

PAUL SZYMANSKI

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Objective: To solve very difficult problems in space warfare, and space situational awareness policy, doctrine, strategies, tactics, studies, analyses and operations research.

SECURITY CLEARANCES

TOP SECRET / SCI, POLY, SSBI, Waived SAP

(Read In To Over 100 Compartmentalized Classified Programs Over Entire Career)

EDUCATION

- 1974 M.S. Physics Measurement & Control Carnegie-Mellon University, Pittsburgh, PA
- 1973 B.S. Physics, Mathematics & Logic Carnegie-Mellon University, Pittsburgh, PA

EMPLOYMENT HISTORY

Space Strategies Center	4305 Chinlee NE, Albuquerque, NM 87110	
7/2013 - Present	Title: Principal Consultant	>40 hrs/wk
Supervisor: Self	-----	You May Contact this Supervisor
Last Salary: -----	Number of Employees I Supervise: 1	
Duties and Accomplishments:		
Performed professional consulting services regarding RASTER proposal. Provided expertise needed to improve and exploit the R&D and operational capabilities at MSSS and SOR that enable Space Superiority by US national agencies. Provided advice and information on how to implement, improve and validate sensors, processing algorithms and processes to meet NE SOI mission requirements. Developed concept papers supporting space warfare, space control, space superiority, space surveillance and Space Situational Awareness (SSA) current issues.		

Metatech Corporation	2340 Alamo Ave., SE #300 , Albuquerque, NM 87106	
12/2006 – 7/2013	Title: Principal Scientist	>40 hrs/wk
Supervisor: Chris Jones, Chairman of the Board	(505) 314-1355	You May Contact this Supervisor
Last Salary: -----	Number of Employees I Supervised: 2	
Duties and Accomplishments:		
Supported the Satellite Assessment Center (SatAC - AFRL/RDST) for: Space strategy, tactics & requirements development; Algorithm development for auto space object mission assessment, space object change of state detection, and space attack strategy assessment; Space attack intelligence indicators development; Automatic space systems scenario generation software tool design; Spacecraft on-orbit visualization modeling; Spacecraft rendezvous simulation; Satellite Threat Envelope modeling; Space Choke Point display development; Space Principles of War analysis; Space Centers of Gravity analysis; Space Escalation Ladder analysis; Space Intelligence Preparation of the Battlespace (IPB) software development; Satellite databases development; Radar Cross Section signature calculations; Orbital optimizations; Military requirements database; Space scenarios development; SSA data collection tracking software development; and, Military communications network vulnerabilities analyses.		

PAUL SZYMANSKI

Schafer Corporation	2309 Renard Place SE, Suite 300, Albuquerque, NM 87106	
5/2003 – 12/2006	Title: Group Manager	>40 hrs/wk
Supervisor: Tim Tamerler	(505) 242-9992	You May Contact this Supervisor
Last Salary: -----	Number of Employees I Supervised: 8	
Duties and Accomplishments:		
Supported AFRL/RV for: Spacecraft on-orbit visualization modeling; Spacecraft rendezvous simulation; Laser Relay Mirror advanced planning CONOP generation; Airborne Tactical Laser simulation; Satellite Threat Envelope modeling; Satellite databases development; Star database development; Crew Exploration Vehicle simulation; Starfire Optical Range (SOR) support; Radar Cross Section (RCS) signature calculations; Military requirements database; FPGA Mission Assurance Center support; Space sensor to shooter networks development; Satellite Orbit Analysis Package (SOAP) orbital coverage & propagation analyses.		

ManTech Aegis Research	12015 Lee Jackson Highway; Fairfax, VA 22033	
3/1994 – 5/2003	Title: Principal Engineer	>40 hrs/wk
Supervisor: George Gibson, Vice President	(703) 218-6000	You May Contact this Supervisor
Last Salary: -----	Number of Employees I Supervised: 4	
Duties and Accomplishments:		
Supported Ed Duff (AFRL/RD Bldg. 405) for: Advanced systems planning; Information Warfare analyses; Software development (Access data basing and user interfacing); Space architecture assessments; Program management; Satellite video animation development; Military requirements generation; Scenario generation; Tactics and strategy conceptual development; Orbital dynamics sensor coverage calculations; Military exercise, war gaming and experiment scenario generation, and analysis; Space threats analyses; Space sensor to shooter networks development; Value of space assessments employing the Space Impact Assessments Model (SIAM) software that I developed.		

The Aerospace Corporation	2310 E. El Segundo Blvd., El Segundo, CA 90245	
12/1987 – 3/1994	Title: Project Engineer	>40 hrs/wk
Supervisors: John Collins, Jim Bailey, MGen Jim Armor	(310) 336-5000	You May Contact this Supervisor
Last Salary: -----	Number of Employees I Supervised: 4	
Duties and Accomplishments:		
Supported the Advanced Systems Program Office under Jim Bailey & MGen Armor (SMC/XRJ), Defense & Surveillance Operations for: Advanced systems planning; Space architecture assessments; Program management; Military requirements generation; Space scenarios generation; Orbital dynamics sensor coverage calculations; Space surveillance long-range system architecture assessments; Space command and control systems management (SPADOC, SPADCCS); Space intelligence data assessments; System trade-off studies; Monitoring contractor systems development programs.		

PAUL SZYMANSKI

Analytic Services (ANSER)	5275 Leesburg Pike, Suite N-5000; Falls Church, VA 22041	
7/1977 – 12/1987	Title: Senior Analyst	>40 hrs/wk
Supervisor: John Kirkham	(703) 416-2000	You May Contact this Supervisor
Last Salary: -----	Number of Employees I Supervised: 1	
Duties and Accomplishments:		
Supported the Secretary of the Air Force (SAF/AQSC) for: Advanced space planning; Space architecture assessments; SSA program management; Space military requirements generation; Space scenario generation; Orbital dynamics sensor coverage calculations; Space surveillance long-range system architecture assessments; Space command and control systems management (SPADOC, SPADCCS); Space systems survivability studies and long-range planning; Space intelligence data assessments; System trade-off studies; Space military roles and missions assessments; Space policy, doctrine, requirements, and strategic long-range planning.		

