The Legacy of TRW and Space Park

A Summary with Key Dates and Milestones

Revision 6

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November 2008

This document was created by the author for educational purposes and is not an official statement of dates and events.

Table of Contents

Introduction

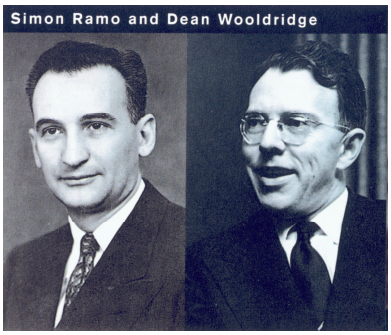
Simon Ramo and Dean Wooldridge were two brilliant scientists who pushed back the frontiers of science and also developed a new engineering integration process called "systems engineering." Both Caltech PhDs at age 23 they formed a team at Hughes Aircraft in 1946 with a goal of establishing an electronics research laboratory. After seven very successful years they chose to form their own company leaving Hughes on the eventful date of 9/11/1953 to pursue the development of advanced electronic systems. They felt that integral electronic systems could be salable products just as an aircraft company would buy complete engines from another company. The R-W Corp flourished doing not only electronic systems development but also in assisting the US Government in developing the brand new and technology-stressing Intercontinental Ballistic Missile (ICBM). Not only were products built, but the concept of integration called systems engineering was validated. On the cover of Time Magazine, Ramo and Wooldridge were truly outstanding examples of American ingenuity and drive. The ability to advance the products of science as well as introduce the new process of system engineering was a most valuable contribution to American industry.

The purpose of the present booklet is to present an abbreviated summary of the important dates and milestones of the company they founded. The booklet also includes the completion dates of the major buildings at Space Park (SP), the launch dates of major satellite systems, and start dates of both ICBM and laser projects. Some of the early organization charts and announcements are included as appendices. The history and role of Thompson Products, Ramo and Wooldridge's initial financial backer, is summarized with dates and milestones in an appendix.

The booklet is not an official document of Northrop Grumman and any errors are the responsibility of the author. Conversation with Dr Ramo regarding events and dates is gratefully acknowledged.

Key Dates and Milestones

The Ramo-Wooldridge Corporation



source: Reference 3

1913 Simon Ramo and Dean Wooldridge born

1936 Ramo and Wooldridge earned PhDs from Caltech

Ramo joined General Electric in Schenectady, NY
Wooldridge joined Bell Telephone Laboratories in New Jersey

1946 Ramo joined Hughes Aircraft and Wooldridge followed
Their objective: develop complete avionics systems for aircraft and missiles

Sept 11 1953 Ramo and Wooldridge left Hughes with Gen. Harold George

Sept 16 1953 The Ramo-Wooldridge Corporation (R-W) incorporated in Delaware with financial backing from Thompson Products (TP)

- Common-stock format:
- 49% Class A controlled by TP
- 51% Class B controlled by Ramo and Wooldridge


First R-W office, opened in 1953

TP historical data and milestones summarized in Appendix A

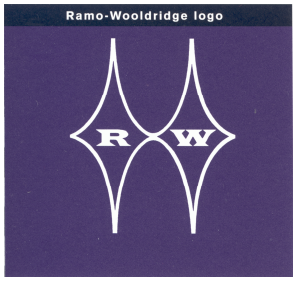
R-W organized with three divisions targeted to develop integrated avionics system:

- Computers
- Communications
- Controls


Site of first R-W office today

1954 Ballistic Missile Systems Engineering and Technical Direction (SETD) contract signed with Air Force

Guided Missile Research Division (GMRD) formed (Appendix B)
ICBM related hardware exclusion accepted



source: Reference 3

Employment Growth

Year	*Total*	*Ballistic Missile*
1953	18	N/A
1954	281	170
1955	1156	760
1956	2657	1557
1957	3269	1961

source: Reference 1

1956 Studies initiated on use of Space for surveillance

1957 Planned expansion into Space with broadening of GMRD

Soviets launched Sputnik on October 4

GMRD reorganized into Space Technology Laboratories (STL) (Appendix C)

1958 STL-built Pioneer 1 launched — 1st NASA satellite

ICBM missile ATLAS flew successfully full range

Oct. 31 1958 Thompson Ramo Wooldridge Inc. was formed

STL remained a separate subsidiary corporation

Gen. Jimmy Doolittle, STL Board Chairman
Louis Dunn, President; Rube Mettler, Executive V.P. (Appendix D)

1959 Moved Controls, Computers, and Communications Divisions to new Canoga Park facility in expansion process and to separate the corporate entities R-W and STL

2nd STL-built satellite, Explorer VI, launched

June 4 1960 Aerospace Corp. founded to provide ICBM advanced planning function for the Air Force 1700 employees of 3680 transferred from STL to Aerospace

1960 Space Park (SP) site purchased from Santa Fe Railroad -- 110 acres in Redondo Beach

Dec 7 1960 — Broke ground at Space Park.
Buildup: R1, R2,
E1, M1 (R3, S followed)

STL proceeded to bid on and build satellites

New Space Park facilities expanded

Building R3 looking west along Marine Ave. 1962

Jan 1 1962 — Wooldridge retired

Employment number was 5440

1963 — The Bunker-Ramo Corporation founded for Computers & Automation

STL's computer stake and Canoga Park facility transferred to Bunker-Ramo

Controls and Communications start to move back to Space Park as facility expands

Corporate consolidation:

- Tapco → TRW Equipment Group
- STL → TRW Space Technology Labs
- Automotive → TRW Automotive Group

May 1965 — Thompson Ramo Wooldridge became TRW, Inc.

STL became
TRW Systems Group under
TRW, Inc. (Appendix E)

Changing of the Building E1 sign, 1965

Fall 1965 Organization of
TRW Systems Group
(Rube Mettler)
(Appendix F)

Buildings R1, R3, E2, and pond

- Systems Engineering & Integration Division (Dick DeLauer)
- Space Vehicle Division (Dolf Thiel / George Gleghorn*)
- Electronic Systems Division (Henry Samulon)
- Power Systems Division (Bob Bromberg / Art Grant)
- Systems Laboratories (George Solomon / Bob Muchmore)
- Special Projects (Bill Carlson)
- Instruments Division (commercial) (Fred Hesse)

Expansion / Spin-off Areas
- Civil Systems and Energy (1965)
- Credit Data (1970)

Feb 1968 Rube Mettler elected Assistant President of TRW Inc.
- Dick DeLauer became Head of Systems Group

1969 Rube Mettler becomes President and COO, TRW Inc.

1970 TRW Systems
(Dick DeLauer)
- Systems Group (George Solomon)
- Systems Application Center (Art Summer)
- Industrial Operations (Fred Hesse)

