



DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY (AETC)

24 JAN 1994

Dear Advisory Committee Member

I see the advisory group as an essential, integral element of Spacecast 2020. (There have been major space studies done every year since the Challenger accident, and several prior. Unfortunately, for the most part, they have been paid too little attention. We want this study to be different.) Your participation can help make this a strong, balanced and comprehensive study which can provide convincing impetus for moving forward in the efficient and effective use of space.

We need your opinion, comment, thought, suggestion. Is there something missing? Is there something in particular we should focus on? Is this idea, concept a good one with potential; if so, work on it; while that one over there -- you're wasting your time. Tell us.

We have intentionally waited until now to ask you to come. We wanted to have something that we hope will be worth your time and, importantly, something that can be used as a benchmark as the effort continues.

We clearly look forward to the point-counterpoint discussion that may ensue. You bring perspectives that must be included for this effort to have value.

We recognize that the considerations important to the credibility, relevance and timeliness of this study are not confined to just the military. Nor will the outcomes concern only the military. Space is an inherently multidisciplinary, multifunctional, and boundless arena. It is the ultimate high-ground which offers too much opportunity and challenge to be fenced in by one interest or another.

Objectives:

1. Form the team (Advisory Group)
2. Assess assumptions
3. Listen to ideas
4. Give us your opinions, comments
5. Resolve to enhance this study

Sincerely

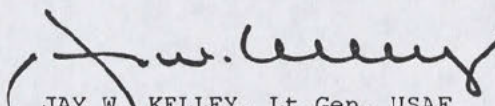

JAY W. KELLEY, Lt Gen, USAF
SPACECAST 2020
Chairman

TABLE OF CONTENTS

SEATING CHART

- A. ADVISORY CONFERENCE ITINERARY
- B. SPACECAST 2020 BACKGROUND PAPER
- C. SPACECAST 2020 MILESTONES
- D. SPACECAST GUEST SPEAKERS
- E. EXECUTIVE BOARD BRIEFING
- F. ASSUMPTIONS REGARDING THE WORLD OF THE FUTURE
- G. LOWELL WOOD SPEECH
- H. BIOGRAPHIES

BLUE FOLDERS: Briefing to Advisory Group - White/Szafranski
Briefing to Advisory Group

As of: 21 Jan 94

FOR OFFICIAL USE ONLY
ITINERARY FOR VISIT OF THE ADVISORY GROUP

MEMBERS OF THE VISITING PARTY:

DISTINGUISHED RETIRED SENIOR MILITARY AND
CIVILIAN LEADERS

John R. Boyd, Col, USAF (Ret)
Consultant

Billeting: Bldg 121 Room 5643
Room Phone: [REDACTED]

PURPOSE OF VISIT: SPACECAST 2020 ORIENTATION AND CHALLENGE

SPACECAST CONTACT POINTS:

Col Charles G. "Snip" White Jr.
Duty Phone: DSN 493-7629 COMM (205) 953-7629
Home Phone: [REDACTED]

Maj Ava N. Webb-Sharpless
Duty Phone: DSN 493-2677 COMM (205) 953-2677
Home Phone: [REDACTED]

Escort Officer

Dr Grant Hammond
Duty Phone: DSN 493-6996 COMM (205) 953-6996
Home Phone: [REDACTED]

23 January 1993

<u>TIME</u>	<u>PLACE</u>	<u>ACTIVITY</u>	<u>RESPONSIBILITY</u>
1325	Dannelly Field	Arrival DL Flt#1211	Protocol
1345-1400	Base Transportation	Enroute to billeting	Protocol
1400-1835	VOQ	Free Time	Col Boyd
1840-1845	Surrey	Enroute to Curry House	Protocol
1845	Curry House	Welcome Reception	Lt Gen Kelley

24 January 1994

<u>TIME</u>	<u>PLACE</u>	<u>ACTIVITY</u>	<u>RESPONSIBILITY</u>
0755-0800	DV Van	Enroute to Wargaming Lab	Protocol
0800-0820	Wargaming Lab	Continental Breakfast	Protocol
0820-0830	Wargaming Lab Conf Rm	Security Briefing	Capt Doederlein
0830-0845	Wargaming Lab Conf Rm	Welcome	Lt Gen Kelley
0845-0930	Wargaming Lab Conf Rm	SPACECAST Overview and Discussion	Cols White and Szafranski
0930-0940	Wargaming Lab	Break	

0940-1020	Wargaming Lab Conf Rm	Speaker Review & Video tape "SPACECAST 2020 Speaker Highlights"	Col Szafranski
1020-1030	Wargaming Lab	Break	
1030-1130	Wargaming Lab Conf Rm	Briefing "The World in 2020: Assumptions"	Lt Col Junge Maj Johnson
1130-1145	Wargaming Lab	Break	
1145-1220	Wargaming Lab Conf Rm	Luncheon	Lt Gen Kelley
1220-1230		Enroute to AWC	Protocol
1230-1400	AWC/Jones Aud	Lecture and Discussion "Future Technologies"	Dr Canavan
1400-1415	AWC	Break/Enroute to seminars	Seminar Coord
1415-1515	AWC Seminar Rooms	Discuss Future Concepts With Assigned Students	Seminar Coord
1515-1530	AWC	Break/Enroute to Wargaming Lab	Seminar Coord
1530-1630	Wargaming Lab Conf Rm	Executive Meeting	Lt Gen Kelley
1645-1650	Car w/ Dr Hammond	Enroute to VOQ	Dr Hammond
1650	VOQ	Free Time	Col Boyd

25 January 1994

0830-0900	Officers Club	Breakfast	Dr Hammond
0900-1125	AWC	Meeting w/Dr Hammond	Dr Hammond
1125-1130	Car w/Dr Hammond	Enroute to Base Ops	Dr Hammond
1215	Maxwell Base Ops	Departure (Pacer 52)	

ATTENDING THE WELCOME RECEPTION

Lieutenant General and Mrs Kelley
Colonel Charles "Snip" White
Colonel Richard "Dick" Szafranski
Mr Edward C. "Pete" Aldridge
Dr Alf Andreassen
Mr Bruno Augenstein
Dr Anthony "Tony" Hyder

Dr Joan Johnson-Freese
VADM William Ramsey, (USN, Retired)
General Bernard Schriever, (USAF, Ret)

Commander, Air University (Jay and Marty)
Project Director, SPACECAST 2020
Research Director, SPACECAST 2020
President and CEO, Aerospace Corp
Information Systems Vice President, AT&T
Sr Scientist, Defense & Technology Planning Dept, RAND
Associate Vice President for Graduate Studies & Research, & Professor
of Aerospace Engineering, University of Notre Dame
Associate Professor, Dept of National Security Studies, Air War College
Vice President of Corporate Business Development, CTA Inc
Consultant

Dress is casual

Heavy hors d'oeuvres will be served

ADVISORY GROUP SEATING CHART FOR THE WARGAMING LABORATORY CONFERENCE ROOM

Col White

Col Boyd

MGen Robinson

BGen Brooks

Mr Thompson

VADM Ramsey

Mr Fuqua

Col Szafranski

Col Warden

Dr Andreassen

General Gray

Mr Augenstein

Gen Schriever

Mr Aldridge

Dr Hyder

Lt Gen Kelley

Dr Johnson-Freese

SPACECAST 2020

"This is the key point: The effective employment of air and space power has to do not so much with airplanes and missiles and engineers as with thinking and attitude and imagination."

Gen. Merrill A. McPeak

Chief of Staff

United States Air Force

BACKGROUND:

- On 10 Sep 93, CSAF signed out message to all MAJCOMs directing Air University to commission a major space study.
- Purpose: SPACECAST 2020 will--
 - • Envision capabilities our country needs to exploit and control space.
 - • Identify innovative applications of space systems and technology that will support national security.

ISSUE:

- Space focused--to the benefit of the warfighter and national security--and not encumbered with service or space doctrine. Unconstrained thinking--encouraging creativity and innovation.
- Air University faculty and students serve as a "think tank" to envision space hardware and uses of space systems to improve our warfighting capabilities.
 - • Three study teams (Creative, Realistic Assessment, and Technology Teams) comprised of AWC, ACSC, AFIT, SAAS, CADRE, SOS faculty and students.
 - • External agencies will contribute ideas--NRO, CIA, Services, US and AF SPACECOMs, and National/AFMC labs and industry.
 - • The study has two teams of advisors.
 - • • AF/XO led team of AF MAJCOM/CVs
 - • • Wise Owls composed of retired senior military officers and distinguished civilians.
- The study is being conducted in a three phase approach.
 - • Generate ideas, concept development, and application refinement.
 - • The first phase broadened and educated participants with guest speakers who addressed creative thinking and problem solving, the future world conditions and geopolitical environment, the nature of future conflict, current and planned space systems, and emerging science and technologies.
 - • Phases II and III will involve research and concept development using material gathered by AFIT through a world-wide data call.
 - • Phase I ended 17 Dec 93.
- Final report to CSAF is due 30 Jun 94.

SPACECAST 2020 MILESTONES

DATE

ACTION

Phase I Begins

- | | | |
|------|----------|---|
| 1993 | 25 Aug | - Brief CSAF; first seminar |
| | 10 Sep | - Msg from CSAF to MAJCOMs |
| | 15 Sep | - AFIT commences Data Call |
| | 20 Sep | - Omnibus disclosure agreement |
| | 13 Oct | - Brief players on the Data Call/white paper process |
| | | - Initial Data Call distribution to C.A.T.s |
| | 27 Oct | - AFIT Data Call process briefing/distribution to C.A.T.s |
| | 9-10 Nov | - Seminars/teams future world briefings to review panels |
| | 22 Nov | - Future world briefing to Gen Kelley |
| | 24 Nov | - Initial definition of final product format |
| | 30 Nov | - Overview and future world briefings to Executive Board; request MAJCOM requirements |
| | | - Broad, one-page, concept papers due to R.A.T. |
| | 8 Dec | - In-house symposium with seminars/teams briefing ideas to each other |
| | 17 Dec | - Holiday Break |
| | | - R.A.T. provide evaluated concept papers to Research Director |

Phase II Begins

- | | | |
|------|--------|--|
| 1994 | 5 Jan | - Reform/refocus creative activity teams. |
| | 24 Jan | - Brief Advisory Group on SPACECAST 2020 |
| | 1 Feb | - Final SPACECAST product format defined |
| | 7 Feb | - Draft white papers to R.A.T. |
| | 28 Feb | - R.A.T. provide evaluated draft white papers to Research Director |

Phase III Begins

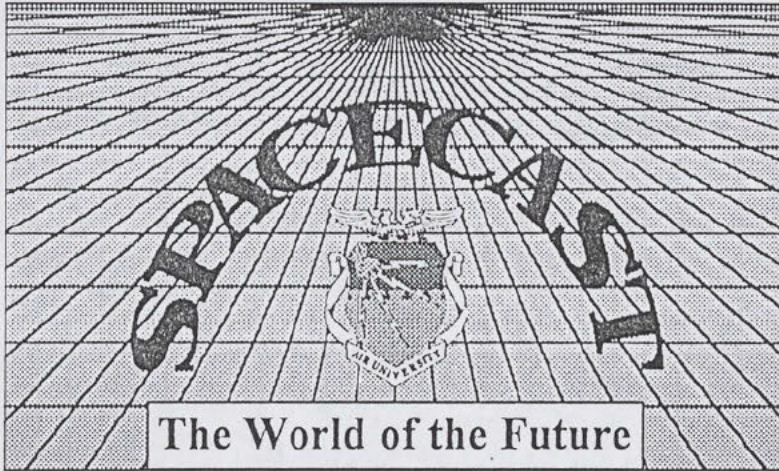
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|--|--------|---|
| | 1 Mar | - Brief best concept white papers to Executive Board and Advisory Group |
| | | - Select papers sent to Advisory Group and funneled external |
| | | - White paper section and chapter assignments |
| | 15 Apr | - Final white paper drafts to R.A.T. |
| | | - Executive Board draft review and Advisory Group final inputs |
| | 6 May | - Rough assembled document |
| | | - Document Proofing |
| | 9 May | - Brief Executive Board and Advisory Group |
| | 13 May | - Assembled book to publisher |
| | | - Students released |
| | 30 Jun | - Draft study to CSAF |

SPACECAST 2020
Speakers 30 Aug 93-2 Nov 93

- 25 Aug 93 Maj Gen Peter D. Robinson, Air War College Commandant, and Col Ted Hailes, "Orientation to the Study."
- 30 Aug 93 Dr. David Webb, (President's Commission on Space) "Future Threat and Proponent of Low Cost Lift."
- 1 Sept 93 Bob King, Goal/QPC, "Creative Thinking: Breaking Down Paradigms."
- 8 Sept 93 Roger von Oech, Creative Thinking Consultant to industry giants (Apple, IBM, Coca-Cola, CBS, NASA) (author of Whack on the Side of the Head and A Kick in the Seat of the Pants). Creative Thinking Workshop.
- 13 Sept 93 Joe Haldemann, science fiction writer and MIT Professor (novels: Mindbridge (1976), Worlds (1981), Worlds Apart (1984), The Forever War.
- 15 Sept 93 Dr. W. Taylor, from SSI (Army War College), and Drs Stein and Ludwig from AWC faculty. "Forecasting the 21st Century."
- 17 Sept 93 Dr. Martin van Creveld, Marine Corps University, "The Transformation of War," (written Command in War and Supply in War).
- 20 Sept 93 Col John Boyd, (USAF, ret.) controversial/maverick thinker. "Destruction and Creation Thinking."
- 22 Sept 93 DIA/NSA. "Intelligence View of the World: 2020-2050."
- 27 Sept 93 Dr Jerry Pournelle, (Inferno and Lucifer's Hammer) scientist and science-fiction writer. Space advisor in Presidents Reagan and Bush administration.
- 29 Sept 93 Col John Warden, ACSC Commandant, "Conflict in 2020." John Arquilla (teleconference), Naval post-grad school, "Netwar, Cyberwar, and Futurewar."
- 1 Oct 93 Dr Edward Teller, Livermore Laboratory, "Uses of Nuclear Power in 2020."
- 4 Oct 93 Col Ken Walsh, AFSPACECOM, "DOD Space Systems"; Lt Col Bob Work, DSPO, "National Space Systems."
- 5 Oct 93 Panel with Dr Joan Johnson-Freese (AWC Faculty), Dr Burton Edelson (George Washington University), Nate Boyer (EOSAT), Dr Dana Johnson (RAND). "Commercial and International Uses of Space."

- 6 Oct 93 Lt Col Mike Wolfert, AFSPACECOM/XPX, "Space Tomorrow"; Col Fred Engleman, AFSPACECOM/INX, "Foreign Reliance on Space."
- 8 Oct 93 Drs Alvin and Heidi Toffler, (Future Shock and The Third Wave). "War and Anti-war--Information Warfare is the Next Wave."
- 12 Oct 93 Col Pete Worden, BMDO, "Future Technology."
- 13 Oct 93 Dr Alok Das, Phillips Lab, "Precision Structures"; Carl Builder (RAND), "Future Technology"; Dr Wendell Mendell (NASA, Johnson Space Center, Chief Scientist Lunar Based Studies, proponent of Lunar mining and uses of Helium 3), Space Exploration.
- 15 Oct 93 RADM Oden, Office of Chief of Naval Operations, "Sonata."
- 19 Oct 93 Col T. Wierzbanski, HYFLITE Program Manager, "NASP"; Dr. F.X. Kane, consultant to Rockwell, "War in Space"; Ms. Rita Sagalyn, Phillips Laboratory, "Space Environment."
- 20 Oct 93 Dr. William Baker, Phillips Laboratory, "Directed Energy and Optical Systems, and Col Lanny Larson, Technology for Space Applications."
- 21 Oct 93 Mr. Bob King, Goal/QPC, "Creativity and Idea Selection."
- 25 Oct 93 Lt Gen Jay Kelley, AU Commander/SPACECAST Chairman, "SPACECAST: The Goal."
- 27 Oct 93 Col Gerry Hasen, AFIT, "Data Call Process," Arthur C. Clarke, science fiction writer, via teleconference; Dr Lowell Wood, Livermore Laboratory, "Brilliant Pebbles and Beyond."
- 2 Nov 93 Mr Stan Bedlington, CIA, "Terrorism in the Future", Dr Carl Sagan, Cornell University, "A View on Space in 2020."

2020



Briefing to the Executive Board
30 November 1993



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Briefers

Lt Col Tamzy House
Air War College
Class of 1994

Major Bill Bruner
Air Command and Staff College
Class of 1994



SPACECAST 2020

Overview

- *Preparation*
- *Caveats*
- *Model*
- *Projections*
- *Where we're headed*



SPACECAST 2020

Preparation

- *All Volunteers*
- *Creative and critical thinking*
- *41 speakers*
- *102 hours of study*
- *Additive to core curricula*



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Caveats

- *Future unknown and unknowable*
- *Far future: not "2020"*
- *Much more is "possible" than "probable"*

Driver: What does it take to control and exploit space?



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Framing Assumptions

Lectures and Readings

- *Certainties*
- *Uncertainties*
 - *Plausible*
 - *Possible*
 - *Probable*

Seminars

- *Possible*
- *Probable*
- *Consensus*

Review Panels

- *Probable*
- *Consensus*
- *Rogue set*

Seminars

- *Review*
- *Consensus*

Today's assumptions



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The "Rogue Set"

- *Large-Scale nuclear war improbable*
 - *But, absent counter proliferation strategy and operations, a nuclear detonation is likely*
- *Collapse of world economic system not likely, but possible*
- *Global plague or AIDS-like virus possible, but not likely*
- *Lunar or Martian colonies, large orbiting colonies, and human inter-planetary travel unlikely before 2050*

POSSIBLE + PLAUSIBLE $\neq$ PROBABLE



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Why Assumptions?

- *To help us understand what may be ahead*
- *To focus our thinking on future national security challenges*
- *To help identify higher leverage space systems and capabilities*
- *To better understand enabling technologies and identify the order of development*



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Boundaries

- *Will not enter Roles, Missions, or Functions discussion*
- *Will not discuss programmatics or Mission Area Planning System linkages*

"America's Space Study" sponsored by the CSAF



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What's Lacking or Broken?

- *According to our speakers*
 - *Lack of national "Space Vision"*
 - *Little constancy of purpose or unity of action*
 - *Diminishing national will*
 - *Military space system acquisition*

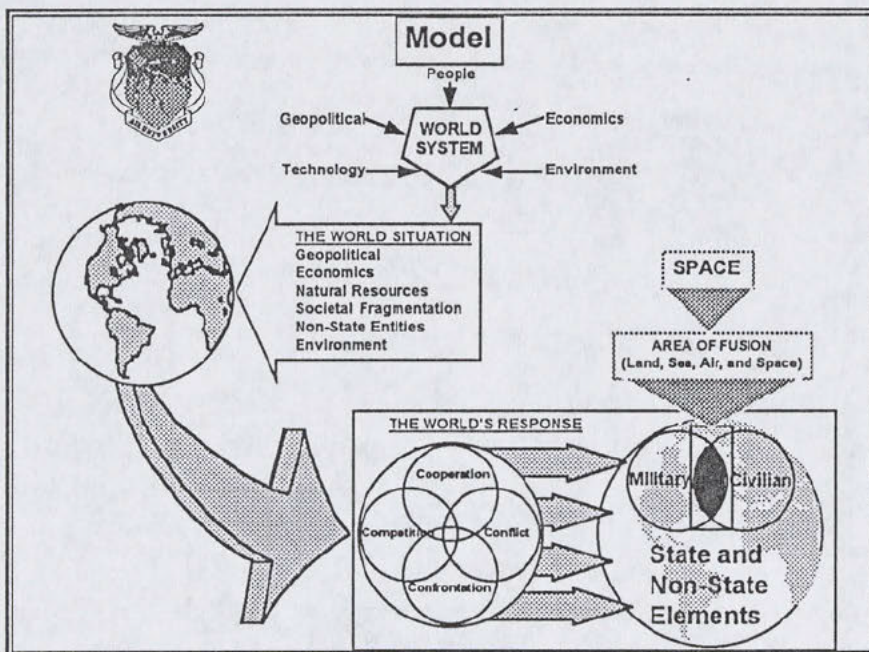
Cheap spacelift



SPACECAST 2020

Overview

- *Preparation*
- *Caveats*
- *Model*
- *Projections*
- *Where we're headed*





SPACECAST 2020

Overview

- *Preparation*
- *Caveats*
- *Model*



Projections

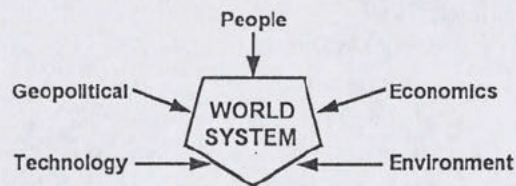
- *Where we're headed*



SPACECAST 2020

The World System

Forcing Functions





SPACECAST 2020

Forcing Functions

- *People*
 - *Population exceeds 8 billion in 2020*
 - *Significant change in mean age of society in "North"*
 - *Increased number of regional centers and micro-states*
 - *Labor force oriented towards achieving individual quality of life*
 - *Non-state associations (religions, transnational corporations, environmental fanatics) exert powerful influence*



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Forcing Functions

- *Geopolitical*
 - *Nation-state structure dominant, but in great flux*
 - *Multi-polar world with loosely organized nation-state regional confederations*
 - *Non-state entities exerting significant influence*

United Nations a stronger world arbitration organization



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Forcing Functions

- *Economics*

- *World's Gross Domestic Product doubles by 2020*
- *US world economic leader*
- *Trade agreements becoming more important than military alliances*
- *Transnational corporations inter-link world's economies*

The century of the Pacific

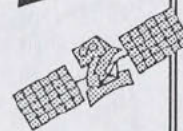


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Forcing Functions

- *Technology*

- *High-speed, high-volume telecommunications*
- *Orders of magnitude increase in computer speed, storage, networking, and capacity*
- *Micro-miniaturization of computer chips, artificial intelligence--revolutionizing product development*
- *Genetic engineering*





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Forcing Functions

- *Environment*
 - *Greater global sensitivity*
 - *Potential for increased climate variability*
 - *Depletion of natural resources—fresh, uncontaminated water, and earth's biomass*

Migrations possible



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World's Character

- *Increase in gap between "haves" and "have-nots" or "have-lesses"*
- *Increase in materialism*
 - *Seeking comfort and control of knowledge*
 - *Resistance to self-sacrifice*

Crisis in values



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America's Character

- *Will and character of society will provide the "bottom-line" for US space control and exploitation*
- *US citizens will support "space program" if:*
 - *Economically benefits them personally*
 - *Protects the nation and their way of life from a perceived threat*



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Issues Shaping World's Situation; Potential Sources of Future Conflict



THE WORLD SITUATION

Geopolitical
Economics
Natural Resources
Societal Fragmentation
Non-State Entities
Environment



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Geopolitical Issues

- *New nations*
- *Refugees and migrations*
- *Regional economic bloc rivalries*
- *Religious extremism*

New problems added to old



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Economic Competition

- *Economic security more significant*
- *Rivalry between blocs may cause conflict*
- *The gap between rich and poor will widen*

No Space = "Have-not"



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Availability/Access to Natural Resources

- *Population growth may lead to conflict over resources*
- *"Have-nots" or "have-lesses" may be motivated to steal from "haves"*

Contested resources could include energy, water, territory



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Societal Fragmentation

- *Racial, ethnic, religious differences*
- *New nations from "wars of self-determination"*
- *United Nations membership over 200—most new states in East Europe and Africa*

More players—more problems



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Actions of Non-State Entities/Institutions (Terrorism, Transnational Influences)

- *Nation-state not obsolete*
- *Influence of non-state actors will increase*
- *Activities of non-state actors will bring them more into conflict with states*

*Non-state actors will continue to use
force and coercion against states*



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Environmental Concerns

- *Non-compliance with waste disposal agreements*
- *Sovereignty will include perceived right to clean air and water*