ARINC Research	2551 Riva Rd., Annapolis, MD 21401	
5/1974 – 5/1977	Technical Analyst	>40 hrs/wk
Supervisor: Richard Coss	(410) 255-4000	You May Contact this Supervisor
Last Salary: -----	Number of Employees I Supervised: 1	
Duties and Accomplishments:		
Provided Integrated Logistic Support (ILS) for Naval Air Systems Command programs. Reviewed environmental and EMI/EMC test plans, developed reliability/maintainability testing programs and analyzed sparing needs for NAVAIR. Also, I was the field representative for reliability/maintainability at the OPEVAL test program for the TV guided CONDOR Missile System, China Lake, California.		

Westinghouse Research Lab	1332 Beulah Rd, Pittsburgh, PA 15235	
9/1973 – 5/1974	Research Staff	~20 hrs/wk
Supervisor: Unknown	(412) 342-1700	You May Contact this Supervisor
Last Salary: -----	Number of Employees I Supervised: 1	
Duties and Accomplishments:		
Conducting paid thesis work designing a Helmholtz resonator used in nuclear fuel processing.		

PUBLICATIONS

[Note: I have produced thousands of publications, point papers, monographs and briefings over my 41 year career supporting the military. For most of that time (27 years) I worked waived SAP/SAR programs that did not permit me to openly distribute these publications, or even publically reveal the titles, subject matter, organizations, or intended recipients. Consequently, only a limited number of publically acknowledged, open, publications are listed below.]

Szymanski, Paul S. (2014), Space Situational Awareness Tools (SSA-T) Space Wargame Software Impacting SSA Policy & Requirements, Unclassified, *Space Strategies Center*, 102p. Community **Impact:** Increased awareness of the benefits of space superiority & SSA sim tools.

Szymanski, Paul S. (2014), What are the Chances of a Surprise Attack in Space and SSA Implications, Unclassified, *LinkedIn, Scribd & Slideshare*, 14p. Community **Impact:** Increased awareness in the community of the issues surrounding detection of attacks against space systems.

Szymanski, Paul S. (2014), Time to Attack Russian Satellites?, Unclassified, *LinkedIn, Scribd & Slideshare*, 24p. Community **Impact:** Assessment of the political and conflict escalation control issues surrounding space superiority and their influence on SSA capabilities.

PAUL SZYMANSKI

- Szymanski, Paul S. (2014), First Global Space War Over Ukrainian Conflict Based on SSA Assessments, Unclassified, *LinkedIn, Scribd & Slideshare*, 42p. Community **Impact**: SSA analysis of space actions taken during the Ukrainian crisis raised awareness of proper Tactics, Techniques & Procedures (TT&P) for best SSA practices.
- Szymanski, Paul S. (2013), Space Principles of War Impacting SSA, Unclassified, *SatAC*, 15p. Community **Impact**: Fundamental principles for conduct of space superiority operations with corresponding implications for SSA best practices.
- Szymanski, Paul S. (2013), Space Conflict Escalation Ladder & SSA, Unclassified, *SatAC*, 1 Detailed Chart. Community **Impact**: Point paper illustrated the relationships between terrestrial and space conflicts correlated to SSA requirements, thus raising awareness in the community of the fundamental origins of SSA required capabilities. Used by White House Staff when developing Space Policy under the Obama administration.
- Szymanski, Paul S. (2013), Top 40 Rules for Space Warfare & SSA, Unclassified, *SatAC*, 42p. Community **Impact**: Fundamental principles of how the next space war will be fought and won with implications for SSA capabilities.
- Szymanski, Paul S. (2013), Sun Tzu's Art of War Applicability to Space & SSA, Unclassified, *SatAC*, 99p. Community **Impact**: Further in-depth look (546 space warfighting principles) on how to fight and win the next space war, with implications for SSA capabilities.
- Szymanski, Paul S. (2012), SWAT-Future Space Strategies & SSA, Unclassified, *SatAC*, 252p. Community **Impact**: Strategies and tactics for space superiority with SSA implications.
- Szymanski, Paul S. (2012), Space Centers of Gravity & SSA, Unclassified, *SatAC*, 13p. Community **Impact**: Point paper illustrates the regions of space that require SSA attention according to conflict level and AOR (conflict terrestrial region).
- Szymanski, Paul S. (2012), SSA Space Choke Points, Unclassified, *SatAC*, 16p. Community **Impact**: Point paper further illustrates the regions of adversary space, time, sequence, doctrine & training that require SSA emphasis.
- Szymanski, Paul S. (2011), Space Warning & Assessment Tools (SWAT) Summary, Secret, *SatAC Briefing to Scientific Advisory Board*, 95p. Community **Impact**: Convinced SAB (my brother is a board member) of the importance of SSA to space conflict resolution.
- Szymanski, Paul S. (2010), Space Warning and Assessment Tools (SWAT), Top Secret/SCI, *Lincoln Labs Space Control Conference*, 20p. Community **Impact**: Generated excitement at this conference that resulted in me handing out 36 copies of this brief after my presentation. This briefing proved that SWAT was an R&D tool developed at AFRL that was ready for operations.
- Szymanski, Paul S. (2010), SSA Requirements - Characterization, Unclassified, *SatAC*, 38p. Community **Impact**: Very detailed ~1,900 unique SSA requirements based on fundamental Air Force doctrine documents, with corresponding SSA requirements tracking software.
- Szymanski, Paul S. (2010), Optical Sensor Data Contribution to Detection of Space Object State Change SSA, Unclassified, *SatAC*, 19p. **Impact**: Illustrated the value of optical sensors to SSA and provided data on some unusual space object behavior requiring further Intel assessment.
- Szymanski, Paul S. (2008), **Satellite Inspector** Action-Reaction Scenarios for Uncooperative RSO's, Counter-Action Consequences, & Adversary Sensor Avoidance, Unclassified, *SatAC*, 141p. Community **Impact**: Convinced senior decision makers at the Pentagon that AFRL was considering the broader military and political implications for satellite inspector systems.