1971 TRW Systems Group
(George Solomon / Ed Doll)
(Appendix G)
- Applied Technology Division (Bob Bromberg / Art Grant)
- Systems Engineering & Integration Division (Bob Burnett)
- Other Divisions (reporting through Dolf Thiel)
  - Space Vehicle Division (George Harter)
  - Electronic Systems Division (Paul Glazer)
  - Defense & Space Systems Division (Bill Russell)

1978 TRW Systems & Energy Sector (Dick DeLauer)

- Defense & Space Systems Group
  (George Solomon, Bob Burnett / George Harter)
  - ESL acquired (Bill Perry)
  - Applied Technology Division (Art Grant)
  - Systems Engineering and Integration Division (Bill Besserer)
  - Ballistic Missiles Division (Bob Anderson)
  - Manufacturing Division (Hugh Brady)
  - Space Systems Division (Bob Walquist)
  - Electronic Systems Division (Charlie Stephens)
  - Special Programs (Dan Scally)
  - Energy Products Group (Gen. Sam Phillips)
  - Energy Systems Group (Johnny Foster)

1980-1983 TRW Electronics and Defense Sector (George Solomon)
(Appendices H & I)
DeLauer left in April 1981 to become Undersecretary of Defense for Research and Engineering

Organization

- Defense Systems Group (Bob Burnett)
- Electronic Systems Group
  (Charlie Stephens, later Ed Dunford)
- Energy Development Group (Bob Anderson)
  EDG merged with S&TG after 1984
- Operations & Support Group
  Manufacturing Division (Hugh Brady)
- Space & Technology Group (Bob Walquist)
  Applied Technology Division (Gerry Elverum)

1985 – 1986 TRW Electronics and Defense Sector (George Solomon/Bob Burnett)
(Appendix J)

- Federal Systems Group (Bob Williams)
- Space and Technology Group (Ed Dunford)
  (Appendix K)
  - Engineering and Test Division (Paul Mayhew)
  - Applied Technology Division (Gerry Elverum)
  - Energy Division (John Sellers)
  - Defense Projects Division (Dan Goldin)
  - Military Space Systems Division (W. J. Wellems)
  - Federal Systems Division (Al Sabroff)
- Electronics Components Group (Lester Hill/Ira Coron/Forbes Powell)
- Operations and Support Group (Ed Noneman)
- Electronic Systems Group (Bob North/Ed Goldburg)
- Defense Systems Group (Don Jacobs/Nat Trembath)

1988 Rube Mettler retired, Joe Gorman became Chairman, TRW Inc.

1989 TRW Space and Defense Sector (Ed Dunford/Bob Burnett)
(Appendix L)

- TRW Defense Systems Group (Don Jacobs/Nat Trembath)
- TRW Electronic Systems Group (Ed Goldberg/Tim Hannemann)
- TRW Federal Systems Group (Bob Williams/John Stenbit)
- TRW Space and Technology Group (Dan Goldin)

1991 Ed Dunford became President and COO, TRW Inc.

1993 TRW Inc. (Joe Gorman/Ed Dunford)
(Appendix M)

- TRW Automotive
- TRW Information Systems and Services
- TRW Space and Defense
  - Space and Electronics Group (Tim Hannemann/Gordy Williams)
    (Appendix N)
    - Defense Systems Division (Don Winter/Marv Stone)
    - Federal Systems Division (Ed Nowacki)
    - Electronic Systems Division (Paul Sasaki)
    - Spacecraft Technology Division (Don Stager)
    - Electronic Technology Division (Bob Fielding)
    - Applied Technology Division (Joe Miller)
  - Systems Integration Group (John Stenbit)
  - Avionics and Surveillance Group (Bob Kohler)

1994 Ed Dunford retired
Peter Helman became President, TRW Inc.

1998 Space & Electronics Group (Tim Hannemann/Don Winter/Wes Bush)
(Appendix O)

- Defense Systems Division (Ed Nowacki/Dick Croxall)
- Space and Laser Programs Division
  (Joanne Maguire / Tom Romesser)
- Telecommunication Programs Division (Dave Vandervoet)
- Space and Technology Division (Al Frew)
- Electronics and Technology Division (Fred Ricker)
- Avionics Systems Division (Roy Adams)

1999 Dave Cote became President and COO, TRW Inc.
(Appendix P)

- TRW Aerospace and Information Systems Sector (Ron Sugar)
  - TRW Space and Electronics Group (Tim Hanneman)
  - TRW Systems and Information and Technology (Phil Odeen)
  - TRW Aeronautical Systems Group (Ken Maciver)
  - TRW Telecommunications Group (John Stenbit)

2001 Space & Electronics Group (Tim Hannemann/Wes Bush/Joanne Maguire)
Reorganized around Processes:
(Appendix Q)

- Business Development (Joanne Maguire)
- Program Execution (Ed Nowacki/Craig Staresinich))
- Engineering (Dave DiCarlo/Tom Romesser)
- Production and Supply Chain Management (Paul Borzcik/Mike McVey)
- Enabling Processes
- TRW Radio Systems, Rancho Bernardo (Dave Vandervoet)

2002 Northrop Grumman (Kent Kresa, later Ron Sugar) acquired TRW
TRW became:

- NG Space Technology (Wes Bush, later Alexis Livanos)
- NG Mission Systems (Don Winter)
- Part of NG Information Technology
- TRW Automotive Divested

2003 Red "TRW" replaced by
blue "Northrop Grumman"
in sign on Building E2

Northrop Grumman Systems
Technolgy (Wes Bush)
(Appendix R)

- Programs (Ed Nowacki)
- Business Development
  (Jeff Grant)
- Technology Development
  (Tom Romesser)
- Engineering (Dave DiCarlo)
- Production and Supply Chain (Mike McVey)

TRW changing to Northrop Grumman, 2002

Additional information in Appendix S
Summary TRW History Table of Contents from Davis Dyer,
TRW — Pioneering Technology + Innovation since 1900