Space systems find violators

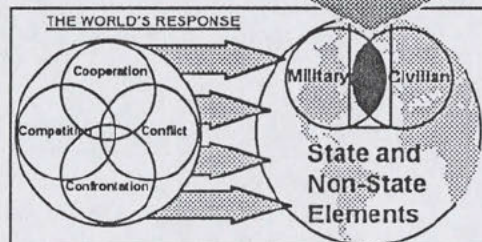


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The World's Response

Controlling and Exploiting Space

AREA OF FUSION
(Land, Sea, Air, and Space)



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Space in the Future

- *Access*
- *Technology*
- *Space Use*
 - *Civil/Scientific*
 - *Commercial*
 - *National and International Security*
- *Planetary Defense*



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Access

*By earlier than 2020
the United States must
bring lift costs down*

Our Achilles' heel in space



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Technology

- *New lift systems*
- *Smaller, faster computers*
 - *Artificial intelligence*
- *Improved sensors*
- *High-power directed energy*

Era of non-lethal, reversible effect weapons



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Space Use

- *Civil/Scientific*
- *Commercial*
- *National and International Security*

Greater convergence likely



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Civil/Scientific

- *Remote sensing of Earth resources*
- *International cooperation*
 - *Peacesats*
- *Permanent, limited human presence*
- *Fewer resources for astronomy and planetary exploration*



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Commercial

- *Remote sensing for resource exploitation*
- *High-power direct broadcast*
- *Orbital cellular/data network*
- *Submeter and multispectral imagery available*

Enemies go underground



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National Security

- *Proliferated surveillance, navigation, C⁴*
- *Remote/virtual presence*
- *CINC Sats*
 - *Fire control, target illumination*
 - *Weapons employment*
- *Ground based and on-orbit ASATs*



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International Security

- *Orbital debris control*
- *Asteroid defense*



SPACECAST 2020

Where We're Headed

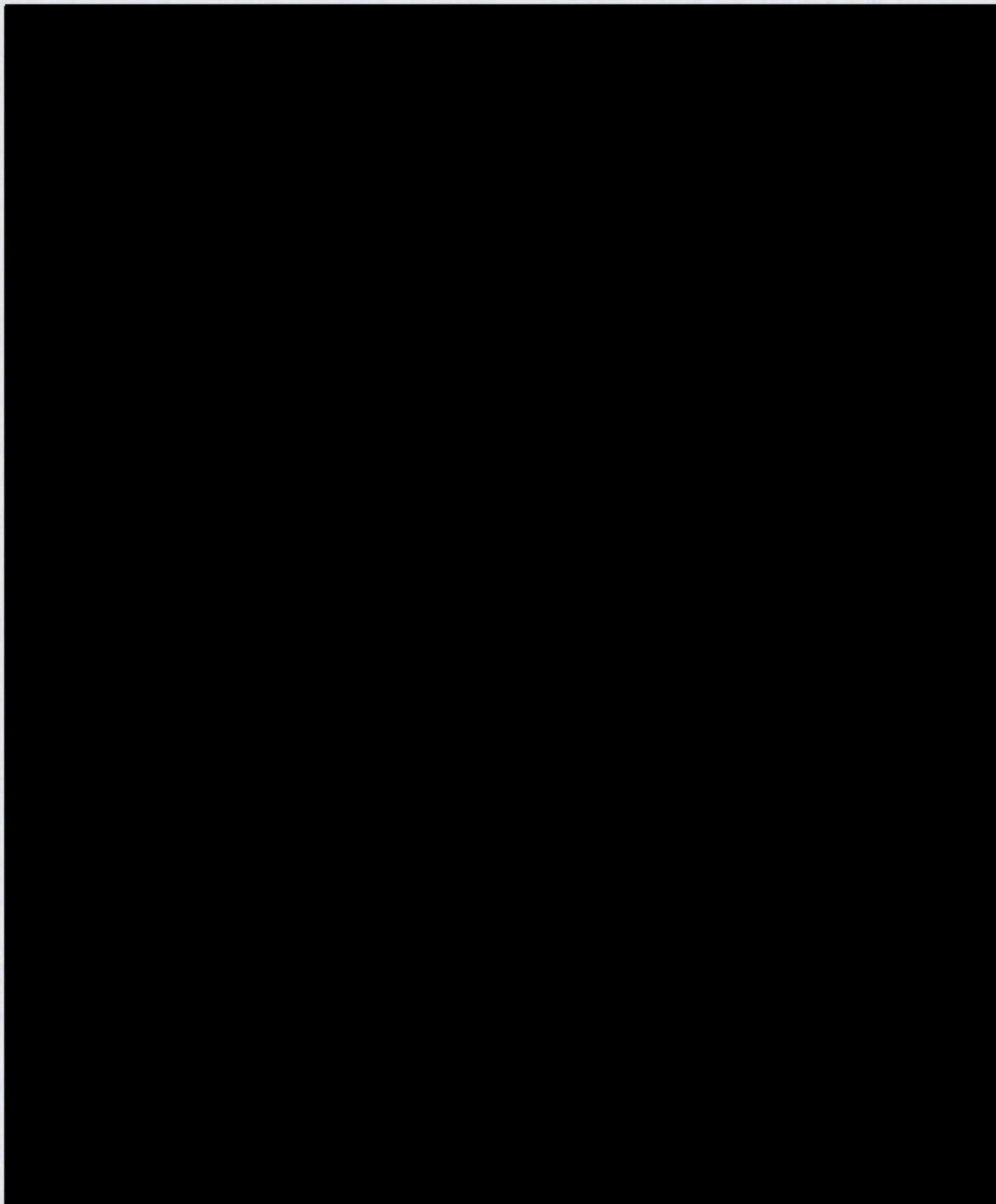
- *Space provides advantages to US economy and national security forces*
 - *Globally, quickly: See, Hear, Sense, Talk, Move, Shoot*
- *In the future we are envisioning*
 - *Space-to-space and space-to-earth weapons, and new hurt or kill technologies*
 - *Better, faster data fusion and distribution*
 - *More coincidence between many military, commercial, and civil systems*
 - *Integration of the vertical dimension from the surface, to circumterrestrial space, to the earth-moon libration points*



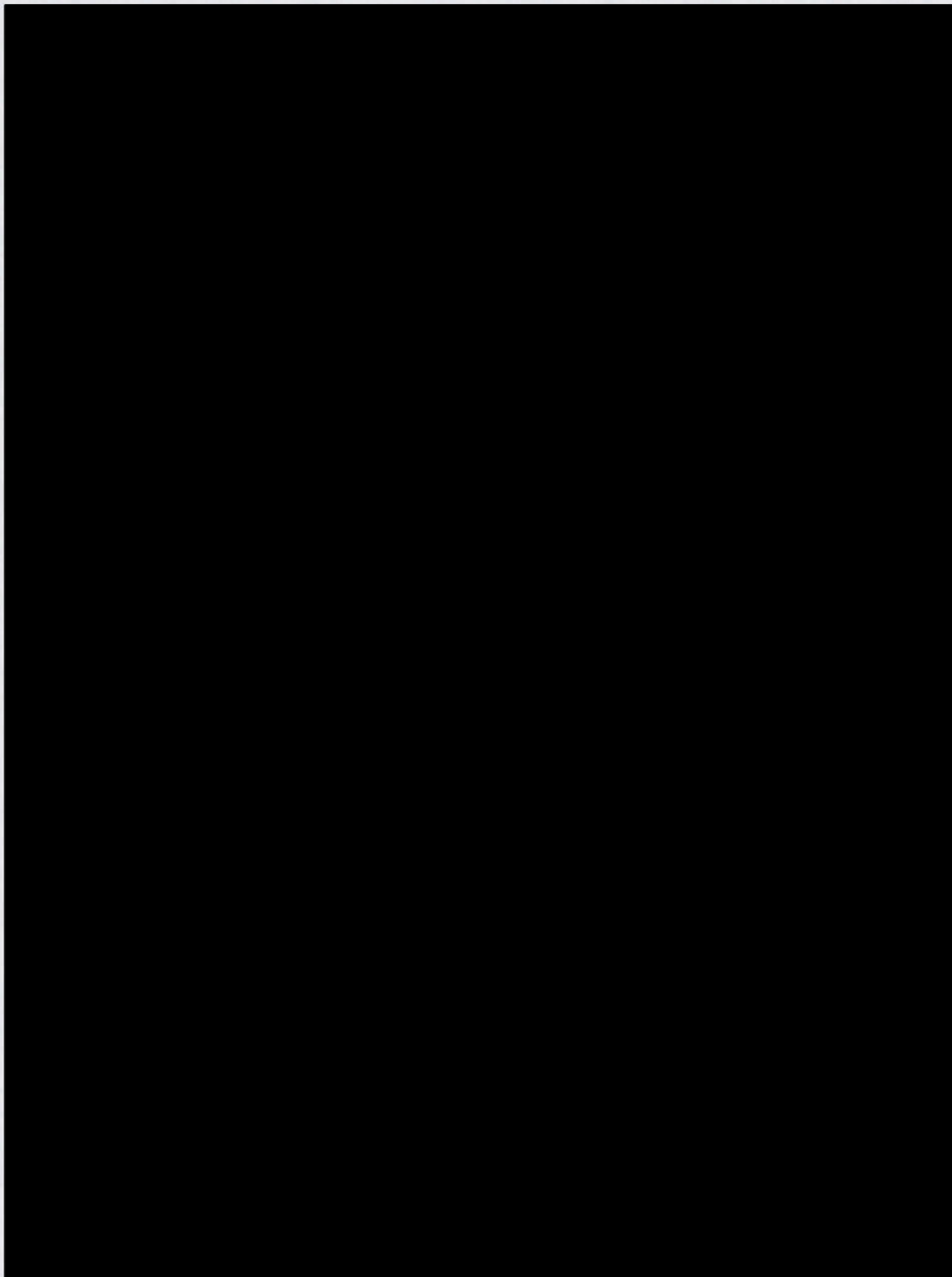
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Questions and Comments from the Executive Board