**PAUL SZYMANSKI
REFERENCES**

Stan Lokaj	AFRL/RVES; 3550 Aberdeen Ave SE; KAFB, NM 87117	
Principal Research Physicist	(505) 846-9768	Stan.lokaj@us.af.mil

Joe Bergin	AFRL/RDST; 3550 Aberdeen Ave SE; KAFB, NM 87117	
DR-03, SatAC	(505) 846-5858	joseph.bergin@us.af.mil

Thomas Allen	The Pentagon, Joint Staff, J8, DDSA Washington, DC 20318	
Deputy Director for Studies and Analysis at Joint Staff	(571) 256-1905	thomas.l.allen66.civ@mail.mil

Mandatory Technical Qualifications Statement

(1) Five pillars of SSA Experience:

a) Detect, Track, and Identification

I have performed many space surveillance technical analyses for the past 38 years for sensor coverage and timelines for both foreign and US systems (land, ship, air and space-based) using computer simulations and orbital mechanics. These included the Space Surveillance Network and the Air Force Satellite Control Network. I have also developed models for imaging of satellites in space, and conducted analyses of solar phase angles for satellite illumination in reference to an observer platform. When I supported the Secretary of the Air Force Air Staff (SAF/AQSC) I helped managed the Space Surveillance Network (SSN) and Integrated Tactical Warning & Attack Assessment (ITW/AA) programs at the Pentagon.

When I was supporting AFRL/RV I developed a space NIIRS (National Imagery Interpretability Rating Scale) intelligence collection rating scale. I also modeled Crew Exploration Vehicle orbits from the earth to the moon. In addition, I constructed satellite CAD models and calculated Radar Cross Section signatures for different spacecraft attitudes. Also, I developed a Microsoft Access database of satellite characteristics and star characteristics to enable quick-reaction analyses.

When I was supporting AFRL/RD I used orbital dynamics tools to determine optimum experiment deployment strategies for the Starfire Optical Range (SOR). I also calculated optimal space surveillance sensor geographic locations, and optimized orbits for satellite inspectors. In addition, I developed Space Threat Envelopes (most threatening regions of space); Space Choke Point Maps; Most Probable Space Attack Time Maps; and space Centers Of Gravity. I also assessed space control requirements documents, and inserted these into a Microsoft Access database I designed to provide linked traceability from fundamental national policy and military objectives to possible Courses Of Action and SSA requirements.

b) Characterization

When I was supporting AFRL/RD I developed a detailed (2,000 lines, 50 columns) Space Intelligence Preparation of the Battlespace (IPB) database. I also developed algorithms that calculates automatic mission characterization and state change algorithms. A Deputy Undersecretary of Defense for Preparation and Warning, described SWAT as “Unique in this country, with no one else conducting this kind of far-thinking research in Space Situational Awareness” and “Critical to this nation’s defense in space.”

While supporting AFRL/RV, I developed a Microsoft Access database of satellite characteristics, failures, optical signature history, images, military requirements, and space object close encounters.

PAUL SZYMANSKI

The satellite failures database assisted with determining SSA requirements for detecting satellite anomalies in terms of anomaly types and resolution requirements. This analysis showed the need for additional consideration for SSA techniques beyond traditional RF and optical sensors.

c) Threat Warning and Assessment

While supporting AFRL/RD I developed extensive lists of intelligence indicators (6,000) and possible adversary Courses Of Action (2,000 space COA's) for a variety of potential space control systems. These were incorporated into my analysis tool, called SWAT (Space Warning and Assessment Tools), to allow the user to conduct Space Predictive Battlespace Awareness (SPBA) for attacks on space systems. This SWAT software has discovered many unusual characteristics and actions of adversary and allied satellites that require further intelligence assessment. An overall threat score in SWAT gives indications when a potential adversary is maneuvering or re-configuring several of his satellites, possibly setting up for a major attack in space. I also developed innovative displays of space object orbital parameters that synthesize to users which adversary actions are threatening to key United States and allied space assets.

With warfighter use of the Space Warfare Analysis Tools (SWAT), requirements for space warfare can be more fully understood. Space objectives, strategies, tactics and checklists would be readily available to the warfighter to better understand the space environment and threats. Operationally, this SWAT tool can provide an analytic "tripwire" in orbital space denoting when potentially threatening satellites can be designated with differing levels of threat awareness as they get too close to key Allied satellites, and they can be rank-ordered for attention by SSA assets. Key intelligence indicators can be tracked and SSA assets optimized for detection of the most probable adversary Courses Of Action. Finally, this tool can help train warfighters in sensitizing them to which particular orbits should have the most attention placed to maximize defense of critical space assets. Use of this tool may very well provide strategic warning of space attack, and thus early warning of possible military actions on the ground.

While supporting AFRL/RD, on my own initiative, I began a study to extrapolate Sun Tzu's (544 BC – 496 BC) Art of War to space strategies. I'm only one-third of the way through on this analysis, but I already have derived over 550 individual space strategies so far. If one knows what possible space strategies potential adversaries may take against United States and allied space systems, then it is much clearer what are the required SSA systems to detect and counter these attacks, and what are the required timelines to accomplish these defensive and offensive space counteractions.

