STRATEGY RESEARCH PROJECT

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LEVERAGING TECHNOLOGY AND TANK DESIGN REQUIREMENTS FOR 2020 SECURITY LANDSCAPE

BY

LIEUTENANT COLONEL MARK T. DOODY
United States Army

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by

Mark T. Doody
Armor, U.S. Army

Dr. Douglas V. Johnson II
Project Advisor

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U.S. Army War College
CARLISLE BARRACKS, PENNSYLVANIA 17013

ABSTRACT

AUTHOR: LTC Mark T. Doody

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The role of a future tank or Future Combat Vehicle (FCV) will change as the future strategic security landscape evolves. The United States future strategic security landscape will evolve due to increasing external dynamic forces that will impact the world in profound ways: information age explosion, economic globalization, evolving nation states, shifting strategic alliances, exponential technology growth in all sciences, and emerging landpowers. To meet this challenging future security landscape, the Army must adopt new warfighting concepts and leverage technology to fundamentally change how it prosecutes land warfare: using precision munitions, multisensor arrays, information dominance, advanced materials, hybrid engine designs, and lighter more deployable platforms that allow for quick entry anywhere in the world. Future adversaries will be at different technological levels than U.S. forces, but will have capabilities that could and will challenge our ability to wage successful landpower campaigns. The design revolution for a future tank or FCV will exploit leap-ahead technologies that will transform this platform from the ground up to become more strategically relevant, dominant, and lethal across the spectrum of crisis. This paper will examine the dynamics of a new strategic security environment where future warfighting concepts require more stringent attributes for a Future Combat Systems (FCV) or tank that predominately must be more expeditionary in order to achieve strategic dominance across the breadth of any opponents battlespace.

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THE STRATEGIC LANDSCAPE 2020

> "Evolutionary developments are relatively easy to forecast, but the course of revolutionary events is inherently upredictable. We live in the midst of a still-unfolding revolution in international relations. It began with the unexpected collapse of the Soviet Empire and the huge increase in East Asian economic strength in the 1980s. This revolution is virtually certain to continue for decades, as the relations among countries are realigned based on their new ratios of strength and weakness."[1] Patrick M Cronin, NDU

As the United States approaches 2020 the strategic landscape will present new challenges to regional security and national interest worldwide. Regional hegemonic powers will begin to emerge as traditional rivalries continue to grow and new ones develop over new issues including economics. This will generate multiple flash points between regional powers. The United States will still be the single greatest power in a multi polar world of shifting bilateral and multilateral alliances.[2]

This new world order can only be predicted based on current trends among nation states when looking at elements of national power: political, military, economic, information, and diplomatic. These dynamic factors set the stage for either peaceful transition periods or a resurgence of century old rivalries that will create regional instability. The effect of 192 globally linked economies will also effect regional conflict in the future.[3] Some of the key assumptions about this future global security landscape that the United States will engage and shape are:

1. "The United States will remain the principle military power in the world." [4]
2. The United States will be an economically strong force and thus have a significant role shaping the international environment. Globalization of national economies will inexorably link alliance and non-alliance trading partners.[5]
3. "Nation states will remain the principle actors."[6]
4. "Imbalance between developing and developed nations will generate tension."[7]
5. "Shifting alliance and coalition partners will both increase the United States' ability to confront complex threats and make it more difficult." [8]
6. "Science and technology will continue to advance and become more widely available for use anywhere in the world, but the benefits will be less evenly distributed."[9]

Given these basic assumptions, a very complex, dynamic and diverse global security landscape emerges that will affect how the United States Army approaches the application of landpower. This will drive a transformational shift in the Army's concept of how to apply strategic landpower in a predominately force projection Army that is less forward deployed. The United States Army will need to address these future trends across the spectrum of conflict.

The United States Military can be expected to execute a wide variety of missions, across the spectrum of crisis from peace operations to major regional conflict. The Two Major Theater of War (MTW) requirement will remain the centerpiece of U.S. landpower strategy beyond 2020.[10] Structuring the U.S.

Army to maintain the strategic edge and provide forces across all mission areas will be a significant challenge into 2020.

The world community "will continue to fragment along tribal, religious and ethnic lines, causing a proliferation of new political entities with attendant internal and regional conflicts."[11] Addressing these challenges that increase tensions and regional imbalances will strain diplomatic and international organizations. Shifting political organizations and factions will blur the line between alliance members and potential adversaries. This can also create an imbalance in the regional military balance of power that may ultimately lead to military build-ups.

Exponential economic growth and prosperity in "new technologies will divide the world as well as draw it together."[12] Growth of technologies will facilitate an explosion of global communications, advances in genetics and biotechnology, and increasing development in the hard sciences. While new technologies will increase productivity and manufacturing there will be increased migration of population to those nation states whose economies provide wider opportunities.

Energy will continue to play a vital role in the global market place and will remain a strategically important resource.[13] By 2020 fossil fuel will be the critical energy source for the global economy, but advances in technology will have developed key alternative sources that will begin to shift reliance to alternative fuels by 2030.[14] United States dependence on Gulf oil will shift to South America and Africa while Asia and Europe will continue reliance on Gulf oil. The uninterrupted flow of oil will continue to be a vital interest for the Untied States and it's allies.

This extremely complex global security landscape will be very fragile and "the United States will be called upon frequently to intervene militarily in a time of uncertain alliances and with the prospect of fewer froward deployed forces."[15] By 2020, U.S. forward presence will likely have decreased and forward basing will present challenges to protecting U.S. interests abroad. There will be a major shift in the NATO alliance with the redeployment of the forward-deployed U.S. Corps in Germany as the European Union (EU) EURO Corps assuming the key security response role. More countries will ask for assistance, but will not want U.S. forces permanently stationed in their country. This will increase the U.S. Army's reliance on force projection, pre-positioned afloat Brigade sets, and a landpower with greater strategic reach.