Assumptions Regarding the World of the Future

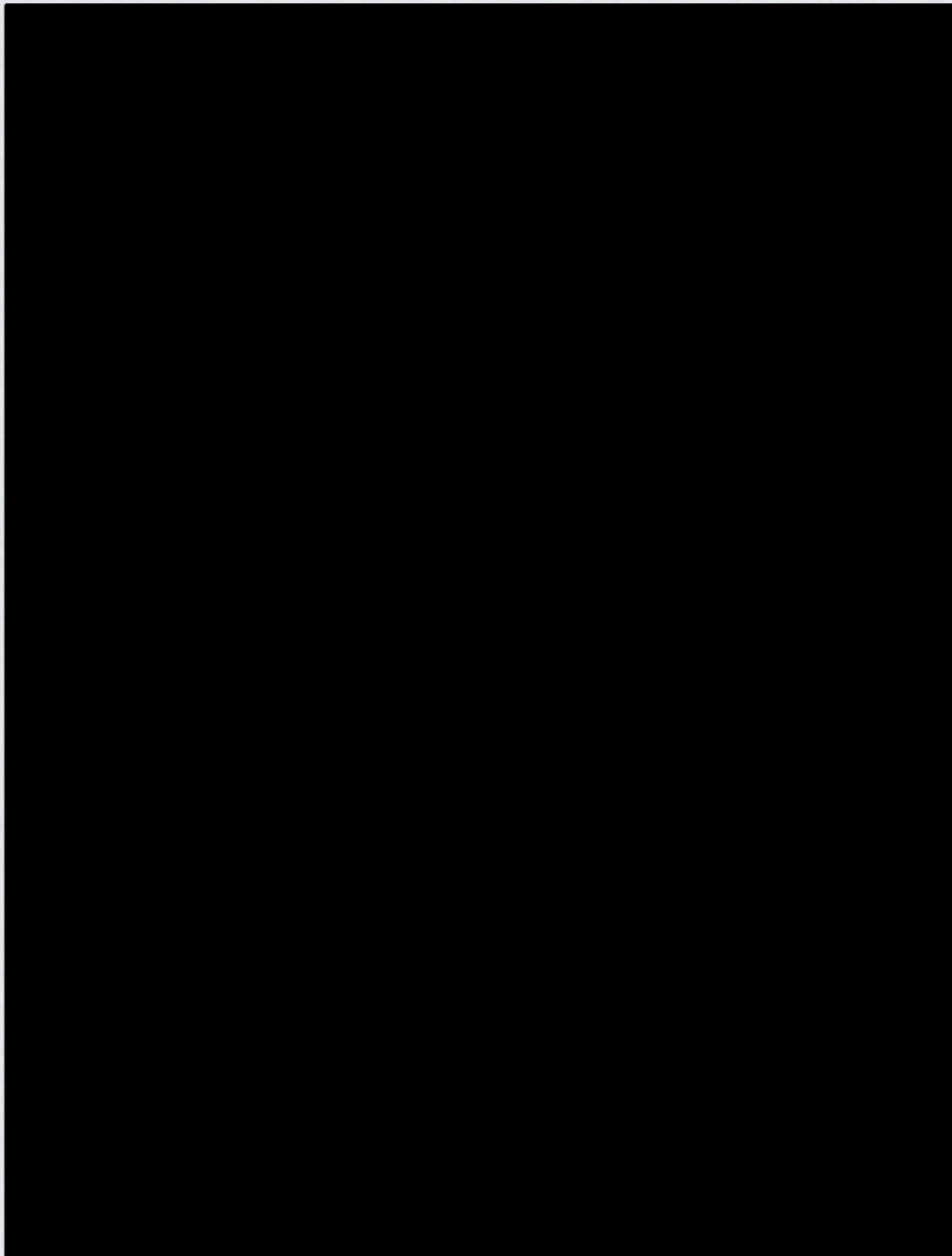


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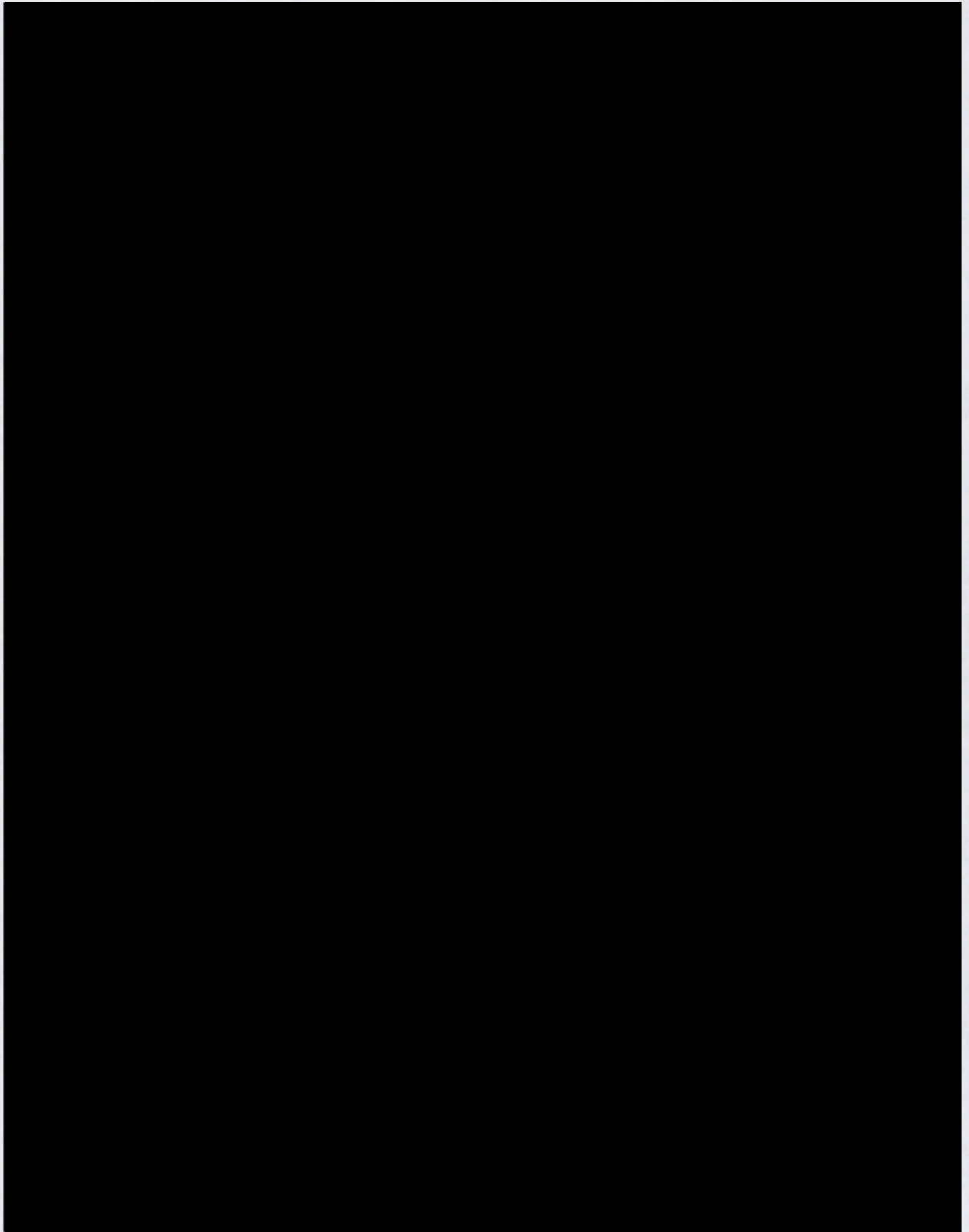
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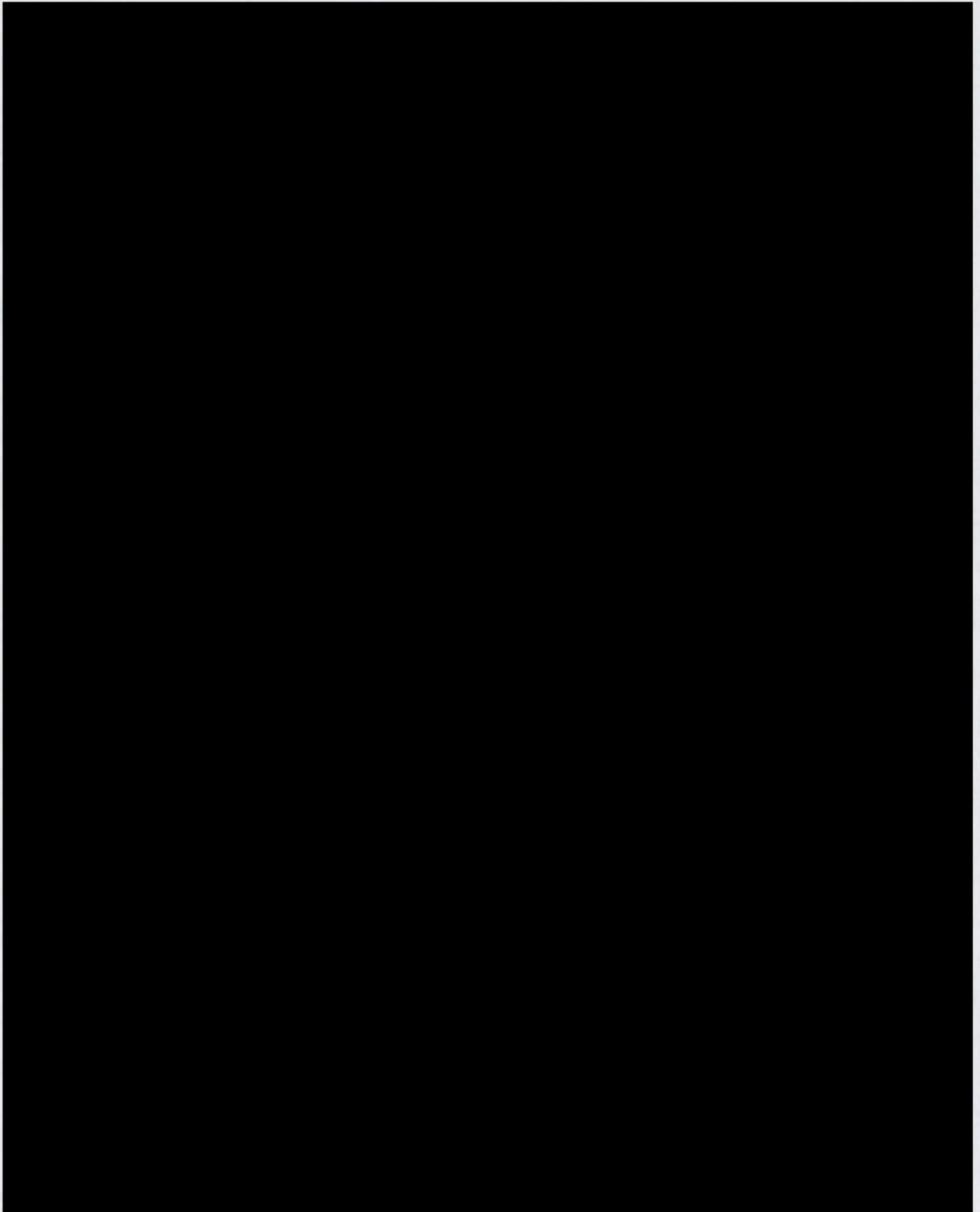
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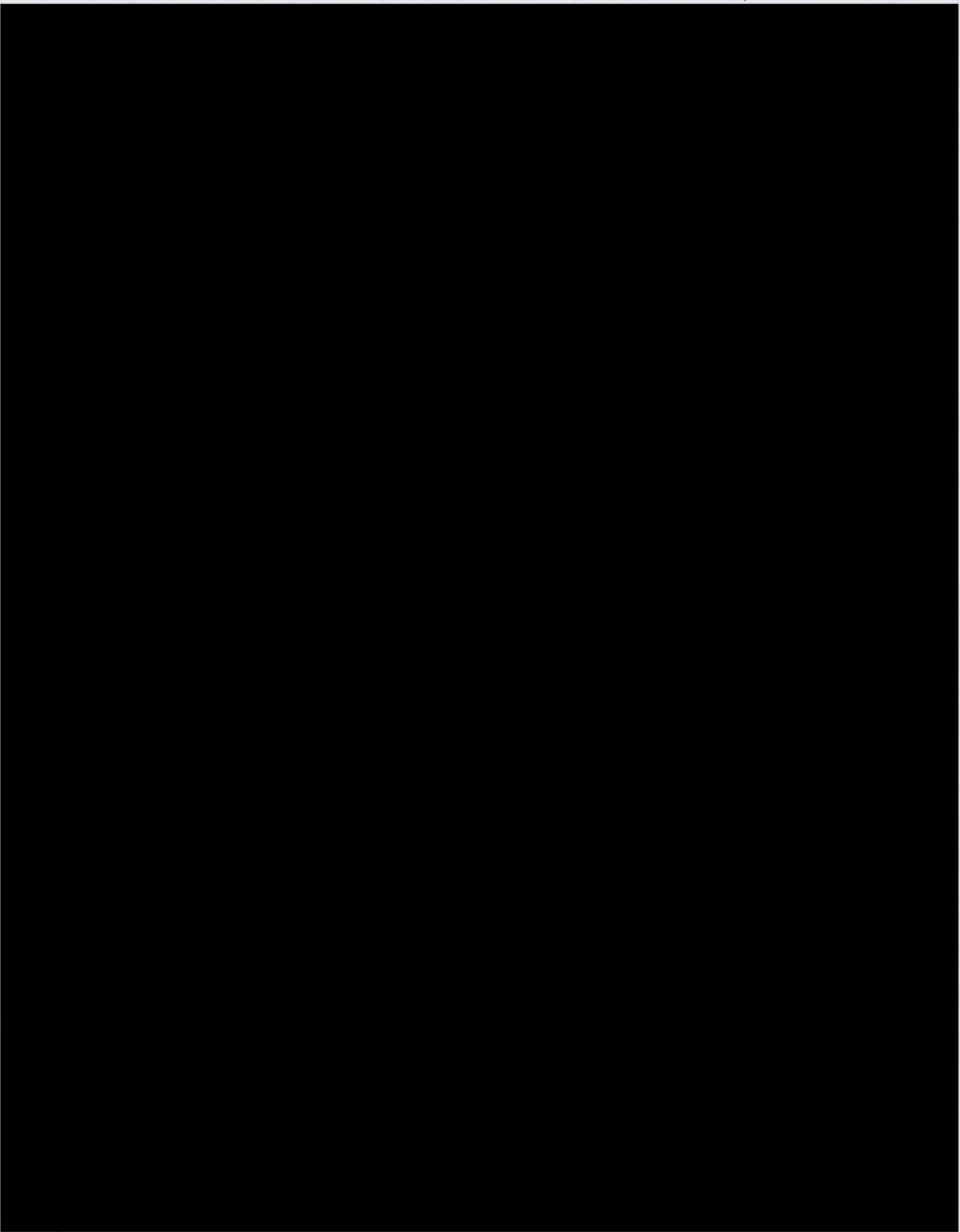
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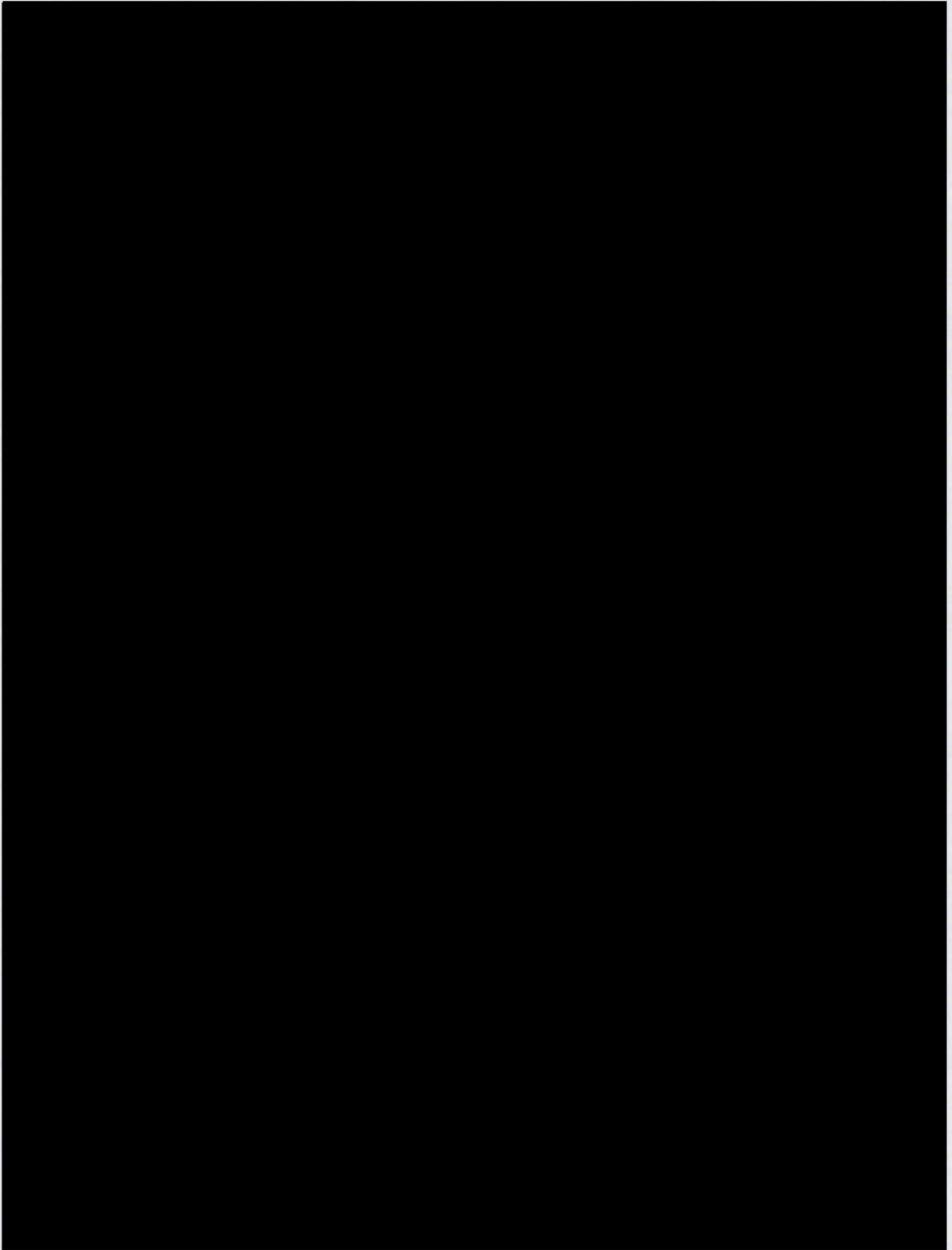
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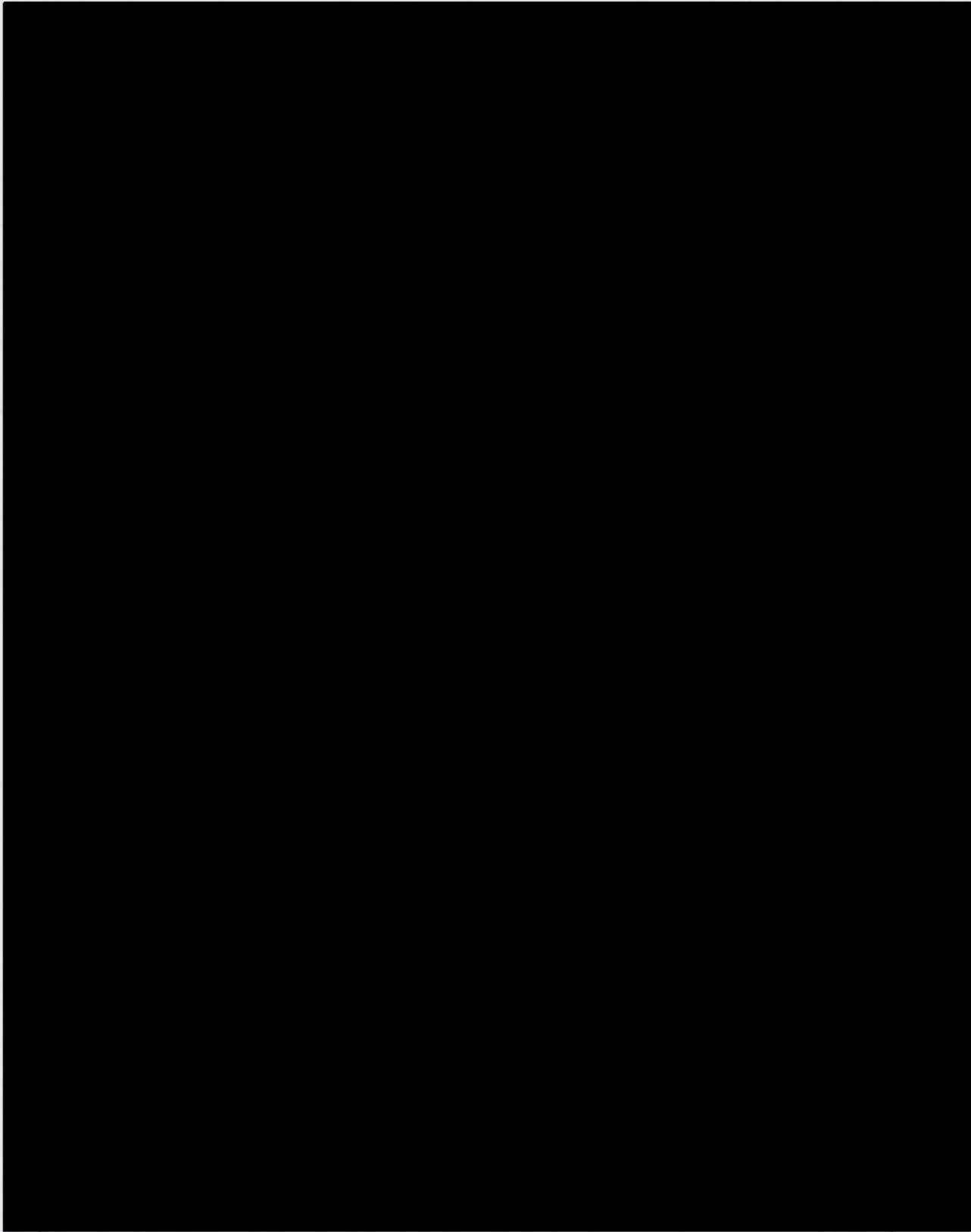
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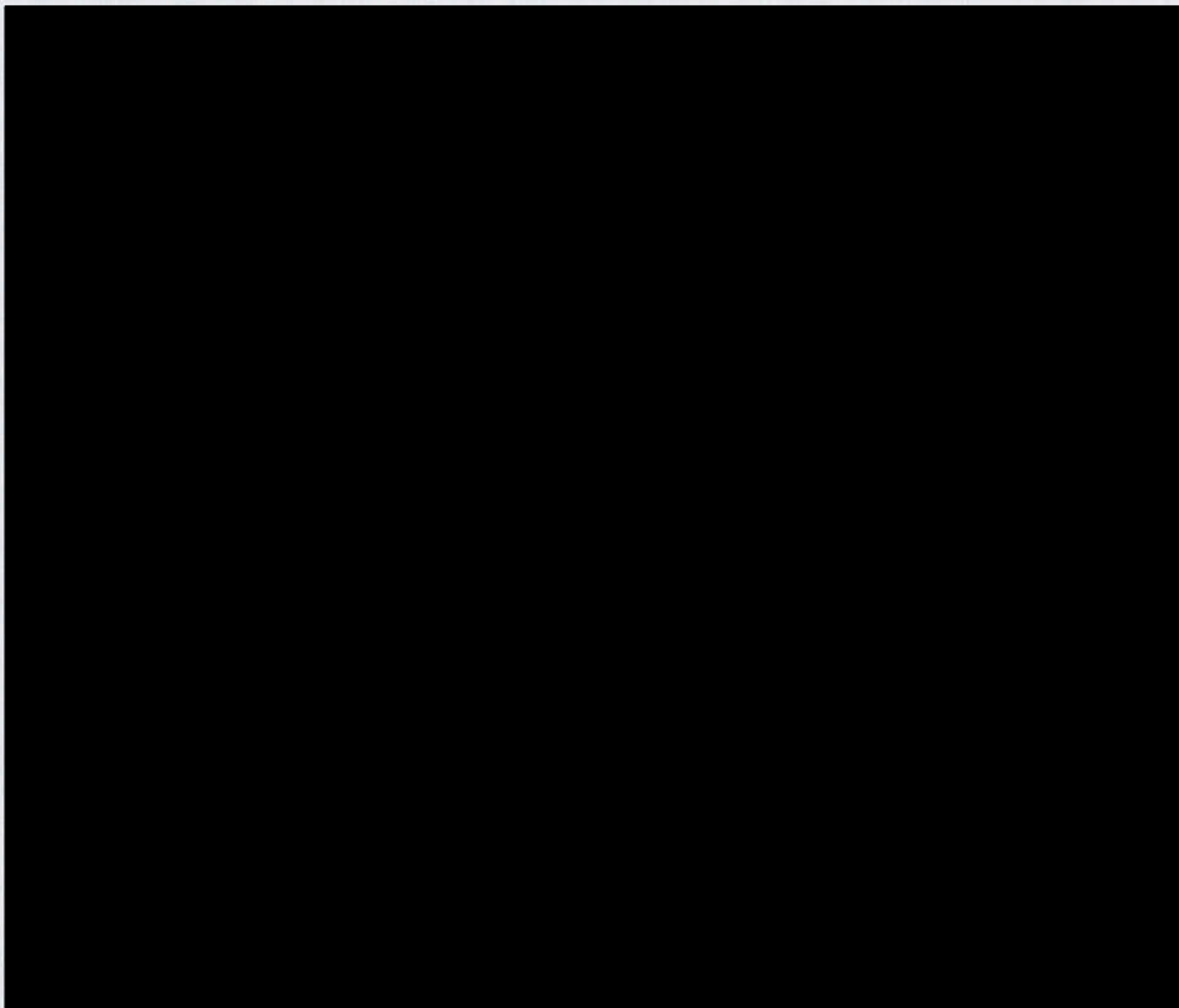
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THE U.S. AIR FORCE IN 2020*

Lowell Wood
Special Studies Program
University of California Lawrence Livermore National Laboratory
Livermore, CA 94550

Introduction. Every half-decade or so, some reckless Air Force officer invites me down here for a occasion of the same basic type as today's. Last time, the poor LtCol responsible for the scandalous provocation discretely fought his way to me immediately after my talk through a surrounding mob of red-faced generals, and quietly-but-urgently importuned me to never disclose his identity, lest his career be terminated untimely. (I've maintained my silence, and I'm pleased to note that he seems likely to become a general officer himself in the distinctly foreseeable future.) Why he was so concerned then, you are about to see – now; it's hard to teach a old dog new tricks.

I'm here in my now-standard role as a technological fortuneteller, to survey for you a few of the more technical aspects of the future a quarter-century hence of the Air Force. I'll riffle through some possible futures, and try to explain why none of them seems to be a sure thing. In the process, we'll consider several aspects of the Air Force's future in space.

I want to make clear at the outset that I speak as a long-term friend, admirer and servant of the Air Force. I was an Air Force ROTC cadet at 16, and was declared best-in-the-wing-of-2000-cadets for 2 of my 4 semesters of ROTC. I didn't go on to finish my officer training mainly because my kindly old Professor of Air Science, in an outburst of candor one day, confided that my contemplated Air Force career would likely culminate with my serving as a senior technical program manager in a big Air Force acquisition program. Dedicated young scientist-in-training as I was at the time, I was privately horrified at the prospect of ending up as a technical bureaucrat, and I thereupon dived headlong into a pure science career track. The gods laugh at the plans of mortals, though, and I stand before you today as a long-term technical bureaucrat; "man can cure disease, but not fate." In the intervening third-century, I've worked on many programs sponsored by or intended for the benefit of the Air Force. I've never tried very hard to conceal the remnants of my youthful prejudice that the Air Force is not only the Nation's technically preeminent Service but, in an ever-more-technological age, likely its preeminent Service, as well.

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However, when you're grinding away on your sixth decade of consciousness, it's very difficult to retain – or, for that matter, even recall – very much youthful naïveté or idealism. Moreover, our time together this morning is acutely limited, and serial circumlocutions can burn up time in fistfuls. I'll therefore speak very candidly, for brevity's sake at least. I don't mean to sound cynical.

I'll not apologize for starting off with ancient truths – they're still with us because they've conveyed useful information across a long interval.

Background. Plato's observation that "Only the dead have seen the end of war" is as true today as it was two-and-a-half millennia ago; "the end of history" is nowhere in sight.

The Half-Century War just concluded imposed a curious sort of discipline on much of the human race: large-scale armed conflicts broke out where and when it was convenient for one of the two opposing superpowers to comparatively delicately test the other's will and capability. What I insufficiently appreciated as I lived through much of this interval of human history was that wars of really substantial scale broke out only under these particular testing circumstances: even kids of mediocre intellect know better than to mess up when the adults are quarreling seriously.

I, along with Francis Fukiyama and many others, had come to think that humankind had somehow – rather inexplicably, really – matured drastically since the Second World War, and had more-or-less stopped playing nasty games in large groups with sharp-edged toys. The last three years have been very sobering: in the large, we presently look like the same old human race as populated – and sporadically de-populated – the planet during the first half of this remarkably bloody century. For instance, I saw a recent report to the effect that 1000 people are dying every day in an Angolan civil war of whose very existence we as a nation are largely unaware. (For baselining purposes, roughly 50 million people died in World War II, and somewhere around that same number have died in the aggregate of all large-scale conflicts since 1945 – at a time-averaged rate of ~2500 per day.)

Depressingly enough, the political inventions of the past half-century which were purported to suppress large-scale warfare have mostly been tried out under post-Cold War conditions – and found to be rather badly wanting. The United Nations is currently looking increasingly like the League of Nations warmed-over, NATO is looking like the Grand Alliance post-World War I, and the United States is diving into its customary inter-War "Fortress America" shell, characteristically throwing away its victorious arms as fast as it can lay hands on the straps-and-buckles. "Those who cannot learn from history will be condemned to re-live it," and Thucydides' eloquent recitation of how Athens won and lost its empire and then its freedom is once again hauntingly evocative of the circumstances and behaviors of contemporary Western democracies.

(At its root, the problem confronting peacefully inclined humans – the vast majority of humankind, I'm still convinced – is that they have only a single feasible response available to give to those who would appeal disputes to the mediation of armed conflict, namely to respond-in-kind. As large aggregates of individuals, we simply lack any response to those who say "Conform your behavior to my will or I'll violently damage you, yours and your property" other than the two classic ones: "We'll entertain you in battle" or "OK, we'll do things your way," with the latter strategy being subject to profound criticism by any competent sociobiologist – or cultural anthropologist. It strikes me as utterly remarkable that, given the race's huge strides in so many other areas, we still must resolve our most serious conflicts in such a primitive manner – but I simply don't understand what else to do when any party to a large-scale disagreement can throw down the High Trump of appeal-to-force-&-violence.)

Basic Determinants. It therefore seems quite clear that the United States will maintain armed forces as long as it continues to exist. Because mass destruction weaponry cannot be dis-invented – indeed, will inevitably proliferate, possibly even at the currently high rates – and because it is most effectively delivered by airborne and spaceborne means, an air-and-space defense will necessarily be a key component of such American armed forces. (The motivation for an offensive – or at least counter-defensive – air-and-space force is comparably compelling but a bit more complicated, as I'll mention shortly.) Given Adam Smith's observation that "There is a great deal of ruin in every great realm," and the undeniable greatness – and undeniable uniqueness – of the present-day American realm, we can conclude with high confidence that an American military service concerned with air-and-space control will be an enduring enterprise, even as far as a quarter-century hence. (If the U.S. Air Force seems absolutely doomed to survive-and-prosper, consider foretelling the future of the German Air Force in 1939 – or that of the Red Army in 1989.)

The issue of the existence of such a service being settled, the question which may then come to the mind of a career-focused young Air Force officer – and assuredly is on the mind of all of the more junior Air Force generals – is whether the Air Force will be this military air-and-space service and, if so, will it retain its current status as the preeminent Service, in overall budget, in R&D budget, in its ownership of a disproportionate share of America's future-in-arms. Crassly phrased, what are the Air Force's prospects for staying in existence and furthermore remaining one of the single largest enterprises in human history, a "business" rivaled in economic terms by less than 10 of the richest nations on Earth?

I suggest that the next quarter-century will, to paraphrase Lincoln, "test the proposition that any organization, so conceived and so dedicated, can long endure." An interval of a quarter-century, I submit to you, is easily ample, in our present-day, very rapidly evolving civilization, for even a great institution to wither, if not blow away entirely. Regard IBM. Consider General Motors. Schumpeter's "winds of creative destruction" blow at higher speed today than ever before – and they are still gathering strength. Having been frozen in the

amber of the Cold War for nearly a half-century since the advent of nuclear weaponry, the Strategic Bombing Survey and related current events called it into existence, can the Air Force as we have known it "long endure" the apparent outbreak of Warm Peace?

The gratitude of the American people – and of their political leaders – for what the Air Force did in Operation *Desert Storm* assuredly will not endure for any large fraction of a quarter-century. Revisionist historians are already claiming that the Air Force's blows against Iraqi forces were not telling ones, while more serious strategists will continue to observe that few future adversaries will be so foolish as to invite and tolerate a half-year of heaping firewood against their front door before a match is set to it. Even the man-on-the-street realizes that hauling TNT by nonstop airplane from North Dakota 8000 miles to the Persian Gulf for carpet-bombing purposes is much more of a testimonial to the great stamina and devotion-to-duty of air crews than it is to the basic sensibility of a modern battle staff. We all loved to watch the laser-guided bombs flying down the ventilation shafts of Iraqi air defense centers, but we are far less thrilled to recall that 5000 *ad hoc* sorties didn't definitively nail a single Scud TEL.

It thus goes without saying that the history-shaping success of the Strategic Air Command in holding the Soviet bear at bay until it collapsed of internal parasites and genetic defects is by now a classic instance of "Fine, but what have you done for me recently?" as far as the American citizenry is concerned. (The behavior of the Tactical Air Command and the various American components of NORAD in abandoning the defense of the American heartland in the face of all foes including the Medellin Air Force has been largely unknown to – and thus tacitly forgiven by – the electorate, a splendid example of a triumph of PR over harsh reality which political scientists continue to document and marvel over professionally. At that, historians will likely conclude that the Air Force got away with this fundamental and prolonged dereliction-of-duty only because Americans have never been bombed, and thus have little appreciation for this aspect of their physical safety.)

To be blunt, the size-and-shape of the Air Force of 2020 will be determined primarily by American political leaders' perceptions at that time of what it will do for them in the following decade and what it has done for them in the previous decade-or-less. What the Air Force does or doesn't do during the next dozen years – all of its current force-in-being and everything that it does initially with all the stuff now creeping along anywhere in the R&D pipeline – likely won't matter much at all in 2020. (If you want to live off gratitude for military services splendidly performed in the distant past, don't sign up to officer for a democratic government – anywhere, any time; they just ain't that kind of animal. Try a banana republic – I understand that Ecuador still has an established-and-uniformed navy, although it lost its only port somewhat over a century ago.)

Opportunities, Imperatives And Their Origins. What will the politicians of 2020 value? What will the people then be proud of? What will the National interest genuinely require in that era? To have any real chance of accurately soothsaying in these matters, it is necessary to take an entirely dispassionate, cold-bloodedly

realistic look at these issues – and then be prepared to frequently revisit and, as appropriate, drastically revise one's interim answers. As I've already hinted, such fairly high-precision fortune-telling is absolutely necessary, if the Air Force is to truly survive and, moreover, actually thrive through the coming quarter-century. Unlike the case with the Army, Navy and Marines, the Nation's need and use for the Air Force simply isn't yet adequately tested by either time or circumstance – the half-century of its existence when normal geopolitics and ordinary world affairs were in the deep-freeze of the Cold War is much too brief a span to support long-range prognostication in the contemporary world.

America a quarter-century hence assuredly will be an older, correspondingly more risk-adverse nation. The external, highly multipolar, relatively rich and lively world then likely will pose less apocalyptic threats than the (rather successfully mass-denied) 10,000 megatons stockpiled for wartime delivery by the Soviet Union. However, it will likely offer a much wider and more credible variety of "little nasty" problems, like a load of Nazi-era neurotoxins in the one-way robot airplane "coming soon to a theater near you" (in the context of the remark of General Charles Horner, currently USCINCSpace, that "CONUS is just the theater we live in.") The American electorate, then filled-to-overflowing with crotchety old codgers like myself, will be demanding that a fraction of the residuum of its tax dollars not expended on Social Security be spent to avert the full spectrum of perceived external threats – some of which may be real ones.

It is difficult to say confidently from the present, very distant vantage whether it will then be fashionable to preempt external threats, whether it will be feasible to deter them or whether emphasis must be placed on defending against them. (I remind you that we could neither preempt Saddam Hussein's Scuds, nor could we deter him from using them, nor could we really defend against them. Had they thrown mass destruction weaponry of any kind, e.g., at Israeli cities, the Middle East today would likely be a very different place than we now see it. I also remind you that the chief UN inspector in post-war Iraq stated that Hussein was 18-30 months away from having Scud-deliverable nuclear weapons when Operation *Desert Storm* commenced. We have entered the era when neither preemption nor deterrence nor defense may suffice – consider Kim Il-Sung's North Korea, if you're convinced that neither Saddam Hussein nor Moamar Gaddafi nor Hafez Assad nor Ali Akbar Rafsanjani nor the ayatollah-in-waiting in Algeria will rise again.)