The Ramo-Wooldridge Element Key-Dates Table*

Year	Project Milestones		Major Facilities Milestones**
	Missile	**Space/Satellite/Propulsion/Laser**	
1953	Oct - Atlas Start		Barber Shop, West 92nd Street
1954			Arbor Vitae
1955	Jan - Thor Start		
1956	Jan - Titan I Start		
1957	Mar - Minuteman I Start		R&D Center, El Segundo
1958		Oct - Pioneer 1	
1959		Aug - Explorer 6; Nov - Able 4	Canoga Park
1960	Oct - Titan II Start		Dec - Space Park Ground Break
1961	Apr - Minuteman II Start		Blds. R1, R2, E1
1962			Blds. R3, M1
1963		Oct - Vela 1, 2 (Total 12, Final Launch 4/70)	Bld. S
1964		Sept - OGO 1 (Total 6, Final Launch 6/69)	Bld. M2, Capistrano Test Site
1965	Jan - Minuteman III Start		
1966		Mar - DSP Start Oct - Pioneer 6 (Total 5, Final Launch 6/69)	Bld. R4
1967			Blds. E2, O1, M3, M4, R5, M5/R6
1968		Sept - INTELSAT III (Total 8, Final Launch 7/70)	
1969		July - LEMDE (Propulsion, Apollo 11)	
1970		Nov - DSP 1 (Total 23, Final Launch Projected 1/06)	
1971		Nov - DSCS II, 1; 2 (Total 16, Final Launch 10/82)	
1972	Apr - Peacekeeper Start	Mar - Pioneer 10 (Total 2, Final Launch 4/73)	
1973		BDL (Laser)	
1974			
1975		NACL (Laser)	
1976		July, Sept - VIKING 1, 2	
1977		Sept - HEAO I (Total 3, Final Launch 9/79)	
1978		Feb - FLTSATCOM 1 (Total 8, Final Launch 9/89) July - TOMAHAWK (Propulsion) MIRACL (Laser)	

*See acronym list ** Primary building list, occupation or dedication date listed

Year	Project Milestones		Major Facilities Milestones**
	Missile	Space/Satellite/Propulsion/Laser	
1979		Sept - MILSTAR	
1980	March - ABRES		Bld. O2 Start
1981			Blds. 110, TF-1
1982	Apr - Small ICBM Start		Blds. O3, 140, D1
1983		Apr - TDRS 1 (Total 7, Final Launch 7/95)	Blds. 134, T-1
1984			Rancho Carmel
1985			Bld. O4
1986		Jan - TDRS 2, Challenger	
1987			
1988			
1989			
1990		ALPHA (Laser)	
1991		Apr - GRO	
1992			
1993			
1994		ALI (Laser)	
1995			
1996		July - TOMS	
1997			
1998			
1999		Jan - ROCSAT 1; July - Chandra; Dec - KOMPSAT	
2000		Sept – THEL (Laser, missile-salvo shoot-down)	
2001			
2002		May - EOS AQUA	
2003			
2004		Feb - DSP 22; July- EOS AURA ABL (Laser, “first light”)	
2005			
2006		Jan - DSP 23 (Projected)	

Acronyms

Organizations

BR	Bunker Ramo
BTL	Bell Telephone Laboratories
CSD	Civil Systems Division
DSD	Defense Systems Division
E&D	Electronics and Defense Sector
E&TD	Electronics and Technology Division
EDG	Energy Development Group
GE	General Electric
GMRD	Guided Missile Research Division
NG	Northrop Grumman
S&TD	Space and Technology Division
S&TG	Space and Technology Group
STL	Space Technology Laboratories
Tapco	Thompson Aircraft Products Company
TRW	Thompson Ramo Wooldridge

Programs

ABL	Airborne Laser
ALI	Alpha Lamp Integration
AXAF	Advanced X-Ray Astrophysics Facility (Chandra)
BDL	Baseline Demonstration Laser
DSCS	Defense Satellite Communications System
DSP	Defense Support Program
EOS	Earth Observing System (Aqua and Aura)
FLTSATCOM	Fleet Satellite Communication System
GRO	Gamma Ray Observatory
HEAO	High Energy Astronomy Observatory
KOMPSAT	Korea Multipurpose Satellite
LEMDE	Lunar Excursion Module Descent Engine
MILSTAR	Military Strategic-Tactical and Relay
MIRACL	Mid-Infrared Advanced Chemical Laser
MM	Minuteman
NACL	Navy ARPA Chemical Laser
OGO	Orbiting Geophysical Observatory
ROCSAT	Republic of China Satellite
TDRSS	Tracking and Data Relay Satellite System
THEL	Tactical High Energy Laser
TOMS	Total Ozone Mapping Spectrometer – Earth Probe