With all the dynamics of a changing global security environment, "the next quarter century will require a different military and other national capabilities."[16] By 2020, the Army will have transformed itself and shifted its fundamental warfighting strategy for employment of landpower and its application as a strategic super power. Key attributes of this transformed force will be stealth, speed, range, an unprecedented precision, lethality, strategic mobility/reach, superior knowledge and intelligence, and an uncompromising will to prevail. [17] Advances in technology will enable the Army to achieve an unprecedented edge over any adversary. The technology edge is not a "silver bullet" but an enabler that

will increase U.S. ability to prosecute decisive operations. National capabilities will have to be balanced between global security concerns and domestic issues that will pose tough political/diplomatic choices.

Despite the fluidity and challenge of the global security landscape "the essence of war will not change."[18] While the actors, nation states and the weapons to wage war might change, the carnage and devastation that are characteristic of war will not. There will be a prevailing American societal norm that lacks tolerance for casualties during any U.S. action. The notion that war will be like a video game or surgically clean from death and strife will challenge U.S. national will to follow through.

This future global security environment will challenge U.S. interest in 2020 and pose tough choices for the U.S. Army to transform itself in to a strategically dominant force projection Army. Technology will play a key role in how societies develop and militaries either evolve their capabilities or develop new revolutionary systems. The centerpiece of this transformed landpower will continue to be the tank. The relevance of the tank or FCV in future warfighting concepts will be critical to enhancing the strategic reach of U.S. forces worldwide. New force designs and warfighting concepts will be developed to strategically project landpower globally. The notion that U.S. landpower will be predominately a force projection combat force will require a more robust flyaway structure. These light forces will inherently be more lethal then legacy heavy forces and increasingly more deployable.

FUTURE STRATEGIC LANDPOWER

> "The surest way to win at minimum cost is to win quickly. A decisive, quick victory can best be assured by an early arriving force of overwhelming power capable of conducting a strategic takedown.[19] MG Robert H. Scales, Jr.

The United States military has experienced the victory of Desert Storm and Operation Just Cause all within the framework of the Post Cold War Army. Since 1990, the U.S. Army has conducted 30 plus operations worldwide across the spectrum of crisis. The Army continues to adapt with little change in conventional force structure. The Army has recognized the need for refining Peace Operations and establishing appropriate doctrine. In 1991, when GEN Gordon R. Sullivan assumed the position of Chief of Staff of the Army (CSA) he saw an Army without an adversary, no more cold war, new challenges and missions. Since that time, the Army has continued to build Cold War systems that are too big, too heavy, and logistically unsupportable and lacking strategic responsiveness for the type of operations it is being called upon to perform today

The security landscape will change by 2020 and the Army has to take advantage of this transition point in its long history to prepare for future conditions. The current CSA, GEN Eric K. Shinseki, has chartered a course for revolutionary change from the ground up. Some retired senior leaders contend that the Desert Storm structure and battlefield concepts will serve the Army well into the 2020, but global security environment is becoming more complex and intricate. This will require a different Army that leverages technology to enable it to be more robust across the full range of military operations and strategically responsive to the National Command Authority (NCA).

Characteristics of a Military Technical Revolution (MTR) or Revolution in Military Affairs (RMA) are the basis for developing a new strategic level competency that will better satisfy the Nation Military Strategy requirements. The notion of a MTR encompasses radical innovations in weapons or military equipment, and such technologies are, or soon will be, available on the world market. An RMA results when a nation's military seizes an opportunity to transform its very being: doctrine, training, equipment, tactics, and operations and strategy.[20] The U.S. Army is moving along this future transformation glide slope.

The ability to shape the strategic security environment through peacetime engagement and bilateral military exercises will impact our ability to respond within regional conflicts. Forward presence will be limited in the future; therefore, naval activities will have to assist in strengthening our alliances in that fashion.

The ability to respond to a crisis or influence major a regional actor begins with strategic speed and knowledge. Strategic speed is the ability to quickly deploy to a troubled region with large but lethal organizations that can act independently of one another yet be mutually supportable. Forces will be light enough to be deployable by C130 and lethal enough on the ground to be strategically decisive once committed against an adversary. New informational technologies will provide a backbone of intelligence and situational awareness of both friendly and opponent forces. In order to achieve this new strategic relevance as a landpower, new strategic concepts have to be developed.

STRATEGIC CONCEPTS

The first of four strategic concepts that support a new force projection Army breaks the old paradigms on how organizations operate. Strategic preclusion is achieved by taking Joint Expeditionary Forces (JEF) comprised of modular and tailorable early-entry ground forces operating in conjunction with collective air, sea, space, and special forces assets.[21] This force will move into the opponent's battlespace so fast and with such lethality that before his forces set, U.S. forces will gain positional advantage compromising his immediate goals. This capability will cause the opponent to quickly settle any dispute and come to a peaceful resolution with minimal loss of life and property.[22] If the opponent sees his position as untenable and continues the conflict anyway the U.S. will intervene with a more robust campaign force.

Second, the notion of Strategic Maneuver envisions rapid movement over global distances with highly lethal air, land, sea, and space capabilities to converge with overwhelming power upon the enemy centers of gravity and to cause the rapid disintegration of an opponent or cause him to concede to U.S. terms.[23] These forces will be light, lethal, fast, informationaly linked to one another and robust across all systems. These forces would fly from multiple locations and either converge on an Intermediate Staging Base (ISB) for intra-theater lift or fly straight into hostile territory to engage the opponent. Units would coordinate in flight with sophisticated data links for rehearsals prior to arrival. This operation can be accomplished in days versus weeks or months.[24]

Third is the concept of strategic fires and interdiction that make up a critical component of full-dimensional operations. This concept optimizes the use of long-range standoff weapons and space based systems to destroy key strategic targets prior to entry of a land force. Upon entry of land forces strategic fires will provide a "protective umbrella" over the theater and assist in supporting the ground commander's maneuver.[25]

Fourth are major campaign forces that are deployed when an opponent is dedicated to extending the conflict. These forces will embark from multiple ports and use propositioned equipment sets to reduce time of deployment to theater. Once the campaign force has achieved the NCA mission, a sustaining force presence will provide for stability operations. [26]

The very nature of the Cold War battlefield will be a relic compared with future strategic concepts for the employment of landpower. The revolution in technology will forever change how soldiers and systems interrelate on the battlefield. The ability to tier force structure to respond to any crisis with strategic speed and dominance will be the cornerstone of future landpower.