A crucial point is that the feasibility of each of these American threat responses a quarter-century hence may well depend on presently only dimly foreseeable technical advances, and on comparably unclear societal trends. (If the Air Force isn't a credible source of either effective preemption, or plausible deterrence or workable defenses against the full spectrum of such threats-from-afar, I'll not bet a great deal on its survival as the United States' air-and-space defense force – the American people are more likely to give their large-scale security business to one or more Services which seem capable of really engaging these challenges. My current most-likely candidate would be a Service with a well-established core business that had greatly expanded its concept of naval aviation, starting, for instance, by leveraging its ~5000 missile-launching tubes for theater ballistic

missile defense, then growing into broadly capable theater air defense and deep-strike roles, meanwhile expanding its space-asset-deployment capabilities to support enhanced ocean surveillance and control which unavoidably would give comparable capability over all land masses, etc.)

However, some technological and societal trends are so deep and broad that they can already be extrapolated over the coming quarter-century. I'll note just a few of the more salient of these trends, taking the societal ones first.

Americans rather uniformly love the paradigm of the swift-and-definitive shootout at high noon at OK Corral, and are deeply convinced that only the Bad Guys should ever really bleed. They thoroughly liked the way Panama, Grenada and *Desert Storm* worked; they didn't care at all for the way Korea and Viet Nam didn't work, and they threw out 3 separate governments whom they held responsible for these debacles. Services that support the desired types of international conflict resolution and that avoid the undesired types will win the favor of politicians and the plaudits of the citizenry; Services which do not will assuredly wither.

There are several obvious, utterly fundamental lessons to be drawn here: perform your military mission effectively and quickly, without sending your people where they can be killed, wounded or captured. While you're at it, don't kill enemy civilians in any significant quantities – recall the Baghdad Bunker bombing – and kill enemy combatants only very sparingly – remember the Highway of Death and the war that ended one fateful day too soon. (If you can't hack these specs, hope that your alumni association and the inertia of the political system will keep your Service alive until you retire, and then stand 'way clear.)

The Air Force has been sneered at by some in its sister Services for being manpower-light, officer-heavy and fond of sleeping in its own beds at its own bases every night, but I tell you that this is indeed the wave of the future for all Services that really have a future. Americans now demand that their wars be fought bloodlessly and won from afar – and they want all of this done breathtakingly quickly. Thus, the future sure looks like it's the Air Force's to lose, as far as underlying societal trends are concerned.

With respect to basic, long-term technological trends, given likely expenditures on military technologies and the hideous inefficiencies of military RDT&E in peacetime, that Service which most effectively bends to its military purposes the basic lines of rapid technological advance in the civilian sector during the next quarter-century is the one which will win. The basic numbers here are compelling: the Air Force presently spends a bit over 10% of the total National R&D budget, with an average efficiency which I'll generously estimate at half of that of the American industrial sector; both the fraction and the efficiency will surely decrease, as far as the eye can reliably see. Thus, if the Air Force could aptly identify 10% of total National R&D which it can leverage with 50% efficiency over the next quarter-century, it might be able to at least double the total time-averaged return on its R&D expenditures.

What might this 10% be, and how might it be aptly leveraged? The most apt civilian sectors for such purposes are just those which are already good-sized and presently accelerating most rapidly, namely sensors, computer systems, and communications. Information processing technologies and the associated businesses in the U.S. alone presently constitute nearly twice the resource scale as does the entire Air Force, and are characterized by long-term double-digit annual percentage growth rates. World-wide telecommunications businesses presently represents a resource stream ten times the size of the Air Force's current one, and the aggregate of these is estimated to grow by four-fold during the next decade. Not only Americans but First World politics world-wide are already demanding more personal computing and communications support that would have been considered conceivable just a decade ago.

This set of accelerating trends extends into the foreseeable future, as I'm sure other speakers in this series have assured you. Following immediately on the heels of these two enormous market demands is one for high-bandwidth, low-latency, very inexpensive world-wide video-equivalent imagery generation and transmission. Already, kilobuck-scale add-ons to personal computers will generate and transmit semi-acceptable video over phone line-attached modems, in response to the leading-edge of the demand for in-your-face-from-my-face communications; too much of person-to-person communications is visual, not verbal, for people to be satisfied with old-style telephones very much longer.

Now sensors, computers, and communications jointly comprise the essence of targeting. For sensor-deploying platforms, there is currently an abundance of riches, with more coming along all the time. Truly modern small robotic vehicles, whether operating in the air or in space, are strongly performance-potentiased in the present era by cheap-and-plentiful GPS-based navigational aids and small-antenna-aperture-based, commercial comsat-supported anywhere-to-anywhere communications. The gains currently being made in on-site mission-relevant endurance are indeed striking; for instance, it presently seems feasible to have a single platform continuously surveilling a 100,000 km² theater-of-operations anywhere in the world for the entire duration of such operations - returning sub-meter resolution imagery in many widely-spaced wavebands of whatever portions of the theater are of current interest to its ground commander - and simultaneously to the Joint Staff.

The ability to image, process, communicate, store, retrieve, further process, etc. with, say, tenth-meter resolution confers a potential ability to attack targets at sub-meter accuracy. Even if some types of targets are moving at characteristic military speeds, sufficiently fresh imagery and adequately tight control loops can aptly support such high-precision attacks. (More than a decade has passed since a civilian satellite first spotted, identified and body-tracked a military aircraft operating in normal circumstances.) The two crucial advantages of very high precision attacks are that they can be conducted with very small, light-weight means and that they can be expected to induce only very slight collateral damage. It thus seems feasible, from the present time forward, to effectively attack much of the machinery of modern warfare, perhaps without inflicting significant damage on its operators or on nearly non-combatants.

Of only slightly smaller significance is the related prospect of delivering large quantities of such compact, ultra-precision munitions over great distances with only small delays, so that tellingly large-scale counter-attacks can be mounted from afar on very short notice. This is of great, if little-recognized significance, for the Air Force will be required in the future to block large-scale attacks launched in inconvenient locations with advance notice measured in hours, not weeks or months – unless it wants to concede the Defense Secretary's No. 1 business to some other Service. If it doesn't use quite small objects to negate the multitude of presented targets, necessarily with great precision, it will manifestly run out of short-notice hauling capacity – it simply couldn't buy enough 500-pound bomb-hauling capacity, even if its FY'86 budget were magically restored to it in perpetuity. No American politician will soon forget the lessons in this respect which were taught in January-February 1991 in the Kuwaiti Theater of Operations.

The Space Force. The Air Force, over the past 3 decades, has built up a very profitable little business, deploying sensors in support of national imaging interests, mostly in space. I say profitable, because the national resources made available to buy the rather modest quantity of product have been of impressive magnitude – HASC Chairman Les Aspin last year remarked they have amounted to \$6 B per year – and the appreciation of the product by the national leadership has been large and unflagging, even though the basic product has improved rather slowly in recent times. (Merchants pray for such *de facto* monopoly markets and such unfailingly loyal customer communities.)

Only recently has the present-day foolishness become manifest to Air Force leaders of cloistering these capabilities so intensively – they have been noticed to be at once potentially useful to, but effectively unusable by, the warfighting Air Force. Indeed, the Air Force currently seems to be debating internally whether it will be easier to build-and-buy an entirely new set of space-based sensing capabilities – perhaps implemented with modern (i.e., commercial!) technologies – or to struggle to declassify the existing capabilities down to such pedestrian levels that they might actually be used to support tactical operations. (To some of our less fortunate military colleagues elsewhere in the world, living in tents or still-closed cities and wondering if the next month's payroll will even arrive, it must appear as though the American jackass is characteristically fasting, indecisively, between the proverbial two bales of hay.)

I make these remarks, not to be contentious, but to highlight-with-brevity the basic point that the Air Force has developed its strategic targeting/imagery capability to the virtual exclusion of its tactical analog. Air Force imaging and target-sensing systems can look anywhere in the world, moreover at impressive best-circumstances resolution and entirely acceptable latencies on most strategic time-scales. However, they have been demonstrated to be able to support run-of-the-mill *Desert Storm*-type warfighting only marginally. In addition to having only a quite modest real-time capability, they have rather sobering coverage, revisit and viewing condition limitations – as well as virtually no links to tactical target-engagement machinery, such as usefully capable comm lines to cockpits and

command-posts. (Recent concept-level feasibility demonstrations utilizing these assets merely recall to mind Sam Johnson's comment on women preachers-on-the-streetcorner.)

Given this profound deficiency in world-wide imagery support for tactical airborne operations of any significant scale, it is quite understandable that the corresponding weaponry is also nearly completely lacking. Nevertheless, as it approaches the half-century mark in its institutional age – at the close of the century of most rapid technological advance in human history – the Air Force has no better way of enforcing the national will in the air and space environments than having a man drive an airplane up to a target, kick it somehow, drive his airplane home – and then iterate this process without variation. This capability is neither an "aerospace team" nor is it a genuine air force – in simple honesty, it must be labeled an "airplane force."

Several explanations may be offered for this fundamental failure-to-advance beyond World War I tactical concepts. First, it may be that this is the best that can possibly be done, at least through the present time. Second, it may be that it isn't the best, but it's good enough. Third, it may be that it was the best – or at least good enough – the last time the system was really put to the test, and that missed opportunities for basic advances since that time simply haven't been surfaced yet by harsh military reality. I suspect that the truth is close to this last possibility. (Many other distinct possibilities doubtless exist.)

Even more notable than the *de facto* inability of Air Force assets-in-space to support tactical operations near the Earth's surface is the Air Force's essentially perfect impotence with respect to tactical operations in space. The man-in-the-street can surely be forgiven for asking "If the Air Force's space assets can't perform tactical military operations in space, why do they call it an "aerospace force?" Now the Air Force response to this has been along the lines of "If we deploy actual real honest-to-goodness usable weaponry in space, we'll encourage others to do so as well. Since we have more space assets at risk than other folks, encouraging other folks by our example to gain an ability to threaten our space assets would be a strategic mistake."

Now of course this is logic of a quality that a bright kid in grammar school would hoot at – it would have precluded American development of either intercontinental bombers or air-to-air missiles in the '50s, for instance. Nonetheless, it's been the Air Force's *de facto* position through the present time, and it's come to threaten the Air Force's competitive position – intranationally as well as internationally.

The Navy is presently moving into space, slowly but across a broad front, in support of fundamental Navy missions that have been given short-shrift by the Air Force, and I warn you most seriously that the Army will not stumble-and-fumble forever in its space activities.

The ludicrous Army performance of the past several years on the anti-satellite front is the non-serious Army at its worst, not the serious Army at its best. Just as soon as the lesson really sinks in from *Desert Storm* regarding the extreme peril to the

war-winning "left hook" posed by anybody's "for rent, lease or sale" space reconnaissance assets, the Army will act. The Air Force then will find itself owning eyes-in-space, while the Army owns a complete, end-to-end warfighting capability on the High Frontier - a term popularized by an Army general, I remind you. (The diaphanous arguments to the contrary of the arms control crowd will melt like an ice cube on a summer sidewalk in the face of Army generals bellowing about the clear-and-present danger to America's brave young men- and women-in-uniform in the forward areas of the world. Recall how eager politicians were to step forward and acknowledge their part in denying requested armor to the Rangers in Mogadishu - the memory of this will be a long time dying in Washington.)

The bottom line here is that the Air Force is currently burning up the tag-end of its grace period in deciding whether or not it will provide the nation's armed force in space. America's technologists have long offered it methods in abundance, and present-day geopolitical imperatives constitute close-to-the- strongest possible set of opportunities; history is now inquiring for the final time as to whether the Air Force has the motivation. (To be sure, I wonder whether the officers leading the Air Force's present space activities will stand idly by and watch the other Services move into and take over their turf, or whether they'll remember the amiable mutiny of the Army Air Corps right after World War II, and decide to constitute themselves as the U.S. Space Force - while they may. The Colorado Spring Air Force looks to me as though it has had about enough of being taunted that it's the only command in the American armed forces that "shoots only bits, and never bullets." I expect that the Air Force will either use this officer corps to constitute an armed force-in-space in this decade, or it will lose it.)

Soviet Perspectives. In any case, it may be instructive to consider what our former adversaries saw as the future of warfare, during the coming quarter-century. Chained to an innately inferior technology base and pressed down under a low economic roof by the fundamental flaws in their system, it has long seemed to me that our Soviet counterparts understood that they had to try harder, if they were to have a decent chance to match us, let alone beat us. In particular, it is my definite impression that they have long believed that they had to think more, think harder and to do both with a more quantitative and longer-range perspective, if they were to leverage their limited technological and economic capabilities into a semblance of parity with the only occasionally serious Americans, who play in their technological and fiscal cornucopias in such an undisciplined and often outright frivolous manner.

Even though the Soviet Union is now gone, these Soviet perspectives should not be forgotten. Those who articulated them were far from fools, and they will be with us for some long time yet. Others will think the same thoughts and come to the same realizations in time-to-come, and the resulting conclusions may see militarily tangible expressions in times and places that we ourselves must care about.

The thrust of this for the present-day Air Force is along the following lines:

- **World-wide, tactical-quality surveillance capability is a *sine qua non*, for spotting problems-in-progress, for targeting and for damage assessment.** Linear extensions of present-day strategic imaging systems won't even begin to get you there. Both air- and space-going platforms offer high leverage for various missions. Essential features of such capability are proliferation, very low unit cost, both active and passive modes, unmanned platforms, and full-and-timely leveraging of commercially originated technologies, particularly in sensors, digital systems and long-haul/high-bandwidth communications. Happily enough, these requirements are synergistic not competing. (The unmanned character of the platforms confers a wide variety of military utilities, but its crucial significance is that it removes the otherwise large element of doubt as to whether a democratic government will respond promptly – or even at all – to international aggression. If its citizens aren't thereby placed at physical risk, modern history teaches that most democratic governments react more predictably – and more swiftly – to military challenges.)

- **World-wide tactical strike capability with eight-hour-scale generation time and ten thousand equivalent-sorties-per-day intensity is required to project power on effective space, time and mass scales.** Much of modern civilization lives on the physical "skin" of countries, where it is subject to immediate trans-border predation by aggressive neighbor-countries. In addition to nearly totally lacking strategic depth, many countries are far less militarily capable than aggression-inclined neighbors. Thus, if the United States is to be an effective leader of any international peacekeeping community, it must be able to effectively rebuke Iraqi thrusts into Kuwait City, North Korean thrusts into Seoul, Syrian raids into Galilee, etc.

In a single day, an aggressor may be able to seize so much friendly human and capital stock that he cannot feasibly be counter-attacked in conquered territory. Thus, it's essential to block his thrusts before they can possibly penetrate even a few dozen kilometers into a lightly defended friendly country. Initial counter-strikes thus must commence in not much more than an hour from initial border violations, and tellingly extensive counter-blows must be imposed on his forces a few hours after the invasion commences.

(Such exceedingly swift and extensive counter-strikes will also very effectively attrite political will within the aggressor government at a time when history suggests that it may well be at low ebb, and anticipation of them may be rationally expected to deter the majority of large-scale international military aggressions from ever commencing. After all, just as horse races are run because of honest differences of opinion as to which is the fastest horse, armed conflicts break out because of honest differences of opinion as to which country or coalition possesses the greatest combination of military capability and political will. The daunting military superiority of the United States is universally acknowledged, while its

political will – and particularly the durability thereof – has become widely doubted over the past quarter-century. When an American President can act militarily by putting not American blood-and-treasure but only American treasure at risk, he will be counted upon by friend-and-foe alike to act more reliably and more swiftly in the international arena. Hostilities will then break out much less frequently.)

Unless it becomes feasible to reliably pre-position aggression-rebuking assets in appropriately large quantities within say, 1000 km, of every possible point-of-need, it will apparently be necessary to deliver more modest overall quantities from afar to whatever they're needed, by either very high-speed aircraft or by spacecraft. Since we've recently tossed our only really high-speed, long-range aircraft – of which we never had very many anyway – spacecraft-based delivery seems indicated. Interestingly enough, heavy ICBMs – presently in excess to their owners' needs – have a lot of 'round-the-world hauling capacity. For example, the Soviet ICBM force – still all there, and still ready-to-go – can throw something like 5,000 tons of munitions – hydrogen bombs, in the Bad Old Days – over a 10,000 kilometer distance, in about a half-hour. (Moreover, it can do so at very high rates, on extremely short notice!)

Now a high precision-delivery micromunition which can negate a tank or an artillery piece has a mass of the order of 1 kg; packaged up for intercontinental delivery-and-dispensing in the aggressor-invaded area, it might mass around 3 kg – say 5 kg on the average, to account for finite P_K and imperfectly efficient utilization. The throw-weight of the Soviet ICBM force thus is overall mass-equivalent to something of the order of a million tactical target-negations. (By way of comparison, Iraq's order-of-battle when it attacked Kuwait consisted of perhaps 25,000 interesting armor, artillery and close-air-support assets.) Since virtually all of this Soviet force-in-being is scheduled for scrapping during the next decade or less under the START I and II agreements, it doesn't seem unreasonable to inquire as to how some fraction of an existing asset of this scale might be utilized for international peacekeeping. (Indeed, I was approached informally recently by a long-time colleague who is presently a senior official in an ex-Soviet Republic, with a quite interesting proposal regarding the use of a large chunk of the SS-18 force for just such international aggression-suppressing applications. It's indeed a strange new world.)

This prospect is naturally accentuated by the more modest but still large MIRVed ICBM force which the U.S. will necessarily retire by the end of this decade.

A crucial technicomilitary point to recall in this context is that, in the Silicon Age, it always pays to chop your total ordnance load into as small pieces as will do the military job, if delivered exactly on-target – and then demand that the digital artists make sure all of these small pieces go to precisely where they'll be most militarily effective. This was the basic logic of MIRVing-to-a-fare-thee-well the warheads of ballistic missiles a quarter-century ago, and doing so bought the U.S. enormous politicomilitary advantage – for a while.

However, we completely neglected – on this front, at least – to recall that, for every military measure, a countermeasure eventually arises. Thus, when the Soviets

parried our MIRVing thrust simply with so much more of the same that the Air Force's MIRVed missiles became strategically ever more incredible – a titanic national effort on their part, the largest single-purpose marshaling of Soviet will and resources since the Second World War – the Air Force corporately still failed to do its basic counter-countermeasure homework.

Finally, the politicians had to step in – on the personal initiative of a Navy admiral, I remind you – and order the commencement of the obvious next step – SDI. Still oblivious to politicomilitary imperatives, the Air Force institutionally played a shamefully minor and highly equivocal role in SDI, and by now it has virtually lost the nation's security business in this area – the Army just got awarded the bulk of it, and the Navy bagged almost all of the rest.

However, this whole sad little story assuredly doesn't represent a failure of the fundamental logic of fractionating total deliverable ordnance payload and delivering the resulting pieces precisely and independently to as many targets as feasible. Rather it was an even more basic – and proportionately more disgraceful – lapse with respect to understanding and acting upon one of the most elementary lessons taught by the history of arms: there never has been and never will be an ultimate weapon, and every security measure of every type commences to age-and-die the day it is born.

The conclusion seems obvious that existing ground-based, space-traversing assets may currently be strongly leveraged by alternative integrations of present-day hardware into very low-latency, extremely high striking-power, effectively infinite staying-power means for rebuking trans-border military aggression anywhere in the world. This, of course, is but a single example of how the Air Force might aptly proceed to develop capabilities which the national leadership will highly value during the coming quarter-century.

Caveats. Along the way to realizing these capabilities and thereby securing its quarter-century future, several essential lessons from the successful portions of the American business world should be kept in mind:

– Never, ever traffic with monopoly suppliers. Monopolists, we all learned in Economics 1A, typically deliver sub-state-of-the-art products late and at very high prices; often, their products don't work very well or for very long. Monopoly suppliers simply lack any real incentives to excellence. (Free markets, we recall, don't really reward any but a comparatively few businessmen; however, they discipline all of them.) Whether we talk about the institutional Air Force buying weapons systems from a single commercial company or the warfighting Air Force acquiring weapons systems only via Systems Command, trafficking with monopolists is the mark of only the very rich or the rather stupid. An Air Force which is also a smart buyer – that is to say, a survival-oriented beast, in the near-term environment – will maintain at least two distinct, end-to-end tracks for every significant acquisition. It will thereupon find itself getting better products sooner and for less overall cost, in spite of the incremental overhead of dual-tracking.

The motif of "No single track-segments in acquisition, anywhere, ever" is the "straight-but-narrow way" – it alone leads to salvation in the current environment – but few Services there are that find it.

One obvious example of how to implement this is to immediately give the Air Force's warfighting commands at least 10% of the Air Force's total acquisition cash stream, primarily but not exclusively for exploiting CINC-perceived opportunities for high-leverage, short-term upgrading of his force-in-being. The present acquisition monopolists will scream, loudly and utterly predictably, about how their existing acquisition programs will all be ruined by such a brutal cut. However, in the budgetary environment of the '90s, this is manifestly incredible – they will merely be giving up a funding-stream fraction now that the politicians will be taking from them anyway, a couple of years hence. (More sophisticated wails about loss-of-uniformity, logistics snarls, etc. are even less worthy of serious concern – all competent military machines operate this way in wartime, as a matter-of-course, as any Israeli general will tell you.)

As soon as the warfighters are no longer the completely captive customer of the desk pilots, the acquisition process will drastically improve its level-of-service to them – and they'll also benefit from the locally-designed and -executed leveraging of force-in-being.

– Don't feed your problems or starve your opportunities. Where does the Air Force typically put its best, brightest, hardest-charging officers? Fixing problems with FEWS, the C-17, Titan IV and SpaceLifter, etc., of course. This is the straightforward and most effective way to minimize near-term pain, whether it comes from the field commands, the Congress, OSD, or wherever else. (2)

Who takes care of pushing really new opportunities? Why, whomever can be spared from the more time-urgent activities, of course.

Why do students of how big businesses age and die fear for the Air Force's long-term future? Need you ask?

– Refrain from cost-based pricing; price-based costing is the only way to stay ahead of the competition. The Devil takes the hindmost. Brilliant Pebbles didn't come into existence for any of the oft-imagined reasons offered in the press, but rather was born out of utter necessity. The political leadership of the strategic defense thrust called a few of us in one day in 1986 – when the organizational SDI was not yet 2 1/2 years old – and stated simply that the present approaches just wouldn't do the job, and that basically new thrusts were urgently required. At the time, the space-based layer of the emerging architecture had an estimated cost of \$69 B, offered marginal defensive performance, and depended for its functionality on space assets which the SDIO Director, an Air Force general, subsequently described publicly as "a few soft, juicy targets."

Brilliant Pebbles, offered up just a year later, was, from the very beginning, a design-to-price endeavor. As Brilliant Pebbles was undergoing the "wire-brush scrub" specifically mandated by NSDD 14 three years later, the senior government

engineer most responsible for the space-based interceptor approach superseded by Brilliant Pebbles commented privately to me, "It's really not that you guys are so clever or are using such advanced technologies. You just went about the whole thing very differently. We did our system design the standard Air Force way, using the existing technologies put together in the obvious ways to get the obvious architecture, and then added up all the costs. You guys started with a target cost for the capability you decided you had to have and then rigorously fitted the architecture and then the technologies into the dollar envelope you gave yourselves, allowing no exceptions. It's really not at all astonishing that you came in a factor-of-four cheaper; indeed, I'm a little surprised that your price is still so high."

In confronting just about any complex technological challenge, there's many ways to skin the assigned cat. Some are a whole lot cheaper than others, some perform a whole lot better than most, some can be realized much more quickly than most others, etc. The basic point is that there's a very rich spectrum of technical choices from which to select and even to mix-and-match. Unless you have really specific, well-understood selection criteria, figures-of-merit, or whatever, to guide you, you're actually quite likely to make retrospectively fairly bizarre choices – e.g., ones of abysmally low cost-efficiency.

