The methodology employed also follows Gordon and Glenn's prescription that no single method should be trusted and cross referencing methods improves foresight.[49] The following chapters will present the results of this theory and methodology.

Notes

[1] Jerome C. Glenn and Theodore J. Gordon, eds., *Futures Research Methodology V2.0* (Tokyo, Japan: United Nations University, 2000), CD-ROM, Millennium Project.

[2] John Elfreth Watkins, Jr. "What May Happen in the Next Hundred Years," *Ladies Home Journal*, December 1900, 8.

[3] Jules Verne describes manned spaceflight using a bullet-shaped capsule fired from massive cannon. Jules Verne, *From the Earth to the Moon* (Strasbourg, France: Pierre Jules Hetzel, 1865). Original publication.

[4] In this classic, H.G. Wells describes the Martian death ray "directed energy" weapon. H.G. Wells, *War of the Worlds* (London, England: Heinemann, 1898). Original publication.

[5] Guillaume De Syon, *Zeppelin!: Germany and the Airship, 1900-1939* (Baltimore, Md.: Johns Hopkins Press, 2007) 15.

[6] Norman Friedman, *U.S. Submarines through 1945: An Illustrated Design History* (Annapolis, Md.: United States Naval Institute) 19.

[7] Jerome C. Glenn and Theodore J. Gordon, eds.

[8] Stanley Schmidt, *The Coming Convergence: Surprising Ways Diverse Technologies Interact to Shape Our World and Change the Future* (Amherst, NY: Prometheus Books, 2008) 50-56.

[9] Ibid., 62-64.

[10] Ibid., 185, 212.

[11] Jerome C. Glenn and Theodore J. Gordon, eds.

[12] Ibid.

[13] The Office of Net Assessment (ONA) reports directly to the Secretary of Defense. ONA's broad mission is to prepare the DOD for the future.

[14] *Future Warfare 20XX Study Group*, "Future Warfare Workshop," presentation, Center for Strategic and Budgetary Assessments, Washington D.C., 21-22 October 2008.

[15] Ibid.

[16] Ibid.

[17] Thomas L. Friedman, *Hot, Flat and Crowded* (New York, N.Y.: Farrar, Strauss & Giroux, 2008). Friedman warns of the depletion of fossil fuels and the need to develop renewable and "green" energy.

Notes

[18] *Blue Horizons* is a Futures Study Project at Air University.

[19] Ray Kurzweil, *The Age of Spiritual Machines: When Computers Exceed Human Intelligence* (New York, N.Y.: Penguin, 1999). *The Age of Intelligent Machines* and *The Singularity is Near: When Humans Transcend Biology* are two more of his influential books dealing with the fusion of GRIN technologies and the singularity.

[20] Vernor Vinge, "The Coming Technological Singularity: How to Survive in the Post-Human Era," *VISION-21 Symposium*, NASA Lewis Research Center and the Ohio Aerospace Institute, 30-31 March 1993.

[21] Damien Broderick, ed., *Year Million: Science at the Far Edge of Knowledge* (New York, N.Y.: Atlas & Co., 2008).

[22] Joseph Coates, "How to do a Future's Study, lecture, Georgetown University, Washington D.C., 3 September 2008.

[23] Thomas Ehrhard, "The Military Instrument of Power," lecture, Georgetown University, Washington D.C., 26 February 2009.

[24] Maj Shelley Kavlick, HQ USAF Plans and Programs, interviewed by author, 12 November 2008.

[25] "Northrop Grumman Announces the FIRESTRIKE Laser, World's First Weaponized Solid-State Laser for U.S. Military Services," *GlobalSecurity.org*, 13 November 2008, n.p., on-line, Internet, 10 April 2009, available from http://www.globalsecurity.org/military/library/news/2008/11/mil-081113-northrop-grumman01.htm.

[26] Jack Spencer and James Jay Carafano, "The Use of Directed-Energy Weapons to Protect Critical Infrastructure," *The Heritage Foundation*, 2 August 2004, n.p., 1 April 2009, available from http://www.heritage.org/research/ballisticmissiledefense/bg1783.cfm.

[27] Ibid.

[28] Ibid.

[29] "Sticker Shock: Estimating the Real Cost of Modern Fighter Aircraft," *Defense Aerospace.com*, 2006, n.p., on-line, Internet, 1 April 2009, available from http://www.defense-aerospace.com/dae/articles/communiques/FighterCostFinalJuly06.pdf.

[30] The GAO estimates the Unit Procurement Cost of the F-22 at $177.6 million. From "Sticker Shock: Estimating the Real Cost of Modern Fighter Aircraft," *Defense Aerospace.com*, 2006, n.p., on-line, Internet, 1 April 2009, available from http://www.defense-aerospace.com/dae/articles/communiques/FighterCostFinalJuly06.pdf.

[31] TSgt. Russell Wicke, "Rising Fuel Costs Tighten Air Force Belt," *Air Combat Command News Service*, 8 September 2006, n.p., on-line, Internet, 1 April 2009, available from http://www.af.mil/news/story.asp?id=123026679.

[32] Ibid.

[33] SSgt. C. Todd Lopez, "US Air Force FY 2008 Budget Includes Pay Raise, New Facilities," *Air Force Print News*, 2 May 2007, n.p., 1 April 2009, available from http://www.saffm.hq.af.mil/news/story.asp?id=123041988.

[34] Glenn and Gordon.

[35] Ibid.

[36] Ibid.

[37] Ibid.

[38] Ibid.

Notes

[39] Col William Eldridge poses a valid question which underscores the difficulty in making the subjective choices required to decide if a SOFI variable or factor is "improving" or "declining." He notes that a B-52 used to need a crew of six, then 5 (gunner position eliminated because technology made that position obsolete). A B-1 has a crew of 4. A B-2 has a crew of 2. All made possible by technology doing human work (GPS navigation, better radar displays, and better cockpit interface). Similarly, a 4-ship of F-16s is much more powerful than a squadron of P-51s. We have a lot less fighter squadrons than we had in the past largely because the aircraft we have today are more capable.

[40] Data for 1997 to 2013 was taken from the "Facts and Figures," *Air Force Almanac* 91, no. 5 (May 2008), 36-66.

[41] This method differs slightly from Glenn and Gordon's technique. The combining of variables was done arithmetically for this study using weights to denote the level of importance of each variable vice a subjective assessment on how to combine the variables. Also, in place of a program, Glenn and Gordon used equations for a linear, logarithmic, exponential, power, and S-shaped curve to determine the best fit for the weighting of the variables (factors).

[42] Wilton and Cleide Pereira da Silva, *LAB-Fit Software Program* version 7.2.45, Campino Grande, Brazil, 2009. The program executes Curve Fitting for nonlinear regression using the least squares method, Levenberg-Marquardt algorithm.

[43] *Excel* Graphing Tool, Microsoft Corporation, 2003. A limitation of the *Excel* tool is it can only display a linear slope. However, for the purposes of a SOFI, which only purports to predict if conditions are improving or declining, this was sufficient and more readable than the using LAB-Fit software to display the final result.

[44] Glenn and Gordon.

[45] Ibid.

[46] Peter Schwartz, *The Art of the Long View: Planning for the Future in an Uncertain World* (New York, N.Y.: Bantam, Doubleday & Dell, 1996), 4-6.

[47] Glenn and Gordon.

[48] Col John P Geis, "Delphi Poll Round Two," 31 January 2009, email, 31 January 2009.

[49] Glenn and Gordon.

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Chapter 3

The Worst Case Scenario

We are in the Sopwith Camel stage of Cyber Warfare, in 2108 the JSFs of cyber warfare will be rolling out.

—LtCol Bartz Sykes

The Worst Case Scenario is not the worst imaginable Scenario—the axiom is true, no matter how bad things are, they can always get worse. The "real" Worst Case Scenario is a future with no future, where mankind has been exterminated by an Extinction Level Event (ELE) such as a comet or asteroid impact. While certainly possible, examining such a future is rather pointless except in hopes of avoiding an ELE. This Scenario avoided the ELE and envisioned a United States weakened by economic decline, loss of manufacturing base, ineffective governance and severe resource depletion. The world fractionalized along ethnic lines creating many small states. Technological development continued but not necessarily for the good of mankind.

Status of the Nation

In this Scenario, United States influence and national power declined, likewise, so did the rest of the world. However the decline was not relative. Because of their commitment to renewable energy, the European Union's decline was both slower and less severe, as it was with many other developing nations whose economies were not entrenched in a foundation of fossil fuels. Climate change caused the collapse of the Atlantic thermohaline circulation, leading to

increased carbon dioxide and further warming.[1] This development led to sustained drought in the United States, especially in the western region. The United States also faced the danger of breaking apart and the government expended considerable effort in quelling secessionist threats and rebellions. The rationale for secession was based primarily on the energy and water "have" and the "have-not," but there was considerable pressure from Mexico and Mexican-American groups to reclaim the southwest region.[2]

Elsewhere in the world, the trend of large states breaking apart had been steadily progressing. This trend has modern roots. For example, Yugoslavia fractionated along largely ethnic lines to form five separate nation states. This trend is so common that it spurred creation of its own verb—Balkanization. Author and diplomat Strobe Talbot notes that this trend has been occurring since the "fall of empires" starting with the Greeks, then Romans, then Ottomans, then British and arguably the Soviets.[3] While the counter-argument is that empires rise and thus reconsolidate nation states, this rarely happens to the degree that they fragment. Thus the trend has been consistently toward the net creation of more nation states.

These trends affected national security and USAF missions in two ways. First, this self-determination process normally led to some degree of armed conflict, perhaps involving the United States. This was true in the Balkans in the 1990s and was indeed true for America in 1776. A second consequence of this process was an overall net decrease in national power across the globe as larger states devolved into many smaller states. The Soviet Union provides a clear example of a single nation capable of opposing the United States as a peer competitor that Balkanized into a myriad of smaller nations whose parts do not equal what was once the whole.

Technological Advancement

Despite the decline in US national power, GRIN continued to advance, but application was stunted and the fusion of these technologies never reached its potential. Often GRIN was used for destructive purposes or to gain advantages over other groups or nations. While GRIN did provide for more advanced computers, true artificial intelligence (A.I.) did not exist. Only a handful of the population received genetic and mechanical enhancements for several reasons. First, the governments of this conflict-ridden world rigorously enforced laws against enhancements for fear these tools would be weaponized. Second, the enhancements were expensive and required special governmental permission. However, The US government and the USAF encouraged the genetic, cybernetic and mechanical enhancement of personnel primarily to combat enhanced personnel from warring states or groups.

Natural Resources

In approximately 2080, nearly all of the usable oil and much of the easily-accessed coal was depleted (see Figure 12 below).[4] The United States and much of the world did not develop viable alternative energy sources until massive increases in the price of oil wrecked the global economy. While the technology for renewable and alternative energy existed, it was not widespread and very few industries made the switch, choosing instead to pay the escalating prices rather than make the expensive initial investment. Oil remained the primary energy source for transportation until supplies were nearly depleted. Once the price of fossil fuels became exorbitant, the switch was started, but the technology and money to complete the switch in a timely manner did not exist. This led to the most severe and rapid global and national economic depression in history. Warning of the severity of this development, Ambassador Steven Mann stated, "Its remarkable how quickly a developed country's economic activity drops

to single digits when its energy supply is interrupted."[5] The speed and depth of the depression overwhelmed governments at all levels.

Oil was not the only natural resource in short supply. Global climate change led to severe scarcity of fresh water.[6] For the first time in US history, thousands of citizens died of thirst Due to continued drought and general depletion of fresh water, the United States ceased to be the breadbasket of the world and only fed its own population on an exclusively vegetarian and synthetic diet because there was no additional agricultural output to support livestock.

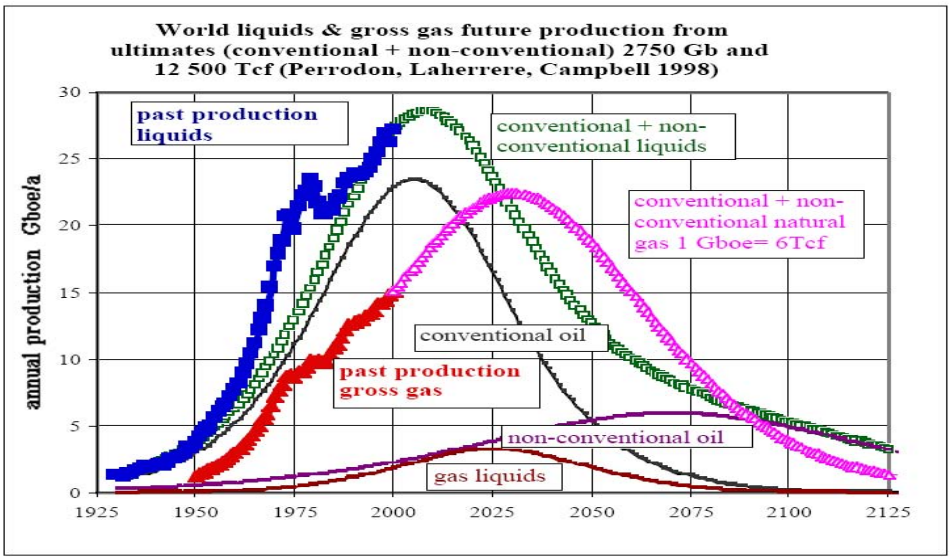

Figure 12. An estimate of future fossil fuel production showing conventional oil depletion around 2080 (From Jean Laherrere, *Forecasting Future Production from Past Discovery*. OPEC Report (Vienna, Austria: OPEC, September 2001), 25.)

Amount and Intensity of Conflict

The amount of state and non-state conflict continued to accelerate. Military altercations spanned a wide swath of the spectrum of conflict from peacekeeping to nuclear and bio war. The US military in general and the USAF in particular saw an ever-increasing operations tempo with

ever-decreasing financial sustainment. As natural resources dwindled, more state conflict arose as the United States scrambled to secure access to energy and resources both globally and nationally. Severe restrictions on the supply and access to fresh water also drove state and non-state conflict. Frequent water and energy wars and rebellions required constant military intervention both within the borders of the United States and across the globe. Because of their grave effectiveness and relative affordability, biological weapons were used quite routinely and nuclear detonations were not uncommon.[7]

SOFI Index Results

The SOFI curve indicates the USAF in a slight decline from 2008 until 2080, then a massive drop, resulting in a 75 percent decrease over the next 100 years. From 2008 until 2080, there is a modest decline in capability due primarily to the lack of capital re-investment and continued high-operations tempo. The reason for this lack of capital re-investment is due, ironically, to the success of the USAF in the 20th and early 21st centuries.[8] Since the fall of the Soviet Union, the USAF had no peer competitor and continued to easily defeat its adversaries and maintain the appearance of air superiority throughout the mid-21st century. The government continued to neglect USAF development and recapitalization as dwindling funds were diverted to programs, agencies and military services that were more obviously struggling to accomplish their mission. Governmental priorities until the mid-21st century were fixing the crumbling national infrastructure, shoring up social security, providing universal healthcare, bolstering the Border Patrol, rebuilding the US Army and militarizing law enforcement to handle the increasingly well-armed population.[9]

A similarly neglectful attitude occurred at NASA that led to catastrophic failure in 2003. NASA failed to respond to the problem of insulating foam from the booster rockets striking the

orbiter. Shuttle managers "had treated each additional debris strike *not* as evidence of failure that required immediate correction, but as proof that the shuttle could safely survive impacts that violated its design specifications." The Shuttle kept flying, accomplishing its mission despite the need for critical maintenance action to repair the errant foam…with each mission and foam strike categorized as a success. Then in February 2003 while returning from its 27th voyage, the Space Shuttle Columbia burned up during re-entry because insulating foam had dislodge some heat-shielding tiles.[10] This concept of "success masking failure" is prevalent in many engineering and organization problems alike where critical issues are not recognized as such until disaster strikes.