BREAKING THE PARADIGM...NEW OPERATIONAL/TACTICAL CONCEPTS

> Technology is advancing at an astonishing pace. The fruits of the information age--Precision and information--coupled with future breakthroughs in mobility, could lead to significant new capabilities at every echelon. Even modest investments in the most promising technological options may combine to increase tactical-level combat power by an order of magnitude[27] BG (RET) Huba Wass de Czege

While concepts for warfighting will change with new and challenging security environments, soldiers on the ground executing the NCA directive show U.S. resolve and commitment. There are two essentially different concepts for structuring the force for the future battlefield. One concept proposes that forces should be tiered to meet the full range of future security challenges. The second concept proposes all forces have the same structure and be able to adapt to any security environment. No matter which warfighting concept is applicable, there are some common characteristics of the future force. These are: global projection capable, lethal with precision munitions, speed and mobility, maximum standoff capability, survivability and reduced weight, modular or common chassis design, reduced logistic tail and high reliability, and sophisticated information fusion at all levels. These characteristics are critical to operating within a high tempo and extremely lethal security environment of 2020.

TIERED FORCES "TEAM OF TEAMS"

BG Wass de Czege's concept is that tiered forces better respond to a crisis or major theater of war scenarios. This "team of teams" concepts is an attempt to break an old Army habit of packaging forces from different units to build a new one, thereby breaking up cohesion in fighting organizations that would not normally task organize.[28] This piecemeal approach to warfighting breaks down unit cohesion and delinks organic command structures. While some task organizing will occur, it will be minimal.

Several studies have indicated that a better mix of forces that can cover a broad range of missions at the tactical level would optimize the force into at least four types of tactical capabilities.[29] These four capabilities would have a mix of type units that would reside within a bigger organization.

- Rapid Deployment Forces capable of quicker departure and closure times than current airborne units. This force would be a more robust and lethal force, thereby offering a strategic and psychological advantage.[30]
- High mobility forces with greater mobility and protection than light forces. These forces primary purpose would be to bring a rapid conclusion to a campaign with highly mobile and lethal forces capable of exploiting a seam or weakness within the opponent's plan. These forces would exploit centers of gravity very rapidly and collapse his will to fight.[31]
- Campaign Forces are the next level of protection of highly mobile forces. Strategically deployable and able to engage in decisive combat with an opponent's heavy force. They offer the strategist a capability to wage protracted conflict if necessary as the second echelon shock wave.[32]
- Special purpose forces would operate in complex terrain and urban zones as well as conducting stability operations, both in peace and war. This force would range from Special Forces and Rangers to general infantry forces and would provide a variable niche capability. These forces would operate anywhere along the spectrum of crisis.[33]

The tiered force concept represents an optimization of force design to better organize for warfighting without taking units apart to accomplish single type missions. Forces would be designed to achieve dominance with their respective niche areas. This would also allow graduated responses to any conflict or peace operations with relative speed.

HYBRID FORCE 2025

The Army After Next (AAN) Directorate at TRADOC developed hybrid future forces that are a blend of capabilities, a range of force structures and functions. This force is optimized for a specific range of missions. By leveraging technology and using leap ahead advances in fuel cell design and new ballistic materials this heavy force narrowed the gap between heavy forces and light forces with respect to deployability, lethality, and speed. With modular type force there is more flexibility to work at the next higher level of conflict intensity. TRADOC's AAN Directorate has proposed a future tiered force comprised of: contingency forces, campaign forces, homeland defense forces and SOF.[34]

Contingency forces are part of a JEF that has modular brigade size elements that are tailorable as Battle, Strike, light and mechanized forces operating in conjunction with SOF.[35] Battle forces are the most modernized forces in the Army and field revolutionary capabiltities. This force will have a strategic self-deployment capability, complemented by ultra fast lift, and the ability to execute strategic preclusion and maneuver. This force conducts operations both vertically and horizontally within the depth of the opponent's battlespace. Strike force is a medium weight force that provides speed, lethality, reduced

logistics, and depth in relative battlespace. Well suited for early entry shaping operations. Light forces will also provide early entry and are optimized for complex urban terrain warfare.[36]

Campaign forces will consist of Force XXI legacy systems that have been modernized with advanced technologies. This force will take longer to deploy or can quickly linkup with pre-positioned ships and draw in theater. This is the sustained landpower force that will build combat power slowly over several weeks and months.[37]

Homeland defense forces will consist primarily of Reserve Component (RC) forces that will be fully modernized with new technologies. This force will be linked to governmental organizations that provide domestic support across all state government functional lines.[38]

Special Operations Forces (SOF) will continue to provide the same mission support the Joint warfighter at the low end of the Spectrum of Crisis.[39]

The ability to project the force with speed across all operating systems is the key to both force designs presented. In each case, a newly designed FCV is essential to a tiered response. The keys to a new FCV are speed, survivability, modularity, lethality and precision munitions, sustainability on the battlefield, advanced C4I capability and situational awareness. Both authors present viable force designs to optimize the objective force across the entire spectrum of crisis. The FCV is the centerpiece of the maneuver strategy as it has been and will be in the future. Although, both view a requirement for a medium weight tank system for quick deployment by air and heavy FCV for major campaigns, my proposal is one FCV that is modular and adaptable to contingencies and major campaigns. Future technologies will propel FCV design beyond today's standards for strategic relevance and bring the Army into a technical revolution beyond any opponent's expectations in 2020.

