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To UAV or Not To UAV:
That is the Question; Here is One Answer

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Thousands of years ago, man lived in caves and hunted what he could catch. Realizing that the larger animals had an inherent advantage, man began a journey that he continues today and one he will hopefully never end. He began to evolve. Part of that evolution included developing pictogram writing, the harnessing of fire, and the club. Admittedly, picking up a stick and learning to wield it is not what we would consider a revolutionary leap forward today. Nor would we consider learning to throw a rock a major accomplishment. Yet, it was exactly these type advances that allowed man to survive and eventually dominate this planet. Many of those creatures that did not evolve perished. Today's advances in weapons are seldom revolutionary, but if we fail to look to advances in technology and warfare – we stagnate and die.

This paper examines the setting for and evolution of the UAV, why technology should be advanced, precision-guided munitions – the "pseudo-UAV", and the inherent advantage of technology. The overriding theme here is that technology and man are not at odds with one another. Clearly, the two are not mutually exclusive, but co-exist in tandem. As man and his surroundings evolve, so do his goals and desires. Hence, with the advent of the computer, we expect to see the computer more places – even in combat. This papers further argues that it is not reliance on technology but a lack of diversity and poor strategy that causes technology failures.

Theory and Background

We are exploring fascinating new technologies today, not the least of which is the prospect of unmanned aerial vehicles (UAV) and the next generation unmanned combat aerial vehicles (UCAV). In some cases, the potential exists to remove the man from harm's way. Does this mean there will no longer be a man in the loop? No. Does this mean that brave men and women will no longer face death in combat? No. There will always be a need for the intrepid souls to fling their bodies across the sky. The UAV and UCAV only remove the need to place precious humans at unacceptable risk when there is no need.

This in no way means that there will no longer be a loss of human life in warfare. At this time and for the foreseeable future, humans in combat will be necessary and, this author would argue, a good thing. Taking the human factor out of warfare cheapens the expense of combat and would lead to more conflict. Furthermore, that uniquely human concept of chivalry on the battlefield helps separate us from the beasts.

Operation DESERT STORM

Operation DESERT STORM whetted the public appetite for quick, clean, surgical warfare. Certainly, the carnage of the conflict was not as readily apparent as it was in Vietnam. This did lead to the perception that warfare no longer carried a human cost. What were not seen in the news coverage of the "Highway of Death" were the casualties in all those vehicles. After a B-52 strike on Iraqi ground forces, we did not televise what remained, partly because there would be little to show and what did remain would have been particularly gruesome. Likewise, the thousands of Iraqi tanks that were "plinked" by US aircraft carried crews of approximately four. If you have ever seen the inside of a manned tank after it has been struck by Maverick, sabot round, or other such destructive weapon, you know the human cost. If you have not seen this, count your blessings. The press was very likely kept from reporting directly from the battlefield and showing the death and destruction first hand for several reasons: having reporters on the battlefield would have tipped our hand as to where and when strike would occur; the majority of DESERT STORM was an air war and putting reporters in the cockpit or behind enemy lines at the target site was not an option; and showing scenes of combat casualties turned public opinion in Vietnam. If public support of a conflict is important (which most students of warfare would agree it is important if not critical) and showing death turns public opinion away from the cause, why would you want it shown? Besides CNN was reporting live from Baghdad when the bombs began to fall.

Operation DESERT STORM represented the nearly ideal environment in which to showcase the capabilities of US might. The forces of the Coalition fought using advanced, mostly US, weapon systems against an aging or obsolete force that was technologically inferior. We could easily conclude that it was the technology that carried the day and, to a large extent, it was. The observation "that 93 percent of all bombs that fell from the skies in Desert Storm were ‘dumb’ munitions, guided only by pilot’s skill" is at once true and false. Admittedly, the ratio of guided-to unguided-munitions was 13.6 to 1. However, Colonel Boyne states that the ratio was "uneconomic and had to be reversed in future conflicts." (Boyne, 312) So, while the brute force method got the job done, fewer planes and munitions being expended – achieved through precision guided munitions – would have been preferable. The success of the air campaign in the Persian Gulf relative to the air war in Vietnam was predicated on the fact that "reliance was no longer placed on sheer weight of ordanance and volume of sorties but instead upon the accurate placement of that ordanance." (Boyne, 309) [Original spelling shown here] The technological advances made us better warriors.