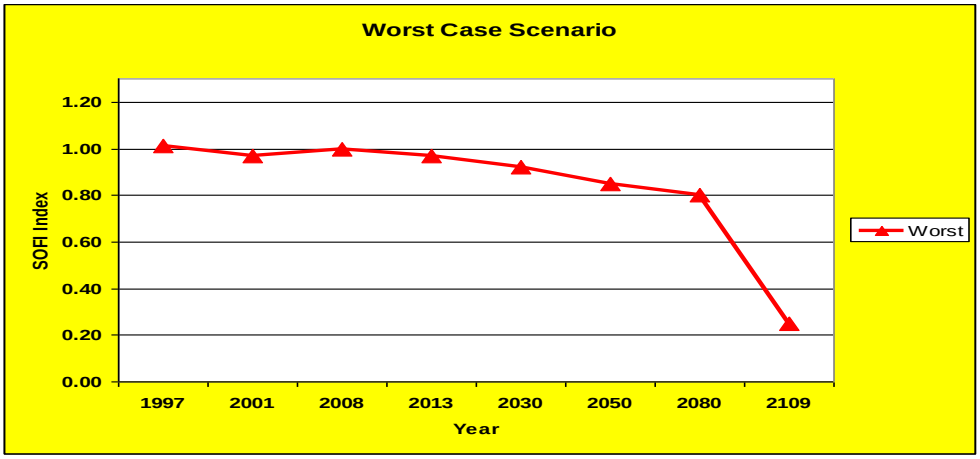

Figure 13. SOFI Index for the Worst Case Scenario (From LtCol J.M. Chesnutt, 2008).

Despite the fiscal neglect, the USAF cushioned the decline by leveraging GRIN, chiefly by replacing expensive people with much less expensive machines or software. However, the USAF failed to develop alternative energy sources for its aircraft. This resulted in a fossil-fuel based force that proved too expensive to adequately train. The same economic downturn that stunted the GRIN fusion also proved to be a significant cost to the USAF. While the technology existed to build advanced virtual-reality simulators that would have provided realistic training,

lack of funds prevented development and procurement. This was largely the result of the decreasing purchasing power of the DOD due to the excessive cost of modern weapons systems and the inefficiencies of the acquisitions process.

The USAF did begin developing solar and hydrogen powered aircraft, but the designs were not viable when compared to their fossil-fueled adversaries and the projects were continually placed below the funding line. Oil baron T. Boone Pickens's prediction of $500 a barrel for oil comes true in 2070, which caused these projects to be are re-prioritized after languishing for decades.[11] Interestingly, the USAF dusted off the 1950's plans from Project Pluto which had made considerable headway into designing nuclear-powered aircraft.[12] The USAF then fielded a very small fleet of nuclear, solar and hydrogen-powered transports, bombers and unmanned attack and surveillance aircraft.

After 2080, the USAF could not independently fly, fight, or win to any significant degree and had to carefully prioritize which missions to conduct with its few alternative fuel-powered aircraft. After the "Greatest Depression" of 2080, the funding to purchase more alternative-fuel powered aircraft did not exist although the technology has matured appreciably.

Coates Futures Diagram Results

The Worst Case Scenario suggests dire policy implications for the USAF. Aside from multiple medium and low-intensity conflicts abroad, the USAF would also be heavily engaged in domestic peacekeeping, border protection and civil support—all after declining 75 percent from today's Air Force. A consequence of having no fossil fuel and very little funds to purchase alternative-fueled aircraft results in a "technological" regression to the earliest days of the USAF. In this Scenario, the primary airlifters are solar-powered dirigibles and the primary surveillance and attack aircraft are solar-powered "gliders."[13]

Making matters worse, the United States must adopt a policy of continuously threatening to use nuclear, cyber or bio weapons because it is incapable of waging a general or regional conventional war. In addition, the United States formally declared its policy of using tactical nuclear weapons or bio weapons if attacked conventionally. This policy led to several small-scale tactical nuclear and bio weapon exchanges, several of which occurred on US soil, further contributing to economic decline and anti-government sentiment.

Delphi Poll Results

Round One of the Delphi Poll asked which missions would be most important and if those missions would change significantly. This poll uncovered ten major trends, six of which are most applicable to this Scenario. First is the increasing prominence of the cyber-domain in all aspects of military operations.

Cyberwarfare

Even without the advanced artificial intelligence, cyberspace still becomes the pre-eminent battlespace. However, cyberwarfare in this Scenario is not nearly as advanced as in the Best and Most Likely Case Scenarios. The primary change in function is the ubiquitous nature of cyberwarfare in the 22nd century. Every machine battles every other machine for information—either to protect it, distort it or share it. Whoever controls cyberspace will control all the weapons reliant upon it.

Second, many Oracles believed that the United States will suffer a significant or relative loss of economic and military power while Brazil, Russia, India and China will gain in power, eventually overtaking the United States or at least reaching parity. This belief, combined with the fact that cyberwar is relatively inexpensive to conduct, leads to its frequent employment

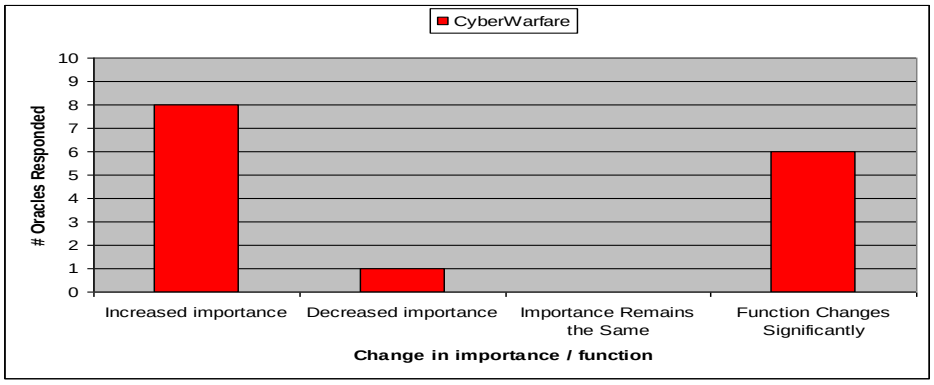

Figure 14. Cyberwarfare results from Round One (From LtCol J.M. Chesnutt, 2008).

Due to the relative lack of pervasiveness of information technology in this Scenario, cyberwarfare is not effective against all state and non-state adversaries. In these cases, the United States resorts to force employment, often with the threat or use of bio or nuclear weapons.

Counterair

The third trend most applicable to this Scenario is the need to transition to non-fossil-fuel-based aircraft. In this case, specifically, were the ramifications of failing to do so. A consequence of this trend is offensive counterair, one of the vaunted missions of today's USAF, is of little importance due the lack of capable aircraft. Even in the relatively modest technological environment, missile and sensor systems have a significant advantage over the relatively slow solar and fuel cell-powered aircraft. This is also the fourth trend—the gain in capability of cheaper defensive systems which can counter expensive offensive systems. Gaining air superiority is virtually impossible because of defensive "anti-access" systems, making sustained land offensives very costly.

Round Two of the Delphi Poll clearly indicates that cyber-warfare, surveillance and reconnaissance, special operations and intelligence would constitute the most important missions. Interestingly, many Oracles still believed space missions will play a vital role despite

the *Mad-Max* nature of this Scenario. The majority, minority and outlier opinions as to which missions will be most important are graphically displayed below.

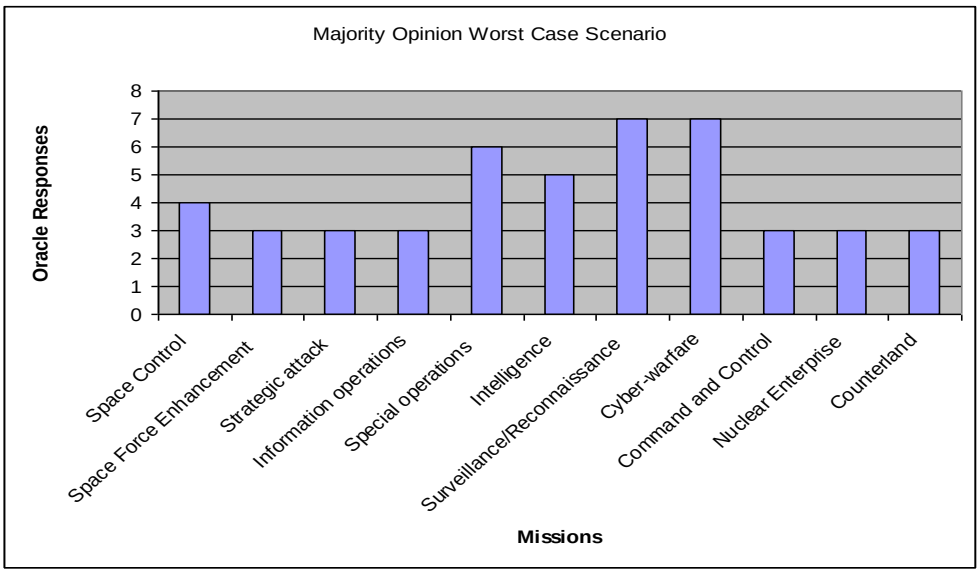

Figure 15. Delphi Poll Round Two Results—Majority Opinion (From LtCol J.M. Chesnutt, 2008).

Nuclear Enterprise

Oracle Col John Geis echoed the results found in the Coates Diagram in that nuclear weapons loom large in this Scenario.[14] In essence, the United States would revert back to the 1960s policy of "Mutually Assured Destruction" to deter attacks. Surveillance and reconnaissance are important both home and abroad as the USAF must monitor friend and foe alike. Special operations provide a relatively inexpensive method for achieving a strategic effect and therefore figure prominently in this cash-strapped Scenario.

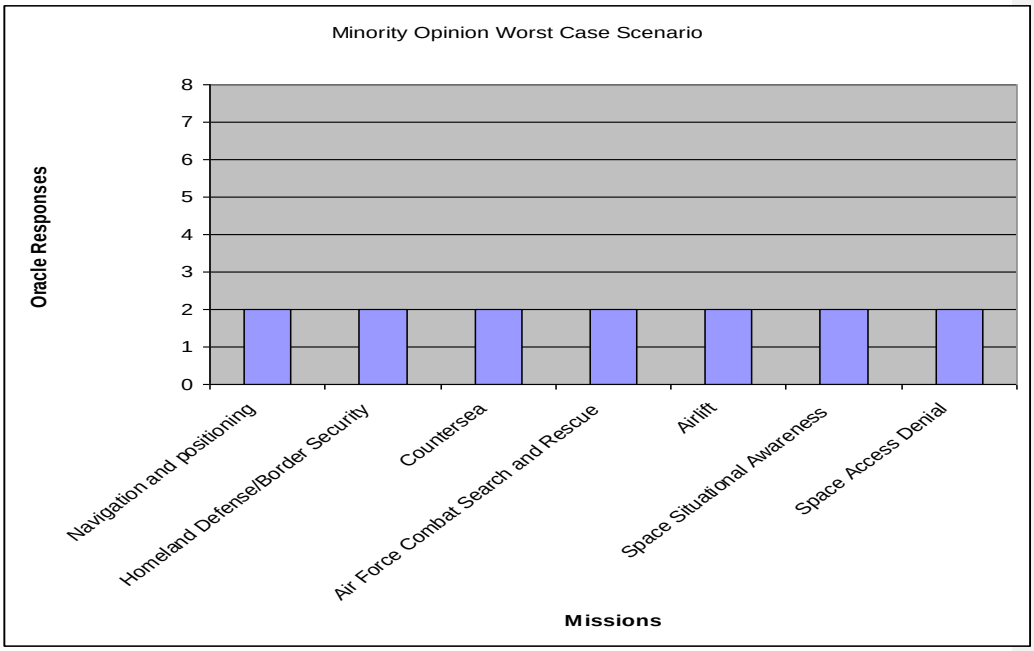

Figure 16. Delphi Poll Round Two Results—Minority Opinion (From LtCol J.M. Chesnutt, 2008).

Homeland Defense and Civil Support Operations

Several Oracles predicted that if the homeland is in turmoil then naturally the USAF would expend considerable effort toward air policing and homeland defense missions in addition to surveillance and reconnaissance.[15] This follows the fifth trend of the USAF adding more missions to its repertoire. The USAF is already predicting a need to accomplish these types of mission and recently added "Humanitarian Assistance Operations" and "Disaster Response" as mission subsets in its draft memo on core missions.[16] Regardless of Scenario, the pressure for the USAF to participate in homeland defense will continue as existential threats brought about by nuclear proliferation and GRIN fusion increase. Several Oracles noted that one of the most dangerous trends is the consolidation of immense destructive power in the hands of small groups, or even one person. This trend was seconded by the Future Warfare 20XX working group.

Traditionally, enormous destructive power was reserved for nation states…no more as the proliferation of nuclear power (and hence weaponry) continues to advance along with potentially nefarious uses of GRIN.

Space Access Denial

Space Access Denial (SAD) is one of the missions proposed by Oracle Dr. Vernor Vinge.[17] He purported that keeping your adversary from getting into space is potentially much easier and less expensive than getting there yourself. So, while you may not have the high ground, neither does your opponent. Therefore, developing anti-satellite and anti-launch-vehicle (anti-missile) systems will be a priority. The sixth trend of the increasing importance of directed energy weapons, which in theory could offer cheap counters to expensive projectiles, will undoubtedly play a major role in SAD mission evolution, as does the trend of increasingly effective and cheap defensive systems.

The Worst Case Scenario laid out the ramifications of failing to recognize the fairly obvious and game-changing trend of America's sloth-like approach to developing alternative energy, especially renewable energy. Oil is literally the lubricant and the fuel of the world's economic engine, when it depletes, the world economy will "throw a rod." The only hope is a back up engine will be standing by with an abundant supply of (alternative) fuel. However, the SOFI did not assume a backup engine, which resulted in a precipitous decline in the USAF. The major policy recommendation from the Coates Futures Diagram is a return to the Mutually Assured Destruction mindset on the 1950s because the United States possesses such a paltry conventional arsenal. Two Oracles made prescient statements regarding this Scenario which serve as apt summations. The first warned to resist the temptation, especially when faced with extreme economic challenges, to discard an appropriately-sized force in favor of a smaller elite one.

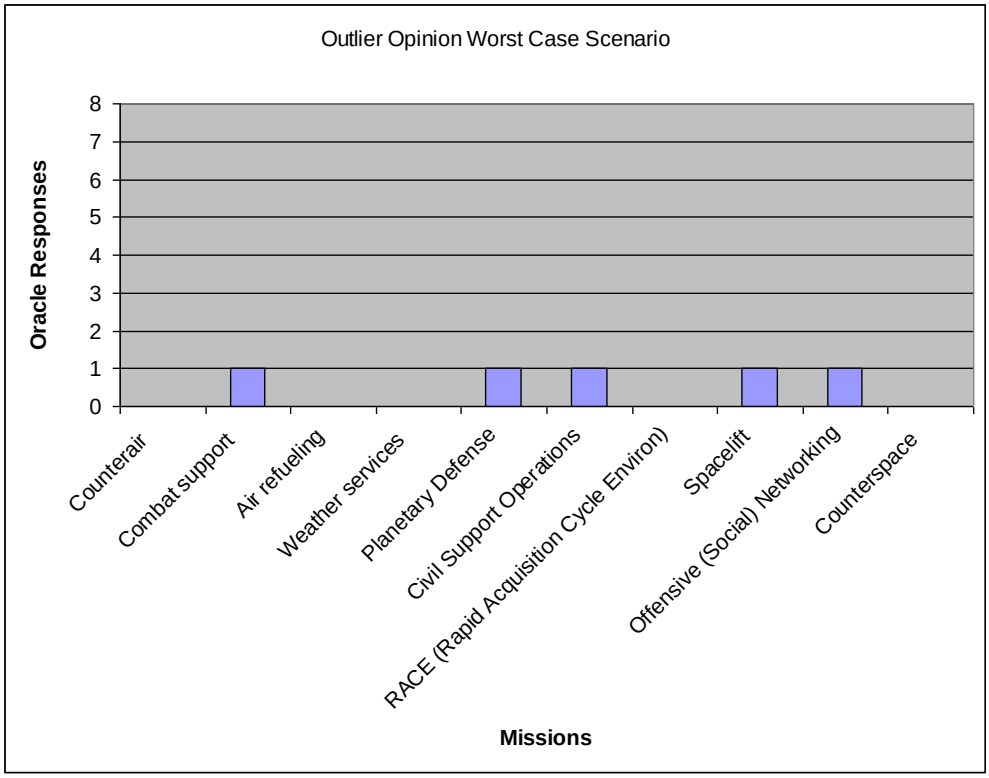

Figure 17

Figure 18. Delphi Poll Round Two Results—Outlier Opinion (From LtCol J.M. Chesnutt, 2008).