Appendix A

Key Dates and Milestones

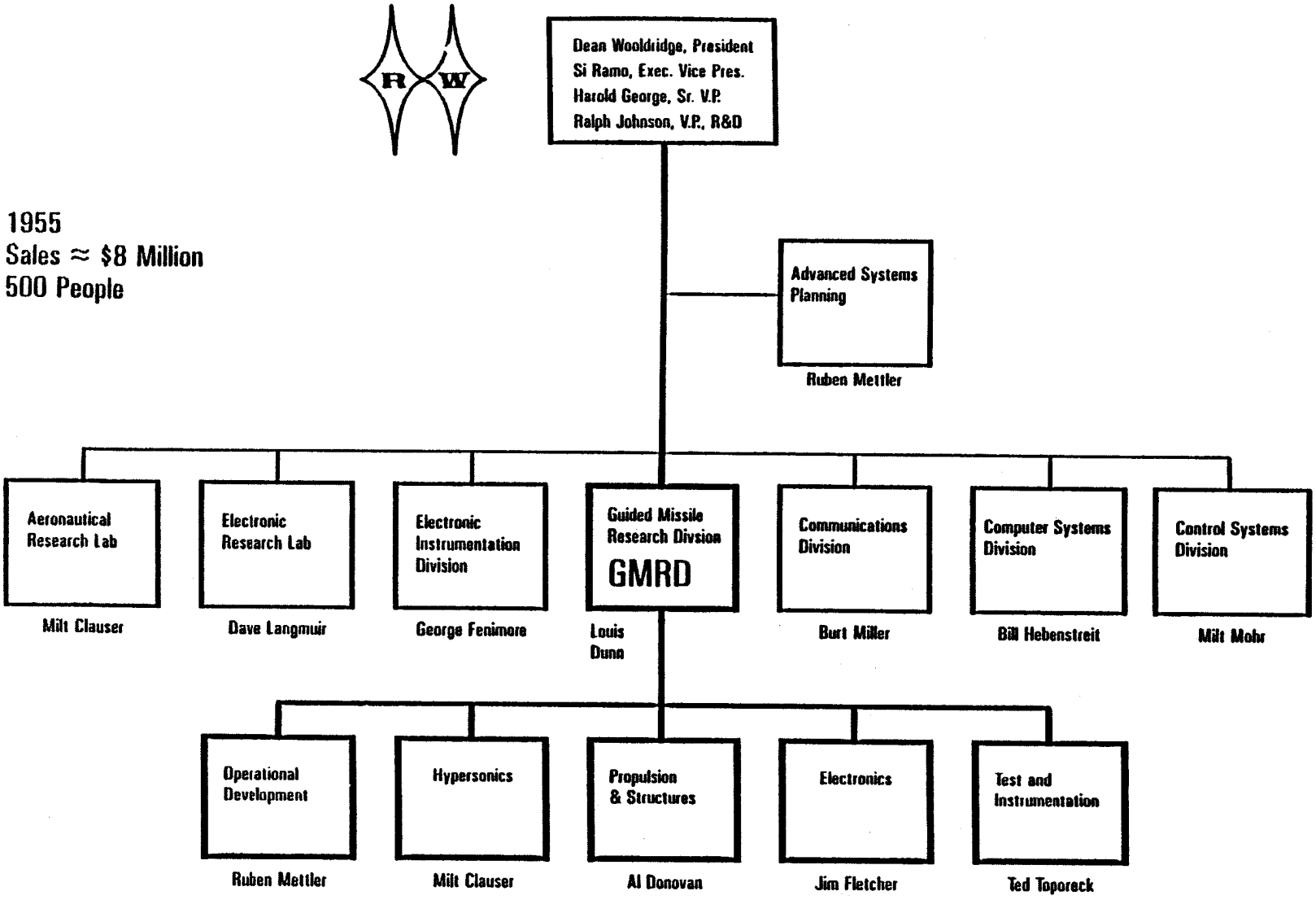
Thompson Products

Key Dates and Milestones
Thompson Products

December 1900	Incorporated as “Cleveland Cap Screw Co.” for producing machine screws by electrically welding heads to stems
August 1903	Alexander Winton (born 1860) bought stock in the company
1904	Charlie Thompson (born 1871) hired as electrician
1905	Winton Motor Co. acquired majority interest in Cleveland Cap Screw Co. with Winton as president
1906	Automobile valve production started using the electric-welding cap-screw method
	Thompson appointed General Manager
1908	“Cleveland Cap Screw Co.” renamed “Electric Welding Products Co.”
1915	“Electric Welding Products Co.” renamed “Steel Products Co.”
	Market expanded to aircraft valves
1916	Thompson hired Harvard graduate Fred Crawford (born 1891)
	Thompson forced Winton and his investors to sell their interest in Steel Products Co. Thompson became president
1926	Company renamed “Thompson Products”
1927	Produced valves for Lindberg's airplane, “Spirit of St. Louis”
1933	Thompson died suddenly
1934	Crawford successfully assumed company control
1941	Tapco (Thompson Aircraft Products Co.) founded Produced 400,000 automobile and aircraft valves per month at peak
1953	Thompson Products provided the financial backing for The Ramo-Wooldridge Corporation
1958	Crawford retired (died at age 103 in 1994) Dave Wright, Horace Shepard assumed management of Thompson Products

Appendix B

The Ramo-Wooldridge Organization Chart, 1955


1955
Sales ≈ $8 Million
500 People
Dean Wooldridge, President
Si Ramo, Exec. Vice Pres.
Harold George, Sr. V.P.
Ralph Johnson, V.P., R&D
Advanced Systems Planning
Ruben Mettler
Aeronautical Research Lab
Milt Clauser
Electronic Research Lab
Dave Langmuir
Electronic Instrumentation Division
George Fenimore
Guided Missile Research Divsion
GMRD
Louis Dunn
Communications Division
Burt Miller
Computer Systems Division
Bill Hebenstreit
Control Systems Division
Milt Mohr
Operational Development
Ruben Mettler
Hypersonics
Milt Clauser
Propulsion & Structures
Al Donovan
Electronics
Jim Fletcher
Test and Instrumentation
Ted Toporeck

Appendix C

STL Organization Announcement, 1957

THE RAMO-WOOLDRIDGE CORPORATION

LOS ANGELES 45, CALIFORNIA

INTEROFFICE CORRESPONDENCE

TO: All Employees CC: DATE: November 22, 1957

SUBJECT: Organizational Announcement FROM: D. E. Wooldridge

The attached news story, to be released to the press tomorrow, tells of the creation and functions of the new Space Technology Laboratories as an autonomous division of The Ramo-Wooldridge Corporation.

Dr. Simon Ramo will be President; Dr. Louis G. Dunn, Executive Vice President and General Manager, and Dr. Ruben F. Mettler, Vice President and Assistant General Manager of the Laboratories.

Dean E Wooldridge

DEW
aj

news release

THE RAMO-WOOLDRIDGE CORPORATION
5500 W. EL SEGUNDO BLVD. · LOS ANGELES 45, CALIFORNIA · OREGON 8-0511 · OSBORNE 5-4651

release date: SATURDAY A.M., NOVEMBER 23, 1957

NEWS BUREAU
Don Flamm, Ext. 1769

LOS ANGELES, Calif. --Establishment of the Space Technology Laboratories as an autonomous operating division of The Ramo-Wooldridge Corporation was announced today by Dean E. Wooldridge, President.

The new division is an outgrowth and extension of the former Guided Missile Research Division, a unit of the company responsible for the technical direction and systems engineering for the Air Force Ballistic Missile Program ATLAS, TITAN and THOR missiles.

Space Technology Laboratories will have its own completely separate personnel, facilities and services, according to Dr. Wooldridge. Transfer to the Laboratories of certain additional research facilities, technical and administrative supporting services previously provided on a company-wide basis, is also planned. In addition, transfer of several top R-W scientists and technical experts to the enlarged Laboratories' organization will shortly be announced.

In pointing out that all organization rearrangements are intended to increase the strength and flexibility of the Laboratories' technical support provided to expanding Air Force space weapons programs, Dr. Wooldridge revealed that only research, development, systems engineering and technical study types of activities are planned. He added that "like its predecessor, the Guided Missile Research Division, Space Technology Laboratories will engage in no manufacturing operations, its objective being to serve the Government and its production contractors in the vital field of space weapon systems."