While supporting AFRL/RV I also designed a Monte Carlo model in MatLab for satellite maneuvering to visualize space threat envelopes. I have also modeled satellite keep-out zones for safety and threat warning constraints.

While supporting AFRL/RD I designed and constructed a computer animation and video illustrating the threat to our military forces from commercial imagery satellites. I also conducted threat assessments of commercial space systems.

While supporting SMC/XRJ I developed Space Division policy on interfaces to the Tactical Warning and Attack Assessment Program.

While supporting AFRL/RD I developed on my own initiative a State Change Detection algorithm to compare satellite orbits and characteristics with other satellites of the same mission, and with its own historical data. The change of state algorithm detects changes outside the bounds for other satellites of that mission, and for changes outside the bounds of that space object's historical characteristics. Space object characteristics monitored for change include orbital elements (altitude, inclination, eccentricity, etc.), size, shape, stabilization (spinning, 3-axis stabilized), RADAR Cross Section (RCS), optical cross section, mass, power, drift rate, delta-v, and spin rate. The satellites with the most significant

PAUL SZYMANSKI

changes can be presented to the space warfare operator so that he can task additional space surveillance and intelligence sensors to determine if anything suspicious is happening with this satellite or space object. This tool is able to automatically predict when a satellite is preparing to maneuver, re-configure to an anti-satellite (ASAT) mode, expel a sub-satellite package, or is beginning to fail.

Additional SSA analyses undertaken by myself include: space attack intelligence indicators development, Spacecraft on-orbit visualization modeling (including spacecraft rendezvous simulation), Radar Cross Section signature calculations, orbital optimization calculations, and SSA data collection tracking software development.

d) Data Integration and Exploitation

While supporting AFRL/RD an algorithm was developed on my own initiative to automatically classify the mission of an unknown space object. This technique compares orbital and physical characteristics of a space object, as measured by ground or space sensors, and statistically matches it to an extensive database of satellites with known missions. This algorithm uses the Satellite Information Database (SID) and the Space Power Analysis and Requirements Keystone Software (SPARKS - my personal satellite characteristics database) and compares the satellite characteristics and associated missions of these databases with any known characteristics of the unknown space object. Example satellite characteristics that are matched with the unknown space object include: Radar Cross Section (RCS), optical cross section, orbital elements, stabilization type (spinning or 3-axis), object shape (sphere, cylinder, box), length, width, height, mass, and spin rate.

If the SWAT user knows, at a minimum, the RCS, size (through RADAR imaging) and orbital elements of the unknown space object, then 98% of the time the SWAT tool detects the correct mission within its top three choices. SWAT has even automatically corrected some of the mission designations in the NORAD satellite catalog.

An additional algorithm was developed to automatically determine the most probable attack strategy that an adversary may be conducting against US and allied space systems. It takes sometimes obscure intelligence indicators, and compares them to those indicators related to possible adversary strategies in space warfare. SWAT has extensive lists of potential adversary attack strategies against space systems. For each of these potential attack strategies, SWAT delineates the intelligence indicators that would be present if the strategy was being implemented against US and allied space systems. The SWAT user enters any INTEL indicators that are being currently observed, no matter how seemingly insignificant, and SWAT automatically matches these with the most probable attack strategy that an adversary may be implementing towards United States or Allied space systems. SWAT can also automatically increase the INTEL tasking priorities for those factors that would best verify which strategy is being implemented by a potential adversary.

e) Protection and Resiliency

While working with the Secretary of the Air Force Acquisitions Office (SAF/AQS), I provided analytical and policy support for the Space Systems Survivability program element. I conducted many space systems survivability analyses, and participated in major space systems survivability community architecture long-range planning studies. I also provided inputs to Congressional inquiries concerning space systems survivability issues.

While supporting AFRL/RD I developed a unique concept for integrating space, terrestrial and info war targeting into one unified methodology with common measures of merit. This shows the flow of information from sensor to shooter, and from space to terrestrial systems. I then programmed this algorithm into Microsoft Access, and have successfully used it in many studies and exercises.

PAUL SZYMANSKI

While supporting AFRL/RD I developed on my own initiative Space Threat Envelopes. This provides a graphical representation of which regions of space are most threatening to a particular satellite, based on assumptions of adversary satellite size and delta-v maneuver constraints. The SWAT software tool called SPACE (Space Power Analysis Computational Elements designed by myself) is used to conduct Monte Carlo calculations for satellite maneuvers. Calculations are made and visualized for threat envelopes surrounding a potential targeted satellite (red asterisk in the center), assuming the attacking satellite is using a low thrust maneuver profile. Spreading out from the targeted satellite into regions of space are locations (circles) where potential space control satellites can maneuver to a close approach of the satellite target. The size of each circle corresponds to the amount of delta-v that is required to rendezvous with the targeted satellite. The color of each circle shows the amount of time it would take to achieve this rendezvous. Thus, higher inclination attacking satellites would need to expend more fuel and take more time to reach the targeted satellite. This implies a bigger attacking satellite that can carry more fuel, thus being more easily detected when initiating attack orbital maneuvers, or the defending satellite has more time to detect and prepare for attack. If one can assume maximum sizes of threat satellites, and thus maximum delta-v constraints, then these can also be plotted on this chart to give an accurate picture of how much attack warning time does the targeted satellite have, and where does it have to look in space to detect preparations for attack.

The black boxes towards the center of the display are actual locations of current live satellites in relation to the targeted satellite (in flattened space), and the gray boxes denote actual locations of dead space objects. If one assumes that an attack would come from a known live satellite, then the defending satellite would need to look towards the black boxes for suspicious activities that may be initiating an attack. If one assumes the attack would come from a supposedly “dead” space object, then defensive sensors should concentrate on the gray box locations. Otherwise, if one is concerned about an attack coming from “out of the blue,” then attack detection sensors must concentrate on successive concentric lower probability fans around the defended satellite based on assumed attacking object size, timeliness of detection, and the defending satellite timeline for response.