Renowned author, scientist and Oracle Dr. David Brin warned that such an approach, if taken to the extreme, "can only be an absolute guarantee of long-term failure…and, once failure occurs, that model allows almost no paths back from defeat." The other Oracle, Col Alan Woodcock, provided an appropriately succinct comment for this Scenario, "In 100 years the margin for error that we currently enjoy will evaporate." This unpleasant reality is all the more reason to take positive steps to avoid this Scenario and aim for the Best Case future.

Notes

[1] Timothy M. Lenton, et al., "Tipping Elements in the Earth's Climate System," *Proceedings of the National Academy of Sciences* 106, no. 6 (12 February 2008), 1793.

[2] John Tiffany, "The 'Reconquista'—Mexico's Dream of 'Retaking' the Southwest," *The Barnes Review*, 20 March 2001, n.p., on-line, Internet, 19 April 2009, available from http://www.thegawds.com/reconquista/.

[3] Strobe Talbot, *The Great Experiment: The Story of Ancient Empires, Modern States, and the Quest for a Global Nation* (New York, N.Y., Simon and Schuster, 2008), 46-53.

[4] From Jean Laherrere, *Forecasting Future Production from Past Discovery.* OPEC Report (Vienna, Austria: OPEC, September 2001), 25.

[5] Ambassador Steven R. Mann, "Energy, Russia and the European Union," lecture, Georgetown University, Washington D.C., 16 April 2009. Ambassador Mann is the Coordinator for Eurasian Energy Diplomacy. The ambassador noted how Central European economic activity nearly halted when Russia cut energy to the Ukraine.

[6] William E. Halal, "Technology's Promise: Highlights from the TechCast Project," *TechCast Project*, November-December 2008, n.p., on-line, Internet, 19 April 2009, available from http://www.techcast.org/Forecasts.aspx?ID=19.

[7] Futurist Ray Kurzweil predicts a Biowar agency will be established to regulate police the use of Bioweapons. Ray Kurzweil, *The Age of Spiritual Machines: When Computers Exceed Human Intelligence* (New York, N.Y.: Penguin, 1999), 216.

[8] Henry Petroski, *Success through Failure: The Paradox of Design* (Princeton, N.J.: Princeton University Press, 2006), 165-166.

[9] Lt Gen Michael Short, "Delphi Poll Round One," 11 November 2008, email, 11 November 2008. Gen Short sees a continued decline in military spending as social programs continued to garner a larger share of the federal budget.

[10] Petroski, 165-166.

[11] T. Boone Pickens, "The Pickens Plan," lecture, Georgetown University, Washington, D.C., 22 September 2008. In response to a question, Pickens said he would live to see $300 a barrel for oil and his grandkids would live to see $500 a barrel "well before the turn of the century."

[12] Gregg Herken, "The Flying Crowbar," *Air and Space Magazine* 5, no. 1 (April/May 1990): 28.

[13] Vikas Shekhawat, "Top 12 Solar Powered Aircraft," *Blazing Wings*, 13 September 2008, n.p., on-line, Internet, 28 April 2008.

[14] Col John Geis, "Delphi Poll Round Two," 2 December 2008, email, 2 December 2008.

[15]Col William Eldridge, "Delphi Poll Round One," 18 November 2008, email, 18 November 2008.

[16] New USAF Mission Statement (Draft), HQ USAF, Washington D.C., 2009

[17] Dr. Vernor Vinge, "Delphi Poll Round Two," 14 March 2009, email, 14 March 2009.

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Chapter 4

The Best Case Scenario

> *However, if the Singularity happens, and I believe it will happen well before 2100, then our planning for that era is NOT like a young 1918 Billy Mitchell trying to imagine 2018 -- it's more like a flatworm trying to imagine the opera.*
> — Dr. Vernor Vinge (2008)

This Best Case Scenario envisioned a counter-trend to the Balkanization of the United States. Instead of fractionalization, the United States formed a megastate, as did most countries. To draw and cosmological analogy, this would be the Big Crunch that would signal the end of the expansion resulting from the Big Bang. Oracle Dr. Charles Gannon, a noted futurist and author, postulates that blocs (his terms for megastates) would form in order to more efficiently utilize scare resources and to balance against other blocs.[1] This type of behavior is common in business when corporations "vertically integrate" to increase efficiency and reduce costs by absorbing competitors or suppliers.

Status of the Nation

The Best Case future suggested not a United States of America, but a United States of North America (USNA) consisting of the "former" United States, Canada, Mexico, all the Central American and most of the Caribbean states. Increased globalization, leveraging of economies of scale and dwindling natural resources provided the motive force behind the consolidation. The

United States expanded the North American Free Trade Agreement to include an open border. When Russia joined the European Union (EU), the United States pushed for the establishment of the USNA in order to counter EU economic and military power.

Interestingly, the megastate trend continued as other nations fused to better balance against the USNA and the EU.[2] All of South America consolidated into the Confederated States of South America; Australia, New Zealand, India, Japan and most of Polynesia formed Oceania; China, Korea, Thailand and Vietnam, Laos, Cambodia formed the Asian Federation; The Muslim states of the Middle East and North Africa formed the Union of Muslim States; and the Southern states in Africa formed the Aligned African Nation. Only a handful of independent states remained, and they all signed economic and defense agreements with the most suitable megastate, such as Israel with the USNA and Switzerland with the EU. All these megastates had a high degree of resource, economic and military self-sufficiency. While relations between megastates remained quite positive, there were still areas of conflict. Most disputes where resolved at the United Nations, which had shrunk from 192 member states in 2009 to 11 countries in 2109.

Technological Advancement

The technological trends center on GRIN and the degree of fusion attained. The lynchpin technological future trend was the "singularity." Dr. Vernor Vinge coined the term to explain the point where greater-than-human artificial intelligence is "born" by developing computers or networks with such intelligence that they "wake up."[3] He believes that "computer-human interfaces may become so intimate that users may reasonably be considered superhumanly intelligent."[4] Vinge's supposition is certainly supported by the Figure 19 below.

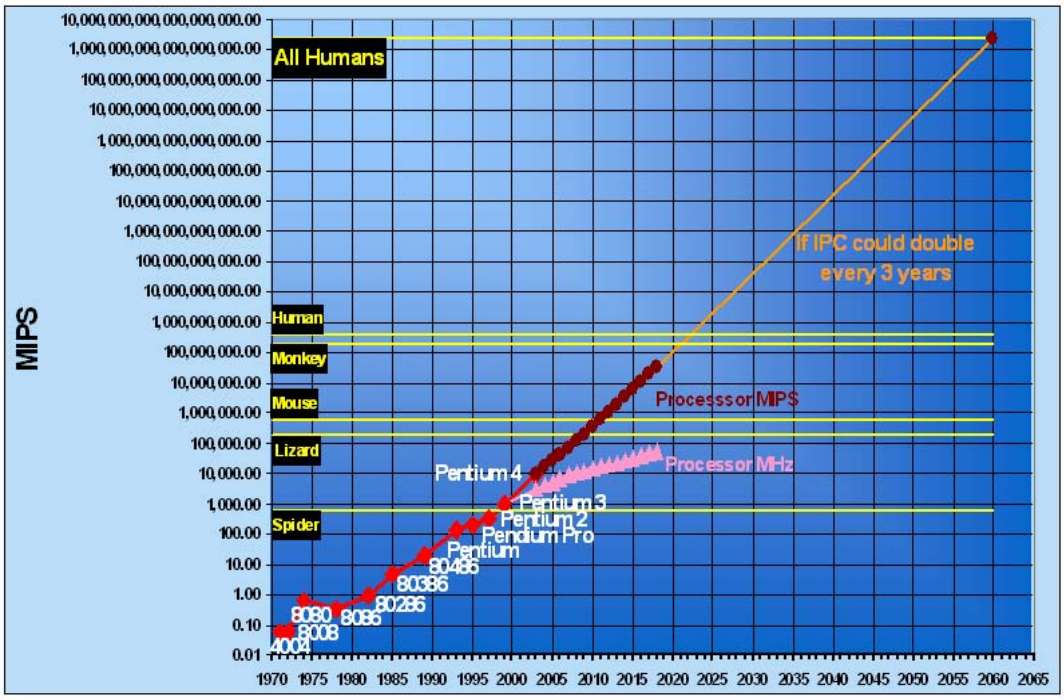

Figure 19. Projected development of computing capacity through 2100 showing Million Instructions Per Second and the development of inter-process communications (IPC) as compared to various animals (From *Future Warfare 20XX*, "Future Warfare Workshop," presentation, Center for Strategic and Budgetary Assessments, Washington D.C., 21-22 October 2008).

Figure 19 shows that a Pentium 3 computer chip can perform 1,000 Million Instructions per Second (MIPS), which is about the same computing capacity as a spider's brain. If Moore's Law continues through 2030, then computers will have the same computing capacity of a human brain. In 2030, true A.I. could be born. By 2060, a single computer will have the computing capacity as all of humanity. Most futurist agree on the inevitability of the singularity—so named because computing power increases with an asymptotic slope with respect to time. If the singularity occurs, then the slope depicted on Figure 19 would "go vertical." The singularity would drive even faster and more advanced artificial intelligence…and thus even more rapid progress in other fields.[5] This would lead to an "exponential runaway beyond any hope of

control" and developments previously thought would take a million years, if ever, will happen by the 22nd century.[6] The singularity has been foretold in science fiction films such as *Colossus: the Forbin Project*[7] in the 1970s, *The Terminator*[8] in the 1980s and *The Matrix*[9] trilogy in the 1990s. In these Scenarios, the self-aware computers enslave or attempt to destroy mankind.

Futurist Ray Kurzweil sees the opposite—the singularity ushers in a near heaven-on-earth Scenario.[10] In this future, most people choose a great deal of enhancements; while some choose only modest enhancements and others choose none.[11] The people who choose only a modest level of enhancements are referred to as Mostly Original Substrate Humans (MOSHs) and retain their human bodies and neural systems. Many futurist agree with Kurzweil that the flesh and blood people of the next century will be genetically enhanced either in-vitro or after birth and employ mechanical or cybernetic devices to improve performance.

The forces and means to genetically enhance will be pervasive. How many couples could resist engineering their son or daughter a 150 IQ, especially if most other parents chose that path? Imagine if your kid was the only one in his or her high school who did not receive mental or physical genetic enhancement? He or she may not make the football team and may not get into the best colleges, even if he or she scored above average as a "non-enhanced" human.

Much more difficult to morally dissuade is the desire to genetically remove defects or diseases. While parents may question the ethics of giving their offspring a 150 IQ or the ability to run a four second 40-yard dash, they probably would not hesitate to remove a genetic precondition for a deadly disease. Governments could pass laws restricting genetic enhancement, but the United States would have the same problem on the world stage as the parents did in their community—some countries would not restrict enhancement. In order to stay competitive, the United States would be compelled to follow suit and allow or even

persuade its citizens to enhance themselves. This trend and the forces behind it will only grow and become more intense as the world "globalizes" and GRIN fuses.

The nascent steps toward creating "super soldiers" are already underway at the Defense Advanced Research Project Agency (DARPA). The Continuous Assisted Performance project strives to eliminate the need for sleep by mimicking dolphins and whales, which remain awake for their entire lives.[12] Considerable personnel cost savings could be attained if there were no need to augment an aircrew for long-duration missions, as is standard practice in today's USAF. Other DARPA programs are investigating blocking pain, regenesis (regrowing body parts), and increasing the immune system enough to ward off severe diseases such as Smallpox and Ebola.[13]

Oracle John Smart, a futurist specializing in human performance, takes a contrary view, at least until the year 2032. He states that our DNA has so much "legacy code protecting older systems" that we have "about saturated our ability to make genetic changes to the human organism."[14] Smart feels that our "wetware is just too delicate, old, slow and sloppy to improve significantly."[15] Smart's work, evidently, does not assume the singularity will take place by 2032; if it does, it will not immediately spur genetic enhancements. Once the singularity occurs, many of the remaining secrets of the human body will be uncovered and some of the barriers Smart delineates will most likely be overcome.

It is possible that within 90 years, cybernetic brain implants will enable humans to fuse their minds with A.I. In 2099, Kurzweil postulates another type of being—a software-based human whose abilities dwarf even the most enhanced people. By the 22nd century, the human brain will be completely reverse engineered and all aspects of its functioning will be understood. For these software-based "people," the concept of life expectancy has become irrelevant and they can attain knowledge and skills instantly.[16] They are capable of manifesting themselves at will in the

physical world by creating or taking over robotic bodies.[17] They would make "back-ups" of themselves in case they were inadvertently or intentionally damaged or erased. The software-based humans would be responsible for the vast majority of discoveries and would solve the most complex problems because they are capable of assimilating trillions of terabytes of information and multitasking in countless directions.[18]

As Vinge mentioned in the epigraph, the changes the singularity brings will defeat our capacity to imagine. Glenn and Gordon's fifth axiom of futures research that "humans will have more influence on the future than they did in the past" may prove the understatement of the eon.[19] Homo sapiens have existed for the last 250,000 years, but in the next 100, most of our species could become unrecognizable as humans.

Many futurists agree with Kurzweil that the singularity could bring about radical change not only in the way we live, but in who we are. However, such an eventuality would negate most of what this research paper endeavors to uncover—in fact, it would negate much of the research undertaken by everyone everywhere. Conceding that a flatworm would do a poor job investigating the future of the USAF, the Kurzweillian software-based humans only exist to a limited degree in the Best Case Scenario. Kurzweil has compiled an impressive track record as a futurist; he accurately predicted the widespread use of wireless networks, portable computers and cell phones, as well as dwindling privacy, and therefore his prediction of software-based humans in 2099 should not be discounted.[20] While it is arguable to the degree at which humans and A.I. will interact, it is not arguable that the trend of the increasing importance and reliance on GRIN will continue, especially in this future.

Natural Resources

In this future, the United States led the world in the development of renewable power, perfecting nuclear fusion breeder reactors, fuel cells, high-efficiency solar cells, wind power and tidal generators. All transportation fuel was switch to fuel cells or electric power by 2070, a decade before the oil price spikes. In the 2050s, the electric grid was updated to accommodate the vast western solar array, the Midwestern wind farms, the New England breeder reactors and coastal tidal power plants. These measures stemmed carbon dioxide emissions and arrested the global warming trend. Collectively, mankind, harnessed nearly all the energy sources of the planet and therefore is effectively considered a Kardashev Type I civilization [21]

Despite success in energy production, the United States still suffered from occasional scarcity of raw materials. Fresh water was recognized as a highly-prized resource and the government took substantive steps to protect and recycle it. The USAF assisted in this endeavor by flying surveillance missions in the Arctic to prevent "ice poachers" from stealing icebergs and glacial ice.