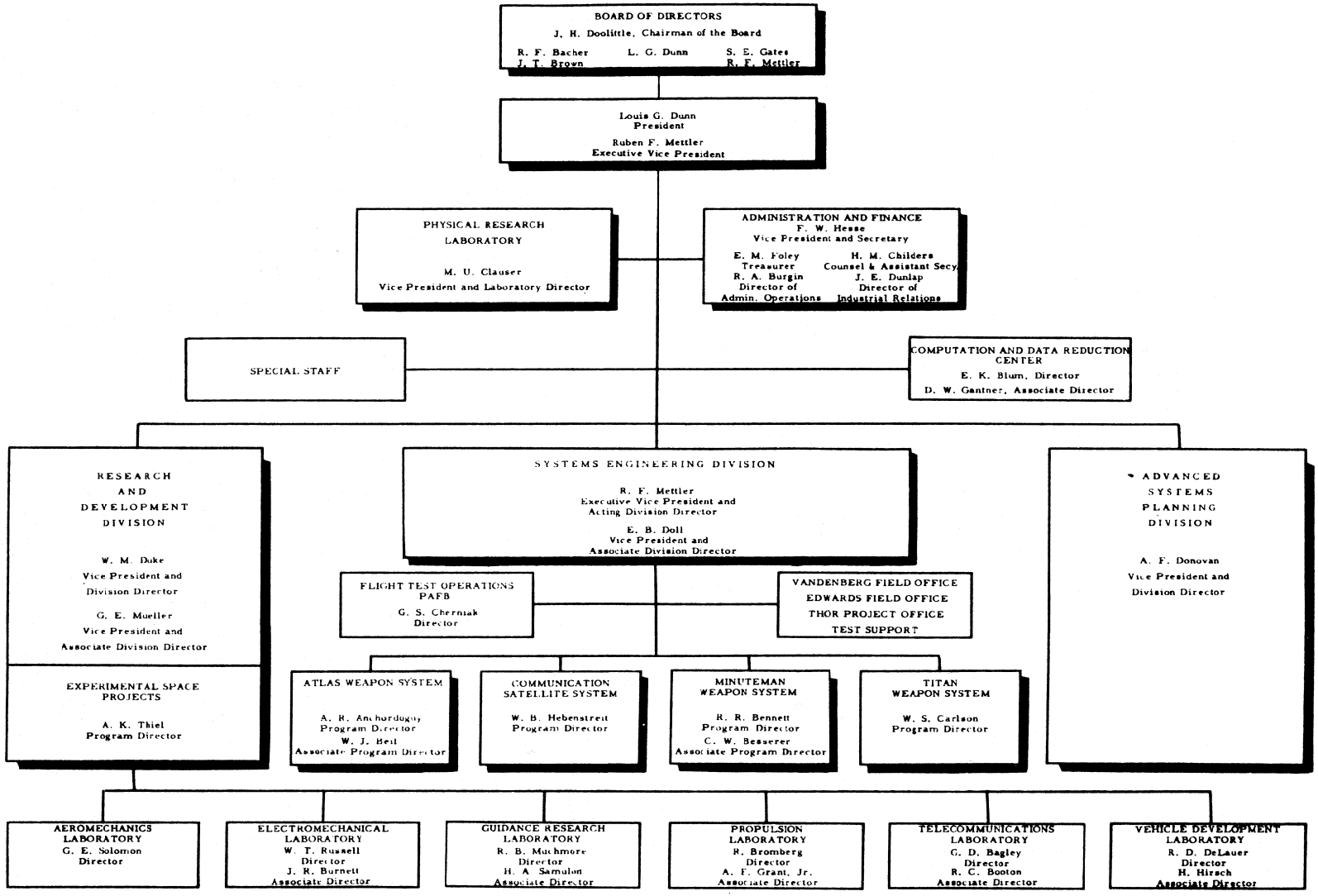
Ramo-Wooldridge Corporation executive changes, reflecting the importance of the Space Technology Laboratories' role, were also announced by Dr. Wooldridg Dr. Simon Ramo will relinquish his duties as Executive Vice President and Secretary of the Corporation to devote full time as President of the Space Technology Laboratories. Dr. Ramo will remain as a Board member of the parent Ramo-Wooldridge Corporation. Other top officers in Space Technology Laboratories will include Dr. Louis G. Dunn, Executive Vice President and General Manager, and Dr. Ruben F. Mettler, Vice President and Assistant General Manager.

Appendix D

STL Organization Chart, April 1960

(just prior to formation of Aerospace Corp.)

SPACE TECHNOLOGY LABORATORIES, INC.



Appendix E

TRW Inc. Organization Announcement, 1965

TRW INC.

July 1, 1965

MEMORANDUM TO ALL DIRECTORS AND MANAGERS

GUIDELINES FOR USE OF OUR NEW NAME

Two significant name changes have been announced recently:

Thompson Ramo Wooldridge Inc. has been changed to TRW Inc., and

Effective today, TRW Space Technology Laboratories becomes TRW Systems Group

For use external to TRW it is preferred that the short version of our name, TRW Systems, be used. Either TRW or TRW Inc. is correct to describe the Corporation as a whole. When it is desired to maintain our separate identity within the Corporation, and/or to indicate our position in the Corporation, our full name, TRW Systems Group, should be used for clarity and emphasis. When space is limiting, and if it is not essential to distinguish us from other units of the Corporation, TRW is an appropriate abbreviation for TRW Systems. All other abbreviations, such as TRW/S, TRW-S, TRW-SG, etc., are not to be used.

External correspondence, other than that requiring the full corporate name, should be signed as follows:

For one-page letter on company letterhead	For a letter of more than one page (final sheet on plain bond)
Sincerely,	Sincerely,
R. D. Jones, Director Guidance Laboratory	R. D. Jones, Director Guidance Laboratory TRW Systems

For proposals, official contractual correspondence and other instances where the full corporate name should be used for formal or legal purposes, the following signature block applies:

TRW INC.

R. D. Jones, Director
Guidance Laboratory
TRW Systems Group

In this signature block, the use of TRW Systems instead of TRW Systems Group is optional. As a general rule, we will refer to ourselves as TRW Systems in the body of all letters, reports, etc., prepared for outside use.

External to TRW we will use new stationery, business forms, etc., prepared with our new name. Until such new material is available, a label, "Our New Name is TRW Systems, TRW Inc.," has been prepared for use with old forms.

Where it is desirable to identify our old name with our new name, a label, "Formerly TRW Space Technology Laboratories (STL)," is available for use with our new stationery.

Internal to TRW and TRW Systems, including interoffice correspondence, the TRW prefix may be dropped from our name. Here we will use either Systems Group or Systems. Internally our present stocks of stationery, business forms, and other materials will be utilized until they are exhausted.