Additionally, the leap of faith that iron bombs are "guided only by pilot skills" is an utter fallacy. We no longer use only the pilot to estimate when he is over the target and then arbitrarily release. We are even well beyond the famed Norden bombsight of WWII. The first strikes of the war by AH-64 Apaches with MH-53 PAVE LOW IIIs were guided by GPS, FLIR, NVG, INS, and Doppler radar to name a few of the systems. Even the iron bombs dropped by F-16s, A-10s, and F-111s among others were aided by CCIP and CCRP delivery methods. Terrain following and terrain avoidance radar allowed aircraft to fly low and undetected to the aimpoint. Do pilots have final release authority for their aircraft? Yes. Is it only their skills that put bombs on target? Perhaps the bomb-nav on a B-52 or the WSO in an F-15E or F-111 might have something to say about that - not to mention the Weasel EWOs.

The overall accuracy of iron bombs must be mentioned, if only briefly here. What paper on aerial bombardment would be complete with out referencing the Tranh Hoa and Paul Doumer Bridges. F-105 THUD pilots dropping unguided munitions flew 113 sorties over four years against the two bridges with negligible results. In 1972, both bridges were dropped by F-4s using laser-guided PAVEWAY I bombs. (Boyne, 166) PGMs only got better with time and research. One former Secretary of the Air Force said "In World War II it could take 9,000 bombs to hit a target the size of an aircraft shelter. In Vietnam, 300. Today, [May 1991] we can do it with one laser-guided munition from an F-117." (GAO, quoted from Lockheed Corporation summary) Though the one-bomb, one-target claim is disputable, there has been massive improvement because of technology. DESERT STORM did show that on average four LGBs were used to ensure hits and the desired level of damage was achieved.

UAV Come into Their Own

DESERT STORM provided the opportunity to show the world the combat might of the United States and to field-test in real-world conditions the newest systems. The UAV caught the public eye during DESERT STORM as well as that of the battlefield commander. A small, lightweight intelligence, surveillance, and reconnaissance (ISR) asset, the UAV became one of America's favorites. Mustin puts forward two reasons for the popularity of UAV. First is the lack of casualties. Certainly this is a bonus, but if the platform is not succeeding in its mission, then being casualty free is like taking pictures of the Grand Canyon from Boston with a disposable camera. There is no danger of falling, but there are no good pictures either. Secondly, he addressees the "technology fetish" brought about by DESERT STORM. Discounting the previously made observation that Americans have always been enamored with technology, UAV were available before and during DESERT STORM. Therefore, something changed. One possibility is that the UAV were able to get good intelligence in a timely manner and with no threat to human life. Certainly flying a manned ISR aircraft over people who have just been bombed to see how successful you were would seem inherently dangerous. Furthermore, UAV video footage released to the public media was much like having a news crew at the scene. The video imagery was more popular than the still photos derived from other sources and caught the public's attention. This hardly constitutes a technology fetish.

The UAV was not merely a flash-in-the-pan. The successes of UAV, PREDATOR in particular, have continued to mount through an array of employments and the accolades from the operator to the senior leaders have been clear and abundant.

> I was looking at PREDATOR [imagery displays] yesterday…It had been up there [at 25,000 feet] for a long time…you could see a window, focus on a window. You could put a cursor around it and [get] the GPS latitude and longitude very accurately, remotely via satellite. And if you passed that information to an F-16 or an F-15 at 30,000 feet, and that pilot simply put that latitude and longitude into his bomb fire control system, then that bomb can be dropped quite accurately onto that target, maybe very close to that window, or, if it's a precision guided weapon, perhaps it could be put through the window…I'd buy a lot of UAV in the future.

Admiral William A. Owens
Vice Chief of the Joint Chiefs of Staff
June 1995

The next generation of UAV will likely see the benign observer evolve into a fierce hunter-killer. One problem that has always plagued targeting is the lag between collecting the intelligence and getting bombs on target. In the early days of ISR, a pilot or observer on board had to wait until landing before the information could be useable. Later, they needed to radio back to base what was seen. This proved difficult when personnel at home base tried to anticipate what number and type of bombs and aircraft would be needed. Furthermore, it was difficult to adequately analyze a target from the air while avoiding being shot down. Weaponizing the UAV solves that time critical targeting problem. In February 2001, PREDATOR completed test firing of a HELLFIRE anti-tank missile against a stationary target with resounding success. More testing and development is necessary, but initial results make a strong argument for pressing ahead. There are those who question the wisdom of the UCAV fearing that the UCAV and its technology could be easily overcome through exploitation of some unseen weakness. Those fears should be laid to rest. Even the aged B-52 has some autonomous release built into it. Capt Doug Fries, a B-52G radar navigator, described a BUFF mission over Iraq and how in the final seconds of the bomb run "the navigation computer opened the bomb bay doors and dropped the weapons into the dark." (Fries)

The USAF's senior leaders have been presented an amazing opportunity and a phenomenal system. These men and women are guiding us into the future with wisdom and prescience. They have been battle tested and many are combat pilots. They hold those positions of authority based on their ability to lead and this author is confident that they will steer us to success.