Cost growth in a program is akin to weight growth on a spacecraft – it's seldom utter necessity which is speaking, but rather laziness with respect to examining real alternatives, simple professional indiscipline – or worse. (When a lead professional comes in to tell me that he can't meet his agreed-upon mass, dollar, power.... budget or his program schedule, my first inquiry is usually as to the identity of the individual he considers to be his most apt successor. As Mark Twain remarked, imminently scheduled execution tends to wonderfully concentrate the mind.)

In an era of continually declining budgets and rapidly shifting politicomilitary requirements levied on the Services, designing new weapons systems to price and to date-of-IOC isn't a luxury, but rather is a necessity. Most crucially of all, the price design-point which is chosen must be manifestly affordable-to-the-Nation, and cannot be compromised along the way; hope-a-little on true affordability or bulge-a-little on program budget are each recipes-for-ruin, not so much in themselves as because they initiate disastrous practices-become-habits. If the Air Force recognizes this set of truths significantly later than does the first Service to do so, it assuredly will bleed resources – and may never recover them.

– **Establish and maintain accountability at all levels.** I am constantly impressed at the fact that the Air Force's weapons acquisition system works at all, considering that it's essentially impossible to tell who was responsible for what aspects of success or failure in almost every oh-so-prolonged development. It's either an enormous tribute to the competence and professionalism of the Air Force's program manager-officer community collectively, or else some theorem of which I'm ignorant to the effect that when you spend \$20 B annually for decade-after-decade, something's bound to emerge eventually.

However, I don't know of any business in the real world that's able to detach outcomes so completely as does the Air Force from the rewards and punishments

given to those responsible for the outcomes. Given that the typical acquisition program stretches over between one and two decades, the typical O-5s or O-6s who actually run all of it or each of its major components for most of its history are either retired or promoted into some far corner of the Air Force universe, long before the program either crashes or has its outputs deployed. If they're promoted, it's because of a set of glowing annual testimonials to their thinly specified and unquantitated contributions to the asserted progress of the program, never because they took it from start to finish, on-schedule, on-budget and on-performance spec. It's ancient wisdom that "only fools and children judge by work half-done," but this is seemingly almost the only basis on which the Air Force promotes its weapons acquisition officers.

A most obvious, time-proven remedy for this intrinsically unsatisfactory state-of-affairs is to conform acquisition cycle-lengths to typical middle-level officer times-in-grade, and to promote officers only for unquestionable end-to-end success in acquisition program management; the most successful American companies do just this, virtually without exception. The other benefit of enormous importance would be more timely availability of modern technology to the Air Force warfighting community – assuming that you care nothing about the implicit drastic reduction in program cost and that you also have completely forgotten how the Services do acquisition in wartime. It is clearly feasible to conduct more incremental and more frequent weapons acquisitions, even in peacetime – half-decade-long acquisition cycles were the motif of the Soviet armed forces, a practice which many believe was the primary means by which they compensated effectively for their grossly inferior technology and economic bases.

Summary. The basic thoughts that I would leave with you today are these:

- The future of the Air Force is not assured on time-scales of a quarter-century. The Air Force has never existed in a non-Cold War world. Thus, it manifestly doesn't know how to do so, and it's not altogether clear that it can learn, well enough and fast enough to survive-and-thrive. Even without strenuous efforts or inspired leadership, the far more senior Services may respond more effectively to geopolitical imperatives and domestic political demands, and thus win the competition for a dwindling pool of defense resources. The future now is far more uncertain than it was a half-decade ago, and it's unfolding far more rapidly than it was a decade ago.

How might the Air Force wither and die? (Let me count the ways.....) To those who savor scenarios, I offer the following possibly illustrative one:

"Technological advance persuaded the Army that it made a major blunder in ever letting the Air Force get control of the land-based missile force, which, after all, is just very long-range artillery. At the same moment in history, the Air Force took the strategic institutional decision to bail out of all flavors of ICBMs in favor of pure airplane-based deterrence ("Manly men don't live their professional existences in prairie dog-holes, never seeing the sky").

"Investing unusually effectively in the rapidly emerging intercontinental cannon technology, the Army convinced national leaders that it could perform the strategic deterrent mission both swiftly and cheaply – aided notably by the stunning effectiveness of the Arizona-based prototype cannon in repelling the Iranian raid on the United Arab Emirates. As a side-effect, the Air Force's new manned bomber was deferred to generate the required resources to create a set of fully operational cannons.

"Nearly simultaneously, the Army's high-altitude, long-endurance RPV program, nominally directed to theater tactical reconnaissance, got its missile-based self-defense capability operational. To the professed surprise of the Army and the certain surprise of the Air Force, this nominally defensive capability proved to be remarkably effective in single-handedly establishing and maintaining theater air supremacy and in suppressing theater ballistic missiles, in the brief-but-violent course of the Indo-Pakistani War which broke out abruptly at that time.

"Also during this contretemps, an Army crew commanding a squadron of these RPVs, unaware that the Air Force was also operating covertly in what they had been authorized to regard as a free-fire zone, inadvertently acquired a B-2 on an RPV's laser radar, and shot it down as a bandit with one of the RPV's zippy little self-defense missiles. Fortunately, the B-2's crew bailed out successfully; unhappily, though, they were captured and put on an unusually carefully-staged show-trial, live on CNN, with a quite unfortunate impact on American policy in the region. As part of the domestic political fallout, the Congress deferred the next phase of F-22 procurement, in favor of a sharply stepped-up buy of the Army's RPVs – and their self-defense missiles.

"Diverted by the varied adverse consequences of technological resurgence on the part of its parent Service, the Air Force leadership failed to realize that the Navy's chronic unhappiness over the level of support extended by the space-going Air Force to the Navy's ocean monitoring and control mission had taken on a quite bitter edge after the *Vinson* was mauled in the Gulf of Sidra, an occasion when Air Force-operated national assets which the Navy believed were monitoring adversary air-and-space operations in that region had been re-programmed to higher priority use elsewhere.

"The leadership was therefore taken by surprise when the Navy revealed that its long-rumored Black Cloud program was not just an advanced ocean surveillance satellite thrust, but had been extended to include a novel carrier-based, fully reusable, single-stage-to-orbit space-launch capability of extraordinary economy and time-averaged launch rate and that the Black Cloud satellites, far more numerous than had been rumored, also featured an extensive suite of space-control capabilities which the Navy declared to be essential to the survivability of its sailor-bearing ocean-going assets during hostilities.

"The Army was understandably delighted when the Navy, noting the ocean tactical surveillance from space of the quality which it had found necessary also supported tactical-level surveillance of all land operations, offered the Army joint operational control of the Black Cloud system which it had already paid for.

Defense commentators, including ones on Capitol Hill, immediately hailed the Navy's novel level of inter-service collegiality.

"Air Force anger and dismay engendered by the Navy announcement and the immediate, spectacular commencement of the orbiting of the Black Cloud constellation found full expression at that year's Corona conference, which happened to run the following week, just as news media reaction to the Navy's actions was peaking. As the Navy's strategists had anticipated, the Air Force's assembled leadership formally demanded an immediate, wall-to-wall review of all the Services' roles and missions by DoD and the Armed Services Committees, a demand which the other Services rather surprisingly proposed be addressed immediately and in a maximally definitive fashion.

"On the kickoff day of the unprecedented joint OSD-SASC-HASC closed-session review a few weeks later, the Navy and the Army jointly tabled the historic "On Land And Sea, In Air And Space" white paper, which proposed a fundamental restructuring of the armed forces of the United States, a re-chartering of the remaining Services, and a corresponding reduction of the total defense budget by 20%.

"The end-game was exceedingly brief. The first major amendment of the National Defense Act in a half-century passed both Houses of Congress by acclamation barely a month later."

• **The Air Force has been too successful recently for either its own or the U.S.'s long-term good.** *"You learn more from your defeats than you do from your victories. I don't know who said that - it was probably a Russian."* General Merrill McPeak is quoted as remarking to his hosts during a recent Moscow visit.

The Air Force adapted itself as only a small, young, fast-on-its-feet bureaucracy can to the early-time imperatives of the Cold War, and acquitted itself acceptably in the Nation's three real shooting wars during the past half-century: it fought doggedly in Korea, bombed vigorously in Indochina, and applied itself memorably in the Persian Gulf. It didn't win any of these wars - in the sense that the Allies won World War II - and it's debated as to whether its role was even decisive in determining the outcome of any of them - in the sense of the pair of nuclear raids on imperial Japan. No one will deny, however, that it participated credibly in all three of them.

Concurrently, during the entire Half-Century War, the Air Force brandished a nuclear sword of such length and breadth that it almost appeared like a shield as well. It also took and employed a majority of the politically-permitted portion of the High Frontier of space.

The Air Force hasn't had the benefit had any really serious defeats to learn from, particularly the defeats-in-battle that really teach the major, lasting lessons. (A possible exception is the mauling which it took from the Soviet-piloted MiGs in Korea, as a result of which American air superiority fighters have been the best in the world - by far - for most of the last two decades.) Today, it's not just self-

confident; it's almost complacent. This is a dangerous – possibly even life-threatening – stance to be in when the world suddenly shifts under your institutional feet.

Just because effective control of the planetary air and space environments is central to American interests as a great power, this looming threat to its chosen instrument for these purposes – the Air Force – indirectly but definitely clouds the future of the United States.

• In the contemporary world, "global reach" looks slender-and-slow, and "global power" looks flimsy and non-decisive. The Air Force's subsonic bomber wings can't get to most foreign sites significantly faster than I can fly to them in commercial passenger aircraft, nor can they get much more tonnage there in a week than commercial air freight can routinely deliver. Multi-hundred-pound bombs loaded with TNT don't do telling amounts of damage at all quickly to a fair-sized nation, even when precision-delivered by existing wings of bombers. At least half of Seoul likely will be taken-by-storm and our 38th Parallel trip-wire forces chopped into bits before the first kiloton of STRATCOM TNT can fall anywhere in North Korea.

Moreover, it's not been demonstrated in combat that contemporary precision munitions can be really effective unless air supremacy has already been won, and therefore invoking them as a qualitative difference from LeMay's capabilities in the Pacific campaign is akin to assuming your conclusion in mathematical theorem-proving. F-15s can loiter in really forward areas only about as long as arriving commercial airliners can loiter over busy airports; when strike aircraft go home, the skies again belong to the guy who owns the ground underneath them. We couldn't even cover a dinky little country like Iraq sufficiently well in *Desert Storm* to begin to hold down the Scud TELs – and we'll have a lot fewer total assets with which to work in the quite near future.

Air crews are still made of the same flesh-and-blood as they were in World War II, and they're not going to fly very many sorties per week from Minot to Camel Jockey City, even if their planes somehow remain airworthy and avoid significant attrition. Captured airmen are currently the Air Force's exceedingly fragile glass jaw.

Bluntly put, when you take hydrogen bombs away from present-day STRATCOM, it looks remarkably like Curtis LeMay's capabilities in the campaign against the Japanese home islands – except that STRATCOM has far fewer platforms with which to work, and likely will be given only days to perform military missions that took LeMay months to perform.

Every tinpot tyrant everywhere understands after *Desert Storm* that the way he keeps his air defense system working against the worst the Air Force will be allowed to do to it is to put it 100 feet underground, equip it with back-up electrical service, tie it together with redundant fiber-optic cables, cue it with lots of little throw-away radar antennae and give it teeth that the CIIssies are now selling for

hard-currency pennies-on-the-dollar. Leverage such robust defensive capability with the mangled bodies of children laid out for the ubiquitous CNN cameraman near bombed targets while their mothers wail piteously over them, and season it with videotapes of a handful of captured American airmen stammering their regrets, at off-camera cocked pistol-point. His skies will be entirely his own again, by default, in no time flat – even if the American President publicly denounces him as the Hitler of his era-and-region!

To stretch the point only slightly, from what real origins comes "global reach"? What is the objective basis of "global power"? Why shouldn't a thoughtful skeptic of a politician conclude that true world-wide power projection capability will come in the future as it has in the past: "from the sea"?

• **Technology marches on – and it's dressed in civvies.** We all understand by now that the good old days when the DoD – and particularly the Air Force – almost single-handedly drove major sectors of national-and-planetary technology advance are long-gone and gone-for-good. The enabling domestic budgetary and political/cultural resources have largely evaporated, both economic and technological wealth now are much more uniformly distributed around the planet, and – most tellingly – the Air Force today sure ain't the lean, mean and youthful operation in was in the '50s.

It may well be that the last truly great impact of the "Golden Age" of DoD technology on the civilian sector is now underway: the GPS revolution in ground transportation. At that, GPS and its ramifications constitute a distinctly two-edged sword vis-a-vis Air Force contributions to National security. (A dozen years ago, when the House of Representatives provisionally killed the GPS program, I argued vigorously for a reprieve to the principals, citing a modest fraction of the military benefits already being realized today from its use and proposing means adequate to retrieve its compromised wartime robustness. Interestingly enough, the principal downside then foreseen from GPS's advent was excessive reliance upon it by U.S. forces, which would become a catastrophic weakness in wartime when the Soviets would swiftly and thoroughly "punch it out.")

It has already become fairly apparent that the most severe single threat posed by GPS to America's national security is its potential use by even sub-national groups of quite modest means to reliably vector mass-destruction weaponry into chosen targets in American cities, by simple conversion of even executive passenger aircraft into one-way, light intercontinental robotic bombers of utterly obscure origin. Combined with the predictable impacts of ongoing civilian wresting-of-control of the system from DoD, GPS may prove to be a veritable Pandora's box for the Air Force.

This example just illustrates in one rather small-and-little-noted area both the magnitude and the swiftness of impact of civilian technology on apparently pure military matters. We face these rather troubling issues at the present only because anyone anywhere can now slap down a single kilobuck of credit-card and procure a shirt-power-sized widget conferring no-worse-than-10-meter 3-

dimensional positional knowledge anywhere on this fair planet, complete with a digital interface. Another 15 kilobucks will add twentieth-of-a-degree-accuracy pitch-yaw-and-roll knowledge to the basic package – no modern autopilot requires anything more!

In the early '80s, a GPS receiver was seen to be an object costing tens of kilobucks and of such mass and volume that it would be barely man-portable. Moreover, it was seen to be likely fitted eventually into only the largest civilian airliners, in very modest quantities, and would confer even on SAC bombers only relatively crude position/velocity/time information. DoD didn't sanction – let alone pay for – such strides in packaging, economy, mass-production and universal popularity as have already occurred; the civilian sector did, simply responding to marketplace incentives. The civilian sector also added – independently of the military, to the best of my knowledge – the all-axis orientation-sensing capability and differential (bias-corrected) GPS, which simultaneously buys a 30-100-fold improvement in positional accuracy and incidentally robustly defeats GPS's wartime datastream dithering scheme.

At the same time, I know of no really high leverage Air Force thrust to exploit GPS, e.g., for ultra-high-precision delivery of weaponry from great distances, in telling circumstances. All of the upcoming military applications of GPS known to me are those which would likely be proposed by study groups of earnest-but-naïve upperclassmen at the Air Academy – characterized by obviousness, incremental advance, and relatively low leverage. None open up entirely new areas of military advantage to the Air Force.

The bottom line here has two components: (1) failure to anticipate the impacts of civilian technological advances in the military sector may be ruinous, even in quite active senses; (2) failure to prepare to exploit such technological advances may throw away military opportunities of great value, opportunities which others elsewhere may not overlook. How tedious it is to have your own tools turned back on you!

- **Stealth and technology will be sweet – while it lasts.** The set of technologies which make our most modern warplanes nearly invisible to most of the world's air defense systems must be viewed as merely the latest half-play in the eternal measure-countermeasure-countermeasure-.... game.

American technologists did a great job, and responsible American political and military leaders deserve enormous credit for bringing stealth into existence well and swiftly enough to make a reasonably telling difference in at least one war. Without diminishing any of this, however, the Air Force would be foolish to count on virtual undetectability of its planes for very many more years. What military technological advance giveth, the next technological advance often taketh away.

Ways of effectively circumventing stealth are well- and widely-understood, even if the classification folks like to pretend otherwise. I'm particularly concerned that the hungry Russian design bureaus who literally "wrote the book" on many of the

basic aspects of stealth will be selling to all comers-with-hard-currency the know-how and perhaps even the hardware that will enable ever-greater degrees of stealth-defeat. Recent news reports to such effects are indeed troubling.

The stealth advantage could be depressingly short-lived – just because it's so widely perceived to have such great present-day value.

Moreover, stealth is just one vivid present-day example of a sweet-but-vanishing technology-based advantage. A second one, advanced reconnaissance capability – photographic, radar-imaging, and other modalities – from air and space, is by now very widely recognized as highly valuable. Therefore, it will proliferate widely and quickly, sold or traded away by us or by the Russians. (Or the Iranians will buy it from the Germans, or the Israelis will sell it to the Chinese, or – whatever "it" may be)

More generally, whatever major technological advantages we may have at any time will – by their very nature – slip away with the passage of time thereafter. We should expect that they will do so more swiftly in the near future than previously, for Cold War disciplines are relaxing very rapidly, and COCOM is already rudderless-and-adrift.

- The future belongs to that Service that can detect-and-report problems occurring anywhere on the planet and, if-and-as directed, address them tellingly and with very low latencies, with no friendlies-at-risk and stringently minimized bloodshed. The basic wants-and-needs of political leaders in contemporary liberal democracies vis-a-vis military power are manifest: as-small-as-ever-possible maintenance costs between exercise occasions; small opportunity costs, paid out very quickly, for exercise of military capability; high effectiveness of military capability and high-policy-precision when exercised. Those Services which most aptly support such wants-and-needs will be the ones which prosper in the ever-more-intense American governmental marketplace for national security services. In an era of ever-shrinking overall resource envelopes for the military aspects of national security, such prosperity of the more successful Services will be at great cost to the less successful ones.

American politicians of most all stripes will continue to trim traditional divisions, fighter wings, ships, etc. – things that they don't see as really aptly servicing their geopolitical requirements – to buy things which they see as providing them with better military value for anticipated near-future needs – e.g., rapid deployment capability, attack-blunting "military telepresence", etc. If the results of the recent Bottom-Up Review didn't signal clearly enough to these effects, nothing else will. Those officers "which have eyes with which to see will see" – and will become the future CINCs and Chiefs. (Their less perceptive peers will become the post-Cold War analog of Beltway Bandits.)

- The future of the Air Force is not prejudiced by technological deficiencies, for there are none – nor by powerful foreign adversaries – for they have vanished

away. Rather, it is the collection of "enemies domestic" which may prove deadly: institutional lethargy amplified by long intervals of apparent peace, failure to generate capable and visionary leaders, intra-DoD institutional weaknesses, and consequent failure to perform decisively and affordably when called upon.

Edward Teller has remarked, "This is not the century of art, or of literature, or of music. Contrary to widespread opinion, it has not been the century of science.

The 20th century has been the great century of human technology." The Air Force currently suffers from a surfeit of technology, not a deficit, as far as its ability to exploit it for National benefit is concerned. Its innate strengths and its heritage considered, it thrashes remarkably ineffectively in a pool of technology which deepens and broadens exponentially in time, its force-in-being expressing technology which, with depressingly few exceptions, falls ever further behind the best available. (E.g., we're presently staggering through SPADOC 4 – can SPADOC 8 be that far in the future?)

Moreover, the Air Force presently "owns" a huge resource stream, relative to the foreseeable military load which it must bear. The Cold War has abruptly concluded with the irreversible politicoeconomic implosion of our great adversary of the past half-century, and there is no other major conflict on the horizon. The inertia of government funding processes and the bewildering, not-altogether-friendly view of the post-War world from Capitol Hill combine to assure the Air Force at least another half-decade of resources far in excess of real, traditional military needs.

The Air Force is thus confronted with enormous opportunity, the scale of which it hasn't seen since its infancy, when LeMay forged SAC. It has a quarter of a trillion dollars of "mad money" at its disposal between now and the end-of-the-decade. It can reinvent and then retool itself to seize the commanding geopolitical heights of the early 21st century for the American nation. It can definitively establish itself as the preeminent Service, not only in Cold War but in Warm Peace, as well.

Of course, it is extremely unlikely that the Air Force will institutionally realize any of this, or that it will act to secure the future for its country or itself. History teaches that victors almost inevitably squander the fruits of victory. For every Alexander who will, at stunningly great personal risk, lead a day-and-night-long commando raid from the battlefield at Gaugemala to seize the imperial treasury at Persepolis and thereby, in a single stroke, secure an empire, there are a thousand George Meades, who will dissipate telling strategic advantage to no point.

The basic problem here is that the fabulous victory of the Cold War was not won by active military effort along classic lines on the part of the Air Force. As I noted already, the Air Force – particularly SAC – held the center of the Western line against the Soviet Union, implementing in a highly successful fashion the strategic military aspect of the basic containment strategy of NSC 13. In all candor, though, it must be acknowledged that it was aspects of the civilian sector – particularly mass-media telecommunications and consumer products generation – which, as the heavy cavalry of the West, smashed into the vulnerable flanks of the Soviet system and buckled its will-to-resist.

As a result, the Air Force is not presently blessed with an excess of Hap Arnolds, Jimmy Doolittles or Curtis LeMays – generals who created and led military campaigns to smashing victories, throwing away the last war's rulebooks and their Service's outmoded doctrines, enduring huge setbacks, taking great risks, inspiring and leading their troops into battle along the way. Instead, the large majority of its senior general officers are peacetime bureaucrats who have seen combat recently only on Capitol Hill, whose only serious enemies have been GAO auditors – the types who publicly advise their juniors to duck risk and armor themselves in lawyers when they run weapons acquisition programs. Such officers are managers, not leaders; "managers do things right, while leaders do the right things." They assuredly are not paradigm-shifters. Without any doubt, their kind will lead the Air Force into a long twilight, not a new dawn.

In addition to this notable deficiency of Bennie Schrieviers in its current ranks, the Air Force must cope with a Pentagon weapons acquisition system which must have been designed by the KGB – on one of its best-ever days. Nothing so aptly characterizes this system as Uncle Remus's tale of Brer Fox and the Tar Baby: every time the Congress or the Defense Secretariat tries to fix the particular stupidity of this system which has surfaced most recently – and they never stop trying – they seem to inadvertently break it a bit more. If the Law of Unintended Consequences ever needs a thick book of exquisitely validating examples, it need go no further than the history of Pentagon weapons acquisition during the past 3 decades.

I'm a thoroughly battered veteran of a recent skirmish – not even a decent-scale war – with the acquisition system. I went into this encounter with a few little advantages – the personal interest of two Presidents, a detailed written mandate from the Secretary of Defense specially exempting my program from all the real nightmare features of the acquisition system, the patient and unceasing tutoring of the chairmen of the Defense Science and Defense Policy Boards, the nation's senior defense strategist, several of the nation's most accomplished retired CINCs and other comparable folks, active day-to-day support from cognizant Assistant Defense Secretaries, a series of gifted-and-determined program directors to work for, and a few other little legs-up on the normal Pentagon acquisition situation. Five years later, slightly over a billion dollars had been spent – and the IOC of the Brilliant Pebbles system had slipped at least 6 years in time, reckoned by DoD's formal declarations. When I'm in a really upbeat mood, I can convince myself that the country got perhaps a third of billion dollars of benefit from the billion-dollar expenditure – but only because of the extraordinary advantages with which the effort was gifted.

This was not my first "time in the barrel." I have observed close-up or actually participated in many other acquisition programs in which there was no discernible benefit to the American nation obtained by the times they were finally terminated. The loss which I really feel from a great remove is not so much due to the human or the material wastages, which I can mostly rationalize away by one means or another. Rather it is the loss-of-opportunity to the nation, its people, their security and the damage to their place-in-history. Things really could have

gone much better in each of many instances, perhaps even to historically telling extents, if the system weren't so broken. It's definitely not because of incompetent or maliciously motivated people – almost without exception, the men and women staffing the acquisition system are representative of America, and many of them are among America's best. It is their grotesquely excessive numbers, their *de facto* organization into warring parties and – most importantly – the Kafkaesque rules under which they operate which are so ruinous.