Amount and Intensity of Conflict

Megastates made prolonged violent state vs. state conflict exceedingly rare. Most conflicts were of an intrastate nature based on religious, ethnic or resource quarrels. When states did fight, the conflicts were normally of low intensity and normally quickly resolved. Since the singularity and the formation of megastates, there had not been a general war or even a regional conflict. This too bears on the roles of a 22nd century USAF. In a world divided up into megastates, "winning" a war against any one of them would prove extremely difficult, and all megastates possess nuclear weapons. This required the USAF to stay engaged in the nuclear enterprise as a deterrent while simultaneously preparing for low-intensity conflict fought from

under a nuclear umbrella. The ramifications of the singularity and the advancement, fusion and widespread deployment of GRIN essentially eliminated many issues of human need ranging from health care to food production, which in turn reduced the source of many conflicts.

Coates Futures Diagram Results

The policy recommendation for the USAF in this Scenario are to maintain a balanced and adequately sized force structure oriented primarily towards the lower end of the spectrum of conflict. However, the USAF must maintain a credible nuclear deterrent and develop non-fossil fuel aircraft and systems.

SOFI Index Results

The SOFI indicates that the USAF will improve more than three fold from its current baseline. From 2008 to 2030, the USAF experiences a steady improvement due to continual technological advancement. The USAF begins to rapidly improve as a result of the singularity in 2030 and GRIN fusion. Manned with MOSHs and robots with A.I., the USAF possesses remarkable capabilities and constantly improving technology from 2030 onward. At the turn of the century, software-based humans emerge and shatter all pre-existing paradigms. These beings would essentially be omniscient and could only be deterred by similar software-base beings on the other side of the conflict. The closest example of such a being would be the character "Neo" from *The Matrix* films, able to upload skills and knowledge at the press of a button and able to materialize wherever an appropriate computer "node" existed.[22]

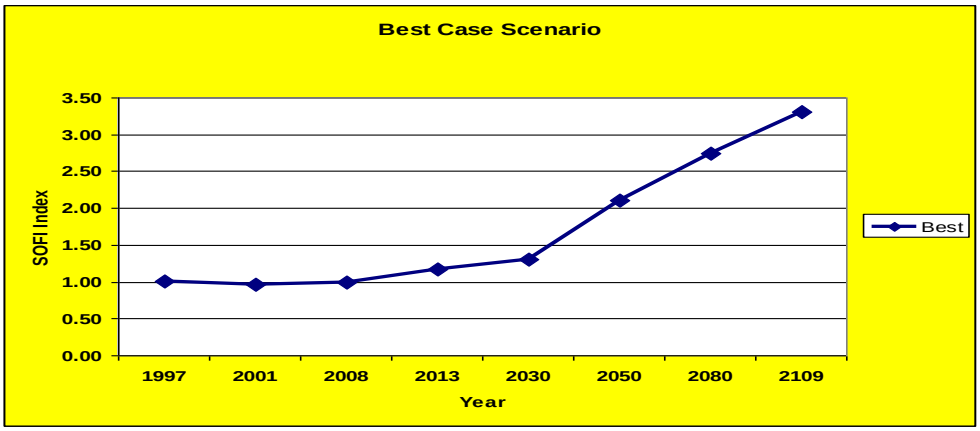

Figure 20. SOFI Index for the Best Case Scenario (From LtCol J.M. Chesnutt, 2008).

Delphi Poll Results

Cyber-warfare will truly be the primary battlefield especially if Kurzweil's vision of software-based humans comes to fruition. The virtual realm will be as deadly a battlefield to these beings as the trenches of Verdun were to the soldiers of World War I. However, none of the Oracles proposed the existence of software-base humans in their answers or how such entities would affect USAF missions. Seven of the trends indentified are particularly applicable to this Scenario.

Strategic Attack

Several trends drive changes in the strategic attack mission. First is the trend of the increasing importance of space and second is the development of directed energy weapons. The fusing of these trends leads to some very potent orbiting weapons. While the peaceful subtext of this scenario means strategic attack will likely suffer a decrease in importance, it does not imply a lack of capability in this realm. Although less important in the future, strategic attack will undoubtedly change in function significantly. Oracle Col Mark Weatherington suggested that it

will become increasingly easy to target individual leaders, thus leading to the "ultimate expression" of strategic attack.[23] Col John Geis predicts that to be effective, strategic attack will need to be near instantaneous and survivable.[24] One method he suggested is to use a quantum entanglement device to "re-arranging matter at the molecular level by quantum entangling pairs and then teleporting materials into places where they are disruptive."[25] This would be the 22nd century equivalent to the Unabomber's modus operandi.

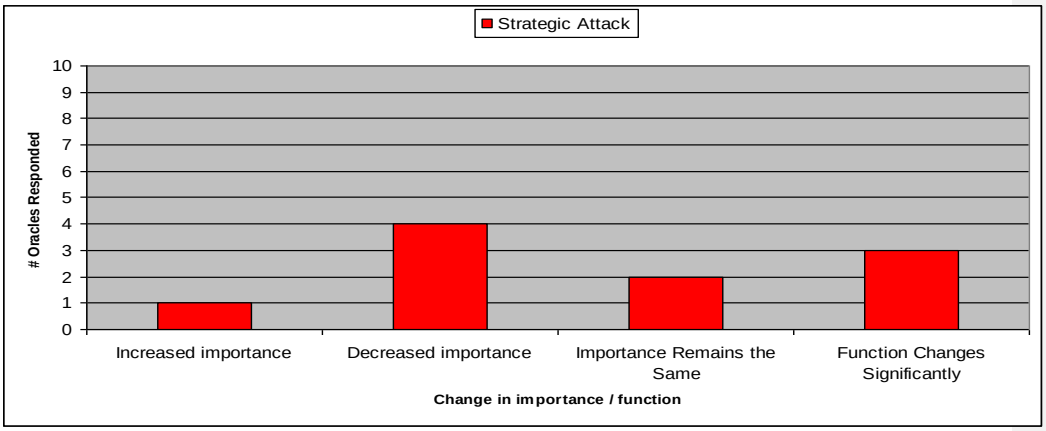

Figure 21. Strategic Attack results from Round One (From: LtCol J.M. Chesnutt, 2008).

Counterspace

Unlike strategic attack, counterspace will drastically increase in importance. While this world is generally peaceful, futurist Dr. Mike Nelson foresees a need for the counterspace mission in combating of private satellites. He notes that "if thousands of different companies start launching satellites, it seems likely at least a few 'bad apples' or 'space hackers' will be able to launch devices that could cause serious damage to US space assets."[26] This leads to the third trend of cheaper defensive or anti-access systems negating expensive offensive systems. This could lead to "space-based asymmetric warfare" with rather cheap, steerable satellites threatening billion-dollar reconnaissance satellites." Science Fiction author Dr. David Brin put it

much more bluntly when he emphasized that "LEO (low earth orbit) is toast" because Earth-based space offensive and defensive weapons will reach at least to geosynchronous orbit.[27] He see the LaGrange Points,[28] especially the stable L4 and L5,[29] as possible contested territory because it is sufficiently far from Earth that hardened spacecraft could be remain out of range and survivable from Earth-based weapons.[30]

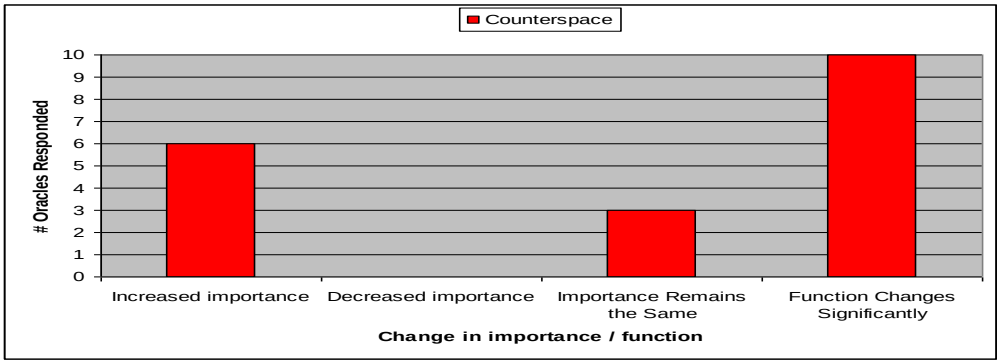

Figure 22. Counterspace Results for Round One (From LtCol J.M. Chesnutt, 2008) .

Planetary Defense

Several Oracles proposed planetary defense as a future mission, highlighting the fourth trend of the USAF increasing its mission set. Brin focused on the space-based threat and Geis included Earth-based threats such as the responding to natural disasters.[31] One such disaster would be the eruption of the Yellowstone Caldera, which is "overdue for an eruption by around 10,000 years."[32] The last time it happened 600,000 years ago, it destroyed about 60 percent of North America.[33] Dr. Bill Morgan proposed a more devious suggestion. He postulated that planetary defenses would be necessary to counter man-made threats from space such as an adversary "nudging of a small asteroid into a collision course with a particular spot on earth."[34]

Round Two concentrated on the missions most important for the Best Case Scenario, the results are graphed below for the majority, minority and outlier opinion.

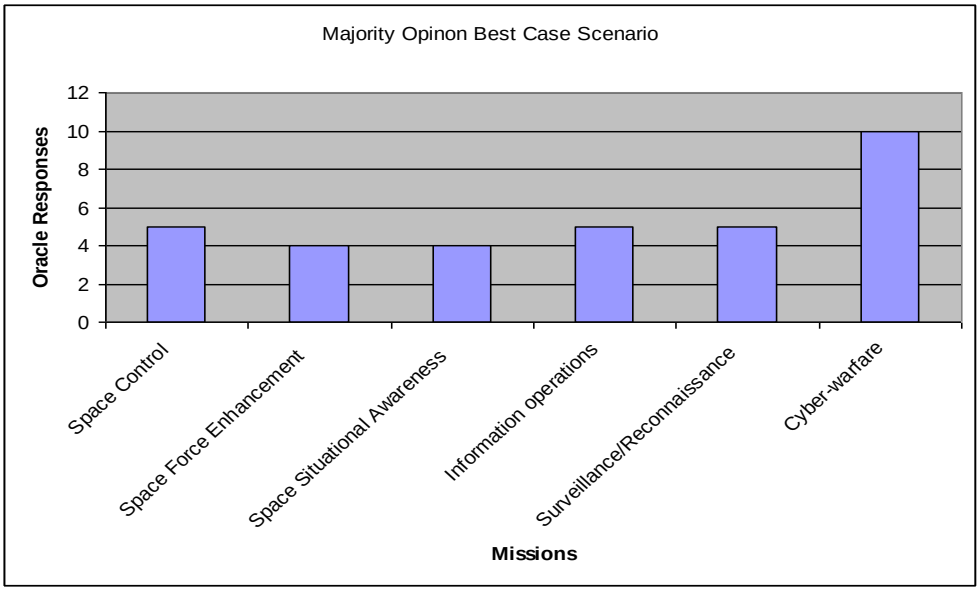

Figure 23. Delphi Poll Round Two Results—Majority Opinion (From LtCol J.M. Chesnutt, 2008).

Information Operations

Col Craig Wills and Morgan echoed the fifth and six trend of the increasing importance of GRIN fusing with the trend of an increasingly pilotless Air Force. They asserted their belief that sensors will become unthinkably advanced and will be deployed on robotic A.I. or unmanned long-duration aircraft and spacecraft.[35] The logical USAF mission ramifications of a world where nearly everything is watched and recorded coupled with extreme speed of processing capable with A.I. leads to a nearly total lack of operational security. At best, A.I. must be deployed to fight the A.I. attempting to detect critical information. Machine versus machine information operations would be ongoing much the same way that the battle for the electromagnetic spectrum is ongoing today.

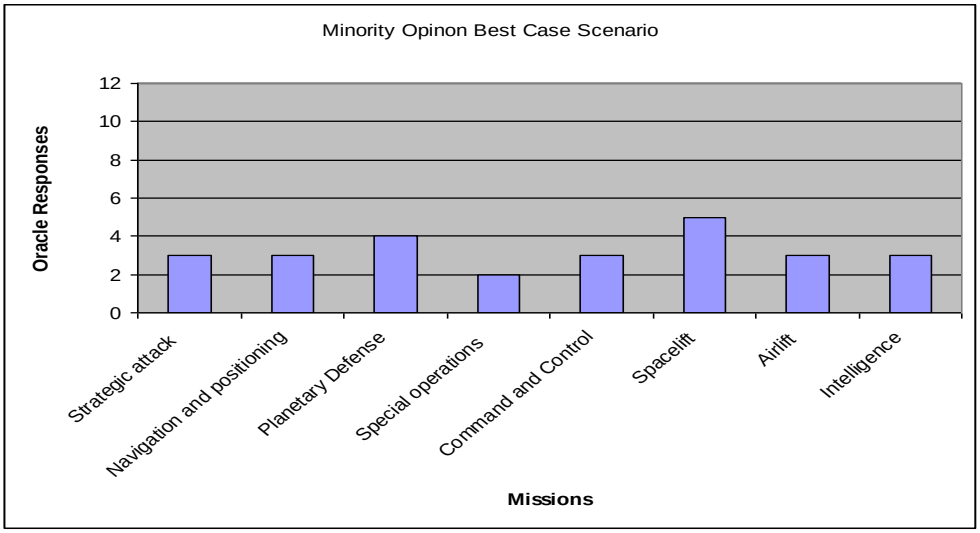

Figure 24. Delphi Poll Round Two Results—Minority Opinion (From LtCol J.M. Chesnutt, 2008).

Spacelift

Science fiction writers Walter Jon Williams and Sage Walker noted the importance of spacelift because it will enable strategic attack, reconnaissance and intelligence.[36] Spacelift will also provide a means to "exploit resources available in space, such as mining the moon for tritium, asteroids for minerals, or using the sun as a source for solar power beamed to the earth's surface."[37] Thus, spacelift will a chief enabler for most aspects of the nation's instrument of power; military, economic and informational.

Intelligence

Dr. Mike Nelson and Dr. Silvana Rubino-Hallman see intelligence becoming paramount in a world where it is virtually impossible to conceal any information. The Herculean task will be data processing and analysis, not data collection.[38] In this Scenario, A.I. would be the only entities who could reasonably assemble and process all the data into "actionable" information collected by the ubiquitous multi-spectral sensors.

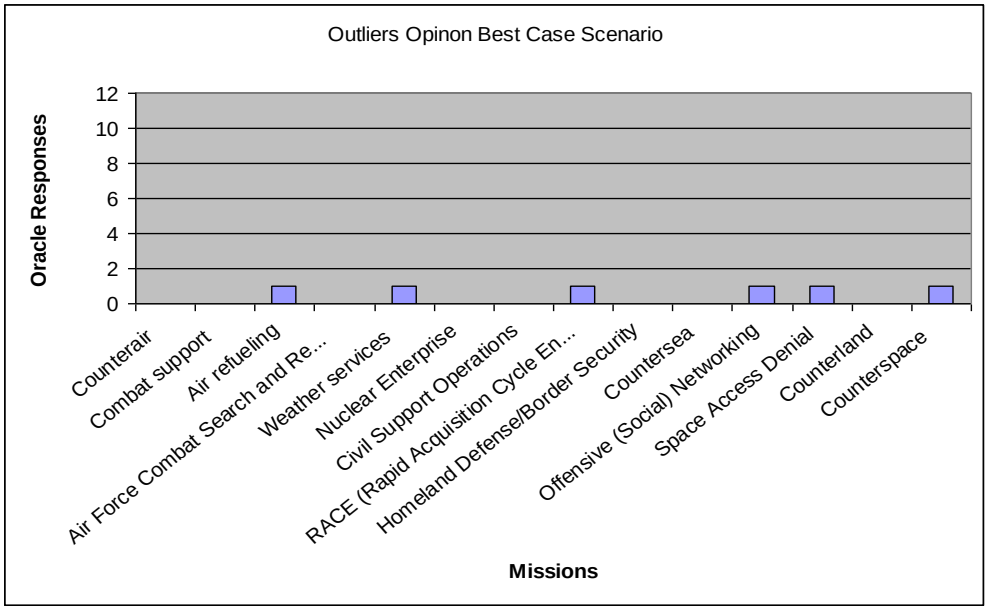

Figure 25. Delphi Poll Round Two Results—Outlier Opinions (From LtCol J.M. Chesnutt, 2008).