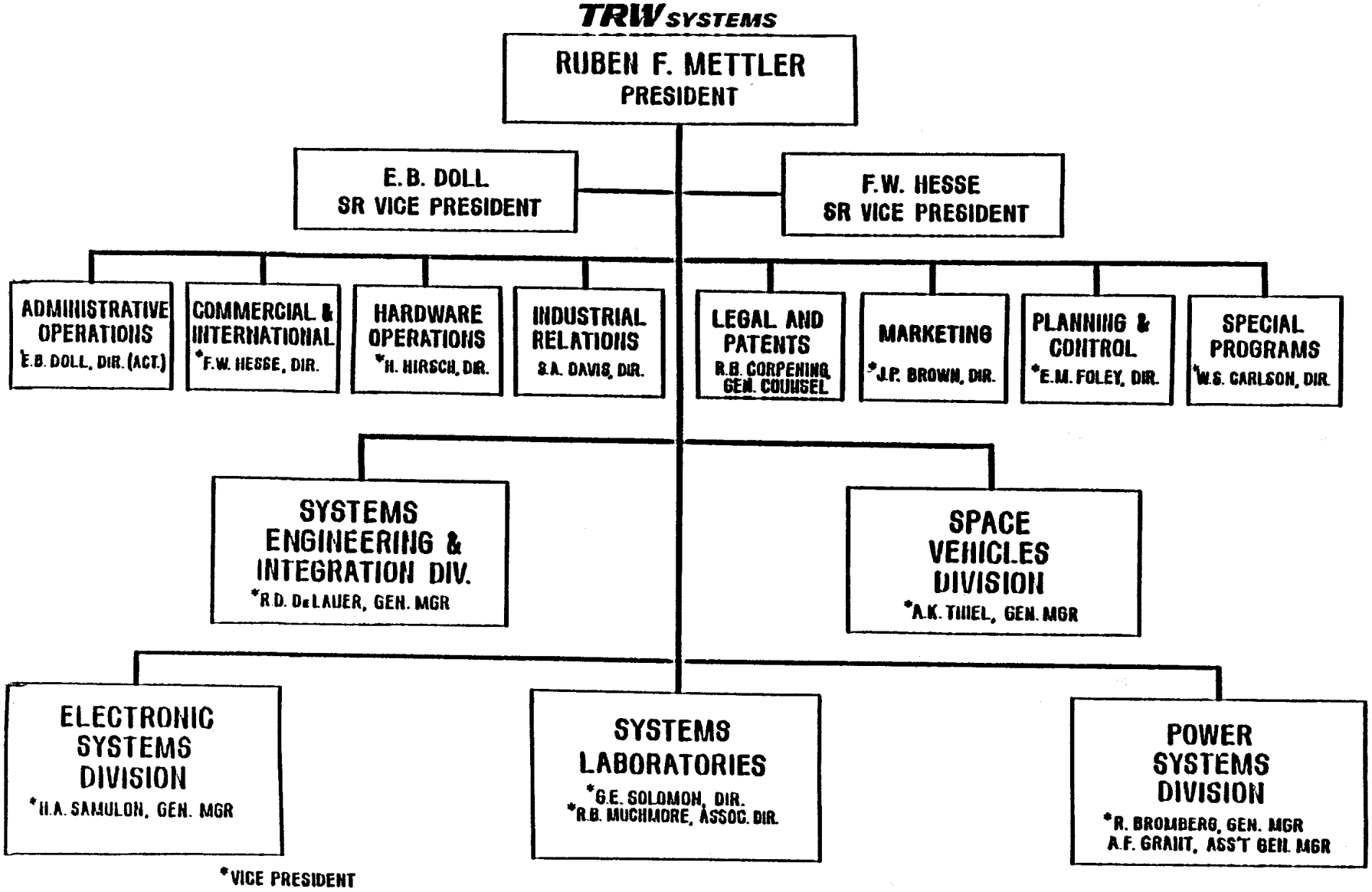
Effective today our switchboards will answer "TRW Systems," and our official mailing address is:

TRW Systems
One Space Park
Redondo Beach, California 90278

E. B. DOLL

Appendix F

TRW Systems Organization Chart, 1965


TRW SYSTEMS
RUBEN F. METTLER
PRESIDENT
E.B. DOLL
SR VICE PRESIDENT
F.W. HESSE
SR VICE PRESIDENT
ADMINISTRATIVE OPERATIONS
*E.B. DOLL, DIR. (ACT.)
COMMERCIAL & INTERNATIONAL
*F.W. HESSE, DIR.
HARDWARE OPERATIONS
*H. HIRSCH, DIR.
INDUSTRIAL RELATIONS
S.A. DAVIS, DIR.
LEGAL AND PATENTS
R.B. CORPENING, GEN. COUNSEL
MARKETING
*J.P. BROWN, DIR.
PLANNING & CONTROL
*E.M. FOLEY, DIR.
SPECIAL PROGRAMS
*W.S. CARLSON, DIR.
SYSTEMS ENGINEERING & INTEGRATION DIV.
*R.D. DeLAUER, GEN. MGR
SPACE VEHICLES DIVISION
*A.K. THIEL, GEN. MGR
ELECTRONIC SYSTEMS DIVISION
*H.A. SAMULON, GEN. MGR
SYSTEMS LABORATORIES
*G.E. SOLOMON, DIR.
*R.B. MUCHMORE, ASSOC. DIR.
POWER SYSTEMS DIVISION
*R. BROMBERG, GEN. MGR
A.F. GRANT, ASS'T GEN. MGR
*VICE PRESIDENT