The only fix to this general problem which is adequate-in-principle is to burn it to the ground and then re-build a far smaller and more rational one; varying shades of clever incrementalism have been tried on many occasions, and have always been transmogrified into meaninglessness – or worse – by the system. However, radical change seems to be completely precluded by the 350,000 *de facto* tenured Government employees and officers who collectively staff this system. In (slight) sub-scale, it's the same basic problem as is facing the various governments of the republics of the former Soviet Union: they have upwards of 18 million members of the Communist *nomenklatura* who are superfluous-at-best in a democratic, market-oriented system but who are solidly in-place and not-at-all inclined to give way. You can't shoot 'em, you can't afford to retire 'em even if they would accept retirement, and you can't keep 'em in-place, if you're to have any chance of success. What do you do? You muddle forward, one-day-at-a-time, thereby expressing nothing so much as the triumph of hope over experience – or maybe it's desperation over rational expectation. So it will be for the future Air Force coping with the Pentagon acquisition system, I fear.

Conclusion. The upshot of all of this is that it will be remarkable if the Air Force is able to perform credibly for our nation's political leadership in time to come, if our adversary is a significantly better strategist or a substantially better tactician or a notably better general than was Saddam Hussein. I worry very much that there may be such foes in our nation's future. Nonetheless, I continue to be hopeful.

Biographical Synoptic
Dr. Lowell L. Wood

Dr. Lowell L. Wood is a senior staff scientist at the Lawrence Livermore National Laboratory. He currently heads the Advanced Technology Program and the Special Studies Division in the Physical Sciences Directorate, and is a member of the Director's Technical Staff.

Dr. Wood received a Bachelor of Science degree in Chemistry and Mathematics from the University of California at Los Angeles in 1962 and his Ph.D. in Astrophysics in 1965. From 1965-1972, he was a consultant at the University of California Lawrence Livermore Laboratory and at the UCLA campus as an Assistant Research Geophysicist. In addition, during this time period, he held a teaching and research position as an Assistant Professor with the University of California's Davis/Livermore Department of Applied Sciences. His scientific work during this period (done in collaboration with John Nuckolls) culminated in technical proposals leading to the establishment of the National Inertial Confinement Fusion Program. From 1972-1975, Dr. Wood served as the Associate Physics Department Head at the Lawrence Livermore National Laboratory. In 1972, he founded the Special Studies Group at the Laboratory, and in 1975, he started the related Special Studies Program.

Dr. Wood is the author/coauthor of several hundred papers, briefing documents and Government-classified papers, and of approximately 25 patents. In 1981, he received the E.O. Lawrence Award from the Department of Energy "for his outstanding contributions to national security in the areas of directed energy, inertial confinement fusion, underwater communication, nuclear design concepts and computer technology." In 1991, he received the ADPA Abrahamson Award that declared that his work has "led directly to the revitalization of all strategic defense systems programs and made all elements more robust and cost-effective."



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SPACECAST 2020

ADVISORY GROUP

<u>NAME</u>	<u>WK PHONE</u>	<u>TITLE</u>
Mr Edward C. "Pete" Aldridge	310 336-5872	President and CEO, Aerospace Corp
Dr Alf L. Andreassen	301 608-4100	Information Systems Vice President, AT&T
Mr Bruno W. Augenstein	310 393-0411	Sr Scientist, Defense & Technology Planning Dept, RAND
Mr Norman R. Augustine	301 897-6185	CEO, Martin Marietta
Col John R. Boyd (USAF, Ret)	407 265-3727	Consultant
Brig Gen Elmer Brooks (USAF, Ret)	202 358-2022	Deputy Associate Administrator for Space Communications, HQ NASA
Mr Don Fuqua	202 371-8501	President, Aerospace Industries Association of America Inc
Gen Alfred M. Gray (USMC, Ret)	703 892-9350	Senior Associate, GIA Inc
Dr Anthony K. "Tony"Hyder	219 631-8591	Assoc Vice Pres for Grad Studies & Research, & Prof of Aerospace Eng Univ of Notre Dame
Dr Joan Johnson-Freese	205 953-7427	Assoc Prof, Dept of National Security Studies, Air War College
VADM William Ramsey (USN, Ret)	301 816-1424	Vice President of Corporate Business Development, CTA Inc
Gen Robert W. RisCassi (USA, Ret)	703 685-5520	Vice President, Land Systems for Loral Corporation
Gen Bernard Schriever (USAF, Ret)	202 452-8836	Consultant
Mr James R. Thompson Jr.	205 971-0800	Executive Vice President & General Mgr Launch Sys Group, Orbital Sciences Corp
Gen Larry D. Welch (USAF, Ret)	703 845-2300	President, Institute for Defense Analyses
Dr John P. White	617 496-4685	Director of the Center for Business and Government, JFK School of Gov't, Harvard Univ

as of 12 Jan 94

EDWARD C. "PETE" ALDRIDGE, JR.

President and Chief Executive Officer
The Aerospace Corporation

Edward C. Aldridge, Jr. is President and Chief Executive Officer of The Aerospace Corporation, a nonprofit organization which is dedicated to the objective application of science and technology toward the solution of critical national problems.

Mr. Aldridge came to Aerospace from McDonnell Douglas Electronic Systems Company where he served as President from 1988 to 1992. Previously, he had been Secretary of the Air Force; Under Secretary of the Air Force; Vice President, National Policy and Strategic Systems Group, System Planning Corporation; Director, Planning and Evaluation, Office of the Secretary of Defense; Deputy Assistant Secretary of Defense (Strategic Programs), Office of the Assistant Secretary of Defense (Program Analysis and Evaluation); Senior Management Associate, Office of Management and Budget; Manager, Advanced Concepts, LTV Aerospace Corporation; Advisor, Strategic Arms Negotiations (SALT I), Office of the Assistant Secretary of Defense (System Analysis), Operations Research Analyst; and associated with Douglas Aircraft Company in the areas of Missiles and Space, and Aerospace Systems Analysis.

He received his B.S. degree in Aeronautical Engineering from the Texas Agricultural and Mechanical University in 1960 and his M.S. degree in Aeronautical Engineering from the Georgia Institute of Technology in 1962.

Mr. Aldridge has the following affiliations: member, Defense Science Board; Fellow and Vice President, American Institute of Aeronautics and Astronautics; Life Member, the Air Force Association; member, Board of Directors of the Los Angeles World Affairs Council; member, Board of Councilors of the University of Southern California's School of Engineering; member, Board of Directors of Draper Laboratories; Trustee, U.S. Air Force Falcon Foundation; member, Board of Directors, U.S. Space Foundation; honorary member, U.S. Air Force Thunderbirds; former member, the Vice President's Space Policy Advisory Board; former President, Security Affairs Support Association; former member, Board of Governors, National Space Club; member, Tau Beta Pi, Sigma Gamma Tau and Sigma Xi.

Among his military decorations and awards are Secretary of Defense Meritorious Civilian Service Award; Department of Defense Distinguished Civilian Service Award; Department of Defense Distinguished Public Service Award (3); Air Force Exceptional Civilian Service Award; Army Distinguished Civilian Service Award; Navy Distinguished Public Service Award; National Intelligence Distinguished Service Award; National Space Club Robert H. Goddard Memorial Trophy; Air Force Association Jimmy Doolittle Fellow; Air Force Association Ira Eaker Fellow (2); Air Force Academy Foundation Distinguished American Award (2); Air Force Association Max Kriendler Award; Air Force Association W. Stuart Symington Award; Air Force Association Gen. Bernard Schriever Award; National Security Industrial Association James V. Hartinger Award; National Guard Association Harry S. Truman Award; American Astronautical Society Military Astronautic Award; Distinguished College of Engineering Alumnus, Texas A&M University; Armed Forces Council of Chicago Distinguished Civilian Service Citation; and the Brazilian Air Force "Merito Aeronautico" (Legion of Merit).

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ALF L. ANDREASSEN

Dr. Andreassen was born February 18, 1947, in Brooklyn, NY. He received his doctorate in Physical Chemistry from Cornell University in 1971. After a post doctoral fellowship with the Materials Science Center at Cornell, he joined the Applied Physics Laboratory of Johns Hopkins University in 1972.

At APL/JHU he was a principal in the investigations of the security of U.S. strategic submarines. Specific areas of effort included SSBN patrol habits analysis and systems analysis of the impact of emerging technologies on U.S. and adversary ASW capabilities.

In 1977, he entered Government service as the Technical Director for Non-Acoustic Anti-Submarine Warfare with the Office of the Chief of Naval Operations. During this assignment, Dr. Andreassen was a principal in the analysis and exposition of foreign ASW activities and their impact on U.S. submarine operations.

In 1980, he became Technical Advisor to the Director, Naval Warfare (OPNAV). In this capacity, he was involved in the broad spectrum of technical and policy issues shaping the Navy. He was awarded the Department of the Navy's Superior Service Medal in 1983.

During 1982 and 1983 he served in a dual assignment for the Science Advisor to the President.

In 1983 he joined AT&T Bell Laboratories where his primary activities were in Command, Control and Communications. His work focused on the development of secure data networks and messaging systems and on secure operating systems for computers.

In 1987 he was promoted to Director, Information Systems Center where he was responsible for system engineering, development and research efforts for the Intelligence Community. In this capacity, he was responsible for implementing large scale data processing and distribution systems.

In September 1987 he was promoted to C3I Systems Vice President, Federal Systems, responsible for AT&T's growing role in Command, Control, Communications and Intelligence.

In July 1990 he became Information Systems Vice President, Federal Systems Advanced Technologies, responsible for Air Traffic Control as well as Command, Control, Communications and Intelligence.

He is married to the former Barbara Hamilton Kappauf and they have four children.

Professional Organizations

American Chemical Society
American Physical Society

Consulting Agreements (Past and Present)

National Science Foundation/Naval Studies Board
Defense Science Board - Task Forces
Chief of Naval Operations Executive Panel

Board Memberships (Past and Present)

AT&T Datotek (Chairman)
AT&T Gretag (Chairman)
AT&T Services Company
AT&T Member of Western Investors' Group
Saudi Technology Corporation
AT&T Technology Editorial Board
Security Affairs Support Association

January 1993

BRUNO W. AUGENSTEIN

EDUCATION

M.S., Aeronautics and Physics, 1945, California Institute of Technology
B.A., Physics and Mathematics, 1943, Brown University
Teaching Fellow, Physics, 1944, Massachusetts Institute of Technology
Graduate Work, Theoretical Physics, 1951-1953, University of California at Los Angeles

PROFESSIONAL EXPERIENCE

1967-Present -- Management and Senior Staff, RAND, Santa Monica, California
1965-1967 -- Research Advisor to the President, Institute for Defense Analyses, Arlington, Virginia
1961-1965 -- Assistant Director and Special Assistant for Intelligence and Reconnaissance, Office of Director of Defense Research and Engineering, Department of Defense, Washington, D.C. In 1965 he received the Department of Defense Distinguished Public Service Medal, the DoD's highest civilian award.
1958-1961 -- Scientific Advisor and Director of Advanced Planning, Lockheed Missiles and Space Company, Palo Alto and Sunnyvale, California (Satellite and Polaris programs)
1949-1958 -- Member, Senior Staff, RAND, Santa Monica, California
1948-1949 -- Assistant Professor, Aeronautical Engineering, Purdue University, Lafayette, Indiana
1946-1948 -- Supervisor and Manager of Preliminary Design, North American Aerophysics Laboratory, Inglewood, California

RESEARCH AREAS

Science Policy and Strategic Studies. Recent work has included net assessment of U.S. and Soviet capabilities, technology transfer issues, strategies for energy R&D, spacecraft acquisition strategies, role of the Space Shuttle, DoD computer issues, U.S. confidence building measures, and roles for C3I in the National Command Authority. Earlier work related to major RAND studies leading to installment of U.S. programs in ICBMs and satellite systems.

Biomedical Programs. In 1967 Mr. Augenstein was appointed by President Johnson to serve as a Regent of the National Library of Medicine, Department of Health, Education and Welfare. He served a term as Vice-Chairman of the Board of Regents. In 1975 he was Chairman of the Department of Navy Medical Laboratories Review Committee. He has advised recently in the general area of biomedical communications.

Scientific Advisor. Mr. Augenstein served as scientific advisor and advanced planning director for a major contractor engaged in design, construction, launch, operation, and mission support of a large number of satellites, most of which performed classified missions, and which conducted the Polaris program.

Manager, Preliminary Design. He did research in theoretical aerodynamics, managed gas dynamics facilities, and conducted major preliminary designs in satellite vehicles, nuclear rockets, and ramjet missiles.

Consulting and Advisory Activities. Mr. Augenstein has consulted and continues to consult for a number of governmental organizations, including currently consulting for the President's Science Advisor. He was Chairman of the National Academy of Sciences-National Bureau of Standards (now NIST) Evaluation Panel for the Computer Sciences Center. This consulting covers a broad spectrum of science and high technology areas.

Computers and Communications. Current work at RAND focuses on issues of computers and communications, and their integration into future information systems. Mr. Augenstein is the author of several recent documents on "Ultimate Computation," analyzing the probable trends in computer power growth (hardware and software) for the next three decades, the nature of the physical limits which will ultimately bound computer power (principally issues of thermodynamics, quantum theory, and reversibility), and the nature of the new problem resolution areas which can open up as computer power increases, and full congenial access to information bases, and the ability to support individuals in a great range of educational, professional, and leisure activities is enabled.

Comparative Levels of Science and Technology. As an outgrowth of his work in intelligence in his DoD service, Mr. Augenstein has continued work and interest in the science and technology styles of the United States and foreign technology leaders and in key branches of science and technology in such fields as mathematics, theoretical physics, nuclear weapons, materials sciences, computers, automation, models and simulations, and military space and strategic systems.

NORMAN R. AUGUSTINE

NORMAN R. AUGUSTINE was born in Colorado and attended Princeton University where he was awarded a BSE in Aeronautical Engineering magna cum laude, an MSE, and was elected to Phi Beta Kappa, Tau Beta Pi and Sigma Xi. He holds Honorary Doctor of Engineering Degrees from the University of Maryland, Rensselaer, Stevens Institute and Western Maryland College, an Honorary Doctor of Science Degree from the University of Colorado, and an Honorary Doctor of Management Degree from Embry-Riddle. In 1965, he joined the Douglas Aircraft Company where he held titles of Program Manager and Chief Engineer. Beginning in 1965, he served in the Pentagon in the Office of the Secretary of Defense as an Assistant Director of Defense Research and Engineering. Joining the LTV Missiles and Space Company in 1970, he served as Vice President, Advanced Programs and Marketing. In 1973 he returned to government as Assistant Secretary of the Army and in 1975 became Under Secretary. Joining Martin Marietta Corporation in 1977, he has been Chairman and CEO since 1988 and 1987, respectively, having previously served as President and Chief Operating Officer.

Mr. Augustine is Chairman of the Board of Governors of the American Red Cross and Executive Vice President of the Boy Scouts of America. He has served as national chairman of the U.S. Savings Bond Campaign, chairman of the Defense Policy Advisory Committee on Trade (DPACT), president of the American Institute of Aeronautics and Astronautics, of which he is an Honorary Fellow; president and chairman of the Association of the United States Army; chairman of the Defense Science Board; chairman of the Aeronautics Panel of the Air Force Scientific Advisory Board; chairman of the Executive Council on Foreign Diplomacy; chairman of the NASA/White House Committee on the U.S. Space Program; chairman of the NASA Space Systems and Technology Advisory Committee; and as a member of the NASA Advisory Council. He has been elected to the National Academy of Engineering, a Fellow of the American Academy of Arts and Sciences, the International Academy of Astronautics of which he is a Trustee, an Honorary Fellow of the Society for Technical Communications, a Fellow of the American Astronautical Society and a Fellow of the Institute of Electrical and Electronic Engineers. He is a licensed professional engineer in the State of Texas.

He is a member of the Board of Directors of Phillips Petroleum, Procter & Gamble, Riggs National (Bank) Corporation, the Ethics Resource Center, The Planetary Society, the Atlantic Council and the New American Schools Development Corporation. He has served on Boards of the Colorado National Bank, Hoskyns Group plc of the UK as chairman, the Wolf Trap (National Park) Foundation, Ford's Theatre, the American Helicopter Society, the Air Force Academy Foundation and the Research Triangle Institute. He has been on advisory boards to the White House, U.S. Senate, NASA, FAA, and the Departments of Defense, Army, Navy, Air Force, Energy, and Transportation, the General Accounting Office, and NATO. He is Chairman of the President's National Security Telecommunications Advisory Committee, Chairman of the Maryland Business Roundtable for Education, Chairman of the "Scoop" Jackson Foundation for Military Medicine, a Principal of the Council for Excellence in Government, and a member of the Advisory Council of the Women's Research and Education Institute, the Leadership Committee for the Salvation Army Harbor Light Fund, the Policy Council of the Business Roundtable, The Business Council, the Conference Board, the U.S.-Japan Leadership Council, the Carnegie Commission on Science, Technology and Government, a member of the Board of Governors of the Aerospace Industries Association, and has been a member of the Corporation of the Draper Laboratory and of the Chief of Naval Operations' Executive Panel.

Augustine is a Trustee of Princeton University and The Johns Hopkins University, an Honorary Member of the Faculty of the Industrial College of the Armed Forces and a member of the Board of Advisors of the School of Medicine at Johns Hopkins. He has chaired advisory councils for Princeton University, the American University, the University of Maryland and the MIT Lincoln Laboratory, and served on advisory boards for the University of Colorado, Georgia Tech, Duke, Texas A&M, USC, Johns Hopkins, Florida State, and the National Defense University, where he was a Bernard Baruch Lecturer, and has delivered the von Braun Memorial Lecture at the Smithsonian.

He has four times been awarded the Department of Defense's highest civilian decoration, the Distinguished Service Medal, and has received the Defense Meritorious Service Medal, the Army Distinguished Service Medal, the Air Force Exceptional Service Medal and the Department of the Treasury Medal of Merit and Gold Medal of Merit. He is a recipient of the National Security Industrial Association's Forrestal Memorial Award, the National Space Club's Goddard Trophy, the American Astronautical Society's Military Astronautics Trophy, the American Institute of Aeronautics and Astronautics' Goddard Medal, the National Academy of Engineering's Bueche Award, the Association of the U.S. Army's Distinguished Service Award, the American Defense Preparedness Association's Gold Medal, Knowles Award and John C. Jones Award, the American Association of Engineering Societies' National Engineering Award, the Society of Manufacturing Engineers' Gold Medal, the Industrial College of the Armed Forces' Eisenhower Award, the National Contract Management Association's Roback Award, the Armed Forces Communications and Electronics Association's Sarnoff Award, the University of South Florida's Leonardo da Vinci Award, the University of Maryland's Engineer of the Year Award, the Institute of Electrical and Electronics Engineers' Carlton Award, the American Society of Metallurgy's Distinguished Life Membership Award, the Colorado ARCS Man of Science Award, the Boy Scouts Citizen of the Year Award, The N.Y. Navy League Eagle of Industry Award, the Harvard Business School Club of Washington Business Statesman Award, the Air Force Association's John R. Alison Award, the California Institute of Technology Management Association's Excellence in Management Award, the Rotary National Space Trophy, the Public Employees Roundtable Chairman's Award, the Maryland Chamber of Commerce's Public Service Award, and the Aviation Week Aerospace Laureate Award. He is an Honorary Command Sergeant Major of the U.S. Army.

In pursuing his hobbies, he has dog-sledded in the Arctic and explored volcanos in the Antarctic; backpacked in the Canadian Rockies; horsebacked in the U.S. Rockies; sailed a tall ship in the West Indies; traveled the Oregon Trail in a covered wagon; snorkeled on the Great Barrier Reef; hot-air ballooned in Africa; rafted the Grand Canyon; traveled the Out-Back of Australia; been on camera safari in Tanzania and Kenya; photographed polar bears in the Northwest Territory, and is planning a trip up the Amazon.

Augustine is co-author of *The Defense Revolution* and author of *Augustine's Laws*, printed in four languages; holds a copyright on a book for baseball managers; and is listed in *Who's Who in America* and *Who's Who in the World*. He is married to the former Margareta Engman of Stockholm, and they are the parents of a son, Gregory, an electrical engineer, and a daughter, René, an attorney who is married to Mark Alarie, a student at the Wharton School of Business and a former NBA basketball player.

Name: John R. Boyd

Address:

Education: BSC Economics, University of Iowa, 1951
BIE Industrial Engineering, Georgia Tech, 1962

Experience and Contribution:

Officer in the USAF from 8 July 1951 through 31 August 1975. Retired in the grade of Colonel - 1 September 1975. Served in Korea as an F-86 pilot with the 51st Fighter Interceptor Wing 1953-54. Flew 22 combat missions before the war ended. Assigned to Nellis AFB, Nevada from 1954-1960. While there served as a combat crew and fighter weapons instructor in both the F-86 and F-100. As a member of the USAF Fighter Weapons School developed and wrote the maneuver-counter maneuver, tactic-counter tactic concept of Fighter Tactics which appeared in the "Aerial Attack Study" - 1960. During this period as Chief, Training Analysis and Development (1957-58) and Chief, Fighter Weapons School Academics (1958-1960) was responsible for and developed many of the training concepts as well as wrote much of the supporting literature such as mission cards, publications, etc. At Eglin AFB, Florida, during 1962-1966 with co-worker Mr. Thomas P. Christie evolved the Energy Maneuverability Theory which is now used by designers and tacticians to develop new airplanes and new fighter tactics.

Also during this period, once again, with Mr. Christie evolved the digital simulation of SA-2 missile. These simulations were used to evolve maneuvers that were subsequently employed to effectively counter the SA-2. During 1966-69 as a member of the Operational Requirements Team in the Deputy for Research and Development (AFRDQRT) at Headquarters USAF, was responsible for and developed the design trade-off concept and methodology for the F-X which resulted in the F-15. During 1970-72 with Mr. Pierre Sprey and Col. E.E. Riccioni evolved the Lightweight Fighter (LWF) Concept and supporting trade-off methodology that resulted in the YF-16 and YF-17. During 1970-1972 also evolved the Maximum Maneuver Concept which was used in the design trade-offs and Source Selection Evaluation of the LWF competition and in Linebacker operations in Vietnam. During 1972-1973 was Vice Commander Task Force Alpha then Base Commander at Nakon Phanom, Thailand. From 1973 until retirement in 1975 was Chief, Development Plans and Analysis (AFRDQL) at Headquarters USAF. In this capacity evolved the ideas and formulated the concept for integrating development planning with force planning.

From 1 September 1975 until the present has investigated the nature of winning and losing. In this context, has surfaced: A ~~top~~ compendium of ideas and actions that make-up the character of conflict--titled "Patterns of Conflict"; the implicit arrangements that permit effective command and control in complex, fast-moving situations--titled "Organic Design for Command and Control"; key strategic ideas for realizing what we aim for--titled "The Strategic Game of ? and ?"; and the ways we evolve mental concepts to comprehend and cope with our environment--titled "Destruction and Creation". Presentations on these topics have been made to numerous interested individuals and groups.

Awards and Recognition

- 1965 AFSC Scientific Achievement Award for developing the Energy Maneuverability Theory
- 1966 USAF Research and Development Award in Aeronautical Engineering for developing the Energy Maneuverability Theory
- 1969 Air Force Association Citation of Honor for pioneering development of air-to-air fighter tactics
- 1970 Arnold Air Society Gen. Hoyt S. Vandenberg Award for major contributions to the development of theory and tactics for air-to-air combat with special emphasis on blending of missile tactics into overall spectrum of air-to-air tactics
- 1975 Dr. Harold Brown Award for the creation of advanced scientific theories of energy maneuverability and for leading others in detailed design trade-offs and fostering the validation of the theories in hardware prototype (LWF).