Nuclear Enterprise

Interestingly, none of the Oracles thought the nuclear enterprise was one of the most important missions in this Scenario. However, several to them mentioned the importance of maintaining a nuclear capability to be employed as a deterrent. However, the seventh trend of immense destructive power consolidated in the hands of small groups or individuals is a certainty in this Scenario with the advancement of GRIN and nuclear power. Perhaps this apparent disconnect is a result of the relatively peaceful nature of this Scenario. None of the Oracles thought the "big stick" would be called into action. This differs markedly from the assumption in the Worst Case Scenario where small-scale nuclear exchanges had occurred and the threat of nuclear and bio weapon attacks are constant.

Weather Services

Lt Col Joseph Thill suggesting in Round One that the USAF would not only report and forecast the weather, but would modify it for tactical or strategic purposes.[39] Weatherington postulated a conundrum as a result of this capability in Round Two. He asked, "What are the global ramifications of weather modification and would we go to war with China or someone else if their weather modification program adversely affected conditions in the United States?" What is the fallout if we divert a Pacific Tsunami from Guam and it kills thousands in Indonesia?[40]

The Best Case Scenario postulated a relatively peaceful world in which most sources of conflict have been reduced or eliminated by technology, good governance and optimizing resources via the formation of large megastates. The SOFI indicates that by leveraging GRIN, the singularity and developing abundant renewable and alternative energy, the USAF will improve dramatically. The major policy implication from the Coates Futures Diagram is for the USAF to maintain a credible nuclear deterrent while maintaining a balanced force with a tilt toward the lower end of the spectrum of conflict. The USAF in this Scenario carries out many of the traditional missions but also plays a role in the new mission of planetary defense. Traditional missions such as weather forecasting have morphed into weather modification. The overall results of the Delphi Poll most applicable for the Best Case Scenario re-emphasize the primacy of cyberwarfare and space. This fact pervades both Scenarios thus far and holds true for the Most Likely Case as well.

Notes

[1] Dr. Chares E. Gannon, "Delphi Poll Round Two," 2 February 2009, email, 2 February 2009.

[2] Col Mark Weatherington, "Delphi Poll Round One," 3 November 2008, email, 3 November 2008. Col Weathering also expects to see more "dominion-like" union of states in the future for the same reason postulated by Dr. Charles Gannon.

Notes

[3] Dr. Vernor Vinge, "The Coming Technological Singularity: How to Survive in the Post-Human Era," Paper (Cleveland, Ohio: VISION-21 Symposium, 30-31 March 1993), 12.

[4] Ibid., 12.

[5] Ibid., 13.

[6] Ibid., 13.

[7] *Colossus: The Forbin Project* (Universal, 1970) tells the story of a supercomputer that is given complete control of all defense functions. The computer, Colossus, becomes self-aware after linking with a Soviet computer designed for the same function. The melded computer then subjugates mankind.

[8] *The Terminator* (Orion, 1984) borrows heavily from *Colossus: The Forbin Project* in which a defense computer, Skynet" becomes self-aware and attempts to exterminate mankind.

[9] *The Matrix* (Warner Bros, 1999) not only has A.I. subjugating mankind, but an elaborate virtual world complete with soft-ware based humans and "agents" patrolling cyberspace in search of cybercriminals.

[10] Ray Kurzweil, *The Age of Spiritual Machines: When Computers Exceed Human Intelligence* (New York, N.Y.: Penguin, 1999), 233-237.

[11] Ibid., 237.

[12] Joel Garreau, *Radical Evolution: The Promise and Peril of Enhancing Our Minds, Our Bodies -- and What It Means to Be Human* (New York, N.Y.: Broadway Books, 2005), 28.

[13] Ibid., 26-30.

[14] John Smart, "Human Performance Enhancement in 2032: A Scenario for Military Planners," *Acceleration Studies Foundation*, December 2004, n.p., on-line, Internet, 19 April 2009, available from http://www.accelerating.org/articles/hpe2032army.html.

[15] Ibid.

[16] Kurzweil, 280.

[17] Ibid., 236-238.

[18] Ibid., 233-240.

[19] Jerome C. Glenn and Theodore J. Gordon, eds., *Futures Research Methodology V2.0* (Tokyo, Japan: United Nations University, 2000), CD-ROM, Millennium Project.

[20] Kurzweil tracks the accuracy of his predictions on http://www.kurzweilai.net/meme/frame.html?main=/ articles/art0275.html.

[21] Nikolai Kardashev, a Soviet astronomer, developed a classification system of civilizations based upon the amount of mastery each had over its energy resources. From Nikolai Kardashev, "Transmission of Information by Extraterrestrial Civilizations," *Soviet Astronomy*, 8 (1964): 217.

[22] *The Matrix* (Warner Bros, 1999).

[23] Weatherington.

[24] Col John Geis, "Delphi Poll Round One," 10 November 2008, email, 10 November 2008.

[25] Ibid.

[26] Dr. Michael Nelson, "Delphi Poll Round One," 18 November 2008, email, 18 November 2008.

[27] Dr. David Brin, "Delphi Poll Round One," 10 November 2008, email, 10 November.

[28] The Lagrange Points mark positions where the gravitational pull of the two large masses precisely cancels the centripetal acceleration required to rotate with them. Of the five Lagrange points, three are unstable and two are stable. The unstable Lagrange points - labeled L1, L2 and

Notes

L3 - lie along the line connecting the two large masses. The stable Lagrange points - labeled L4 and L5 - form the apex of two equilateral triangles that have the large masses at their vertices. For a more detailed analysis, see http://www.physics.montana.edu/faculty/cornish/lagrange.html

[29] The advantage of a stable LaGrange point is very little energy needs to expended to remain there—it is the ultimate high ground.

[30] Brin.

[31] Ibid.

[32] Geis.

[33] Ibid.

[34] Dr. William Morgan, "Delphi Poll Round One," 14 November 2008, email, 14 November 2008.

[35] Col Craig Wills and Dr. Bill Morgan, "Delphi Poll Round One," 14 November 2008, email, 14 November 2008.

[36] Walter Jon Williams and Sage Walker, "Delphi Poll Round One," 17 November 2008, email, 17 November 2008.

[37] Ibid.

[38] Dr. Michael Nelson and Dr. Silvana Rubino-Hallman, "Delphi Poll Round One," 17 November 2008, email, 17 November 2008.

[39] Lt Col Joseph Thill, "Delphi Poll Round One," 21 November 2008, email, 21 November 2008.

[40] Weatherington.

Chapter 5

The Most Likely Case Scenario

Pestilences extinguished, the world becomes smaller, for a long time the lands will be inhabited peacefully. People will travel safely through the sky, land and seas…then wars will start up again.

–Nostradamus, 1550

The Most Likely Case lies between the Best Case and Worst Case and possesses aspects of each. It is the most realistic of the three scenarios.

Status of the Nation

The United States remained a strong national power and strengthened its relationship with Canada, Mexico and the Central American and Caribbean countries to form the North American Dominion.[1] While each country maintained a central government, the Dominion council had considerable legislative, economic and military powers. The Dominion had its own permanently assigned rapid reaction and peacekeeping forces. The United States maintained only a fleeting military advantage over the EU and BRIC (Brazil, Russia, India and China) countries and required Dominion assistance to decisively win military or economic conflicts.

A socio-political trend widely agreed upon is the US population will increase over the next 100 years, reaching 437 million by the dawn of the 22nd century.[2] Barring any serious Malthusian checks,[3] the US population should be 285 million at the low end and 493 million at

the high end.[4] The world population is likely to swell to nine billion with the possibility of growing as large as 14 billion (see Figure 26).[5] Most ecologists place the carrying capacity of the planet in the 20 billion-person range, based primary on the 22 million acres of ecologically productive land[6] and available fresh water supply.[7] Above 14 billion, Malthusian checks may limit further population growth past that level.[8]

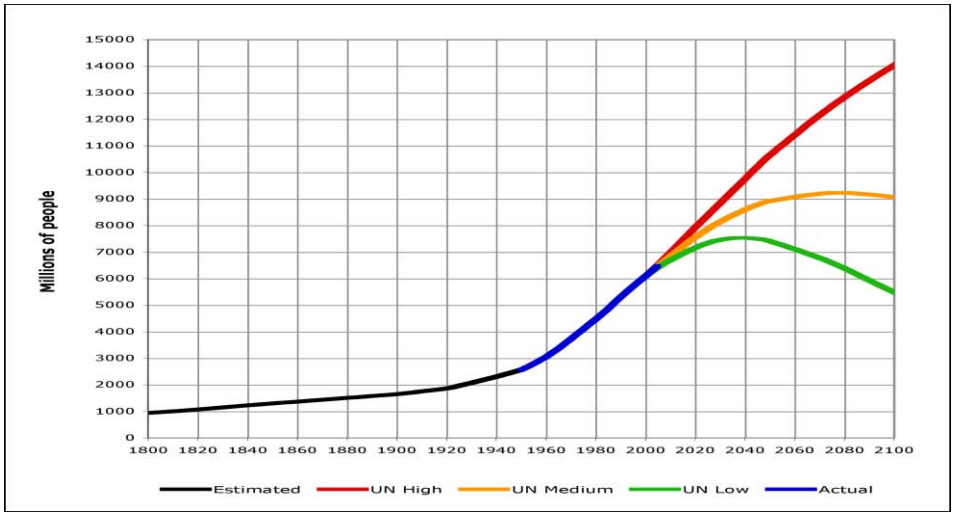

Figure 26. World Population in 2100 (From *World Population to 2300*, United Nations Report (New York, N.Y.: United Nations Department of Economic and Social Affairs, 2004, 50)

Technological Advancement

In this future, the singularity occurred in 2030 but continued conflict stifled some of its applications. Enhanced humans and MOSHs were the majority of the population, with nearly every person choosing to receive at least modest genetic, physiological or mechanical enhancement. Physical enhancement was required for military service, as were cortical jacks to interface with A.I. The convergence of GRIN and a technology called telepresence enabled very small numbers of individuals to gather and use vast amounts of information quickly.[9] This

technological convergence optimized both positive decision making but also made acts of aggression and terrorism serious problems.

Natural Resources

In this future, the world was Kardashev Type Zero civilization, mastering less than seventy percent of the earth's energy.[10] Oil depletion occurred in 2080 but there had been sufficient preparation for the event to avoid an economic depression. Although mankind drastically cut carbon dioxide emissions, the climate continued to warm, leading scientists to believe that climate change was not man made. Water scarcity was the chief resource constraint in the United States and much of the globe, however, other minerals and raw materials were often in short supply.

Amount and Intensity of Conflict

This world was marked by frequent medium-intensity state conflict and frequent non-state conflict, primarily terrorism. There were several general wars leading to a limited nuclear exchange in South Asia and the Middle East, but the United States was not directly involved. The United States suffered several nuclear and biological terrorist attacks and countless cyber-attacks, all of which resulted in massive loss of life. Genetic and bio weapons were routinely employed all along the spectrum of conflict against the United States for objectives ranging from genocide to mild economic disruption.

Coates Futures Diagram Results

The policy recommendation for the USAF in this Scenario is to maintain a balanced and adequately-sized force structure capable of fighting multiple conflicts along a wide swath of the spectrum of conflict. The USAF must maintain a sufficient nuclear deterrent because nearly

every country either has a nuclear weapon or the capacity to develop one in a relatively short time. The USAF must continue funding, developing and fusing GRIN Technology as well as develop non-fossil fuel aircraft.

SOFI Index Results

The USAF has improved twofold in the Most Likely Case Scenario. There is only a slight improvement from 2008 to 2030, but then the singularity leads to rapid advances. This result is promising, however. The curve precedes linearly until the singularity due to the assumption that technology and hence mission effectiveness improvements offset some expected decline in budget, inventory and personnel. In 2080 when oil resources are exhausted, the USAF has already fielded a fleet of solar, nuclear fusion and hydrogen powered aircraft. This commitment to alternative energy coupled with GRIN fusion allows the USAF to improve despite a high operations tempo.

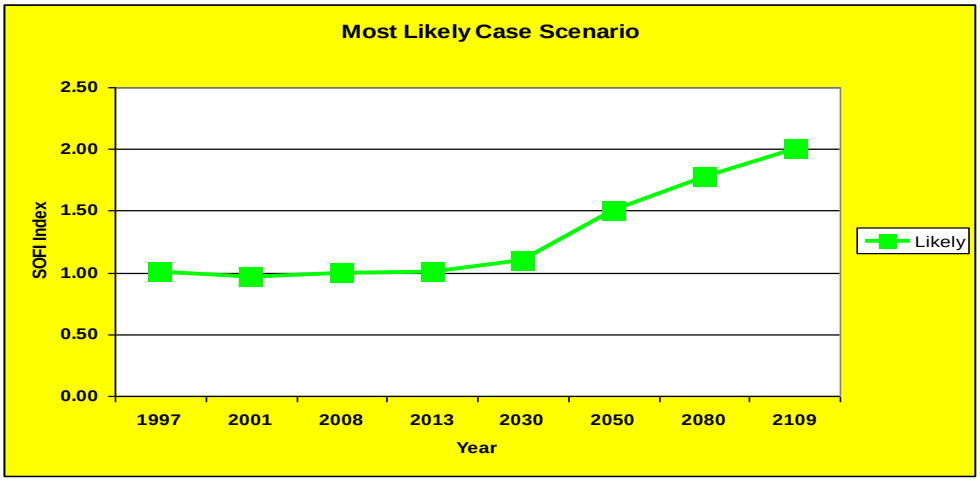

Figure 27. SOFI Index for the Best Case Scenario (From LtCol J.M. Chesnutt, 2008).

Delphi Poll Results

All 10 trends identified are applicable to this Scenario. The first trend is the USAF becoming a nearly pilotless service. The ramifications of this extend beyond the technical and into the essence of the Air Force culture. Oracles Walter Jon Williams and Sage Walker expressed this sentiment when they wrote "the service that lionizes the fighter pilot will have to adjust to a new type of hero: video gamers or programming geeks…this will be a massive cultural shift in itself, and may prove the single greatest challenge to the Air Force in years to come."[11]

The pilotless trend is irrefutable, and nearly every Oracle agreed. The trends of developing faster computers, advances in robotics, advances in sensors, increasing lethality of threat systems, increasing proliferation of surface-to-air missile systems, increasing costs of manned aircraft, increasing demand for long-duration surveillance and reconnaissance aircraft and increasing personnel costs all signal that the pilots' days are numbered.

Combat Search and Rescue

Not surprisingly this trend permeated Round One and Two and solidified combat search and rescue (CSAR) as one of the least important missions…the logic is simple—no pilots, no need to rescue them. However several Oracles mentioned the need to retain some CSAR capability as part of disaster relief operations and to rescue special operations forces or other troops caught behind enemy lines.[12]

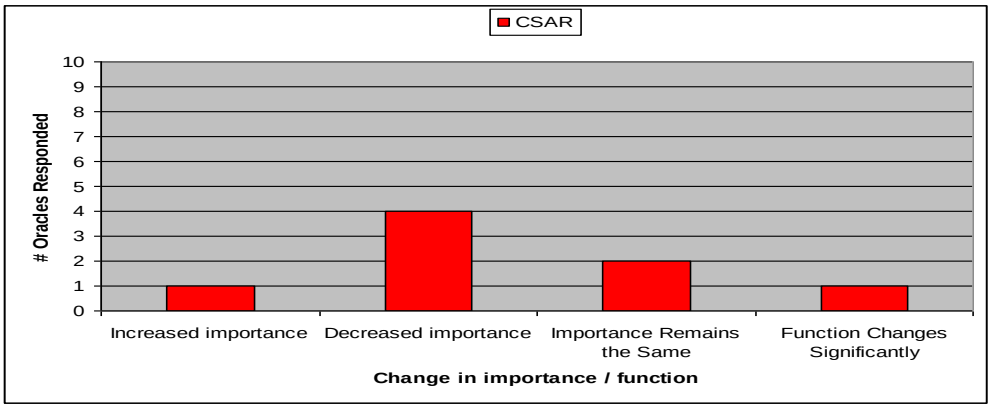

Figure 28. CSAR Results for Round One (From LtCol J.M. Chesnutt, 2008).