FUTURE TECHNOLOGY AND TANK REDESIGN IN THE PRECISION AGE

> Armies of highly developed nation-states will be industrial and information-age hybrids. They will use surface and air-delivered precision-strike weapon systems extensively and employ highly sophisticated survivable and mobile maneuver platforms...Developments in long-range, precision-strike brilliant munitions may result in a redefinition of the classic relationship between fire and maneuver in advanced armies.[40] Colonel Gary B. Griffin

By 2020, there will be a major Military Technical Revolution MTR that will change how systems interact within a future battlespace. The major technology areas that will revolutionize the FCV look beyond traditional characteristics of legacy tank systems of the late 20th Century. By 2020 precision beyond line of sight weapon systems will be the norm and line of sight weapon systems will be passé. Sensors from space to the tactical level will influence information dominance and provide the leverage to see the strategic depth and breadth of the battlespace. Engagement systems will be predominately hypervelocity missiles and top attack, loitering missiles that will link to sensors for exact targeting. The notion of suppressive fires will be replaced with precision discriminate fires that search and attack. Major systems will use advanced materials for protection that can either absorb a direct hit or deflect an incoming projectile with countermeasure systems. FCVs will be lighter, wheeled instead of tracked and

have hybrid or fuel cell engine technologies that give systems 1000-mile ranges per tank of diesel. Of course a real issue is designing and "achieving a system to do to many things, results in a system that does nothing especially well. Striking the proper balance between specificity of purpose and flexibility of application is a fundamental systems design problem."[41] These are some of the technologies that will be morphed and refined within the context of a strategically relevant multi role FCV.

In 2020 the Army will fundamentally change FCV design characteristics to meet the challenges of a new millennium. "The tank reached it technical and strategic heights during the cold war and the cold war was formulated around principles of WWII. The obsession with size and weight would in the end lead to massive extremes in design of increasingly endangered armored vehicles."[42] In what ways can future characteristics be leveraged with technology in designing a FCV that meets the requirement of a force projection landpower?

The following major design characteristics are key to a total redesign of the tank into Future Combat Vehicle:

- Increased mobility and speed - Hybrid engine designs, suspension optimization, volumetric
- Signature management systems- Low observable materials, stealth, reduced crew, turretless
- Unrestricted transportability - optimization of weight, dimensions, air frames
- Maximizing commonality of chassis - optimizing chassis design, crew size, 360 degree view
- Survivability and countermeasure systems - countermeasures against KE round, missiles
- Engagement systems- precision weapons, self protection weapon, missiles, top attack
- Information management - sensor management, target acquisition, data links, reach back
- Reduction of sustainment requirements - increased reliability, self diagnostics, black box

These major characteristics address the important redesign areas that will be examined in the rest of the paper.

INCREASED MOBILITY AND SPEED

Increased mobility and speed essentially must complement one another. The first area to address is the type of suspension system technology that optimizes the FCV performance. There are two arguments: first is "combat platforms with greater than 60% cross country mileage, which require operations in all weather/climatic conditions, and have combat vehicle weights greater than 10 tons should be track configured."[43] This is predicated on a study done in the late 70's with WWII tank concepts. Future wheel technologies will have hydrostatic suspensions, kneeling capability for silent watch or reduction in profile, running flat and self-healing tires, and total weight not exceeding 20 Tons - a six-wheeled vehicle has the right characteristics. The tires will be able to lower pressure to run on sand and will perform open field sprints at speeds up to 70 MPH. Future wheeled chassis will be able to traverse all terrain envelopes required worldwide and maximize road networks.

The second argument is that tracks offer the best suspension and traction for a combat vehicle. When the system weights in at 70 Tons and the main armament is a 120MM main gun, the platform

needs that type of suspension. The limiting factors for large systems are strategic mobility, sustainment, weight of the tracked system, and engine to torque ratios for transmission. Large suspension systems are an evolution of armor platforms since 1917. As platforms grew in armor protection weight all associated characteristics also grew. If all these variables can be reduced a FCV can achieve a fighting weight of 20 Ton in a wheel configuration. Second, if the vehicle is turretless with no main gun or large caliber weapon system, saving 30% of the weight, then large suspension systems in the future are not required. To achieve mobility and speed a FCV with six-wheeled chassis offers the best strategically deployable systems, is easier to maintain optimum dash speeds, and provides better transition from off road to road for overall speed and endurance.

Engine designs that optimize small platforms to reduce weight and increase mobility are hybrid diesel engines that run at constant speed and continually charge the batteries. The vehicle is all-electric except for parts of the suspension. The FCV drive motors are in each wheel hub that reduces weight because there is no transmission, transaxle, spider joint drives or associated drive train items. The FCV will most likely be able continue to move even with only drive motor operational until the operator can get to a maintenance area.

SIGNATURE MANAGEMENT

Signature management in the future will be a function of overall tank design and will include consideration of: volumetrics, two man crews, low profile/shape to reduce radar cross section, advanced composite materials for an outer skin (polymers, ceramics, etc), advanced sensors that detect observation by radar, millimeter wave, and lasers. With this strategy of composite materials comes a net saving in overall weight in the hull of 35% over conventional legacy system weights and for the same level of protection.[44]

The notion of managing a platform signature in the 2020 battlespace is critical to survival. Many opponents will have advance overhead sensor technologies or space based platforms for acquiring targets. It will be critical to reduce the cross section of the FCV and optimize the design for both line of sight acquisition and overhead.