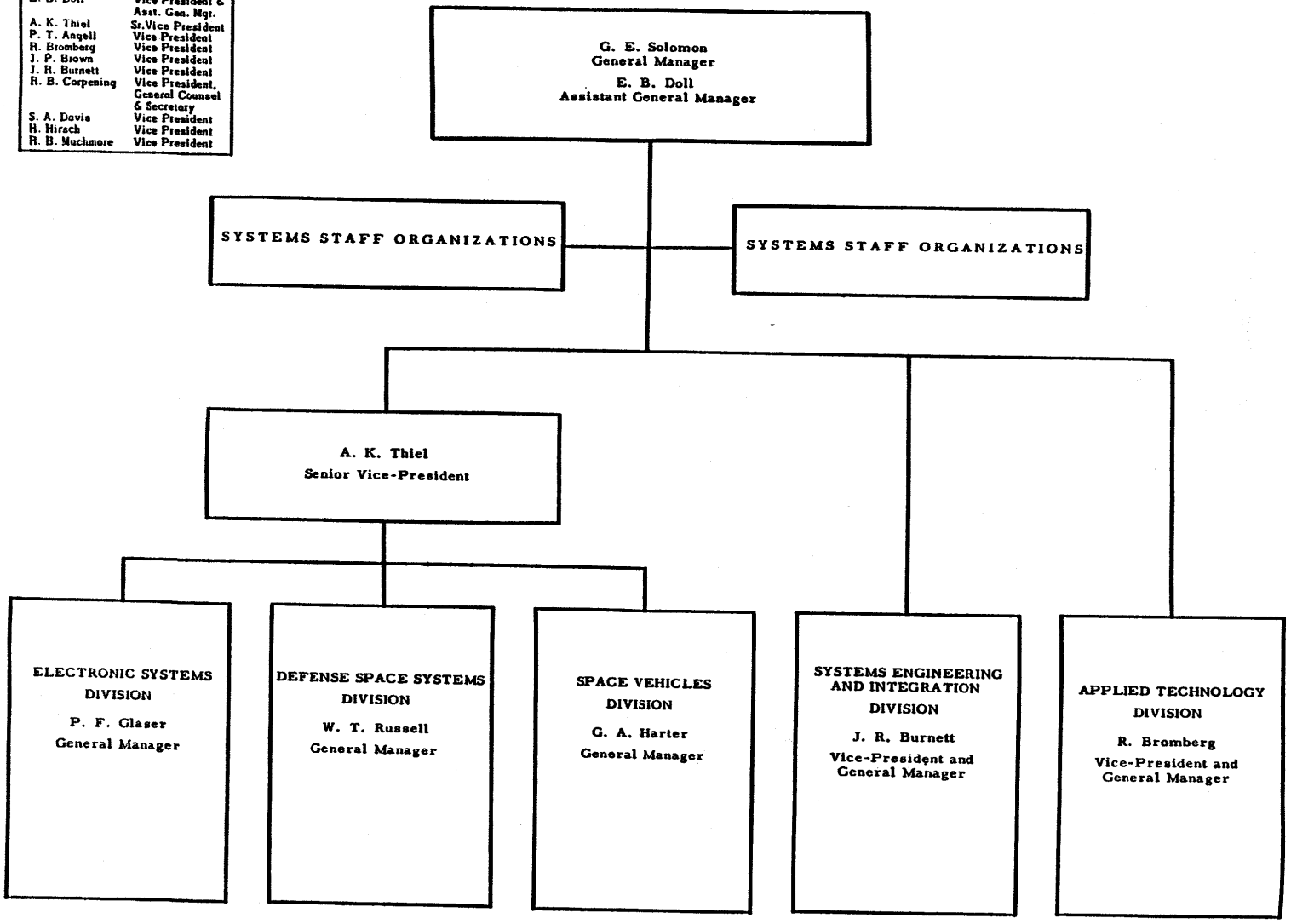
1965 A 003.36

Appendix G

TRW Systems Organization Chart, 1971

TRW SYSTEMS

TW SYSTEMS OFFICERS	
G. E. Solomon	Vice President & General Manager
E. B. Doll	Vice President & Asst. Gen. Mgr.
A. K. Thiel	Sr. Vice President
P. T. Angell	Vice President
R. Bromberg	Vice President
J. P. Brown	Vice President
J. R. Burnett	Vice President
R. B. Corpening	Vice President, General Counsel & Secretary
S. A. Davis	Vice President
H. Hirsch	Vice President
R. B. Muchmore	Vice President