Technology Always Becomes Obsolete

Most of us have owned a computer at one time or another. It always seems that as soon as we purchase it the new model comes out. The new model has more bells and whistles, is faster, bigger, and, in most accounts, is better. We look at our old computer and wonder how we ever got along with that beast. Yet, our original computer served us well. Is it obsolete? That depends on your needs. If the current system no longer meets your needs, then your system is obsolete. The same holds true for military technology. Countries are constantly developing weapons for various reasons. Some are built for offense. Some for defense. Some are built purely for sale. When countries develop weapons, they want them to be the best and take advantage of available technology. Failing to do so would result in a substandard product. However, even the greatest product or weapon will eventually be rendered obsolete. Therefore, we must continue to move ahead or suffer the fate of those who did not.

History confirms that man and his weapons are evolving. The fictitious battle between the Neanderthal and the saber-toothed tiger shows this exactly. Man found his fist inadequate to bring down the large cat and was eaten. The next man gathered others with sticks and killed the cat. The cat could not evolve quickly enough and was defeated. The man had not changed significantly. The cat had not changed. Only the "technological invention" of the club had been introduced, giving the man the combat advantage.

Jumping ahead several thousand years, we examine Medieval warfare and the armor-clad knights. Armored men on horseback for centuries had for been the arm of decision in European armies. Ranks of peasant infantrymen would hold another force at bay preventing them from maneuvering. Then, the knights would be unleashed on the flanks and rear of the enemy. If he did not have his own cavalry or reserve force, he could turn to face the knights and expose himself to the infantry; ignore the knights and be run down; or flee. None were particularly pleasant options.

Still the knights were not undefeatable. Some would argue "that the invention of the crossbow changed all this" and "rendered the knight harmless." There are a few flaws in this logic trail. First, the crossbows had been in use in China for centuries before the rise of knights. In Europe, the crossbow had been noted in the service of Alexander in the 300s BC and had made a resurgence in the 900s. So, the crossbow was not invented in the Middle Ages with the intent of felling knights. Second, most historians would credit the English longbow and its use by Edward V at Agincourt in 1415 against the French for the decline of the knight. Thirdly, the knight continued to be a dominant force on the battlefield for 100's of years after the papal edict of 1139 calling for the end of the use of crossbows (against fellow Christians only). Finally, whatever caused the decline of the knight, the horseman continued as an integral part of warfare well into the 20th century. The fact of the matter is that although the weapon (in this case the knight) was modified so greatly as to be nearly unrecognizable, he continued on wielding saber, musket, or rifle. The tactics changed but the weapon remained.

The last example of the technology cycle is radar. Here we do not need to look at centuries to see the entire cycle but decades. After the airplane was invented, we determined we needed a warning system for their approach. In some areas, visual observers were used and in others, radar was developed. The airplane was now at a disadvantage. Therefore, a counter was developed. And so on. And so on. Today, electronic attack (EA) and electronic protect (EP) are a standard part of any air action, but radar remains the primary method of detecting and tracking aircraft. Eventually, the US produced stealth technology. While this has yet to be fully overcome by an enemy, it will. By then, we may have anticipated the chink in our armor and corrected it or developed new armor.

Technology versus Strategy

Rivers dry up in a drought. Mountains crumble to dust under the forces of erosion. Superman weakened in the presence of kryptonite. Everything has a weakness. The key is not to try to eliminate all your weaknesses, but to minimize them so that no one thing can defeat you. This is where strategy and technology must come together in a joint development effort.

Strategy should influence technology. Technology should influence strategy. One cannot be allowed to constantly drive the other. We learned that lesson in Vietnam. Our strategy at that time was one based on mutually assured destruction. We planned only for a clash with the Soviets in Europe or elsewhere. Our enemy was using high-speed bombers and fighters. Guns were not an effective counter against a supersonic aircraft. Therefore, they were stripped off many new aircraft designs to make them lighter or to give more room for other equipment or other reason. When they were thrown into the Vietnam conflict, they suffered sometimes

staggering losses – not because they were technologically flawed and not because the evolution of the aircraft had been wrong. They were defeated because men had failed to anticipate the next war and placed all their eggs in one basket.