The design characteristic of the FCV must consider smooth surfaces and will operate without a turret. The only outer surface areas exposed will be sensors and a telescopic sensor antenna. There will be onboard defensive countermeasures but they will be embedded into the skin of the platform. The vehicle will have a reduced crew compartment of two thereby reducing the vehicle size and profile. By locating the crew in the hull it "increases their survivability because few hits are scored on tanks below about 0.7 meters."[45] The crew will have 360 degree view using onboard cameras and third generation Forward Looking Infrared Radar (FLIR) for close in situational awareness and targeting.

UNRESTRICTED TRANSPORTABILITY

The ability to be strategically relevant underlies the whole design of a FCV. It must be strategically deployable by air from any point on the earth while optimizing each airframe configuration for immediate

combat operations upon entry into Theater. Future warfighting concepts emphasize the ability to put combat power on the ground in unimproved parts of an opponent's battlespace. Today it takes C130 or C17 airframes to accomplish this mission. The future of strategic airlift by 2020 will be limiting and will predominately be updated legacy airframes. The ability to fit within the characteristics of a C130 is paramount to projecting the force into immature theaters to achieve global strategies like "strategic preclusion."

The key to transportability is weight and cube. Weight will not be an issue with the FCV because of advance material design, wheeled suspension, low profile, no turret, two man crew, and decrease weight in hybrid engine design and electric drives - i.e. no transmission or drive trains. All this adds to weight reductions and space savings. Getting lethal FCV systems into an opponent's battlespace quickly and achieving strategic surprise is the toughest component of any force projection operation. A FCV with a 20T limit can be transported by strategic lift in the following configurations:

- C130 - One 20 Ton FCV (capable of dirt strip landings)
- C17 - Three 21Ton FCV (capable of dirt strip landings)
- C5 - Four 22 Ton FCV (improved runway or better)

MAXIMIZING COMMONALITY OF CHASSIS

The strategy for having common chassis design in 2020 is essential for optimizing combat systems or support systems on the future battlefield. This strategy also greatly reduces parts inventories, commonality of fuels, reduces the logistic tail, visual friend or foe recognition, lower life cycle costs, and lower acquisition costs beyond 2020. The common chassis using hybrid engines and electric drives will increase time on station before refueling and reduce fuel consumption.

With a common chassis design the ground component commander can better tailor organizations for deployment and also optimize his sortie flow to better achieve strategic force projection alternatives. A common chassis design allows more variant platforms available for strategic deployment within the context of future strategic landpower concepts.

SURVIVABILITY AND COUNTERMEASURE SYSTEMS

Since the inception of the tank in 1917, survivability for keeping the crew alive in combat has been a fundamental component of tank design. As tank technology evolved and ballistics of direct fire weapons continued to escalate from early machine guns to 120MM main guns, the armor to protect the crews has grown proportionally. Tank systems overall weight continued to climb with increased layers of armor protection achieved through Rolled Homogenous Steel. When Kinetic Energy (KE) long-rod penetrators were invented the old standards were not good enough, which meant heavier and denser material - Chobham armor and depleted uranium liners within the armor plates. This increased total weight by almost 10 tons, bringing the biggest legacy systems to 70 tons. Armor protection on tanks revolved around protecting the weapon system but mainly protecting the crew.

Also of note is the theory that tanks weighed so much because designers were protecting the whole vehicle with equal amounts of armor and the tanks were gaining immense weight. This would be solved and designers would learn about probability of hit vs kill and apply armor protection where required. "LTC J.M. Whittaker a British tank specialist developed the Directional Probability Variation (DPV) - a study that determined where rounds were more likely to strike. A majority were on the frontal arc measuring 60%."[46] With this, a weight relationship could be achieved and reduction on flank protection and increased armor on the frontal 60% where the probability of a hit is more likely. This was a "calculated and acceptable risk,"[47] and was noted as the first mathematical modeling in weapon design for its time. This same math propelled tanks through the 20th century with no change in logic due to the direct fire nature of war and line of sight acquisition. At the turn of the century frontal armor exceeded 3.5 tons/m^2 which further increased total weight.[48]

Advances in protective materials by 2020 will make the combat systems lighter and more survivable then 20th century armor plates. To improve ballistic protection, composite hulls offer promising technology against KE rounds. "Using aluminum oxide ceramic tiles embedded in epoxy-glass laminates at 60-65mm" will provide ballistic protection and reduce weight of the vehicle by 35%.[49] The logic that a FCV must be able to absorb or deflect a round with countermeasure system is the strategy for 2020.

The material characteristics to have self-absorbing armor or material connotes a metal outer layer, and ceramic sandwich layer, an accommodating layer and an internal plastic/epoxy-glass laminate.[50] This combination of materials slows the penetrator down and the ceramic layer absorbs the hot metal and dissipates it within the center layer. This "ceramic interface defeat mechanism" offers lighter weight armor that is survivable.[51] This type of protection is lightweight and provides equal protection geometrically on all surfaces of the vehicle. In the future, top attack will be the prevalent penetration point and there the FCV will have adequate protection.

Vehicle design that incorporates lower silhouette profile, stealth technology, two person crew compartment for a FCV that is an attack vehicle vs. troop carrier will greatly reduce signature and increase survivability.

There are several active protective countermeasures against an incoming either missile or KE round. The term "active electromagnetic armor" refers to a system that ejects mass elements (typically a plate) which is a hard as the KE round and disrupts its flight path by breaking up the round or seriously reducing it terminal ballistic performance within close proximity of the FCV.[52] This technology uses sensors that detect a round in flight and calculates point of attack for the plate to intercept the round in a microsecond. The critical components of this technology for the future are cueing, tracking, fire control, counter-munitions, base armor, and sensor suites.[53] The FCV will have this system embedded within the platform skin to sense, attack, and destroy any incoming ballistic or missile round. There will be no man in the loop except to monitor the system; the countermeasures will act in a semi-autonomous mode for self-protection using 500 GHZ microprocessors to compute complex algorithms for intercept.