ELMER T. BROOKS
DEPUTY ASSOCIATE ADMINISTRATOR (AGENCY PROGRAMS)
OFFICE OF MANAGEMENT SYSTEMS AND FACILITIES
NASA HEADQUARTERS

Brigadier General Elmer T. Brooks, USAF (Retired), is a native of Washington, DC. He attended Howard University, then graduated from Miami University, Ohio, with a B.A. in Zoology and a commission in the Air Force via ROTC. He later received an M.S. Degree in Administration from The George Washington University, and completed the Industrial College of the Armed Forces and The Executive Program of the Graduate School of Business of the University of Virginia.

In June 1985, General Brooks retired from the U.S. Air Force after 30 years of service during which he held a wide variety of important positions. Among them were flight control technologist for Gemini and Apollo space missions at NASA's Johnson Space Center, R&D personnel manager at Headquarters U.S. Air Force, the military assistant to two Secretaries of Defense, Commander of a major missile unit and Air Force base, arms control policy-maker and advisor to the Joint Chiefs of Staff, Presidential appointee as Deputy Commissioner of the U.S.-U.S.S.R. Standing Consultative Commission, and Assistant Deputy Under Secretary of Defense for Research and Engineering (nuclear and space systems).

After leaving active military service, General Brooks became a self-employed consultant to high technology industry and then General Manager of a private investment banking firm in London. He joined NASA Headquarters on November 14, 1988, as Assistant for Special Projects, Office of the Administrator. General Brooks served as the Deputy Associate Administrator for Management from February 1989, until his current appointment on October 20, 1991. He is married to the former Kathryn Casselberry of Dayton, Ohio, and they have a daughter and three sons. General Brooks and his family reside in North Bethesda, Maryland.



BIOGRAPHY...DON FUQUA, AIA PRESIDENT

Don Fuqua is president and general manager of the Aerospace Industries Association of America, Inc. (AIA). He assumed the position on January 1, 1987, and serves as a leading spokesman for the U.S. aerospace industry. Fuqua is a member of AIA's Board of Governors and oversees the activities of six AIA councils and 10 AIA departments.

Before joining AIA, Fuqua served 12 terms as a U.S. congressman, representing Florida's Second Congressional District. He was elected chairman of the House Science and Technology Committee in 1979 after serving on the committee since his election to Congress in 1963. He gained firsthand knowledge of the U.S. space program as a member of the subcommittee overseeing the program in its formative years and as chairman of the Subcommittee on Space Science and Applications from 1971 to 1981.

More recently he served as a member of the Advisory Committee on the Future of the U.S. Space Program, commonly known as the Augustine Commission. In 1990 he was appointed a member of the NASA Advisory Council, which provides advice to the NASA administrator on NASA's programs and policies.

Awards

Robert H. Goddard Memorial Trophy, 1984
Jack Swigert Memorial Trophy, 1985
National Aeronautics and Space Administration
Distinguished Public Service Medal, 1986
National Science Foundation Distinguished Public Service
Award, 1986
Knight Commander's Cross of the Order of Merit,
Federal Republic of Germany, 1987
The Order of the Rising Sun, Gold and Silver Star,
His Majesty the Emperor of Japan, 1987
Rotary National Award for Space Achievement, 1988

AIA Positions

Chairman, Key Technologies for the Year 2000
Aerospace Technology Policy Forum
Chairman, Board of Trustees, National Center for
Advanced Technologies
Member, Council of Defense and Space Industry
Associations
Past President, International Coordinating Council of
Aerospace Industries Associations

Fuqua also served as chairman of the Science and Technology Committee's Subcommittee on Energy Development and Applications and as ranking majority member of the House Committee on Government Operations.

As chairman of the Science and Technology Committee, Fuqua personally inspected and reviewed research projects throughout the nation. He delved into fields as far-ranging as the development of competitive aircraft of the future, the application of space technology to the needs of the elderly and disabled, the design of more fuel-efficient autos, the development of liquefied coal, and the protection of the environment from hazards as common as water weeds and as advanced as nuclear waste. The committee has direct authorization and oversight responsibility for most of the nation's government-funded civilian research, development, and demonstration programs.

Fuqua served from 1958-62 as an elected member of the Florida House of Representatives from Calhoun County.

Fuqua was born in Jacksonville, Florida, in 1933. He received a B.S. degree in agricultural economics in 1957 from the University of Florida. He served in the U.S. Army from 1953-55.

Boards, Committees, and Councils

Founding Board Member, Challenger Center for Space
Science Foundation
Chairman, Air & Space Heritage Council
Member, USO World Board of Governors
Member, Board of Advisors, Rotary National Award for
Space Leadership
Member, Board of Governors, National Space Society
Member, NASA Advisory Council

Honorary Doctorate Degrees

University of Notre Dame, 1982
Florida Institute of Technology, 1982
Florida State University, 1986
Florida A&M University, 1986
University of Florida, 1991

Memberships

Honorary Member, American Institute of Aeronautics
and Astronautics
Member, National Aeronautic Association
Distinguished Life Membership, ASM International



BIOGRAPHICAL DATA



ALFRED (AL) M. GRAY

In 1991 General Alfred (Al) M. Gray retired from the U.S. Marine Corps after 41 years of service and joined Garber International Associates (GIA) as Senior Associate.

From 1987 to 1991, General Gray served as a member of the Joint Chiefs of Staff and was the 29th Commandant of the Marine Corps. In these capacities, General Gray was responsible for the organization, training, equipment, readiness, effectiveness, efficiency and total performance of the Marine Corps. He served as military advisor to the President, the National Security Council and the Secretary of Defense.

As Commandant, General Gray assisted in the formulation of national and international military policy and strategy. He institutionalized and published a warfighting philosophy for the Marines. General Gray developed and implemented a new long range strategic planning process for the Marine Corps. As a result of his long-range vision, the 1st and 2nd Marine Divisions performed well in the Gulf War. General H. Norman Schwarzkopf stated that the performance of the Marine Corps was text book perfect, and that their achievements in the field would be studied for years to come as the model for operation of that kind.

From 1984 to 1987, General Gray was the Commanding General, Fleet Marine Force, Atlantic, Fleet Marine Force Europe, II Marine Expeditionary Force and Marine Striking Forces Atlantic (NATO). In this capacity, General Gray exercised command of all Marine Corps operational forces, Marine Security and Ship Detachments assigned east of the Mississippi River extending to and including the Atlantic Ocean, Norwegian, Caribbean and Mediterranean Seas and Europe. He was the Senior Marine reporting to the Commander-in-Chief Atlantic Supreme Allied Commander Atlantic (NATO) and the Commander-in-Chief Europe/Supreme Allied Commander Europe (NATO). General Gray was responsible for strategic planning, preparedness and execution of general war and contingency plans as they pertain to Marine Forces.

During the time frame of 1981 to 1984, General Gray was the Commanding General, Second Marine Division at Camp Lejeune, North Carolina. General Gray was responsible for the total performance of a large ground force trained and prepared to execute such diverse missions as a show of force, evacuations, disaster relief, surveillance, reinforcement, amphibious, or other operations, supported by Marine aviation and logistic commands and Navy Forces in order to maintain the security of national and allied interest.

From 1978 to 1981, he was the Director of the Research and Development Center at Quantico, Virginia. As Director, he was responsible for the development in coordination with agencies and representatives of the services, of doctrine, tactical, techniques and equipment employed by landing forces in amphibious operations. He streamlined and accelerated studies and doctrinal development. General Gray directed development of the first approved Mission Area Analysis for Amphibious Warfare. He personally led the program for defense and Congressional approval of a family of Light Armored Vehicles for the Marine Corps.

He enlisted in the Marine Corps in 1950 and achieved the rank of sergeant in combat in Korea. He was commissioned a Second Lieutenant in 1952. From 1952 to 1978, General Gray had extensive experience and command assignments of increasing responsibilities overseas (primarily in the Far East and Southeast Asia) in infantry, artillery, intelligence communications and special operations. He was in charge of operations and training, education and Signal Intelligence/Electronic Warfare capability. He directed the Southeast Asia evacuation operations in 1975.

In addition to being a recipient of numerous American military awards, General Gray has also received awards from the Republic of Korea, the Netherlands, Chile, Argentina, Colombia and Brazil.

General Gray holds a B.S. from the State University of New York. He also attended Lafayette College, the Marine Corps Command and Staff College, Army War College and did graduate work at Syracuse University. General Gray is the recipient of two honorary Doctor of Law degrees, one from Lafayette College and the other from Monmouth College, and is a recipient of a Doctor of Military Science degree from Norwich University and a Doctor of Strategic Intelligence degree from the Defense Intelligence College.

Anthony K. Hyder

Business Address

312 Main Building
Notre Dame, Indiana 46556
(219) 239-8591

Residence

[REDACTED]

Academic Origins

PhD, Physics and Aerospace Engineering, 1971, Air Force Institute of Technology
MS, Space Physics, 1964, Air Force Institute of Technology
BS, Physics, 1962, University of Notre Dame

Experience

(1991-) Associate Vice President for Research and Professor of Aerospace Engineering, University of Notre Dame, Notre Dame, Indiana.

(1991-) Research Fellow, Space Power Institute, Auburn University, Auburn, Alabama.

(1982-1991) Associate Vice President for Research, Associate Professor of Physics and Associate Professor of Aerospace Engineering, Auburn University, Auburn, Alabama.

(1989-1991) Auburn University Director, NASA Space-Grant College Program for the State of Alabama.

(1986- 1988) Founding Director, Center for Advanced Technologies, Auburn University, Auburn, Alabama.

(1985) Founding Director, Space Power Institute, Auburn University, Auburn, Alabama.

(1981-1982) Scientific Advisor to the Director for Research, Office of the Secretary of Defense (Research and Advanced Technology), The Pentagon, Washington, DC.

(1980-1982) Program Manager, Air Force Office of Scientific Research, Washington, DC.

(1975-1979) Chief, Atmospheric Branch, United States Air Force Technical Applications Center, Cocoa Beach, Florida.

(1972-1975) Director of Research and Associate Professor of Physics, United States Air Force Academy, Colorado.

(1964-1972) Staff Scientist, Aerospace Research Laboratories, Dayton, Ohio.

Technical Activities

Conference Director or Co-Director

First Air Force Conference on Research Needs in Space Prime Power(1982)

Fifth Tamarron Conference on Foreign Switch Technology (1984)

Sixth Tamarron Conference on High-Current EML Switches (1986)

NATO Advanced Studies Institute on High-Brightness Accelerators, Pitlochry, Scotland, (1986)

NATO Advanced Studies Institute on the Space Environment, Pitlochry, Scotland (1991).

First Prospector Conference on Issues Facing Space Technology (1990)

ARO Conference on Mobile Battlefield Power Systems (1990)

Technical Committee Memberships

Third International IEEE Pulsed Power Conference (1981)

Fourth International IEEE Pulsed Power Conference (1983)

Fifth International IEEE Pulsed Power Conference (1985)

Sixth International IEEE Pulsed Power Conference (1987)

Seventh International IEEE Pulsed Power Conference (1989)

Eighth International IEEE Pulsed Power Conference (1991)

Ninth International IEEE Pulsed Power Conference (1993)

Fifth and Seventh International Topical Conference on Electron and Ion Beam Research and Development

Tenth International Conference on High-Power Particle Beams, 1994

Second Tamarron Conference on Diffuse Discharge Switches (1982)

Third Tamarron Conference on Spark Gap Switches (1983)

Seventh Tamarron Conference on EML Diagnostic Techniques (1987)

Eighth Tamarron Conference on High-Power Spacecraft Electrical Systems (1988)

NATO Advanced Studies Institute on Fast Electrical and Optical Diagnostics Techniques, Castlevectchio, Italy, 1983

NATO Advanced Studies Institute on Radiative Processes in Discharge Plasmas, Pitlochry, Scotland, 1985

Arrangements Committee Chairman

The First International Conference on the Applications of Diamond Films and Related Materials, Auburn University, 1991

National Advisory Panels

Air Force Scientific Advisory Board, member, 1990-1994

Chair, Science Panel, Air Force Scientific Advisory Board, 1993-1994

Chair, Air Force Scientific Advisory Board Panel on Technology Challenges to Improve National Space Launch Capabilities, 1993-

Defense Intelligence Agency Scientific Advisory Board, 1993-1997

Institute for Defense Analysis, Executive Committee, Power Systems Review Panel, 1993-continuing

Strategic Defense Initiative Organization, Office of Technology Applications, Chair, Power and Related Technologies Panel, 1989-continuing

Advisory Board on Space Environmental Effects, Jet Propulsion Laboratory of the California Institute of Technology, 1990-continuing

Air Force Scientific Advisory Board, advisor, Committee on Space Power Technology, 1989-90

Oak Ridge Associated Universities, Advisory Committee on Data Base Networks, 1989-1991

Oak Ridge Associated Universities Council of Sponsoring Institutions, 1992-
Oak Ridge associated Universities Science and Technology Policy Committee, 1992-

Professional and Honor Societies

Air Force Institute of Technology PhD Fellow
Institute of Electrical and Electronics Engineers, Senior Member
American Institute of Aeronautics and Astronautics, Senior Member
Sigma Xi (Research Honor Society)
Tau Beta Pi (Engineering Honor Society)
Sigma Pi Sigma (Physics Honor Society)
Omicron Delta Kappa (Leadership Honor Society)

Recent Research Contracts

NATO, co-principal director, BF 1.9M, plus \$65K ONR (1985-86).
DoD, co-principal investigator, \$5.7M (1985-90).
DARPA, principal investigator, \$50K (1985-89).
DoD, co-principal investigator, \$9.9M (1986-91).
NASA CCDS, co-principal author, \$5M (1988-92).
NASA Space-Grant College, co-principal director, \$1.6M (1989-94).
NATO, co-principal director, BF 800,000, plus \$100K USNavy (1990).
DoE EPSCoR planing grant, \$20K (1991)
DoE EPSCoR fellowship grant, \$250K (1991)
NASA research grant, \$30K (1993)

Management Education

Squadron Officers School	Distinguished Graduate, 1967
Air Command and Staff College	non-resident, 1972
Industrial College of the Armed Forces	non-resident, 1974
Air War College	Distinguished Graduate, 1980

Personal

[REDACTED]

CURRICULUM VITAE

Joan Johnson-Freese

Air War College/Air University
Maxwell AFB, AL 36112
205-953-7427

December 1993

Current Position

Professor of Public Administration & Defense Management
(1981-1993, University of Central Florida)

Higher Education

B.A. Bowling Green State University, Bowling Green, Ohio, 1974
M.A. Case Western Reserve University, Cleveland, Ohio, 1977
Ph.D. Kent State University, Kent, Ohio, 1981

Experience

Director, Center for Space Policy & Law, University of Central Florida, 1988-1993.
Featured analyst: BBC International Radio documentary on spaceflight, December 1993.
Featured analyst: BBC "Tonight Show" special on the US space program, September 1993.
Featured analyst in Austria public television documentary on hypersonic flight, produced 1993.
AIAA International Cooperation in Space Workshop, Co-Chair Space Science Working Group
Kona, Hawaii, December 1992
Consultant, Canadian Space Agency, 1992-1993
Visiting Researcher, Institute of Space & Astronautical Science, Sagami-hara, Japan, Dec 1991 -
July 1992 (Sponsored by Japanese Ministry of Education)
Space Committee: U.S.-Japan Leadership Council
Guest lecturer: International Space University, 1991 session, Toulouse, France: 1993 session,
Huntsville, AL.
Florida 2000 Committee: Governor's Planning Committee, 1990-91
SPACEQUEST, Board of Directors, 1991
Florida Bar Association, Ethics Grievance Committee, Term 1989- 1991.
Extensive Overseas Research on Space: European, Japanese and Soviet Space Programs
Invited academic political historian for the Inter-Agency Consultative Group for Space
Science.
International Hypersonic Research Institute, Secretary & Board of Directors, 1989-91
Florida Governor's Commission on Space, Education Subcommittee, 1988
Coordinator, UCF International Space Policy Symposium: 1985 -1991

Moderator, UCF Views the News, Weekly radio/cable television show, 1987
Director of International Studies Center, UCF, 1984-86
Producer/Moderator, SPEAKEASY, WFTV, local ABC affiliate
political issues television show, 1984-1987
Editorial Board, GLOBAL PERSPECTIVES, 1982-1987

Publications

OVER THE PACIFIC: JAPANESE SPACE POLICY INTO THE 21ST CENTURY, (Dubuque, Iowa, Kendall-Hunt Publishing, 1993).

THE PRESTIGE TRAP: A COMPARATIVE STUDY OF THE U.S., EUROPEAN AND JAPANESE SPACE PROGRAMS, Joan Johnson-Freese and Roger Handberg, currently in press, Kendall-Hunt Publishing.

CHANGING PATTERNS OF INTERNATIONAL COOPERATION IN SPACE, (Orbit Books, Kreiger Publishing, Melbourne, FL), September 1990.

Joan Johnson-Freese and George M. Moore, "Space Station Reconceptualised: An Apollo-Soyuz Project for the 1990's," SPACEFLIGHT, forthcoming, February 1994.

Joan Johnson-Freese and George M. Moore, "Clash of the Titans: Competing Space Policy Goals," NATURE, 2 December 1993.

"Development of A Global Environmental & Disaster Observation System (EDOS): Political Support and Constraint," forthcoming in SPACE POLICY, February 1994.

Joan Johnson-Freese, Bill Nelson and Roger Handberg, "The Space Station, NASA and Congress: Micromanaging the Space Station," SPACE TECHNOLOGY, Vol. 13, No. 6, 1993.

Joan Johnson-Freese and Roger Handberg, "International Space Station - Reconceptualize Not Redesign: A Quonset Hut in Orbit," SPACEFLIGHT, Vol. 35, 1993, pp. 2-3."

Joan Johnson-Freese, Roger Handberg and David Webb, "Return from Orbit: Economics As A Driver of Japanese Space Policy," TECHNOLOGY IN SOCIETY, Vol. 14, 1992, pp. 395-408.

Joan Johnson-Freese and Roger Handberg, "You Can't Go Home Again: The Bureaucratization of NASA," SPACE COMMERCE, Vol 1, 1992, pp. 1-12. (This is an extended version of the earlier paper)

"The Evolution of the Inter-Agency Consultative Group: From Halley's Comet to Solar Terrestrial Science," SPACE POLICY, August 1992, pp. 245-255.

Joan Johnson-Freese and Roger Handberg, "Realigning NASA's Destiny: The Symbolic Dimensions of Space Flight," TECHNOLOGY IN SOCIETY, Vol. 13, 1991, pp 433-445.

"Understanding Japanese Technological Decision-Making: The Case of Space Policy," HISTORY AND TECHNOLOGY, Summer 1992.

Joan Johnson-Freese and Roger Handberg, "You Can't Go Home Again: NASA As a Mature Bureaucracy," EARTH SPACE REVIEW, April-June 1992, pp. 25-30.

Roger Handberg, Joan Johnson-Freese and David Webb, "Hanging out for the hypersonic plane," NATURE, 6 February 1992, pp. 491-492.

Joan Johnson-Freese and Roger Handberg, "The Tortoise and the Tortoise: The New Race for Space," SPACE POLICY, November 1991, pp. 199-206.

Joan Johnson-Freese and Roger Handberg, "NASP As An American Orphan: Bureaucratic Politics and the Development of Hypersonic Flight," SPACEFLIGHT, March 1991.

Joan Johnson-Freese and Roger Handberg, "The Hypersonic Option: Now More Than Ever," SPACE COMMERCE, December 1990.

"Can Germany Afford Reunification and a Space Program Too?" TECHNOLOGY & SOCIETY, Vol 12, No. 4, 1990.

Joan Johnson-Freese and Roger Handberg, "If Darkness Falls: The Consequences of a United States No-Go on a Hypersonic Vehicle," SPACEFLIGHT, April 1990.

"A Model for Multinational Space Cooperation: The Inter-Agency Consultative Group," SPACE POLICY, November 1989.

"Changing Patterns of International Cooperation in Space: The Soviet Factor," SPACE POLICY, February 1988.

"Canceling the US Solar Polar Spacecraft: Implications for International Cooperation in Space," SPACE POLICY, February 1987, pp. 24-37.

"High Tech, High Cost: Reasons for Cooperation in Space?" INTERNATIONAL SPACE POLICY: LEGAL & STRATEGIC OPTIONS FOR THE 20TH CENTURY AND BEYOND, Dan Papp & John McIntyre, Eds., Quorum Books, Greenwood Press, Westport, Conn., 1987.

WILLIAM E. RAMSEY

VICE PRESIDENT

Security Clearances

Top Secret/Special Compartmented Intelligence
DISCO Case Control #89191-1551

Education

1953 BS Electrical Engineering, US Naval Academy
1960 U.S. Naval Test Pilot School
Certified Engineering Test Pilot
Aeronautical Engineering course work
1965 RAF Staff College, Bracknell, U.K.
Plans and Analysis
1968 U.S. Naval Nuclear Power School
Nuclear Engineering course work
1969 Nuclear Power Plant Prototype
Nuclear Power Plant Operations
Qualified Nuclear Power Plant Supervisor
1974 Naval War College Faculty
Military Chair of Air Warfare,
Adm William Halsey Chair.-
Graduate studies in Military History and Strategy, Operations Research,
Military Operations and Tactics.

Professional Experience Summary

36 years in U.S. Navy, Naval Aviator, Engineering Test Pilot, Nuclear Power Plant Supervisor, Task Force Commander, Commanding Officer of Nuclear Aircraft Carrier, Recognized authority in Space System Operations, Nuclear Propulsion, Tactical Warfare Command and Control. More than 30 years experience/interaction with DoD, NASA, USAF, USN, USMC, US Army

Vice President ; CTA INCORPORATED, 3/90 - Present

Vice President, Corporate Business Development. Provides overall management of all projects within the division. Responsible for developing basic goals, strategy, operating plans and policies for the Space Systems Division consistent with corporate policy and goal. Develops and integrates business plan for the division organization. Manages approved indirect and direct cost objectives. Implements new business activities for marketing and directs, organizes and plans marketing functions. Responsible for division engineering, project financial planning/control, and customer relations activities.

Special Assistant for Space Systems; CTA INCORPORATED, 7/89 - 3/90

Worked with and reported to Systems Segment Director. Provided advice and counsel on new Space related business opportunities. Initiated strategies for expanding aerospace business base. Authored papers and represented CTA at various national symposia.

In January, 1981, Admiral Ramsey became the first Director, Navy Space Systems, Office of the Chief Naval Operations. He became the first Deputy Commander in Chief of the United States Space Command upon activation of the unified command on September 23, 1985. On retirement from active duty on March 1, 1989, Admiral Ramsey was presented

the Defense Distinguished Service Medal, the Department of Defense's highest peacetime award, by the Secretary of Defense.

The Admiral is a naval aviator with more than 4,700 flying hours in tactical aircraft, 912 carrier landings, with 258 at night. His military decorations and awards include the Legion of Merit with gold star in lieu of 2nd award, Bronze Star Medal with combat "V" device, Air Medal with two gold stars and number "8" in lieu of subsequent awards, Navy Commendation Medal with combat "V" device with three gold stars and one combat "V" device in lieu of subsequent awards, Combat Action Ribbon, Navy Unit Commendation awarded USS INTREPID, Meritorious Unit Commendation awarded USS INDEPENDENCE, National Defense Service Medal, Republic of Vietnam Meritorious Unit Citation Gallantry Cross Color, Vietnam Service Medal with one bronze star, Republic of Vietnam Campaign Medal with device, and the Navy Distinguished Service Order, Second Class, by the Republic of Vietnam.

Admiral Ramsey was awarded the 1986 Military Astronautics Trophy by the American Astronautical Society. Admiral Ramsey was one of the five test pilots in 1962 nominated for the Ivan C. Kincheloe Award as the outstanding test pilot of the year by the Society of Engineering for the GEMINI program. The Admiral returned to Houston in 1963 as one of the final group selected for the APOLLO program interviews.