I also conducted many space warfare computer simulations that demonstrated the best tactics for possible future scenarios, including Defensive Counter Space.

(2) Knowledge of SSA R&D:

I have designed and managed development of many computer simulation software tools for space control including orbital mechanics, space surveillance, BMC3 and war gaming. I then ran these simulations for specific scenarios and derived data for use in long-range planning activities.

I participated in the development of simulations for satellite inspectors and microsatellite defense. I also developed simulations of laser relay mirror experiments, and airborne laser weapon systems.

While working in the Advanced Systems Program Office under Jim Bailey and MGen Armor (SMC/XRJ), Defense & Surveillance Operations, I personally managed two contractors conducting multi-million dollar studies to determine the optimal architectures for satellite on-orbit inspectors.

Additional analyses by myself include: spacecraft on-orbit visualization modeling, spacecraft rendezvous simulation, Laser Relay Mirror advanced planning CONOP generation, orbital optimization calculations, and FPGA Mission Assurance Center support.

(3) Proven Analytical Skills:

I have been conducting Space Superiority studies and analyses (requirements, command and control, Space Situational Awareness (SSA), space surveillance, space systems survivability, space weapons,

PAUL SZYMANSKI

space threat assessments, space modeling and simulations, space situation maps, and orbital physics) for 38 years now, which is longer than anyone I'm aware of in this field. Over my 41 year career as a defense analyst I began supporting the Secretary of the Air Force Acquisitions Office (SAF/AQS) on space defense budget issues, then Air Force Space and Missile Systems Center (SMC) for space systems program management, and finally at Air Force Research Labs (AFRL) with technology development planning. Starting at the Pentagon, I was trained to view the big picture for national security military space systems, and I carried this philosophy to the more detailed-oriented space systems development at SMC, and space systems research at AFRL (supporting the Satellite Assessment Center – SatAC, the Directed Energy Directorate, and Space Vehicle Directorate). For 27 years I worked SAP/SAR space programs (not NRO) that were part of the Congressional “waived” programs.

I love analysis, and I am very good at reducing analytical problems to their essential, orthogonal elements. I have managed or participated in 15 different blue-ribbon architecture studies that provided senior Government decision makers with long-term (10-20 year) strategic planning road maps for space systems. These studies have been briefed to the Secretary of the Air Force, Secretary of Defense, Joint Chiefs of Staff, Congress, and the National Security Council. I conducted a technical review of commercial Intelligence, Surveillance, and Reconnaissance (ISR) satellites as to their applicability to military requirements. I have also reviewed commercial communications satellite coverage maps for network vulnerability analyses, along with Global Positioning System (GPS) vulnerability to close-approach foreign satellites. I have independently developed complex analytical and simulation models for detailed space mission analyses, and I have established and managed the space modeling and simulation departments for three of the different companies I worked for. I am an expert in orbital dynamics simulations and operational satellite coverage assessments. I have also designed my own algorithms for detecting unusual space events and Space Situational Awareness state changes.

(4) Present and Defend Independent Positions:

While supporting AFRL/RD I developed a unique concept for integrating space, terrestrial and info war targeting into one unified methodology with common measures of merit. This shows the flow of information from sensor to shooter, and from space to terrestrial systems. I then programmed this algorithm into Microsoft Access, and have successfully used it in many studies and exercises, along with personally briefing this software's capabilities in the Air Force Vice-Chief's private office at the Pentagon. I managed many major architecture studies concerning the observation of objects in space and Space Situational Awareness. I developed study requirements, prepared statements of work, obtained funding approval, negotiated contract awards, monitored contractor technical performance, and briefed study results.

While supporting SAF/AQS Program Element Monitors (PEM's) and SMC/XRJ I helped manage the Space Defense Command & Control System (SPADCCS) Program and analyzed command, control and communications mission and technical requirements. I provided recommendations for program restructuring, and procurement options, along with monitoring contractor performance. I also facilitated Program Office interfacing with Headquarters Air Force to the Secretary of the Air Force level by writing point papers in response to Congressional tasks.

Early in my career, I was the field representative for reliability/maintainability at the OPEVAL test program for the TV guided CONDOR Missile System at China Lake, California. Due to my composure at this location dealing with a Government employee who was subsequently prosecuted for demanding bribes from contractors, I received a Naval Air Systems Command Commendation Letter, along with a similar commendation from my then employer, who refused to cave in to these illegal demands, which fell on me to take abuse as my company's on-site representative at China Lake. I am very good at staying pleasant and reasonable under extreme stress.

PAUL SZYMANSKI
Senior Professional Qualifications

(1) Contributions:

I have always strived to understand the bigger picture for space superiority, and its impacts on SSA requirements and timelines. I started my career supporting the Air Staff at the Pentagon (SAF/AQS) where I helped manage space surveillance (SSN), space systems survivability, and space command and control programs (SPADOC) with the Program Element Monitor (PEM). I provided many recommendations at that time which impacted future program budgets and direction, by both analytic recommendations to the Air Staff, or through responses to Congressional inquiries written by myself. I also developed a unique analytic technique whose results were used by the Joint Chiefs of Staff to help decide on establishing a Space Command rather than a Continental Defense Command. I was one of the few people in the room when the official announcement for the establishment of Space Command was publically announced. I also conducted one of the original Space-to-Earth weapons studies whose results were briefed to the National Security Council (NSC), and some of my conclusions were still in use 30 years later.

When I moved over to SMC/XRJ, I established their modeling and simulation branch entirely on my own initiative. This mod/sim capability provided fresh insight into the effectiveness of the programs at SMC/XRJ. In addition, I directly developed and managed the year-long Space Surveillance Architecture Study which provided the major roadmap for the next ten years of SSA requirements based on future threats, and recommended programs and budget. This study involved the whole SSA community stakeholders, and is one of 15 such space architecture studies that I either managed or supported over my 41 year career.