Combat Support

Financial analyst Mr. Nicholas Street saw the pilotless trend extending to the airlift mission as well when he remarked that freeing up expeditionary combat support from the "ubiquitous 463L Pallet may be a humdrum, but an important development over the next 100 years."[13] He envisions the blend of Unmanned Aerial Vehicle technology with distributed systems and swarming tactics to deliver multiple cargo items to multiple locations simultaneously. Oracle Dr. Regina Lewis proposed that the military and private companies engage in "sharing" noncombat assets to reduce costs, rather than paying a contractor for the use of an asset as is today's standard practice.[14] This measure would help combat the second trend of decreasing DOD purchasing power as well as the third trend of the decreasing economic power of the United States.

Aerial Refueling

The other rather obvious dead-end mission is aerial refueling. Nearly every Oracle agreed the depletion of oil rings the death knell for this mission. If there is still aerial refueling, the tanker will not be pumping gas, but more likely hydrogen or some other alternative fuel,

highlighting the fourth trend of the pressing need to develop non-fossil fuel aircraft. The KC-X will likely be the last tanker the USAF will purchase if it remains in service as long as the KC-135.

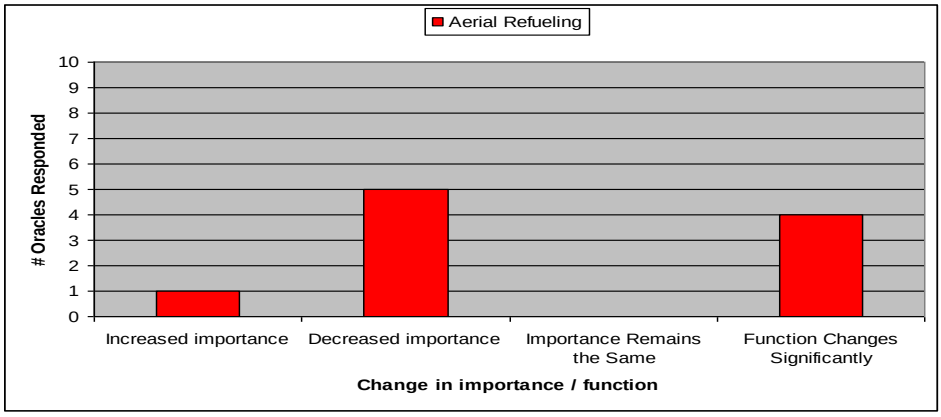

Figure 29. Aerial Refueling Results for Round One (From LtCol J.M. Chesnutt, 2008).

Cyberwarfare

Cyberwarfare again ranked as the most important mission in Round Two, sustaining the fifth trend of the preeminence of the cyber domain and the sixth trend of the importance of GRIN. It is only logical that if humans become completely dependent on machines and A.I. to assist in complex and mundane tasks, then protecting and attacking networks will become the prevalent method for inflicting harm on your adversary. Dr. Vinge provided an example of this dependence when he noted at the network and database level, everything in the modern hospital is inaccessible to unaided humans, even for "routine" tasks. For instance, making a medical appointment is often spread across multiple actors and a large geographical range. Vinge sees our critical dependence on embedded micro-controllers as a major existential threat "even if no bad guys were trying to cause catastrophe."[15] This dependence of computers and networks creates vulnerabilities that can be exploited by "hacktivists."[16] Hacktivism is the process of a

government or group recruiting hackers to attack networks and has already occurred in the recent conflict between Russia and Georgia.[17]

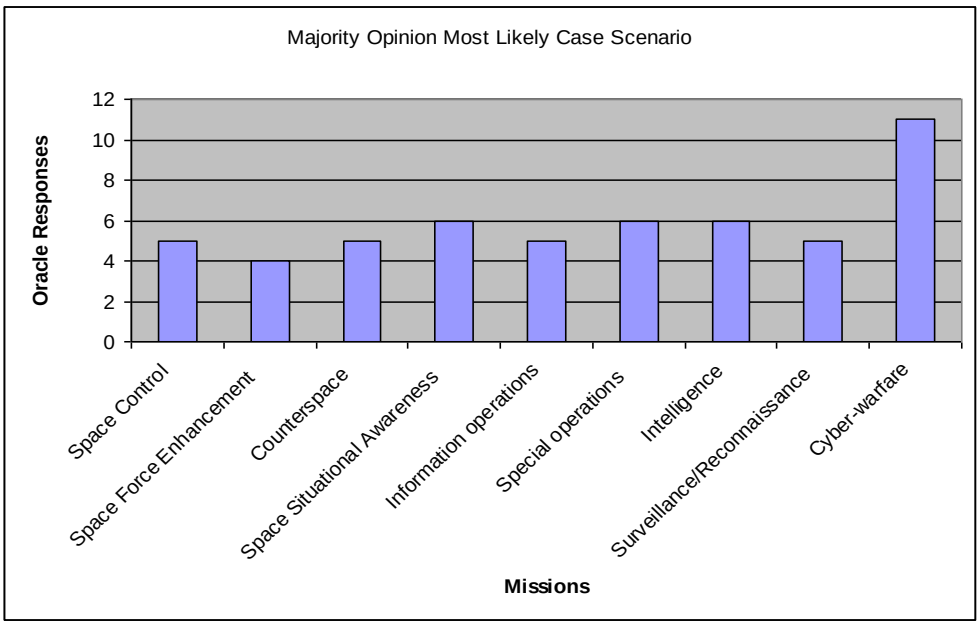

Figure 30. Delphi Poll Round Two Results—Majority Opinion (From LtCol J.M. Chesnutt, 2008).

Colonel Geis suggested ways that the cyber medium could influence people to take up arms for a cause, specifically the use of the internet to recruit Islamic militants. He commented, "What we are coming to believe is that the ground war we now see in Afghanistan is merely the physical manifestation, in the physical domain, of a lost war in cyberspace – where the real battle is taking place…and where we are losing—we may currently be in the middle of the world's first cyberwar…and not be smart enough to know it." A similar realization led another Oracle to propose a new mission for the USAF, illuminating the seventh trend of increasing the number of USAF missions.

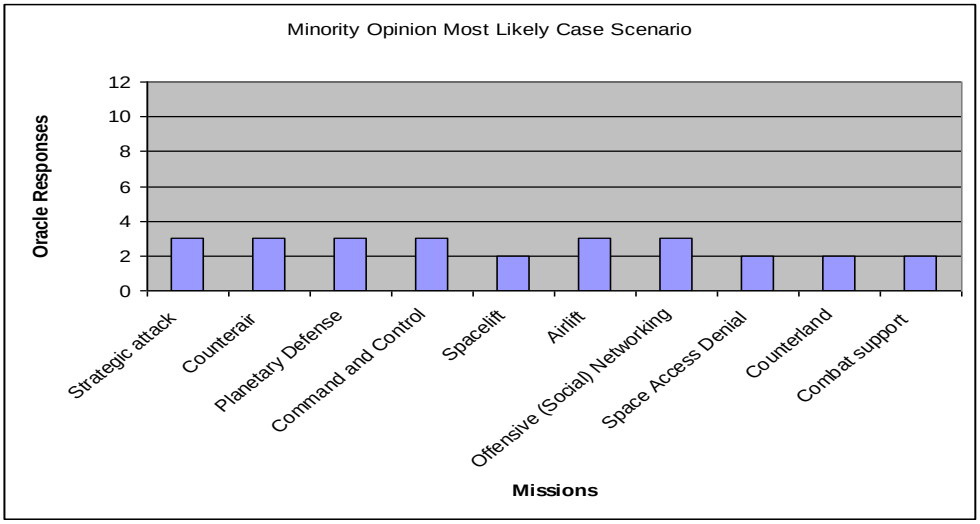

Figure 31. Delphi Poll Round Two Results—Minority Opinion (From: LtCol J.M. Chesnutt, 2008).

Offensive Social Networking

Dr. Mike Nelson proposed the mission of Offensive "Social" Networking, and the suggestion gained a modest following of Oracles in Round Two. He explained the ideas as follows, "Imagine if the US Air Force were able to air drop half a million solar-powered cellphones into North Korea. With the use of mesh networks, an effective telecommunication system could be up and running in hours—without cell towers. Within days, millions of North Koreans could be connected to the outside world (especially South Koreans), could understand that their government was weak and unstable, and could be mobilized into grass-roots action. Imagine a "million man march" through the DMZ coordinated by cellphones. Something similar could mobilize millions of civilian monitors in war zones from Darfur to Congo. They wouldn't have to fight or put themselves at risk. They'd just have to take pictures and report."[18] Shortly after Nelson made this statement, Oracle Mr. Gaurav Mishra, and expert on social media and a Yahoo! Inc. Fellow, wrote a story about how the recent terrorist attacks in Mumbai were

extensively covered by citizens using cell phone cameras and *Twitter*.[19] In fact, professional reporters became dependent on these citizens' images and text messages for the most accurate scoop, often re-broadcasting the citizens' reports without editing. This trend has further implications for operational security and intelligence. In the future, it will be nearly impossible to deploy forces without someone recording the movement and posting the pictures or commentary on an open source social media website such as the future incarnations of *FLICKR* or *Twitter*-type websites. The US military in Iraq already encountered this problem with troops blogging sensitive information direct from the battlefield. With the next generation(s) internet technology, operational security and information operations will be severely challenged.

Manipulating opinion and sentiment has always had a place in warfare. The US Army has dedicated psychological operations soldiers. The cyber and information technology realms are providing a potent medium for this strategy. Mishra sees the geometric expansion of information technology as easy prey for manipulating opinion. Such a tactic has already occurred with social media "Astroturfing"—the creation of false grass roots sentiment, where operatives flood key leaders' websites or media networks with opinions purporting to be from the masses when in fact only a few individuals (or computer programs) are creating the commotion.

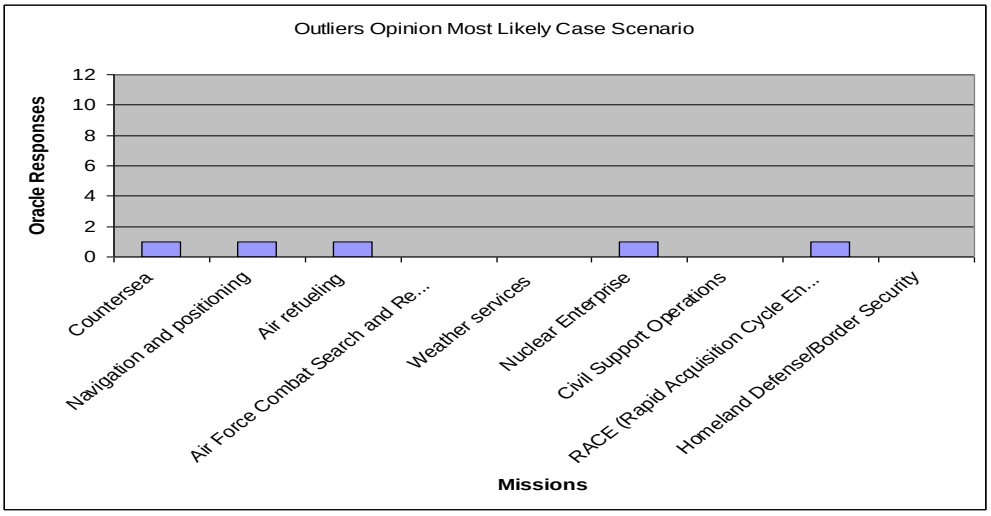

Figure 32. Delphi Poll Round Two Results—Outlier Opinions (From LtCol J.M. Chesnutt, 2008).

The outlier missions of Civil Support Operations, Space Access Denial, Rapid Acquisition Development Cycle, and Homeland Defense/Border Security were not part of the Round Two debate because all were proposed by Oracles during the debate process. Based on the debate these missions caused, had they been included in a third round, there is evidence that many Oracles would rate them in their top five "most important future missions."

Rapid Acquisition Cycle Environment

Oracle LtCol Bartz Sykes expressed his concerned about the USAF's failure to acquire weapons systems in a timely manner. He proposed making acquisitions a new "mission," coining the acronym RACE for Rapid Acquisition Cycle Environment.[20]

> Our resources and people will suffer a cancerous liquidation if we don't RADICALLY improve the acquisition process for the military. We must have an acquisition system that doesn't produce a weapon system that already has obsolete parts as it rolls off the assembly line because it took so long to develop, but an acquisition system where every new piece of hardware/software that is produced is better than the one made yesterday, or even an hour ago. If we don't get this one right, all of the 22 missions fail. If we get it right, America keeps the world from blowing itself up and we progress our way out of our solar system.[21]

One of the consequences of vastly increased computing capacity is the shorter time when almost all technology remains state of the art, which supports the eighth trend of the increasing importance of GRIN. In an increasing information technology-centric world, it may be nearly impossible to shorten the acquisition time line sufficiently to field a true state-of-the-art weapon.

Nuclear Enterprise

Oracle Lt Col Joseph Thill sees another consequence of the digital revolution and A.I., "The nuclear enterprise will be drastically altered. Trusted networks will be so hard to come by, that the USAF will first go to closed loop independent nuclear forces by 2040. No automated triggers or falsifiable (read digital) means will be accepted to launch nukes."[22] Many Oracles accepted Thill's sentiment as a consequence of the cyber realm becoming the dominant battlespace and how even "non-cyber" weapons would become vulnerable to cyber attack. This implicates the ninth trend of the consolidation of immense destructive power in the hands in small groups or individuals. Anyone who can gain an advantage in the cyber realm can control the immense destructive power of the weapons controlled by it. For instance, if some hacker gained control of a directed energy weapon in orbit, he could kill thousands. This eventuality also highlights the tenth and final trend of the increasing importance of directed energy weapons.

Counterland

One of the rather unsettling consequences of the trend in declining DOD purchasing power and increasing cost of modern weapons systems—without a relative and corresponding increase in cost of systems to counter those modern weapons systems—is the decreased capability to conduct counterland and countersea missions. The DOD gets less weapon(s) for its money, and those weapon(s) can be increasingly negated by relatively cheap systems. A current example is a multi-billion dollar aircraft carrier kept at bay by a few cheap anti-ship missiles. Several Oracles

commented that the ubiquitous sensors and cheap anti-access systems of the future will make flying in support of troops on the ground or interdicting targets too costly.[23] In fact, anything not supremely stealthy that operates on the land, in the sky, or in the water of a battlezone will likely be targeted.

The results of the Delphi Poll show a clear consensus that the important missions of the USAF will be cyberwarfare, information operations, space control, space force enhancement, surveillance and reconnaissance. The least important traditional missions will be aerial refueling, combat search and rescue, countersea and weather services.

The Most Likely Case Scenario combined elements of the Worst Cast and the Best Case Scenarios. All ten trends affected the missions of the USAF in this Scenario. The major policy recommendation from the Coates Futures Diagram is to maintain a balanced force. The SOFI index showed a relatively strong improvement, with the USAF "improving twice as much" from today's benchmark. The Delphi Poll showed that twice as many Oracles felt that cyberwarfare would be one of the most important missions when compared with the next most important missions of special operations, space situational awareness and intelligence. The final chapter will provide recommendations how the USAF should best prepare to succeed in mission accomplishment for 22nd century operations.