He was promoted to the rank of Vice Admiral on November 21, 1985.



Robert W. RisCassi
(General, United States Army Retired)

Positions Held:

Commander in Chief, United Nations Command/Korea

Vice Chief of Staff, United States Army

Director, Joint Staff, Joint Chiefs of Staff

Deputy Chief of Staff for Operations and Plans,
United States Army

Commander, Combined Arms Center

Commanding General, 9th Infantry Division and
Commander, Army Development and Employment Agency

Served in a series of positions of leadership and other
positions of increasing responsibility in the United
States Army

Experience:

As United Nations Commander was responsible for the defense of the Republic of Korea and the leadership and management of the largest standing coalition involving United States Forces, to include a standing force of nearly 700,000 men and women.

As Vice Chief of Staff of the Army, was responsible for assisting the Chief of Staff with the leadership and management of the total two million people Army, with particular emphasis on formulating and managing the implementation of a \$75 billion dollar annual budget.

Significant Achievements:

As Commander in Chief of the United Nations Command, led the restructuring of the alliance for post-Cold War challenges and environment; including formulation of a new theater strategy and efforts to prevent peninsular nuclear proliferation.

Conducted discussions and negotiations with numerous heads of state and highest military authorities in Asia and Europe regarding politico-military-economic issues.

Inculcated a strong climate in the Army of high standards, caring leadership, and operating efficiency, all leading to improvements in retention, morale, and effectiveness.

Led the Army's drive to inculcate Total Quality Management throughout the force, leading to savings of hundreds of millions of dollars a year, increased efficiency, and a more effective management and leadership climate.

Directed reforms of Army Research and Development and procurement structures, systems, and methods resulting in streamlined chains, faster decision cycles, and increased accountability.

Initiated and directed the development of state-of-the-art software and hardware for upgrading the functions of command, control, communications, and intelligence that have been applied across the armed forces, from lower unit through theater levels.

As Director of the Joint Staff and coalition commander of American and Korean forces in Korea, advised the Presidents and defense ministers of both nations on defense and foreign policy matters.

As Director of the Joint Staff reformed and adapted the Joint Staff to meet enhanced responsibilities under the Goldwater-Nichols Bill, and reformulated the decisionmaking decisions for strategic planning, program formulation and oversight of the \$270 Billion defense budget.

Professional Skills and Knowledge:

Decision Making and Agency Interaction Within U.S. Government
Strategic and Long-range Planning
Financial Planning and Development of Resources
Human Resources Planning and Leadership Development
Materiel Development and Acquisition
International Relations with Particular Focus on National Security

Civil Education:

1958	University of Connecticut (BA)
1970	Masters Degree in Political Science from Auburn University
1974	Masters Equivalent from the Army War College

BERNARD A. SCHRIEVER
General, United States Air Force (Retired)

Bernard A. Schriever retired from the United States Air Force in 1966 as a Four-Star General after more than 33 years of service. His last assignment of 7 1/2 years was in command of the U.S. Air Force Systems Command which was responsible for all Air Force research, development, testing and acquisition of all USAF weapons systems. As Commander of the Air Force Ballistic Missile Division from 1954-59, he gained fame for having successfully carried out the initial responsibility for the development and deployment of U.S. long range ballistic missiles and military space systems.

After retirement he became a Management Consultant to industry and served on a number of Boards including Control Data, Eastern Airlines, American Medical International and the Aerospace Corporation. He currently serves on the Board of Emerson Electric and is Chairman of Matra Aerospace, Inc. He is on the Advisory Board of Advanced Technology Ventures, a high technology venture capital organization and serves as a consultant to Aerojet-General Corp., Rockwell International and The Wackenhut Corp.

Since retiring he has served in many advisory roles for the U.S. Government. He was Chairman of the President's Advisory Council on Management Improvement (PACMI) during the Nixon Administration. In the Reagan Administration he served on the President's Foreign Intelligence Advisory Board (PFIAB). He has also had numerous ad hoc study assignments associated with the Air Force Scientific Advisory Board and the Defense Science Board. He is currently serving on the Ballistic Missile Defense Organization (formerly SDIO) Advisory Committee.

General Schriever was born in Bremen, Germany in 1910. He has a B.S. degree from Texas A&M (1931) and while in the Air Force he received a master's degree in Aeronautical Engineering from Stanford (1942). He has received seven honorary doctorate degrees. In the military education system, he attended the Air Force Engineering School and the National War College.

General Schriever became a member of the National Academy of Engineering in 1967; he was inducted into the Aviation Hall of Fame in 1980; received the Forrestal Award in 1986; is an Honorary Fellow in the American Institute of Aeronautics and Astronautics; and currently serves as Chairman of the Air Force Armament Museum at Eglin AFB in Florida.

General Schriever is married to Dora Brett and has two daughters and one son, 11 grandchildren and 3 great-grandchildren. He resides in Washington, DC.

July 1993

JAMES R. THOMPSON, JR.

James R. Thompson, Jr., joined Orbital Sciences Corporation as Executive Vice President and Chief Technical Officer on December 9, 1991, and was appointed Executive Vice President and General Manager of the Launch Systems Group on October 1, 1993.

Thompson served as NASA's Deputy Administrator from July 6, 1989, to November 8, 1991, following 33 months as head of the Marshall Space Flight Center, Huntsville, Alabama. During that period, the multifaceted Marshall Center oversaw the redesign and testing of the Space Shuttle's critical solid rocket boosters. The success of that effort was a prerequisite to NASA's "return to flight" on September 29, 1988, when the Space Shuttle Discovery was launched on the first Shuttle mission in almost three years.

Before becoming Marshall Director on September 29, 1986, Thompson served three years as Deputy Director for Technical Operations at Princeton University's Plasma Physics Laboratory, Princeton, New Jersey. From March to June 1986, he served as the Vice Chairman of the NASA task force inquiring into the cause of the Space Shuttle Challenger accident. In that capacity, he headed the day-to-day operations of the 51-L Data and Design Analysis Task Force, which collected and analyzed information in support of the Presidential Commission on the Space Shuttle Challenger accident.

Previously, Thompson spent 20 years with NASA at Marshall in various positions, including Associate Director for Engineering in the Science and Engineering Directorate and manager of the Space Shuttle Main Engine Project in the Shuttle Projects Office.

Thompson joined the research and development team at the Marshall Center in 1963 as a liquid propulsion system engineer responsible for component design and performance analysis associated with the J-2 engine system on the Saturn Launch Vehicle. In 1966, he joined the Space Engine Section in the former Propulsion and Vehicle Engineering Laboratory and became chief of the section in 1968. In that capacity, he was responsible for the design and test evaluation of auxiliary space engine propulsion systems for the Saturn Launch Vehicle and experimental small interplanetary propulsion systems.

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In 1969, Thompson transferred to the former Astronautics Laboratory where he served as chief of the Man/Systems Integration Branch from 1969 to 1974. In September 1974, he was named manager of the Main Engine Projects Office. In that position, he was responsible for the development and operation of the most advanced liquid propulsion rocket engine ever developed. He served in that capacity almost from the beginning of early development testing on the Shuttle main engine through the initial Shuttle flights.

In February 1982, Thompson was named Associate Director for Engineering in the Science and Engineering Directorate. In this position, he was responsible for planning and executing the engineering overview, analysis, evaluation and support for all Marshall projects that were in the hardware development stage.

Born in Greenville, South Carolina, Thompson graduated from Druid Hills High School, Atlanta, in 1954. He was awarded a bachelor's degree in aeronautical engineering from the Georgia Institute of Technology in 1958 and a master of science degree in mechanical engineering from the University of Florida in 1963. He also has completed all course work at the University of Alabama toward a Ph.D in fluid mechanics.

He served as a lieutenant in the U.S. Navy from 1958 to 1960, and was stationed at Green Cove Springs, Florida, as an administrative officer in the Atlantic Fleet.

Thompson began his professional career in 1960 as a development engineer with Pratt Whitney Aircraft, West Palm Beach, Florida.

December 1993

JAMES R. THOMPSON, JR.

HONORS:

- Elected Fellow, AAS, 1992
- 1991 Holley Medalist, The American Society of Mechanical Engineers
- John F. Kennedy Astronautics Award, American Astronautical Society, 1991
- NASA's Distinguished Service Medal, 1991, 1988, 1981
- Elected Fellow, AIAA, 1991
- Presidential Rank of Distinguished Executive, 1990
- Dr. Wernher von Braun Award for Excellence in Space Program Management, AIAA, 1990
- Goddard Memorial Trophy awarded to Shuttle Return-To-Flight Team, National Space Club, 1989
- Holger N. Toftoy Award, AIAA, 1989
- Charter Inductee, Alabama Engineering Hall of Fame, 1989
- Distinguished Service Award, Huntsville, Alabama Chamber of Commerce, 1988
- Honorary Ph.D., Doctorate of Science, University of Alabama/Huntsville, 1988
- First Wernher von Braun Memorial Trophy, National Space Club, 1988
- NASA's Distinguished Public Service Medal, 1988
- Presidential Rank of Meritorious Executive, 1987, 1982
- San Fernando Valley Engineer of the Year Award, 1980
- NASA's Exceptional Service Medal, 1973

General Larry D. Welch, USAF (Retired)

Curriculum Vitae

Education:

B.S. - Business Administration - University of Maryland
M.S. - International Relations - George Washington University
Armed Forces Staff College (Intermediate Professional Education)
National War College (Senior Professional Education)
Harvard National Security Seminar (Graduate Seminar)

Professional Experience:

President and Chief Executive Officer of The Institute for Defense Analyses (IDA) in Washington D.C. — a federally chartered research center providing operations and technical analysis, and management and information systems design and development for the Department of Defense and other U.S. government agencies.

Chief of Staff, United States Air Force 1986-1990

Senior uniformed officer responsible for organizing, equipping, and executive direction. Member of the Joint Chiefs of Staff, serving with the Chairman and other service chiefs as military advisors to the Secretary of Defense and the President on National Security Matters.

Commander in Chief, Strategic Air Command 1985-1986

Joint Specified Command responsible for operational planning for all U.S. strategic nuclear systems. Air Force field command responsible for the operational readiness of the bomber and ICBM legs of the strategic nuclear deterrent.

Vice Chief of Staff, U.S. Air Force 1984-1985

Responsible for the day to day work of the Headquarters, USAF staff and coordination with other services and other government agencies.

Deputy Chief of Staff, Programs & Resources, Hq. USAF 1982-1984

Responsible for formulating program proposals; long range programming; and manpower and organization. Also responsible for programs for sales of military equipment, and associated training and logistics support plans to foreign nations.

Commander, Air Force Central Command and 9th Air Force 1981-1982

Responsible for the daily command and management of USAF tactical forces in the eastern half of the U.S. Also serves as air component commander to the United States Central Command.

Headquarters Tactical Air Command 1977-1981

Served successively as inspector general, deputy chief of staff (DCS) for plans and deputy chief of staff for operations.

Tactical Fighter Wing Commander 1974-1976

Commanded the first operational F-15 Wing.

Earlier service

Enlisted in the National Guard in 1951 then enlisted in the Air Force. Entered officer and pilot training in 1954. Assignments included operational and staff assignments in training organizations and tactical fighter units in Europe, the United States and the Pacific to include combat in Vietnam. Fighter wing deputy commander for operations and vice wing commander.

Professional Associations:

Aerospace Education Foundation, Member
Air Force Academy Foundation, Director
Air Force Association, National Director
Air War College Foundation, Member
Atlantic Council, Councillor
Boy Scouts of America, National Capitol Area Council Executive Board, President
Carnegie Commission on the Reduction of Nuclear Danger, Advisory Council Member
Council on Foreign Relations, Member
Defense Science Board, Member
Institute for Defense Analyses, Board of Trustees
Joint Committee on Nuclear Surety (DOD/DOE), Chairman
Joint Security Commission(DOD/CIA), Member
Lawrence Livermore National Laboratory Director's Advisory Council, Member
National Eagle Scout Association, Member
University of Maryland, Honorary Doctorate of Law
U.S. Strategic Command Strategic Advisory Group, Member
Veterans of Foreign Wars, Member
Washington Strategy Seminar, Advisory Board
World Affairs Council of Washington D.C., Member

Special Awards:

Ira Eaker Fellow - 1985
Distinguished Eagle Scout Award - 1985
Jimmy Doolittle Fellow - 1986
Maxwell A. Kriendler Memorial Award - 1989
Barry Goldwater Fellow - 1990
Stuart Symington Award - 1990
Thomas D. White National Defense Award - 1991
Silver Beaver Award , Boy Scouts of America - 1993
Oklahoma Air and Space Hall of Fame - 1993

JOHN P. WHITE

Director, Business and Government
J.F.K. School of Government
Harvard University
79 Kennedy Street
Cambridge MA 02138
(617) 495-3316



DATE AND PLACE OF BIRTH: [REDACTED]

MILITARY SERVICE: USMC 1959-61 (Lt); Reserve 1961-68 (Maj)

PROFESSIONAL/CAREER EXPERIENCES

B.S. Cornell University, 1959, Industrial Relations
M.S. Syracuse University, 1964, Economics
Ph.D. Syracuse University, 1969, Economics

1959-1962	General Electric Company - Personnel
1963-1966	Syracuse University - Graduate Researcher
1964-1968	Lemoyne College - Economics Professor
1968	Rand - Research Economist
1969-1971	Rand - Director Manpower Research for USAF
1971-1975	Rand - Vice President
1973-1977	Rand - Board of Trustees
1975-1977	Rand - Senior Vice President, National Security
1977-1978	DOD - ASD (MRA&L)
1978-1980	White House - Deputy Director, OMB
1981-1983	Interactive Systems Corp - Chairman
1983-Pres	Eastman Kodak Company, Vice President & General Manager, Integration and Systems Products Division

MEMBERSHIP ON BOARDS, COMMITTEES, PROFESSIONAL SOCIETIES, ETC.

Member, Defense Science Board Task Force on Electronics Management, 1973-74
Member, U.S. Army Materiel Acquisition Review Committee (associate chairman, costing team), 1974-75
Member, Council on Foreign Relations
Member, Defense Organization Project, Center for Strategic and International Studies, Georgetown University, 1984-85
Member, Board of Directors, Proximity Technology, Inc
Member, Business Advisory Committee, Schlumberger Technologies, Inc
Member, Los Angeles Committee on Foreign Relations
Advisory Trustee, The Rand Corporation
Member, Board of Trustees, Council for Excellence in Government
Member, Airway Science Research Advisory Council, Embry-Riddle Aeronautical University

PUBLICATIONS

Numerous Rand and DOD publications



Biography

United States Air Force

AIR UNIVERSITY (AETC)

Office of Public Affairs - Maxwell Air Force Base, AL 36112-6335 (205)953-2014

Lieutenant General Jay W. Kelley

Lieutenant General Jay W. Kelley is commander, Air University, Maxwell AFB, Ala., and director of education, Air Education and Training Command. As such, he ensures that Air Force needs in the areas of enlisted and officer professional military education, professional continuing education and graduate education are met, as well as officer commissioning through Officer Training School, and the Reserve Officer Training Corps.

He enlisted in the Air Force Reserve in 1959, and was selected to attend the Air Force Academy in 1960, graduating and receiving his commission in June 1964. He has served as a base commander and a strategic missile wing commander, been assigned to the Organization of the Joint Chiefs of Staff, was the vice commander of Air Force Space Command, and director of public affairs, Office of the Secretary of the Air Force.



General Kelley and his wife, Marty, both natives of Frankfort, Ind., are the parents of two daughters.

Education:

- 1964 Bachelor of science degree, U.S. Air Force Academy.
- 1967 Squadron Officer School, Maxwell AFB, Ala.
- 1973 Master of science degree in political science, Auburn University, Montgomery, Ala.
- 1973 Air Command and Staff College, Maxwell AFB, Ala.
- 1980 Research associate, International Institute for Strategic Studies, London.
- 1981 National War College, Ft. Leslie J. McNair, D.C.
- 1986 Program for Senior Executives in National and International Security, John F. Kennedy School of Government, Harvard University.
- 1987 Massachusetts Institute of Technology Program on Foreign Politics and National Interest.

Assignments:

1. June 1964 - October 1964, student, Missile Launch Officer Course, Davis-Monthan AFB, Ariz.
2. October 1964 - June 1968, Titan II missile combat crew member/standardization officer, Davis-Monthan AFB, Ariz
3. June 1968 - July 1973, command project officer, Minuteman III Re-Entry System, Office of the Deputy Chief of Staff for Plans, Headquarters Strategic Air Command, Offutt AFB, Neb.
4. July 1973 - June 1977, Missile Tactics Branch, Joint Strategic

(Over)

Target Planning Staff. Later, chief, Missile Tactics Division.

5. June 1977 - October 1979, Operations Directorate, Strategic Operations Division, Organization of the Joint Chiefs of Staff, Washington, D.C.

6. October 1979 - July 1980, Air Force research associate, International Institute for Strategic Studies, London.

7. June 1981 - June 1982, deputy commander for operations, 351st Strategic Missile Wing, Whiteman AFB, Mo.

8. June 1982 - July 1983, commander, 351st Combat Support Group, Whiteman AFB, Mo.

9. July 1983 - June 1985, commander, 381st Strategic Missile Wing, McConnell AFB, Kan.

10. June 1985 - June 1986, assistant chief of staff, Headquarters Strategic Air Command, Offutt AFB, Neb.

11. June 1986 - April 1988, senior military advisor to the director, U.S. Arms Control and Disarmament Agency, Washington D.C.

12. April 1988 - June 1988, assistant deputy chief of staff for plans, Air Force Space Command, Peterson AFB, Colo.

13. June 1988 - June 1989, deputy chief of staff for operations, Headquarters Air Force Space Command,

14. June 1989 - May 1990, deputy chief of staff for plans and requirements, Air Force Space Command.

15. May 1990 - May 1992, vice commander, Air Force Space Command

16. May 1992 - October 1992, director of public affairs, Office of the Secretary of the Air Force, Washington, D.C.

17. October 1992 - present, commander, Air University

Operational Information:

Rating: Senior space officer, command missile officer

Major awards and Decorations:

Air Force Distinguished Service Medal

Defense Superior Service Medal

Legion of Merit

Defense Meritorious Service Medal

Meritorious Service Medal with one oak leaf cluster

Joint Service Commendation Medal

Combat Readiness Medal

Effective Dates of Promotion:

Second Lieutenant	June 3, 1964
First Lieutenant	December 3, 1965
Captain	December 3, 1967
Major	November 1, 1972
Lieutenant Colonel	December 1, 1976
Colonel	February 1, 1980
Brigadier General	August 1, 1987
Major General	June 1, 1990
Lieutenant General	October 28, 1992

(Current as of July 1, 1993)

COLONEL CHARLES G. WHITE, JR

BIOGRAPHY

UNITED STATES AIR FORCE

Colonel Charles G. "Snip" White, Jr., is the project director for the CSAF space study, SPACECAST 2020. The purpose is to envision new and innovative space systems and applications to support the warfighter and national security in the 21st century.

He earned a bachelor of science degree in biology from Clemson University in 1968 and a master of science degree in systems management from St. Mary's University, San Antonio, Texas in 1976. He completed Squadron Officer School in May 1974, Air Command and Staff College in May 1982 and Air War College in May 1989.

Colonel White was commissioned in December 1968 through the Reserve Officer Training Corps program at Clemson University, where he was a distinguished military graduate. He then entered undergraduate pilot training at Sheppard Air Force Base, Texas, graduating in February 1970. In October 1970, he reported to the 23rd Tactical Air Support Squadron at Nakhon Phanom Royal Thai Air Force Base, Thailand, as a forward air controller in the O-2A. He later transferred to the A-1 in the 1st Special Operations Squadron, also at Nakhon Phanom.

In November 1970, the colonel returned to Sheppard Air Force Base and the 90th Flying Training Squadron, 80th Flying Training Wing, as a T-38 instructor pilot and check pilot, training German and American students. In May 1974, he was assigned to the 560th Flying Training Squadron, 12th Flying Training Wing, at Randolph Air Force Base, Texas, as a T-38 pilot instructor training instructor. He also served as an assistant operations officer, squadron executive officer, and flight commander.

In November 1978, Colonel White was assigned to the 313th Tactical Fighter Squadron at Hahn Air Base, Germany, to fly the F-4E. While there, he was a flight commander and assistant operations officer.

In December 1980, he joined the faculty of the Air Command and Staff College, Maxwell Air Force Base, Alabama, as a warfighting curriculum developer. In his third year, Colonel White was chosen as chief of the Theater Warfare Branch.

In July 1983, Colonel White was assigned to fly the F-4E with the 51st Tactical Fighter Wing at Osan Air Base, Korea, and

also was the wing executive officer. The following year he became a programmer in the Forces Division of Headquarters Pacific Air Forces, Plans and Programs Directorate at Hickam Air Force Base, Hawaii. He was responsible for all fighter dispositions in theater and the initial beddown of F-16s at bases in Japan and Korea.

In December 1985, he was appointed as the deputy executive assistant to the U.S. commander in chief, Pacific at Camp Smith, Hawaii, and in January 1988, he became the executive assistant to USCINCPAC.

Colonel White graduated from the Air War College, Maxwell Air Force Base, Alabama, in 1989 and remained at Maxwell AFB as director of the Joint Flag Officer Warfighting Course (JFOWC), Center for Aerospace Doctrine, Research and Education. The JFOWC prepares service chief-selected two-star officers from all military services for theater-level combat leadership responsibilities. The course is tailored to warfighting commanders and service component commanders, with a unique perspective of the operational level of war and campaign planning.

He was assigned in June 1991 to Columbus Air Force Base, Mississippi, as deputy commander for operations for the 14th Flying Training Wing. He assumed the position as vice wing commander in December 1991.

In July 1992, Colonel White returned to Maxwell Air Force Base, assigned to the Department of National Security Studies at the Air War College. He assumed his present position in June 1993.

Colonel White is a command pilot with more than 3,550 flying hours in the T-37, T-38 and F-4E, including 686 combat hours (180 combat missions) in the O-2A and A-1E/H. His decorations include the Defense Superior Service Medal, Legion of Merit, Distinguished Flying Cross with one oak leaf cluster, Meritorious Service Medal with two oak leaf clusters, Air Medal with 11 oak leaf clusters, Air Force Commendation Medal with two oak leaf clusters and the Vietnamese Cross of Gallantry with Palm.

He was promoted to Colonel in October 1989.

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He was promoted to Colonel in October 1989.

26 Oct 93

FROM: SPACECAST 2020 RESEARCH DIRECTOR

SUBJ: FACULTY WORKSHOP

TO: SPACECAST 2020 FACULTY AND RESEARCH
ADVISORS

We've arranged for a SPACECAST faculty workshop to be held in Brock's Auditorium every Friday from 1330 to 1430 to discuss SPACECAST issues and concepts. Please plan to attend.

Rich
RICHARD ZAFRANSKI, COL, USAF
SPACECAST 2020 Research Director

CC: Maj Hendrix

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RICHARD SZAFRANSKI, COL, USAF
SPACECAST 2020 Research Director

CC: Maj Hendrix

25 October, 1993

FROM: SPACECAST 2020 Research Support Director

SUBJ: SPACECAST AWC & ACSC Students' Educational Degrees

TO: SPACECAST 2020 Seminar/Team Leaders and R.A.T. Chief

To compile the SPACECAST students' bios, we need a listing of their educational degrees. Please forward this list to me at SPACECAST 2020, AU library, by 5 Nov 93.

"EXAMPLE"

<u>NAME, RANK</u>	<u>DEGREE</u>	<u>SPECIALTY</u>	<u>YEAR</u>
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Thank you.

Deborah L. Myrick
DEBORAH L. MYRICK, Capt, USAF
Director, SPACEAST 2020 Research Support