When I moved over to AFRL/RD (a MGen begged me to stay at SMC/XRJ as the local civil service professionals feared my analytical abilities being applied to the contractor side against them), I managed a major SSA community study linking SSA requirements to space systems survivability. While supporting Ed Duff, on my own initiative, I developed a unique analysis tool to quantify the value of space systems to the warfighter. I personally briefed this capability in the Air Force Vice-Chief's private office at the Pentagon, with his whole-hearted acceptance of its value to the Air Force. I was even requested by the Army to personally bring this capability to Iraq to support their warfighters (an Army Colonel called my Air Force sponsor to request my presence while he was on the tarmac in a C-130, leaving for Iraq). I was also personally requested by a senior Air Force Major General to participate in one of the Schriever Space Games due to my space Tactics, Techniques and Procedure (TT&P) expertise. I was also invited out to Nellis Air Force Base for a special meeting concerning Space TT&P's due to this expertise.

I also developed, on my own initiative, detailed if-then diagrams of actions and re-actions that a satellite inspector during rendezvous and proximity operations against an uncooperative target might experience. When senior Pentagon officials saw my analysis, they expressed confidence that AFRL was considering the bigger implications for inspector satellites. I also provided some of the original requirements for the ANGELS program. In addition, my unique space object state change algorithms were demonstrated to the SAB, which uncovered several disturbing actions taken by some adversary satellites, and impressed the SAB to recommend further analyses.

When I was supporting AFRL/RV, I designed a very detailed space scenario for a multi-million dollar SSA development program. The military leaders of this program publically stated that it was the best military scenario analysis for future space systems that they had ever seen, and my analysis had a major impact on the future of this program.

Also I developed a detailed space conflict escalation ladder with implications for SSA use supporting conflict escalation control. This space conflict escalation ladder was used by the White House Staff

PAUL SZYMANSKI

(my brother used to work there) when formulating new National Space Policy for the Obama administration.

(2) **Leadership:**

90 % of the analytical studies that I have conducted for military organizations over the past 41 years were conceived and begun on my own initiative. For SSA I provided independent analyses of satellite orbits, ground tracks and ground station geographic coverage. I also conducted ground sensor location studies, and compared these to mission requirements. I headed the Space Surveillance Architecture Study that analyzed current and future mission capabilities versus threats. Deficiencies were identified and recommended program upgrades costed and ranked according to requirements satisfaction. Results were briefed to General Cromer, Space Division; General Teal, Air Force Systems Command; General Kuytena, Air Force Space Command; General Moorman, Secretary of the Air Force/AQS; and Dr. Soper, Assistant Secretary of the Air Force/C3I. Results were also submitted to the Senate Armed Services Committee.

I supported Secretary of the Air Force, Defense, Surveillance and SDI Directorate (Air Staff) in policy and doctrine development, requirements analyses, mission planning, and technical trade studies. These studies included space command and control [Space Defense Operations Center (SPADOC), CSOC (Consolidated Space Operations Center), and Tactical Warning and Attack Assessment (TW/AA)], satellite and ground station survivability, satellite reliability and on-orbit lifetimes, intelligence estimates, and space transportation requirements. Direct ground-to-space aerospace planes were analyzed for technical feasibility and mission usefulness. Survivability studies included satellite attack verification, terrorist threats to ground sites, technology trends evaluation, and research into unconventional means for covert satellite degradation. In addition, doctrine studies I conducted for the Joint Chiefs of Staff contributed to their decision on the organizational structure for a Unified Space Command. I have managed or participated in 15 different blue-ribbon architecture studies that provided senior Government decision makers with long-term (10-20 year) strategic planning road maps in the areas of SSA and space control. These studies have been briefed to the Secretary of the Air Force, Secretary of Defense, Joint Chiefs of Staff, Congress, and the National Security Council.

For the Space Systems Architecture Study, I conducted a long-range planning effort that has had a major impact on the future of military space. I developed the original concept for this study, marketed this concept to the Air Force, convinced them of its importance for validating their space systems, and kicked-off two years of intense analytical studies by the top experts in the field. I established the overall objectives and logic flow of this study, procured and managed contractor support, and performed most of its supporting analyses. In addition, I wrote the final report and briefing. I developed some of the original concepts for space-to-earth weapons (conceptual development and cost-benefits analysis). My landmark study was briefed to the National Security Council, and many of its original conclusions are still used in subsequent studies, 30 years later. I managed threat assessment panels reviewing world-wide threats to space systems. I developed threat assessment requirements and formats, and integrated this data into other long-range planning activities. I also developed threat ranking methodologies. In addition, I modeled threat space systems capabilities in orbital dynamics tools, conducted space surveillance long-range system architecture assessments, and space intelligence data assessments. My additional efforts in support of the Air Staff: analyzed U. S. satellite attack verification capabilities; analyzed U. S. and Soviet on-orbit satellite lifetimes to compare relative space efforts; analyzed saboteur and terrorist threat to space systems ground facilities and conducted site surveys; developed a synopsis of DOD and NASA space programs and identified capabilities, trends, technologies and costs; analyzed industry technology concept papers for the Forecast II Future Technology Study; developed a management information system for HQ USAF; analyzed satellite

PAUL SZYMANSKI

reliability trends and capabilities; and modeled Space Defense C3 timing relationships for conflict scenarios.

(3) **Professional Stature:**

As a recognized SSA leader in the community, I was personally requested to provide professional consulting services regarding RASTER proposal strategy, teaming, pricing, and technology information for one of the competitive bidders. I provided expertise needed to improve and exploit the R&D and operational capabilities at MSSS and SOR to provide high-quality, timely products that enable Space Superiority by US national agencies. I also provided advice and information on how to implement, improve and validate sensors, processing algorithms and processes to meet Near Earth SOI mission requirements for red and blue space stakeholders for resolved and non-resolved data and supporting products. I also was personally invited to lecture a class at the Air University on space doctrine, strategies and tactics.