The problem was not completely with the aircraft either or our lack of vision. Rules of engagement demanding visual identification of the enemy immediately negated the strength of the missile on the aircraft and played to the strength of the enemy. MiG-15s and MiG-17s have short ranged air-to-air weapons. Bringing them in closer for VISID meant the enemy was closer to his weapons employment zone and nearer our minimum firing range. Remember, our missiles were designed to attack enemy aircraft at long range. They had a weakness of large minimum launch distances. Again, this was not a fault of being reliant on technology but the lack of planning. Tactics and methods of employment changed in conjunction with dogfighter training at TOP GUN and RED FLAG – the aircraft were again effective. Once again, technology is not the problem. Relying to heavily upon one aspect leads to combat deficiencies.

The Future Combat

Just as we ask our leaders to be predictive, we too need to look to the future before passing judgment on UAV/UCAV technology. The world is dynamic, always changing. Soon, third world countries will constitute a preponderance of the world's population. Studies show that urbanization is occurring now and that for many nations this will be a potential disaster. Nations that suffer from growing populations, stagnant economies, rising urbanization, and finite resources are at significant risk to political instability. The threat that these nations are most likely to face is internal strife and civil war. When governments fail to meet the needs and expectations of the people, the populace feels deprived relative to its expectations. [for more on relative deprivation theory, see Gurr, Why Men Rebel]

It is quite possible that the US will have some role in quelling some of those conflicts. Mustin sites Davis's study that future conflicts will be conducted in urban or littoral regions. Granting that assumption, the points made are either irrelevant or erroneous. First, the assumption that future war will different from the open warfare of Desert Storm and World War II is quite a leap. Even as I write this, we are dropping bombs on Iraqi radar and surface-to-air missile sites. The Persian Gulf remains a hotly contested area. I see no reason to suspect that another conflict over the sands of the Middle East might not loom in the distance. Second, the two examples of the USS Cole and the conflict in Mogadishu are rife with errors. The fact that we are vulnerable when our guard is down is tantamount to saying my car is defective when I am asleep at the wheel.

The example of Mogadishu present numerous errors and observations that cannot be substantiated. As noted, the urban environment will prove difficult for any commander. Somehow I believe that flying a fighter jet into an urban area may be more difficult than bringing in a UAV; however, since I have never flown a jet or a UAV in a major metropolitan area, this is an assumption based on speed, turning radii, and the like. Next, UAV currently use three different modes for communicating: two satellite and a line-of-sight (LOS). I cannot begin to imagine how "cluttered streets" could obscure communications and since the UAV like the PREDATOR operate at up to 25,000 feet, buildings should not be a problem. As for the threat

from jamming, electronic warfare is not as simple as it sounds. Furthermore, technological advances such as frequency agility currently fielded in radios and the like might be adapted. Once again, evolving to conquer the threat.

Consider also the matter of prisoners of war. With a UAV, you do not have pilots shot down, being dragged through the streets, and globally televised. In 1996, a PREDATOR was lost over Bosnia. That same year Scott O'Grady captured the nation's attention.

Weather will not affect the UAV greatly and certainly no more than most other aircraft. As stated, inclement weather, smog, and smoke can hinder pilot visibility. How is this different between a manned and unmanned aircraft? The UAV has EO/IR/SAR to rely on. The pilot has the Mark I Eyeball. Weather did affect many sorties during DESERT STORM; however, the guidance on a PGM and the sensors on a UAV are significantly different. Additionally, pilots flying iron bomb missions were not allowed to drop without acquiring the target. The observation that EO/IR systems could not see through clouds applies equally for pilots who cannot see through clouds either. SAR does not make the UAV any more susceptible to attack and unless the enemy has advanced direction finding equipment or other tracking systems, this signal cannot be used against the UAV.

The next argument strays into the realm of PGMs and the accuracy of manned aircraft dropping bombs. I will take some time on this point to drive home the fact that the man in the cockpit is not necessarily the best option and because comparing combat effectiveness across platforms is difficult at best. GPS-guided munitions do solve the weather problem. They take the weather out of the equation. GPS guided weapons need accurate target data to be effective. Having inaccurate data for a GGM would be the same as bad weather for a PGM or iron bomb – negating employment. The GAO report shows that FS successful missions used less total tonnage (55.3 tons to 63.1 tons), slightly more guided tonnage (11.2 to 9.4 tons), and a lower ratio in tons of guided to unguided munitions (3.9:1 versus 5.7:1).