With these advanced technologies and lightweight materials the FCV will survive the first engagements and continue to apply precision fires against lesser systems with deadly accuracy.

ENGAGEMENT SYSTEMS

The argument of ballistics vs. precision is what propelled the Army beyond legacy systems of the 20th Century. Ballistics has reached their zenith in term of the possible. As large guns grew and became a burden in size, "ammunition vulnerabilities, and the inherent limited growth potential of solid propellants (SP), the basic governing thermodynamic laws, the velocity at which chemical SP could accelerate a projectile, is controlled by the velocity at which gas could physically expand. For all practical purposes that had reached its ultimate velocity, 1.8 -2.0 m/sec."[54] Even if there was a breakthrough with Electro Magnetic (EM) or Electro Thermal Chemical (ETC) power generation, the capacitor technology in 2020 will have still have not broken through the bounds of capacitor size for combat vehicles to fire penetrators at the energy levels required. This technology does not offer the leap ahead the Army needs to move beyond 20th Century direct fire fights. "It is clearly possible to increase the velocity of gun mounted tanks using EM/ETC tehnology. But would it represent anything new or be merely another phase in the growing senility of the gun - its *reductio ad absurdum*?"[55]

The technologies for low cost, highly accurate, loitering, top attack, precision guided missiles is the leap ahead that FCVs will have. The ability to target through sensor fusion from 1-30 km and control that battlespace with deadly accuracy allows landpower commanders to control ground anywhere any time. A forty missile capability which fire vertically, allows for rapid movement after firing, almost a "hide and seek tactic" where FCV is beyond line of sight of his opponent. [56] Future Combat systems "will break the tyranny of line-of-sight weapons just as the tyranny of ballistic weapons has been broken."[57] Even though opponents will have a mixture of legacy systems and new technologies, the U.S. technological edge will enable the Army to deploy small discrete organizations that can and will rule their battlespace with dominant firepower and precision. These small organizations while semi-autonomous are mutually supporting and can apply mass over greater distances instead of mass by relative position.

INFORMATION MANAGEMENT

Future combat systems or FCVs will be linked via advanced networked cellular technologies using low earth orbit satellites constellations to promulgate the tactical net. Systems will morph off one another and there will be total transparency within networks. Digital information fusion will be instantaneous. Advanced Electro Optical sensors, Microsensors, RF sensors, and acoustic will allow the battlefield management systems to detect optical or audio sensing and apply appropriate cueing for counter measures to take affect.

The ability to see the battlefield through UAVs, satellites, or using a sensor mast to look over a rise while maintaining a hide position will increase survivability and allow better asset management. A crew of two on a FCV will handle numerous tasks while maintaining an "automatic pilot" self defense system that will act once triggered. The ability for the crew to use a "silent watch" mode with battery will allow a two-

man crew to either rest or go 50% alert status. This will allow for greater flexibility with the crew during 24-hour operations.

REDUCTION IN SUSTAINMENT REQUIREMENTS

The FCV design will incorporate new modular subsystems that are self diagnosing, have long mean time between failures, reach back ordering system and fault management, and are easily removed and replaced. It will be imperative that the FCV have extremely reliable systems that optimize vehicle volumetric and use microprocessor technologies. This all electric vehicle will use fiber optic technologies, modular installations and energy distribution, automatic energy management power controls, and flexible integration of drive components.[58] All these highly reliable and effeienct systems will increase the FCV operations envelope between refueling to several days.

Engine or power plant design in legacy systems occupied 40% of the under armor volume which required increased system size and weight.[59] The fuel to support these large power plants weighed up to one ton for the M1A2. By 2020 hybrid engine design will reduce volume, weight and fuel consumption. In all electric vehicles where the engine runs at constant speed to recharge the batteries, diesel engines run more efficiently and will be able to exceed 700 miles before refueling. Reliability by 2020 will be the centerpiece for logistic management.

CONCLUSION

The U.S. security landscape in 2020 will be one of tremendous volitility and uncertainty. The U.S. will be predominately a CONUS based force projection landpower and will depend on robust strategic lift in order to support NCA directives. The relevance of a FCV will be it's deployability, lethality, survivability and speed once introduced into an opponent's battlespace. The FCV will be able to influence large areas using precision strike capability within the concept of strategic preclusion. The ability of smaller more lethal quick entry forces will allow the NCA to act quickly and hopefully overt a major war by interdicting an opponent's ability to mass large forces. The utility of a FCV within a landpower organization will change the battlefield calculus and the tactics for not only quick strike forces but also for sustained campaign forces if an adversary will not concede defeat early. Legacy systems of the 20th Century will not have the strategic deployablity characteristics or precision attack capability to dominate future battlespace. Technology will offer leap-ahead capabilities for the Army and will greatly increase U.S. ability to affect international agreements for security assistance when it is in the U.S. vital interest to intercede.

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ENDNOTES

[1] Patrick M. Cronin, 2015: Power and Progress (Washington D.C.: Institute For National Strategic Studies, June 1996) xv.

[2] "Future Operational and Threat Environments: A View of the World in 2015," TRADOC (Februrary 2000): 2.

[3] Ibid.

[4] Hart-Rudman Commission, "U.S. Commission on National Security,"; available from<http://www.nssg.com/reports/newworldcoming; internet; accessed 15-30 January 2000.

[5] Ibid.

[6] "Future Operational and Threat Environments: A View of the World in 2015," TRADOC (February 2000): 3.

[7] Ibid.

[8] Hart-Rudman Commission, "U.S. Commission on National Security,"; available from<http://www.nssg.com/reports/newworldcoming; internet; accessed 15-30 January 2000.

[9] Ibid.

[10] Army After Next Project, Knowledge and Speed: Battle Force and the U.S. Army of 2025, (Training and Doctrine Command, Fort Monroe Va., 1998), 1.

[11] "Future Operational and Threat Environments: A View of the World in 2015," TRADOC (February 2000): 3.