I have always analyzed the overarching policy issues facing space warfare, and have worked with Congressional staff, technical experts within the Department of Defense, think tanks, and private industry. I initiated a LinkedIn Space Warfare Group to gather a team of excellence of the top military space experts in the United States and allied countries. This Space Warfare discussion group consists of 1,481 hand-picked members on LinkedIn with experience in SSA and space control, and includes: 60 members from military colleges, 61 from Government think tanks, 45 from public universities, 12 from government intelligence agencies, 29 from the Joint Chiefs of Staff, 23 from NATO, 24 from NORAD-NORTHCOM, 61 General officers or equivalents (one to four stars), 40 from the Secretary of Defense office (including the current Secretary of Defense nominee himself), 1 from the National Military Command Center, 46 from House & Senate staffers, 176 from specific military space agencies, 150 from various other military services, 7 diplomats, 20 from the State Department, 299 from various space-related defense contractors, 9 from the White House and National Security Council staffs, and 6 astronauts, among others.

Some of the many awards and special recognitions that have been bestowed upon me are:

- Naval Air Systems Command Special Recognition Letter
- Joint Chiefs of Staff, Deputy Director Special Recognition Letter
- USAF/ AF Space Command, CINC Special Recognition Award
- USAF/RDQX Deputy Chief of Staff Special Recognition Letter
- Space Defense Command and Control System (SPADCCS) Certificate of Appreciation
- Aerospace Corporation Special Projects Office Recognition Award (3 times)
- USAF/SSD/XRJ Special Recognition Letter
- USAF Special Projects Office Recognition Letter
- Aegis Research Corporation Special Recognition Letter (twice)
- Space Program Executive Officer (PEO) Certificate of Appreciation
- Space and Missiles Systems Center Recognition

PAUL SZYMANSKI
Desirable Qualifications Statement

(1) Advanced Degrees:

I have a Master's of Science degree in Physics Measurement & Control (Instrumentation) from Carnegie-Mellon University, along with a Bachelor's of Science in Physics and Math, with a minor in Mathematical Logic from the same university.

(2) Professional Society Standing:

I am a member of the below organizations:

- AIAA American Institute of Aeronautics and Astronautics, **Senior Member** for 35 years
- APS American Physical Society, **Lifetime Member** for 40 years
- CAMP Council on America's Military Past for 25 years
- MVPA Military Vehicle Preservation Association for 33 years
- NMMMMH New Mexico Museum of Military History – Current Board of Directors Member for 10 years
Past Member of the Board of Directors of Sylvan Services Corporation
Currently under consideration for the Albuquerque Police Oversight Board

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REFERENCES



[Dr. Thomas L. Allen, SES Deputy Director for Studies and Analysis, Joint Staff, J8, The Pentagon; 571-256-1905](#)

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["As we've discussed in the past, I think you're terrific; I believe you are an outstanding asset to the military and space operations community."](#)



[Lawrence Cooper, Mission Manager for Space & Cyberspace Warning, Joint Staff, The Pentagon](#)

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["Paul is a first-rate intellect and dedicated to advancing our understanding of space doctrine and strategy."](#)



[Stephen Stroble, Deputy Branch Chief, J257 \(Strategy, Policy and Doctrine\), Joint Staff, The Pentagon; 570-789-0647](#)

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["Great questions... 10 & 11 are superb! Very interested in where you take this next..."](#)



[Matthew Lupone, Enabling Systems Division at Office of the Undersecretary of Defense \(AT&L\), Space and Intelligence Office](#)

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["Very intriguing. As a career space/missile officer, I believe your studies have a lot of merit."](#)



[Brou Gautier, Senior Program Manager, SiloSmashers, Inc.; 703-797-5454](#)

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["Paul Szymanski is an impressive thought leader forging the path in space and space warfare doctrine and policy! There is no more insightful or conversation-shaping voice in the arena!"](#)



[Arnold Sillins, Foreign Policy Officer at Central Intelligence Agency](#)

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["Our country should recognize that you have an out standing mind and welcome it to the table."](#)



[BGen David Uhrich, Dir or Communications, ACC](#)

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["Always great to hear from you and of course your current thoughts on the big issues in space."](#)



[Gary Harmon, Independent Strategic & C4ISR Consultant; 703-980-9449](#)

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["Paul has rare, broad experience and skills that give him insight to fashion space policy and strategy that delivers for our Nation and his clients."](#)

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[Gary Rafferty, GPS / NAVWAR Liaison at 746th Test Squadron](#)

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["Paul is a true Space Warfare Doctrine, Strategies & Tactics expert!"](#)



[Cori Batte-Garcia, Case Manager at ATD LTD NM; 505-710-1532](#)

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["Top notch! Expert in his field. The go to guy to get the job done."](#)



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["A valuable person with great experience."](#)



[Kenneth D- Philippart, Deputy Chief, Office for Offensive Systems, Missile & Space Intelligence Center](#)

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["Paul is the driving force of a discussion group tackling complex issues facing the military space community. He solicited thought-provoking topics while keeping the forum focused on what's important."](#)



[Jeff Heier, Director of Technology, RL Leaders](#)

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["I have worked in the space field for 30 years and I have never met someone who knows more about space warfare and operations than Paul. Anyone he works with is fortunate indeed."](#)



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["Paul continues to provide high-quality, thoughtful analysis."](#)



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["Runs a terrific blog on space policy & conflict issues."](#)



[Shawn C- Gay, Zemax Developer at Radiant Zemax](#)