Notes

[1] Col Mark Weatherington, "Delphi Poll Round Two," 4 December 2008, email, 4 December 2008.

[2] Bureau of the Census, *Census Bureau Projects Doubling of Nation's Population by 2100* (Washington, D.C.: U.S. Census Bureau, 13 Mar 2001), 14.

[3] Robert Malthus argued that population was held within resource limits by two types of checks: *positive* ones, which raised the death rate, and *preventative* ones, which lowered the birth rate. The positive checks included hunger, disease and war; the preventative checks, abortion, birth control, prostitution, postponement of marriage, and celibacy." From Geoffrey Gilbert, introduction to Malthus T.R. 1798. *An Essay on the Principle of Population.* Oxford World's Classics reprint. viii.

Notes

[4] *World Population to 2300*, United Nations Report (New York, N.Y.: United Nations Depart of Economic and Social Affairs, 2004), 50

[5] Ibid., 12

[6] Robert Malthus also argued that "The power of population is indefinitely greater than the power in the earth to produce subsistence for man. Population, when unchecked, increases in a geometrical ratio. Subsistence increases only in an arithmetical ratio. A slight acquaintance with numbers will show the immensity of the first power in comparison with the second." From Malthus T.R. 1798. *An Essay on the Principle of Population.* Chapter 1, p13 in Oxford World's Classics reprint.

[7] A.R. Palmer, "Ecological Footprints: Evaluating Sustainability," *Environmental Geosciences* 6, (1999): 200-204

[8] *World Population to 2300*, 12

[9] Stanley Schmidt, *The Coming Convergence: Surprising Ways Diverse Technologies Interact to Shape Our World and Change the Future* (Amherst, NY: Prometheus Books, 2008), 29.

[10] Carl Sagan, *The Cosmic Connection: An Extraterrestrial Perspective*, ed. Jerome Agel (Cambridge, England.: Cambridge University Press, October 2000), 1973.

[11] Walter Jon Williams and Sage Walker, "Delphi Poll Round One," 17 November 2008, email, 17 November 2008.

[12] Lt Col Bartz Sykes, "Delphi Poll Round One," 14 November 2008, email, 14 November 2008.

[13] Nicholas Street, "Delphi Poll Round One," 18 November 2008, email, 18 November 2008.

[14] Dr. Regina Lewis, "Delphi Poll Round Two," 3 December 2008, email, 3 December 2008.

[15] Dr. Vernor Vinge, "Delphi Poll Round Two," 14 March 2009, email, 14 March 2009.

[16] Gaurav Mishra, "Delphi Poll Round Two," 1 December 2008, email, 1 December 2008

[17] Mishra.

[18] Dr. Michael Nelson, "Delphi Poll Round One," 18 November 2008, email, 18 November 2008

[19] Mishra.

[20] Sykes.

[21] Ibid.

[22] Lt Col Joseph Thill, "Delphi Poll Round One," 21 November 2008, email, 21 November 2008.

[23] Dr. William Morgan, "Delphi Poll Round One," 14 November 2008, email, 14 November 2008.

Chapter 6

Conclusions and Recommendations

Only the dead have seen the end of war.

—Plato

It is not really necessary to look too far into the future; we see enough already to be certain it will be magnificent. Only let us hurry and open the roads.

—Wilbur Wright

Where there is no vision, the people perish.

— Proverbs 29:18

The Future has already arrived; it's just not evenly distributed yet.

—Gaurav Mishra

The USAF of the 22nd century will likely be smaller but more effective and limited to operations in the troposphere, stratosphere and mesosphere—and like all services, the cybersphere. Operations in the thermosphere and exosphere will be the domain of a separate space corps. The services are medium oriented out of necessity, thus the need for a separate cyberwarfare branch.[1] Each medium requires special skills and expertise of those who chose to fight there. While the air domain is not going away, the manner in which the USAF fights there will change significantly. The USAF is facing ten major trends which span multiple missions:

1) Increasing prominence of the cyber-domain in all aspects of military operations.

2) Relative decrease in economic and military power of the United States.

3) Declining DOD purchasing power and increasing cost of modern weapons systems without a relative and corresponding increase in cost of systems to counter those modern weapons systems.

4) Increasing drive toward a pilotless or nearly pilotless USAF.

5) The growing importance and reliance on genetics, robotics, information and nano technology (GRIN).

6) An increasingly pressing need to develop and eventually transition to non-fossil-fuel-based vehicles.

7) Increasing potential and importance for directed energy weapons.

8) Growing importance of the space environment.

9) Increasing the number of missions the USAF performs while decreasing the overall number of personnel

10) The consolidation of immense destructive power in the hands of small groups or individuals

The USAF must internalize the rather shocking realization that many of the most important missions in the future are not and have not been the traditional core USAF missions. Space and cyber will evolve from combat enablers to combatant commands. Like special operations, space and cyber will not even be strictly USAF missions in the next century. Additionally, *many of the least important missions in a hundred years are today's "core" functions and have been for decades.* This begs the question, what will be the USAF's contribution to national security in 100 years if space, cyber and special operations spin off while simultaneously today's core missions decrease in importance? A possible answer is that the USAF becomes a low to mid atmosphere force focused on intelligence, surveillance, reconnaissance, airlift, strategic attack,

and counterland. As Oracle Col Woodcock said, "The air ain't going away."[2] There will need to be a service that can maintain mastery over it and keep others from doing the same. There are very few Scenarios where the USAF becomes irrelevant. There are many possible Scenarios (not just the three in this paper) where the USAF is extremely relevant. For the good of the nation and the service, here are the recommendations that will help the USAF stay relevant.

Recommendations

The purpose of the Coates Futures Diagram is to reach the last block that requires us to *Identify Policy, Plans and Actions to Influence Trends favorably and Reach Desired Future.* This is a tall order. While a potent force today, and in the near future, the USAF does not have the power or prevue to bring about a "Star Trek-like" future by itself. However, the USAF can and must take positive steps to nurture that future while preparing for any combination of the other two. The recommendations listed below should help the USAF plan for the Best Case Scenario and avoid the Worst Case Scenario.

1) Develop Alternatively-Powered Aircraft and Systems

Now is the best time to perfect the technology for solar, wind-augmented, electric, hydrogen, rocket and nuclear-powered aircraft and vehicles while there is still sufficient fossil fuel available to support the legacy fleet. The next Unmanned Aerial system should be completely powered by non-fossil fuels. The USAF could guarantee air superiority by default if the United States was the only country to develop such aircraft before oil depletion becomes a reality. Twenty one out of Twenty two of the USAF current doctrinal missions are critically dependent of fossil fuels for accomplishment…and a good argument can be made that the remaining mission, cyberwarfare, is dependent to at least some degree as well. The USAF (and

the world) will not have to wait until oil depletion before the effects of higher prices and constricted supply wreak havoc on mission accomplishment. Any fighter pilot performing an ocean crossing or a combat mission realizes that without the tanker, the mission is not getting done. No Gas, No Mission… No Mission, No Air Force.

2) Establish, Foster, then Spin Off, Cyber "Command"

The USAF must foster Cyber Command (or the currently proposed Cyber Numbered Air Force), but prepare to let it evolve into its own service. The future for cyber command will likely unfold similarly to the old Aeronautical Division of the US Army Signal Corps that grew into the USAF. Each service will no doubt have a cyber organization, but eventually these should merge to form the US Cyber Command (CyCom). CyCom will be in continuous conflict; forcing the leaders of nation states to determine just what is and *is not* an act of war with regards to a cyberstrike.[3] There will be an entire cyber spectrum of conflict, from "cyber peacekeeping to cyber total war." Cyberspace will be the preeminent battlespace of the 22nd Century, and CyCom will therefore be the most important service. In 100 years, virtually everything will be, well, virtual! Oracle Lt Gen Mike Short predicts that "cyber will indeed be of significantly increased importance, but it will not be an Air Force mission. The nation will centralize cyber efforts in a single COCOM and the Air Force will provide capability to support that COCOM."[4] General Short is not alone, virtually all 31 experts in the Delphi Poll agreed that cyberwarfare will be the most important mission going forward and its function will change significantly.

A separate Cyber Command will be good for the nation. Science fiction authors Walter Jon Williams and Sage Walker offered an insightful analysis and solution to our cyber-security woes when they wrote:

> "The problem with our approach to cyber-security is that it's top-down. The government mandates a "Cyber Security Manhattan Project," spends billions,

> impanels experts, issues directives, and accomplishes very little because the Internet is 1) privately owned anyway, and 2) has evolved new ways of dealing with the problem. The Chinese government has issued hundreds of pages of regulations—far more than anyone can actually remember—has tens of thousands of Internet cops, and produced a so-called "Great Firewall of China" that is porous to any reasonably savvy Internet browser. No cyber-security program so far proposed takes advantage of what is, in effect, our own Cyber-Security Militia—the tens of thousands of systems administrators who have to deal with these issues on a daily basis. We don't even pay these guys; they're doing it for free. Some way of mobilizing their wisdom and expertise should be developed.[5]

Walker and Williams went on to suggest announcing a "Cyber-Security Month" once each year and encourage citizens to hack into our critical sites, report any weaknesses and suggest remedies. At the end of the month, then the government would announce the winners and offer them a reward.[6]

The USAF and DOD must not only lead in this realm, but must be flexible and responsive when that lead is lost—which will inevitably happen with such a malleable medium. While it is entirely appropriate to "downgrade" cyberwarfare from a service command to a numbered air force today, the USAF must ensure there are plenty of expansion joints in place…because cyberwarfare is in its infancy. If in doubt of this, think of the effect on today's military operations if all classified and unclassified email systems were infected by a cyberattack? Are we prepared to revert back to telephones, SARAH-Lite messages and grease pencils for command and control?

3) Foster, then Spin Off, Space Command

The USAF should also follow a similar course with respect to space. While the USAF manages 80 satellites today, that number could increase a hundred fold by the 22nd century with space being the second most important battlefield behind cyberspace. We will likely be joined in space by nearly every developed nation, and as space loses its exclusivity, jockeying for position in orbit will become a vital function. The expertise required to master space is sufficiently

different from that required to master the air that separating the two will prove a natural evolution. Again there was consensus amongst the Oracles that space is increasing in importance and whoever controls space (and the moon), will have great leverage over operations on the Earth. As of now, space is quite peaceful; however, in the Worst Case and Most Likely Case Scenarios, space is highly contested. In the Best Case Scenario, space is generally peaceful but no less important. No matter which future or combination of futures come to fruition, space and space missions are poised to play a critical role.

4) Start Thinking About Planetary Defense

The USAF must begin to think about planetary defenses. In safety parlance, a major asteroid impact is a Risk Assessment Code (RAC) 1B, "1" for being "catastrophic" and "B" for "probably will occur in time." The salient question is not when, but how big and where will it hit? The uncomfortable truth is our planet is moving through a cosmic shooting gallery and it is just a matter of time before we take a round or two (or 21—like Jupiter did a 15 years ago when the comet Shoemaker-Levy 9 hit the planet with a blast of 600 times the entire world's nuclear arsenal), as has happened many times in the past. Our current stance as a nation and as a USAF is similar to the stance taken with regards to automobile deaths. The US government has spent trillions and lost 5,000 servicemen and woman since 9-11 fighting the global war on terror, bringing the total human cost of Americans to approximately 8,000 killed. In the last eight years, the US government has spent a minor fraction of that cost on highway safety while over 300,000 American have been killed driving.[7] The government leaders would argue that in focusing on counter-terrorism, they are hoping to prevent a possible WMD terrorist attack that could kill tens of thousands, maybe hundreds of thousands, in one day. Using this logic, we

should be expending at least some effort to prevent the possible loss of life of everyone on the planet via a comet or asteroid strike.

This planetary defense mission would likely require the development of directed energy weapons. These weapons would stand a decent chance of diverting or destroying a comet or asteroids hurtling towards Earth. Directed energy weapons would also revolutionize warfare and ultimately prove less costly, more accurate, more lethal…or more non-lethal, than any conventional weapon.

5) Maintain an Adequately-Sized and Flexible Force (and Encourage our Allies to do the same)

The USAF should follow Dr. David Brin's advice and avoid the pitfall of trading an adequately sized "general purpose" force for a very small, very elite one.[8] This is true for both personnel and inventory. Because we face the three possible futures, we need a balanced and flexible force. A small force, no matter how elite, cannot be in two places at once…unless of course we are dealing with Kurzweil's software-based humans. Also, if a small force is compromised, then the nation is left defenseless. The pressure to rely on a small cadre of professionals, especially genetically, cybernetically or mechanically enhanced individuals, will become enormous due to the perceived cost savings and increased capabilities. The USAF and DOD have already pivoted towards this path by relenting to procure 183 F-22 aircraft when the original requirement was for 750.[9] In addition, the USAF personnel strength was cut in half since the end of the Cold War with the last cut of 40,000 being made for the expressed purpose to save money to fund recapitalization.[10] As GRIN advances, it will be possible to realize cost savings in personnel. However, in 100 years, GRIN may make it possible to replace nearly everyone in the USAF with a robot or A.I. Human capital may end up being little more than a back-up plan, but it is the wise contingency planner who normally wins the war.

The USAF must not only maintain sufficient force structure, but it must press our allies to do the same. By concentrating on alliance maintenance, the USAF can help ensure conflicts remain at the lower-end of the spectrum, save on personnel costs and increase situational awareness by sharing intelligence. Alliances can be indispensible in increasing economies of scale and as force multipliers. As was presented in two of the Scenarios, there is a strong chance that the nation that forms the broadest and most cohesive alliances will be more prosperous than those who do not.

6) Red Team "Successes" to Guard against "Success Masking Failure"

Admittedly, this is an odd recommendation for a futures study, but as military operations increase in complexity, this tendency for success masking failure becomes even more prevalent. This is the number one threat to continued American air dominance. The USAF is currently the world's tallest dwarf and it is critical that the service realizes the possibility that a foe could grow to 10-feet tall by fusing GRIN (…quite literally with genetic enhancements).

Because the USAF has maintained air superiority since the Korean War, and generally hits what it is aiming at, it has neglected investing and recapitalizing its forces to the degree required to ensure continued dominance. Air superiority is seen as the military equivalent of a "public good"—and while the USAF had maintained it admirably, no one has seriously challenged US air forces since WWII. The USAF has had difficulty justifying capital re-investment in systems that are not vital to success in Afghanistan or Iraq, especially with the US Army and Marines bearing the weight of combat operations. As evidence by the Oracles, maintaining air superiority in the future will be increasingly difficult, thus any future battlefield mission more difficult…perhaps impossible.

In Operation Allied Force, the USAF was bedeviled by Yugoslavia's small but relatively efficient Integrated Air Defense System (IADS). Fighter pilots were still evading surface-to-air missiles on Day 73 of the 78-day war. Because of the overall success of the campaign, a serious deficiency in our capabilities—the ability to adequately suppress, locate and destroy surface-to air-missile systems, remained largely unaddressed. This deficiency remains a decade after the campaign partly because the Yugoslavs only shot down two USAF aircraft and both pilots were rescued. Operation Allied Force was a tremendous success and vindicated many principles espoused by the earliest air power advocates. However, the success of the campaign masked the critical failure that the United States cannot timely and effectively find and destroy mobile missile systems. This was also a failure nearly a decade earlier in another successful campaign, Operation Desert Storm. The United States had minimal success in finding and destroying Saddam Hussein's SCUD missiles. Success masked failure in 1990, and it came back to haunt forces again in 1999, and will likely continue to plague US forces in the next campaign.

In contrast, the Humvees used during Operation Iraqi Freedom were clearly failing to provide adequate protection to US troops—this failure was not masked because the lack of a clear success in the overall effort in Iraq drew attention to the problem. The media highlighted these failures daily, leading to investigations by the congress and the armed services. Within a few years, the US Army fielded mine-resistant vehicles that provided much greater protection against improvised explosive devices and gunfire.