[12] Hart-Rudman Commission, "U.S. Commission on National Security"; available from<http://www.nssg.com/reports/newworldcoming; internet; accessed 15-30 January 2000.

[13] Ibid.

[14] John L. Petersen, Out of the Blue (Washington D.C.: The Arlington Institute, 1998), 142.

[15] Hart-Rudman Commission, "U.S. Commission on National Security"; available from<http://www.nssg.com/reports/newworldcoming; internet; accessed 15-30 January 2000.

[16] Ibid.

[17] Ibid.

[18] Ibid.

[19] Robert H. Scales Jr., "America's Army in Transition: Preparing for War in the Precision Age," Strategic Studies Institute, (1999): 23.

[20] Patrick M Cronin, 2015: Power and Progress (Washington D.C.: National Defense University, June 1996), 118.

[21] Army After Next Project, Knowledge and Speed: Battle Force and the U.S. Army of 2025 (Fort Monroe, Va.: Training and Doctrine Command, 1998), 6.

[22] Ibid.

[23] Ibid.

[24] Ibid.

[25] Ibid., 7.

[26] Ibid.

[27] BG (RET) Huba Wass de Czege, The Army of the 21st Century: Insights for a Power Projection Force, p. 3.

[28] Ibid.

[29] Ibid., 4.

[30] Ibid.

[31] Ibid.

[32] Ibid.

[33] Ibid., 5.

[34] Army After Next Project, Knowledge and Speed: Battle Force and the U.S. Army of 2025 (Fort Monroe, Va.: Training and Doctrine Command, 1998), 11.

[35] Ibid.

[36] Ibid., 12.

[37] Ibid.

[38] Ibid., 13.

[39] Ibid.

[40] Colonel Gary B. Griffin, "Future Foes. Future Fights," Parameters (November 1994): 57.

[41] Ralph Peters, "The Future of Armored Warfare," Parameters (Autumn, 1997): 76.

[42] George Friedman and Meredith Friedman, The Future of War (New York: Crown Publishers, 1996), 127.

[43] TRADOC Combat Developments Web Site. Armor

[44] R.M. Ogorkiewicz, "Transforming the Tank," Jane's International Defense Review (October 1997): 40.

[45] Ibid., 35.

[46] George Friedman and Meredith Friedman, The Future of War (New York: Crown Publishers, 1996): 128.

[47] Ibid.

[48] R.M. Ogorkiewicz, "Transforming the Tank," Jane's International Defense Review (October 1997): 33.

[49] R.M. Ogorkiewicz, "High-Fiber Diet for Armor," Jane's International Defense Review (January 1997): 57.

[50] Dr. Edward Brown, "U.S. Army Research laboratory," briefing slides, Carlisle Barracks, Army War College, 24 February 2000.

[51] Ibid.

[52] Hermann Grosch, "All Electric Combat Vehicle (AECV) Vision and Reality," Military Technology (September 1999): 44.

[53] Dr. Edward Brown, "U.S. Army Research laboratory," briefing slides, Carlisle Barracks, Army War College, 24 February 2000.

[54] Asher H. Sharoni and Lawrence D. Bacon, "The Future Combat System (FCS)," Armor (September-October 1997): 30.

[55] George Friedman and Meredith Friedman, The Future of War (New York: Crown Publishers, 1996), 138.

[56] Martin C Libicki, Illuminating Tomorrow's War (Washington D.C.: National Defense University, 1999), 15.

[57] Ibid., 139.

[58] Hermann Grosch, "All Electric Combat Vehicle (AECV) Vision and Reality," Military Technology (September 1999): 38.

[59] National Research Council, STAR 21 Strategic Technologies for the Army of the Twenty-First Century (Washington D.C.: National Academy Press 1992), 179.

BIBLIOGRAPHY

"Active Tank Protection: the Russian Approach," Military Technology (February 1997): 39-42

"Automated Armor-Busting Missile Success Keyed to Man-in-loop," National Defense (April 1997): 28-29.

Bailey, Chris. "Future Combat Vehicle Draft Requirements." Briefing Slides Army Science Board. Carlisle Barracks: Army War College, 4-6 October 1999.

Berry, Reginald R. "The Utility of the Heavy Main Battle Tank in Mid to High Intensity Conflict in the 2000 and Beyond." Study Project US Army War College USAWC Class of 1996.

Biass, Eric H. and Doug Richardson. "Fighting Vehicles Today, Tomorrow and the Day After." Armada International. (6/1997) (December 1997/January 1998): 22-58.

Brown, Edward. Dr. "U.S. Army Research laboratory." Briefing slides. Carlisle Barracks: Army War College, 24 February 2000.

Cowan, David M. "Armor Modernization." Armor (May-June 1997): 9-10.

Craddock, John. "The Tank is Dead—Long Live the Tank." Study Project US Army War College USAWC Class of 1993.

Defense Science Board. "1996 Summer Study Task Force, Tactics and Technology for 21st Century Military Superiority." Volume 1, October 1996.

Dubik, James M. "The New Logic: The US Needs Capability-Based, Not Threat-Based, Military Forces." Armed Forces Journal International (January 1997): 42-44.

Dunlap, Charles J., Jr. "21st-Century Land Warfare: Four Dangerous Myths." Parameters (Autumn 1997): 27-37.

Eshel, David. "The Merkava and More: Israeli Engineers Pioneer Survivability Upgrades For Armored Vehicles." Armed Forces Journal International (May 1997): 40-43.

Fletcher, Rogia. "Dooming the Behemoths." Armed Forces Journal International (May 1997): 35-38.

Foss, Christopher F. "Main Battle Tank Trends for the 21st Century." Jane's Year of Defense (1 December 1991).

Foss, Christopher F. "Modernization Points Way to Future MBTs." Jane's Defense Weekly (18 June 1997): 23-26.