The GAO also reported on LGB versus iron bomb employment. The F-111F dropping GBU-10 and GBU-12 struck 130 targets with 285 weapons. They were credited with 123 hits for a 95 percent target hit rate. The report did not break out how many actual bombs hit the target. F-16s using 2000-pound MK-84 unguided bombs struck 34 similar strategic targets. They successfully destroyed 18 for 53 percent.

Admittedly, in February 2001, the JSOW did not fair particularly well – 12 of 14 of the "less battle-tested JSOW" missed by a large margin. The submunitions "were still able to inflict some damage on the target complex." (Fulghum) After review of the mission data, one "industry official said the JSOWs that missed their targets all had mission planning done by the same Marine Corps unit." (Fulghum) I have the greatest respect for the USMC, but I do find it at somewhat easier to believe that this may be the source of the error rather than GPS jamming which "would likely have been detected by US intelligence assets." (Fulghum) Even poor GPS signal or coordinates would be more acceptable. Being given bad coordinates will take anyone, even a GPS weapon, to the wrong location.

The JDAM faired much better. In fact, GPS is so good that the OSD has approved full production. JDAM, which uses GPS/inertial navigation system to steer to the target, has been amazingly effective over Kosovo. While weapon accuracy requirements were 30 meters using INS and 13 meters using GPS/INS, "we are getting 14 meters with INS and 8 meters with GPS/INS" according to JDAM program deputy director, Lt Col Richard Walley. How does this compare against iron bombs? The Kansas Air National Guard recently upgraded from unguided munitions to the JDAM for its B-1 LANCER. The new capability to strike 24 separate targets with 24 weapons is a 2000 percent increase. (Barr) The KSANG B-1s are now 20 times more effective than previously!

I do not understand why GPS munitions would be predictable. Presumably, this implies that GGMs could only be employed during times when there is a strong signal. The signal strength requirements of JDAM and JSOW are classified. Therefore, I cannot comment on any of this argument; however, the INS in the JDAM would not be affected by no signal whatsoever. As for simple errors embarrassing the combat capability of the United States, how many planes are lost a year due to simple error? By every nation, not just the US? Does that embarrass us or do we feel for their families? A bomb missing its target is just that, a miss. Need I mention the Udari Range?

The "silver bullet" in this entire travesty of an argument apparently rests in DESERT STORM with the F-117. The claim is put forward that the F-117 was 10 times more accurate than the TOMAHAWK, or TLAM, and that the pilot in the F-117 is the reason because the two systems are similar. This is the crux of the argument? Of 432 targets with BDA reports, 357 total were matched to a BE-number and had campaign input data. This database was used by the GAO to draw several conclusions about the effectiveness of airpower in the Persian Gulf. This data set is the basis for much of this argument. The F-117 had 122 fully successful strike and 87 not fully successful for 58 percent. The TLAM was 18 and 16 respectively, for 53 percent. A fully successful mission did not require restrike to accomplish mission objectives. The F-117 originally was assessed to have had an 80 percent bomb hit rate. This has since been refined to a 55 to 80 percent hit rate and only 57 percent of the targets assigned on the first night were struck (31 hits on 57 DMPIs using 60 weapons (13 no drops)). The lower success rate resulted when the data was rescored using standardized methodology. For instance, originally 32 percent of hits were credited without supporting video. This was contrary to the unit’s "peacetime training policy and the policies of other LGB-capable aircraft in Desert Storm." (GAO, App III:5.2.2)

The effectiveness of the TLAM is slightly more difficult to quantify. The Center for Naval Analysis and the Defense Intelligence Agency estimate "that about as many TLAM Cs and D-Is failed to arrive at their intended targets – termed "no shows" – as are estimated to have hit their targets." (GAO, App III:6.3) Almost all other specifics of success and failure have been deleted, presumably as classified. Further problems are derived from vague objectives making success difficult to assess, 5 aim points were misidentified, and 5 TLAM were launched against that were beyond the TLAM ability to destroy. Based on the lack of data and only rough estimate on TLAM effectiveness, it would be difficult to substantiate the "10 times" more effectiveness.