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["Paul has a valuable and unique knowledge base for space warfare doctrine. On top of that, he is very approachable and a great communicator."](#)

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[Wayne White, President & CEO,
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[“I have worked with Paul on Wikistrat projects, and he was a pleasure to work with. I was impressed with his knowledge and learned a lot from him.”](#)



[Sonny Blinkinsop, Air Attaché to United
Kingdom, USAF; 203-233-5676](#)

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[“Paul provides well structured and highly informative space themed articles. I find his insight interesting and refreshing.”](#)



[Phil Mitchell, President and Founder at Omega
Analytics](#)

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[“I worked with Paul for several years. He knows this area of national security as well as, or better than, anyone I know. It is a privilege to endorse his professional skills in this area.”](#)



[Nicholas Elias, C4I Target Systems Analyst,
USCENTCOM](#)

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[“Paul demonstrates a broad knowledge of space doctrine across all functions. For space control, Paul has an ability to cross the lines of Space/OPS/Targeting doctrine to help answer the hard questions.”](#)



[Rolf Ludvigsen, Senior Counterspace
Intelligence Analyst, Command & Control \(C2\)
Engineer, SRA International; 937-360-6219](#)

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[“Paul is a superior professional that quickly assimilates critical information, identifies key challenges, and takes the initiative to develop solutions to leading problems facing the United States! Paul is an extraordinarily gifted researcher and an equally talented writer. I have known Paul since 2011 when he reached out and developed a 700 member International Space War Policy working group. Space policy is fundamentally overlooked in many countries to include developing nations as a globally agreed upon UNCLASSIFIED policy. Paul recognized this dilemma and took the initiative, time, and compassion in leading the space community in developing provocative policy answers to questions that should fundamentally help develop guiding principles in Space and Counterspace sectors the world over.”](#)

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[Dunning Idle, Senior Principal GN&C Engineer, Emergent Space Technologies, Inc.](#)

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["Paul was a great boss. He has a deep understanding of space control and military tactics in general. His work applying Sun Tzu to space warfare is innovative and relevant. He has vast collections of important space data from spacecraft anomalies to ground sensors to CAD models of spacecraft. He is comfortable using simulations as well especially the Aerospace Corp SOAP tool, which he supported development of earlier in his career."](#)



[Paul Day, Space Liaison Officer at United States Air Force](#)

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["I just wanted to say thanks for passing this along. I have never seen these charts before, and I learned a lot as a space operator today. This discussion group is proving hugely valuable to my knowledge-growth efforts."](#)



[Judge Bourque, Director, Spectrum Strategies at URS Fed Services](#)

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["Your conversations are as informative as they are timely."](#)



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["Our interaction in the space field will be more of a mentor-mentee relationship which I realized when I was going through your stellar profile. I would be very interested in learning from you, Sir."](#)



[Dan Harel, Aerospace and defense, Guidance, Navigation GPS & inertial, Control, Algorithms & flight software](#)

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["Your field of expertise is wide and very interesting. Your activities demonstrate a remarkable capability to raise funding for broad variety of subjects."](#)



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["Very cool stuff. All of your comments make sense having spent much time doing Multi National Coordination. Working with NGOs and IGOs having corporate presence makes sense per your need. Good stuff and thanks for sharing. Fascinating discussion. Thanks for the postings and discussion. I am learning a great deal."](#)

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["Thank you for your email, I learned a lot from you."](#)



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["I just wanted to say that I found your concept briefings quite helpful."](#)



[Andre Hebert, Senior Intelligence Service Officer, National Reconnaissance Office/CIA](#)

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["Paul Szymanski is a well known space tactician in the aerospace industry and would be a great asset to any organization operating in that sphere. He is most highly qualified."](#)



[David Scott, Vice President, International Programs at Merlin RAMCO Inc.](#)

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["Out of the box thinking. Pretty neat."](#)



[Eugene Choi, Chief, Space Situational Awareness, National Reconnaissance Office; 310-706-8286](#)

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["Very impressive background with SSA! I would love to get your ideas and have discussions on the topics you've mentioned."](#)



[Maria Pozza, Lauterpacht Fellow \(Space Law\), Lauterpacht Centre for International Law, Faculty of Law, University of Cambridge](#)

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["Thank you for your comments which I have enjoyed reading with much interest. You touch on some startling points which need further investigation. The lack of structure particularly at the international level through law and policy, is worrying. Please do keep sending us your emails, I enjoy reading them."](#)



[Nick Martin, Architecture Branch Chief, Advanced Concepts Division, SMC/XR](#)

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["I've found your emails fascinating, and I would be interested in reviewing the strategies you've mentioned you're working on."](#)



[Eric Sterner, National Security/Aerospace Expert, Missouri State University Department of Defense and Strategic Studies](#)

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["I think you're right about the state of strategic thinking in the community."](#)

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[Todd Westhauser, Director, Doctrine Development](#)

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["Thank you for your very interesting discussion on space war."](#)



[Andrew F. Wimberly, Training and Doctrine Specialist at Department of the Army](#)

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["Very interesting and thought provoking!"](#)



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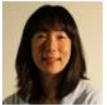
["I applaud your efforts to decompose the history of the space work force and extrapolate the doctrine we so desperately need."](#)



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["I appreciate your efforts in this area and look forward to hopefully some great discussion!"](#)



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["Paul, sounds like you have a fantastic background. Fascinated by what you're doing."](#)



[William B. Scott, Author, former Bureau Chief for Aviation Week & Space Technology, & Space Communications Engineer at NSA,](#)

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["Paul, you are a real-world, front-line space warrior! Thanks for your services to America, Sir!"](#)



[Bruce Milligan, Project Manager, Game Designer, Writer and Editor,](#)

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["To me, from what I have read so far, you are the Liddell Hart of space warfare, which is about the highest compliment I can offer you."](#)