Friedman, George and Meredith Friedman. The Future of War. New York: Crown Publishers, 1996.

Gilvydis, J.B. "A future U.S. Main Battle Tank For the Year 2010 – A New Vision." Armor (May-June 1994): 7-11.

Gourley, Scott R. "Latest Future Combat System Plan Unveiled." Jane's Defense Weekly (2July 1997): 26.

Grau, Lester W. "Bashing the Laser Range Finders with a Rock." Military Review (May-June 1997): 42-48.

Griffin, Gary B. Colonel. "Future Foes Future Fight." Military Review (November 1994): 56-60.

Grosch, Hermann. "All Electric Combat Vehicle (AECV)-Vision and Reality." Military Technology (September 1999): 37-47.

Harmeyer, George H. "Force Development—Where We Are Headed." Armor (September-October 1997): 4-5.

Hart, Liddell. The Remaking of Modern Armies. Boston: Little Brown and Company (1928).

Hart-Rudman Commission, "U.S. Commission on National Security." Available from <http://www.nssg.com/reports/hewworldcomming; internet; accessed 15-30 January 2000.

Killebrew, Robert B. "The Army After Next: TRADOC's Crystal Ball Eyes the Service's Shape Beyond Force XXI." Armed Forces Journal International 134 (October 1996): 36-45.

Loughlin, Don. "Remaining Relevant: Army's Future Combat System Must Shake off a Case of Bad Genes." Armed Forces Journal International (October 1997): 52-57.

Macgregor, Douglas A. Breaking the Phalanx: A New Design for Landpower in the 21st Century. Westport, Connecticut: Praeger, 1997.

Meadows, Sandra I. Meadows. "In 2025, Fast, Compact Units Will Range Over Vast Areas." National Defense (April 1997): 26-27.

Morehouse, David A. Nonlethal Weapons, War Without Death. Westport, Connecticut: Praeger, 1996.

National Defense Panel. "Final Report of the National Defense Panel." (December 1997).

National Research Council. "STAR 21 Lethal Systems, Strategic Technologies for the Army of the Twenty-First Century." (August 1993).

National Research Council. "STAR 21 Special Technologies and Systems, Strategic Technologies for the Army of the Twenty-First Century." (August 1993).

National Research Council. "STAR 21 Strategic Technologies For the Army of The Twenty-First Century." June 1992.

Orgorkiewicz, R.M. "Future Tank Armors Revealed: Developments in Electric and Explosive reactive Armor." Jane's International Defense Review (May 1997): 50-51.

Orgorkiewicz, R.M. "High-Fiber Diet for Armor." Jane's International Defense Review (January 1997): 57.

Orgorkiewicz, R.M. "Transforming the Tank." Jane's International Defense Review (October 1997): 30-39.

Patten, George, and Craig Langhauser. "The World's First 21st Century Tank." Army RD&A (March-April 1997): 16-19.

Perry Walters, Pirnie Bruce R., Gordon IV, John V. "Issues Raised during the Army After Next Spring Wargame." Rand Arroyo Center, June 1999

Pengelley, Rupert. "Going Farther, Faster: Tank Fire Control Advances." Jane's International Defense Review (November 1997): 49-54.

Peters, Ralph. "The Future of Armored Warfare." Parameters (Autumn 1997): 50-59.

Peterson, John L. "The Road to 2012: Looking Towards The Next Two Decades." Defense Technical Information Center, Cameron Station Virginia (1993).

Pinder, John D. "Reactive Armor Tiles for Army and Marine Corps Armored Vehicles." Rand (July 1999).

Roos, John G. "Wizard Warrior: Even Though Its Debut Is Two Decades Away, the Next Generation Tank is Already in the Spotlight." Armed Forces Journal International (June 1996): 23-31.

Scales, Robert H Jr. "Cycles of War." Armed Forces Journal International (July 1997): 38-42.

Scales, Robert H. Jr. "America's Army: Preparing For Tomorrow's Security Challenges." Strategic Studies Institute, Carlisle, Pa. (March 1999).

Scales, Robert H. Jr. "America's Army In Transition: Preparing For War In The Precision Age." Strategic Studies Institute, Carlisle Pa. (November 1999).

Sharoni, Asher H. and Lawrence D. Bacon. "The Future Combat System (FCS), A Technology Evolution Review and Feasibility Assessment." Armor (July-August 1997): 7-13.

Sharoni, Asher H. and Lawrence D. Bacon. "Part two: Armament, The Future Combat System (FCS), A Technology Evolution Review and Feasibility Assessment." Armor (September-October 1997): 29-33.

Sharoni, Asher H. and Lawrence D. Bacon. "Part Three: Powering the New System, The Future Combat System (FCS): A Satellite-fueled, Solar-powered Tank?" Armor (January-February 1998): 37-42.

Sherman, Jason. "21st Century Tank: US Army Lays Plan for Its Next Generation of Armored Warriors." Armed Forces Journal International 134 (October 1996): 46-51.

Simpkin, Richard. Race to the Swift: Thoughts on Twenty-First Century Warfare. London: Brassey's Defense, 1985.

Sdydloski Dennis J. "Will the U.S. Army Have a Tank In 2020?," Study Project US Army War College USAWC Class1998.

Sullivan, Gordon R. and Michael V. Harper. Hope Is Not A Method. New York: Random House, 1996.

Toffler, Alvin and Heidi Toffler. War and Anti-War: Survival at the Dawn of the 21st Century. Boston: Little, Brown and Company, 1993.

Turbiville Jr., Graham H., William W. Mendel and Jacob W. Kipp. "The Changing Security Environment." Military Review, (May-June 1997), 4-10.

U.S. Army Training and Doctrine Command "Knowledge and Speed: Battle Force and the U.S. Army of 2025." (December 1998).

Von Fosson, Marion H. "Future Combat Vehicle." Army Science Board Briefing Slides. (October 1999).