It should also be addressed that the F-117 and the TLAM are significantly different. The F-117 has any number of aids available for guidance and assistance in finding its target. The TLAM

Block II, which was the version used in DESERT STORM, used terrain contour matching (TERCOM) to find the target and DSMAC (Digital Scene Matching Area Correlation). Imagine being told to travel 1000 miles into the desert with directions given in the rising and falling dunes and pictures of desert. Anyone who spent time in the desert can tell you that the terrain is always changing. DMA was unable to create accurate information because of "the relatively flat, featureless, desert terrain in the theater." This cannot be held as a flaw in the weapon or the technology. In 1994, the new TOMAHAWK Block III achieved initial operational capability. The Block III adds GPS navigation to assist in correcting the problem.

Potential Weaknesses and Drawbacks to UAV

One area of concern that needs to be addressed is the logistics trail and footprint of a UAV deployment. A PREDATOR can be deployed using five tactical airlift C-130s or one C-17/C-5 strategic airlift aircraft and requires 28 personnel. This seems to be a point of consternation with some who argue this as too large. Deploying one aircraft is a "frightening aspect" and a "substantial logistics trail?" An actual deployment of the 11th Reconnaissance Squadron from Indian Springs (home of the PREDATOR) includes "55 people [5 pilots, 15 imagery/intelligence analysts, 20 maintainers, and additional support personnel], a ground control station van, four PREDATOR air vehicles, electrical generators, two HUMVEE vehicles, and a satellite dish communications trailer called the TROJAN SPIRIT." (Airman 7/98) Additionally, it is noted "the total system cost is $28.3 million, about the same as a single seat F-16A when first designed." (Mustin) In reality, each PREDATOR costs approximately $3.2 million and a TROJAN SPIRIT Van about $2.9 million. These components, four PREDATORs and one van, cost $15.7 million. (Jones)

A unit's "footprint" is basically the area and impact it will have when stationed in a given area. The idea that the above numbers constitute a "huge 'footprint'" is ridiculous. Drawing on my personal experience of having spent sometime at Indian Springs, the PREDATOR squadrons have a very small footprint at home base, let alone deployed. Furthermore, the idea that a UAV footprint is equal to that of a manned combat force lacks merit. A fighter squadron deploying is a major undertaking and the advanced team (ADVON) can often fill a large cargo plane. Furthermore, a UAV can also fly across the ocean and do it unrefueled as evident by the recent GLOBAL HAWK deployment from stateside to Australia. UAV, such as PREDATOR, can deploy out of any base with enough runway just like a combat aircraft. Certainly, it must remain under control of the operating facility – that is where the pilot is. A manned aircraft must remain under constant control of its operating facility (the pilot) except that the UAV pilots can get up and change out in the middle of a mission if necessary. Also, all aircraft must return to a safe location or perish. A UAV could be landed at another base nearby and recovered just as a manned aircraft might divert to an alternate base. For example, an A-10 with an in-flight emergency is forced to divert. If the base it lands at cannot correct the problem, personnel from the home base may be required to go to the jet before it can be recovered. Likewise, an F-16 diverting to a tanker base could not be rearmed and returned to combat. Every airframe has certain unique requirements. It is not like pulling into any gas station, gassing up, and getting back on the road. Finally, the "electronic tether" does not tie the UAV to a particular location. It allows the UAV to range over hundreds if not thousands of miles. Would you say that the F-14 has a "jet fuel tether" because it is tied to the aircraft carrier and limited in mobility based on fuel

constraints? How is the mobility paralyzed? The UAV can fly anywhere within a 400nm radius of the base and then provide 16 hours of loiter. This is paralyzed mobility?

Future threats to UAV technology are most certainly being developed today. Fortunately, we are already working on ways to prevent those from being effective. Jam resistant communications are just one of those aspects being researched today and should be deployed by 2009. Upgrades to the UAV are also underway including larger payloads and more powerful engines to make them faster and more maneuverable. Chinese forays into space and the sale of Russian military technology should concern us, but should not stymie our own advances. Some technology could be developed that would render our most advanced weapons obsolete. An electro-magnetic pulse (EMP) weapon would render almost all electrical systems in its effective radius non-functioning. This does not mean we should give up microprocessors and return to vacuum tubes.

Conclusion

UAV and UCAV represent a significant step in the right direction. They will augment manned flight, not replace it. Only extreme futurists predict the end of humans in cockpits. Placing total reliance on anything creates a single point of failure that could be easily exploited. Therefore, we must embrace the advantages of UAV and guided weapons. They are cheaper to mass-produce, eliminate some risk to humans, are generally more accurate, and do not mind flying into a "no-win" situation. Relegating the UAV to only ISR missions would be no less provincial and narrow minded than limiting the airplane to scouting and patrolling.

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