If the USAF were asked to fight in an environment with a moderately potent IAD, the odds of gaining and maintaining air superiority in a timely manner would be dubious at best. This should be supremely troubling to all services, but especially the USAF who bears responsibility to gain and maintain air superiority. Success masking failure, along with the military's overall

tendency to trumpet the good and bury the bad, means the USAF must turn a very critical eye on its own operations and procurement strategy and uncover the deficiencies that could result in failure in future operations. Most importantly, the USAF must "red team" what it perceives as "success" and ask the soul-searching question "we won, but what if "X" happened 10 more times, would we still have won?" This question must be asked in relation to each mission the USAF performs, not just the overall campaign. For example, "we defeated Iraq during Desert Storm, but did we succeed in the CSAR mission or the weather services mission?" Normally the answers to these questions, if they are even asked, are relegated to a chapter in an "after action report" that often goes largely ignored amidst the ticker-tape parade.

7) Develop and Fuse GRIN—Give until it Hurts

Even in a resource-constrained environment, the USAF must push development of GRIN in military applications and countermeasures. GRIN holds the secrets to refine the next generations of stealth technology and a host of vital military developments. This is vitally important because in the 22nd century, if it can be detected, then it likely can be destroyed. Whoever develops and fuses GRIN will enjoy an asymmetric advantage over those who do not. DARPA has led the way for decades in this realm and their model has proved successful. DARPA created the internet and email, and more so than any other organization, is the alpha and omega of fusing GRIN for the betterment of the USAF. DARPA must be protected and expanded.

However despite the great promise of GRIN fusion, it would be a dire mistake to believe any technology would fundamentally change the *nature* of war. Human nature and the politics that accompany it have a timeless quality that will not change in the next 100 years. War will still be fought and fraught with human frailties and virtue—no matter what the humans of the 22nd century may look like.[11] The USAF cannot afford to lose itself in the grand possibilities of a

utopian future where technology makes all things possible. We must still invest in personnel and training. The beauty of GRIN is it offers an integrative solution. GRIN will make training better and people better—and perhaps make people virtually obsolete in military operations. All roads to the future, utopian or dystopian, must pass through the valley of GRIN.

8) Prepare for the Singularity and Enhanced Information Operations

When the singularity happens and A.I. is born, we need systems that can capitalize on the advantages it brings. A.I. has the potential to tighten our "OODA" loop[12] from days to milliseconds if we are ready and structured to capitalize on the advantages it will bring. If our adversaries have and we have not, then the United States will fare no better than the Polish horse cavalry did against the German Blitzkrieg—no matter how many horses we have. Information superiority will play an increasingly important role in future military operations. He who has the best information and processes it the fastest is likely to make the best and most rapid decisions. The Oracles highlighted information operations as one of the five most important missions going forward. We should take advantage of their wisdom and add "Access to Information" to the list of principles of war. This will help ensure most planners and commanders think about how, when, where and what information is available.[13] Ensuring our A.I. has access to information will be a vital step in defeating our adversaries. Once the singularity comes, "crunching the numbers" will no longer be a problem, the problem will be making sure there are numbers to crunch.

9) Continue Futures Studies

Certainly many of the "predictions" in this paper will prove erroneous, but by following the trends that led to those "predictions," we can make more accurate predictions next year, for each year we can glean more information about how and where the trends are driving the USAF.

Each year, one Senior Developmental Education Fellow should be required to conduct a long-range futures study. This would be an inexpensive way for USAF leadership to stay abreast of the trends that could affect operations in the future. If you found this paper useful, then you should agree, if you did not, then the officer next year will certainly do a better job!

The Three "Gs"

What will save us from the Worst Case Scenario and increase our chances of a Best Case Scenario? Part of the answer is laid out above in the recommendations. The rest of the answer is the three "G's": God, Governance and GRIN. Using the term God does not refer to any religious deity, but to "acts of God." The dinosaurs were getting along quite swimmingly for 180 million years when an asteroid (or asteroids) the size of a large city collided with the Earth and evidently brought about a nuclear winter that led to their extinction.[14] Humans have reigned for only one tenth of one percent as long as the dinosaurs…and we will be lucky to exist half as long as they did. The dinosaurs lasted so long because Glenn and Gordon's fifth axiom[15] *did not apply* to them. Dinosaurs could not influence their future—they could alter their habitat to make it unlivable or develop a bioweapon that would wipe them out. Humans, however, must find a way to survive precisely *because* the fifth axiom *does* apply to us. This makes the next two "G's" vital.

Governance must improve. As the planet becomes more crowded and resources become increasingly scarce, decisions by elected officials, bureaucrats and military leaders will increase in importance, and mistakes become more costly. Also, as resources become more constrained and the population of the planet swells, good governance is required to ensure appropriate allocation of those scarce resources when the markets become interrupted or disrupted—either by happenstance or by nefarious actors. Congress has been slow to pass laws governing the use

of new technologies. Additionally, law enforcement has been even slower in enforcing those laws or predicting how new technologies may be used to commit crimes. A cogent example of government not keeping pace with change was uncovered by 9-11. While most Americans felt the FBI and CIA had been "successful" in keeping terrorists at bay, in fact both agencies had been failing to keep tabs on known terrorists. Not until Congress passed the Foreign Intelligence Surveillance Act[16] did government agents have a fighting chance to track terrorists as they trotted the globe and switch cell phones and email addresses. In the rapid-fire femtosecond world of the 22nd century, our government must keep pace with society.

The final "G" is GRIN. No doubt that GRIN has and will pose challenges to society. How much do we enhance our children? When do we allow robots to make "kill" decisions in wartime? What about in peacetime? What are the implications of nearly everything being recorded and sample and no one being able to guarantee their privacy…ever? Yet GRIN also holds the most promise for a better tomorrow and a better USAF. GRIN will usher in better aircraft, better efficiencies, better decision making, and even better people.

With the advancement and fusion of GRIN and the singularity, the answer to any problem can be found, but we must have good governance to enact it while being prepared for acts of God that might extinguish any possible future. If the United States follows the recommendations above and heeds the three Gs, then the USAF stands a fair chance of flying, fighting and winning 100 years from now just as we did nearly 100 years ago when Mr. Watkins predicted fleets of airships. Except next time they likely *will be* hurling deadly thunderbolts.

Notes

[1] Col Alan Woodcock, "Delphi Poll Round One," 6 March 2008, email, 2 December 2008.
[2] Woodcock.

Notes

[3] Jay Wiener, "Delphi Poll Round One," 9 January 2009, email, 9 January 2009. Wiener, who is an accomplished lawyer, thinks that our words, and thus our thoughts, will change in 100 years.

[4] Lt Gen Michael Short, "Delphi Poll Round One," 9 November 2008, email, 9 November 2008.

[5] Walter Jon Williams and Sage Walker, "Delphi Poll Round One,"17 November 2008, email, 17 November 2008.

[6] Ibid.

[7] *Early Estimate of Motor Vehicle Traffic Fatalities in 2008,* National Highway Traffic Safety Administration Report (Washington, D.C.: Department of Transportation, March 2008), 1.

[8] Dr. David Brin, "Delphi Poll Round One," 10 November 2008, email, 10 November 2008.

[9] *Defense Acquisitions: Assessment of Selected Major Weapons Systems,* US Government Report (Washington, D.C.: Government Accountability Office, March 2006), 8. The original F-22 buy was listed at 750, but was reduced to 648 as a result of the end of the Cold War.

[10] "Air Force to Speed up Job Cuts to Save Money," Associated Press, 20 Sep 2006, n.p., on-line, Internet, 17 April 2009, available from http://www.msnbc.msn.com/id/14926389/.

[11] Woodcock.

[12] Military theorist Col John Boyd's concept of "Observe, Orient, Decide, Act" (OODA), then repeat the process after getting "feedback" on how action played out. He suggested that whoever observes more, orients correctly, decides logically and acts swiftly and decisively will have an advantage, but must do so faster than his adversary to maintain the advantage. Getting inside the adversary's OODA loop mean you are deciding smarter and faster then the enemy.

[13] One of my students here at Georgetown University, Russell S. Greene, proposed this and supported the theory by showing how access to information was the linchpin in five modern campaigns, much more so many of the principles of war.

[14] A new theory postulates that multiple asteroids or comets impact may have ended the reign of the dinosaur. This theory evokes the images of Comet Shoemaker-Levy 9's collision with Jupiter in which 21 distinct impacts pummeled the planet.

[15] The fifth axiom is "Humans will have more influence on the future than they did in the past."

[16] FISA, the Foreign Intelligence Surveillance Act, gave the US Government the legal standing to eavesdrop a person, not just a specific telephone number.

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Appendix A

Air Force Missions (Functions)

From *Air Force Basic Doctrine,* Air Force Doctrine Document 1 (2003), DOD Directive 5100.1 *Functions of the Department of Defense and Its Major Components* and Draft Mission Statement from HQ USAF.

1) Strategic Attack. Strategic attack is defined as offensive action conducted by command authorities aimed at generating effects that most directly achieve our national security objectives by affecting the adversary's leadership, conflict-sustaining resources, and strategy.

2) Counterair. Counterair consists of operations to attain and maintain a desired degree of air superiority by the destruction, degradation, or disruption of enemy forces.

a. Offensive counterair (OCA) consists of operations to destroy, degrade, or disrupt enemy air and missile power as close to its source as possible and at a time and place of our choosing.

b. Defensive counterair (DCA) entails detection, identification, interception, and destruction of attacking enemy air and missiles and normally takes place over or close to friendly territory.

3) Counterspace involves those kinetic and nonkinetic operations conducted to attain and maintain a desired degree of space superiority by the destruction, degradation, or disruption of enemy space capability.

a. Offensive counterspace (OCS) operations deny, degrade, disrupt, destroy, or deceive an adversary's space capability or the service provided by a third-party's space asset(s) to the adversary at a time and place of our choosing through attacks on the space nodes, terrestrial nodes, or the links that comprise a space system.

b. Defensive counterspace (DCS) operations preserve space capabilities, withstand enemy attack, restore/recover space capabilities after an attack, and reconstitute space forces. DCS operations should be proactive in nature to protect our capabilities and prevent the adversary from disrupting overall friendly operations.

4) Space Situational Awareness is understanding what objects are in space, where they are and what capabilities they possess.

5) Space Force Enhancement supports operations to improve the effectiveness of military forces as well as support other intelligence, civil, and commercial users. The space force enhancement mission area includes: intelligence, surveillance, and reconnaissance; integrated tactical warning and attack assessment; command, control, and communications; position, velocity, time, and navigation; and environmental monitoring.

6) Space Control encompasses combat, combat support, and combat service support operations to ensure freedom of action in space for the United States and its allies and, when directed, deny an adversary freedom of action in space

7) Counterland is defined as air and space operations against enemy land force capabilities to create effects that achieve JFC objectives. The main objectives of counterland operations are to dominate the surface environment and prevent the opponent from doing the same.

a. Air interdiction is a form of aerial maneuver that destroys, disrupts, diverts, or delays the enemy's surface military potential before it can be used effectively against friendly forces, or otherwise achieve its objectives.

b. Close air support (CAS) provides direct support to help friendly surface forces in contact with enemy forces carry out their assigned tasks.

8) Countersea functions are an extension of Air Force capabilities into a maritime environment. The identified specialized collateral tasks are sea surveillance, antiship warfare, protection of sea lines of communications through antisubmarine and antiair warfare, aerial minelaying, and air refueling in support of naval campaigns.

9) Information operations (IO) are actions taken to influence, affect, or defend information, systems, and/or decision-making to create effects across the battlespace.

a. Influence operations employ capabilities to affect behaviors, protect operations, communicate commander's intent, and project accurate information to achieve desired effects across the cognitive battlespace.

b. Electronic warfare operations are those military actions involving the use of electromagnetic and directed energy to control the electromagnetic spectrum or to attack the enemy across the electromagnetic battlespace.

c. Network warfare operations are the integrated planning and employment of military capabilities to achieve desired effects across the digital battlespace.

10) Combat support is the essential capabilities, functions, activities, and tasks necessary to create and sustain air and space forces.

a. Agile combat support (ACS) is the timely concentration, employment, and sustainment of US military power anywhere—at our initiative, speed, and tempo—that our adversaries cannot match.

b. Expeditionary combat support (ECS) comprises the expeditionary subset of ACS. ECS includes the essential capabilities, functions, activities, and tasks necessary to employ and sustain all elements of aviation and ground combat operations forces in a deployed location.

11) Command and Control (C2) is the exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission.

12) Airlift is the transportation of personnel and materiel through the air, which can be applied across the entire range of military operations to achieve or support objectives and can achieve tactical through strategic effects.

13) Air refueling is the in-flight transfer of fuel between tanker and receiver aircraft.

14) Spacelift delivers satellites, payloads, and materiel to space.

15) Special operations are the use of special airpower operations (denied territory mobility, surgical firepower, and special tactics) to conduct the following special operations functions: unconventional warfare, direct action, special reconnaissance, counterterrorism, foreign internal defense, psychological operations, and counterproliferation.

16) Intelligence is the product resulting from the collection, processing, integration, analysis, evaluation, and interpretation of available information concerning foreign countries or areas.

17) Surveillance is the function of systematically observing air, space, surface, or subsurface areas, places, persons, or things, by visual, aural, electronic, photographic, or other means.

Reconnaissance complements surveillance by obtaining specific information about the activities and resources of an enemy or potential enemy through visual observation or other detection methods; or by securing data concerning the meteorological, hydrographic, or geographic characteristics of a particular area.

18) Air Force Combat Search and Rescue (CSAR) is a specific task performed by rescue forces to recover isolated personnel during war or Military Operations Other Than War.

19) Navigation and positioning provide accurate location and time of reference in support of strategic, operational, and tactical operations.

20) Weather services provided by the Air Force supply timely and accurate environmental information, including both space environment and atmospheric weather, to commanders for their objectives and plans at the strategic, operational, and tactical levels.

21) Nuclear Enterprise provides for the stewardship of USAF's nuclear arsenal and therefore strengthens our Nuclear Deterrence.

22) Cyber-warfare is the use of computers and the Internet in conducting warfare in cyberspace.

Missions Proposed by the Oracles

23) Swarm Force is the use of distributed systems that operate independently but can come under centralized control when required to "mass" forces.

24) Planetary Defense is the act of defending the planet from solar system and extra-solar system threats such as asteroid and comets. Also implies protection against disasters on Earth such as volcanic eruptions

25) Offensive (Social) Networking is a form of information operations where information technology is leveraged to influence public opinion to compel or deter their government from taking an action.

26) Civil Support Operations are any mission taken to support the population, especially during disasters.

27) Space Access Denial is preventing an adversary from launching vehicles into space

28) RACE (Rapid Acquisition Cycle Environment) is the process of rapidly procuring and upgrading military hardware and software.

29) Homeland Defense/Border Security is protecting the borders of the United States and responding to natural or man-made threats to the homeland.

Glossary and Abbreviations

CAP: The Continuous Assisted Performance: Program at DARPA focusing on enhancing the physical performance of human beings

DARPA: Defense Advanced Research Project Agency: Department of Defense agency that funds and promotes cutting edge research.

Delphi Poll: A controlled and guided debate amongst anonymous subject-matter experts.

DOD: Department of Defense

GRIN: Genetics, Robotics, Information and Nano Technology: Leading areas of study that are poised to offer significant advancements in the next 100 years

MOSH: Mostly Original Substrate Humans: Human beings in the coming century that have some genetic, mechanical or cybernetic enhancements, but retain "mostly" original human parts.
Oracle: A subject matter expert commissioned to participate in a Delphi Poll.

SOFI: State of the Future Index: Futures study method used to determine if a system is improving or declining by consolidation and combing many variable into several factors and then graphed.

USAF: United States Air Force

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