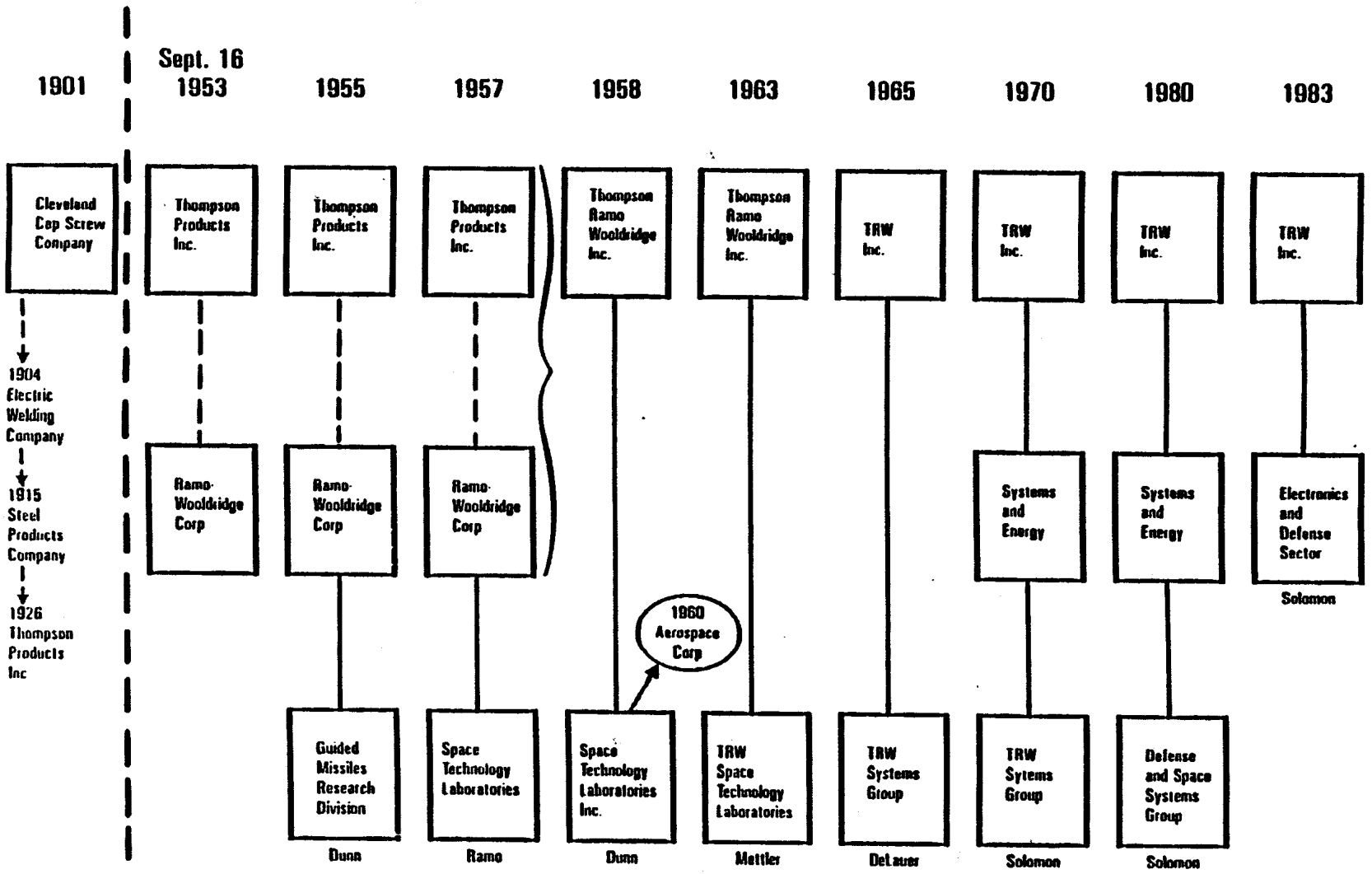


March 1971

Appendix H

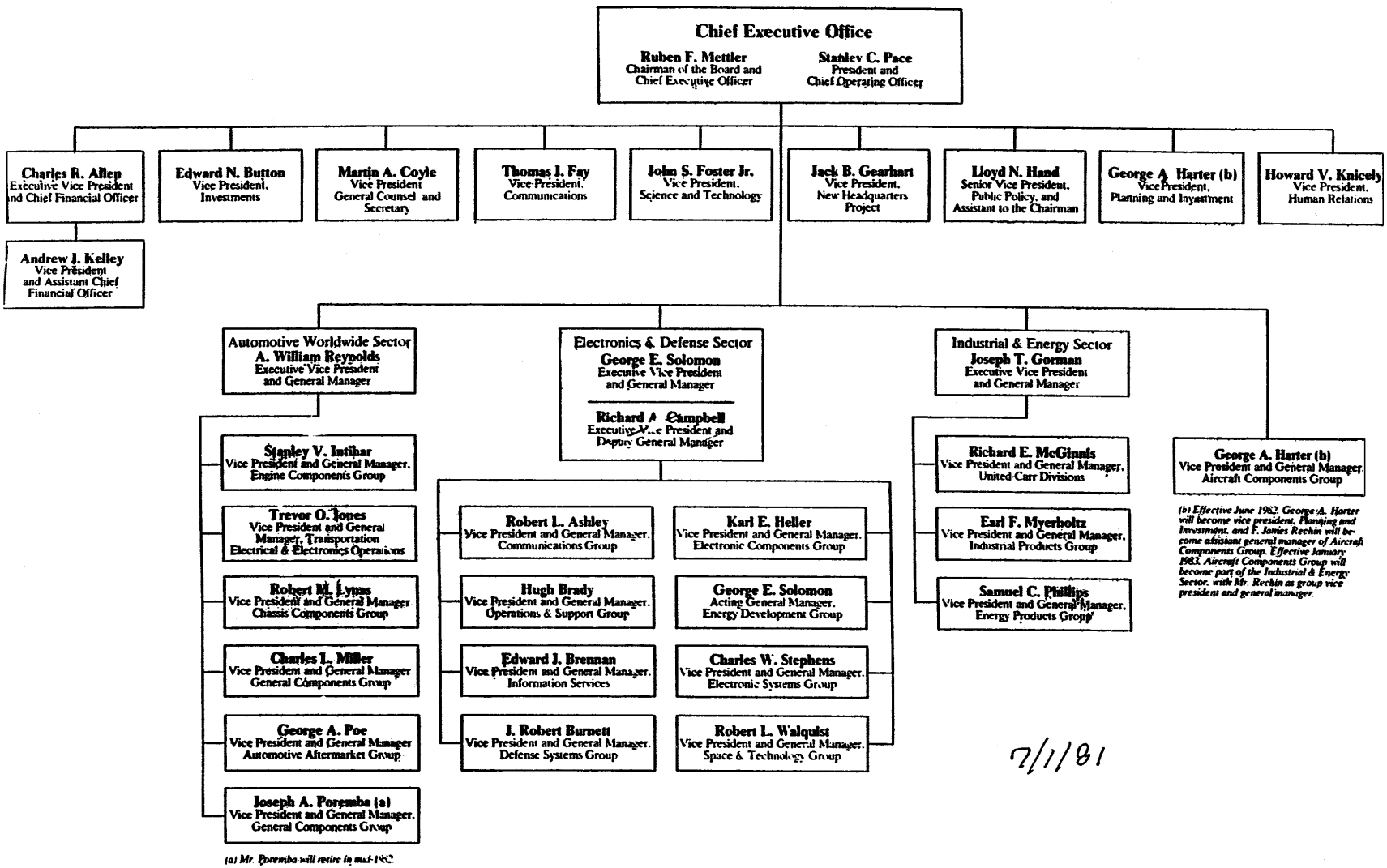
Evolution of E&D Sector Names

Evolution of Electronics & Defense Sector



Appendix I

TRW Inc. Organization Chart, 1981


Chief Executive Office
Ruben F. Mettler
Chairman of the Board and
Chief Executive Officer
Stanley C. Pace
President and
Chief Operating Officer
Charles R. Allen
Executive Vice President
and Chief Financial Officer
Andrew J. Kelley
Vice President
and Assistant Chief
Financial Officer
Edward N. Button
Vice President,
Investments
Martin A. Coyle
Vice President
General Counsel and
Secretary
Thomas J. Fay
Vice President,
Communications
John S. Foster Jr.
Vice President,
Science and Technology
Jack B. Gearhart
Vice President,
New Headquarters
Project
Lloyd N. Hand
Senior Vice President,
Public Policy, and
Assistant to the Chairman
George A. Harter (b)
Vice President,
Planning and Investment
Howard V. Knicely
Vice President,
Human Relations
Automotive Worldwide Sector
A. William Reynolds
Executive Vice President
and General Manager
Stanley V. Intihar
Vice President and General Manager,
Engine Components Group
Trevor O. Jones
Vice President and General
Manager, Transportation
Electrical & Electronics Operations
Robert M. Lynas
Vice President and General Manager
Chassis Components Group
Charles L. Miller
Vice President and General Manager
General Components Group
George A. Poe
Vice President and General Manager
Automotive Aftermarket Group
Joseph A. Poremba (a)
Vice President and General Manager,
General Components Group
(a) Mr. Poremba will retire in mid-1982.
Electronics & Defense Sector
George E. Solomon
Executive Vice President
and General Manager
Richard A. Campbell
Executive Vice President and
Deputy General Manager
Robert L. Ashley
Vice President and General Manager,
Communications Group
Hugh Brady
Vice President and General Manager,
Operations & Support Group
Edward J. Brennan
Vice President and General Manager,
Information Services
J. Robert Burnett
Vice President and General Manager,
Defense Systems Group
Karl E. Heller
Vice President and General Manager,
Electronic Components Group
George E. Solomon
Acting General Manager,
Energy Development Group
Charles W. Stephens
Vice President and General Manager,
Electronic Systems Group
Robert L. Walquist
Vice President and General Manager,
Space & Technology Group
Industrial & Energy Sector
Joseph T. Gorman
Executive Vice President
and General Manager
Richard E. McGinnis
Vice President and General Manager,
United-Carr Divisions
Earl F. Myerholtz
Vice President and General Manager,
Industrial Products Group
Samuel C. Phillips
Vice President and General Manager,
Energy Products Group
George A. Harter (b)
Vice President and General Manager,
Aircraft Components Group
(b) Effective June 1982, George A. Harter will become vice president, Planning and Investment, and F. James Rechin will become assistant general manager of Aircraft Components Group. Effective January 1983, Aircraft Components Group will become part of the Industrial & Energy Sector, with Mr. Rechin as group vice president and general manager.
7/1/81

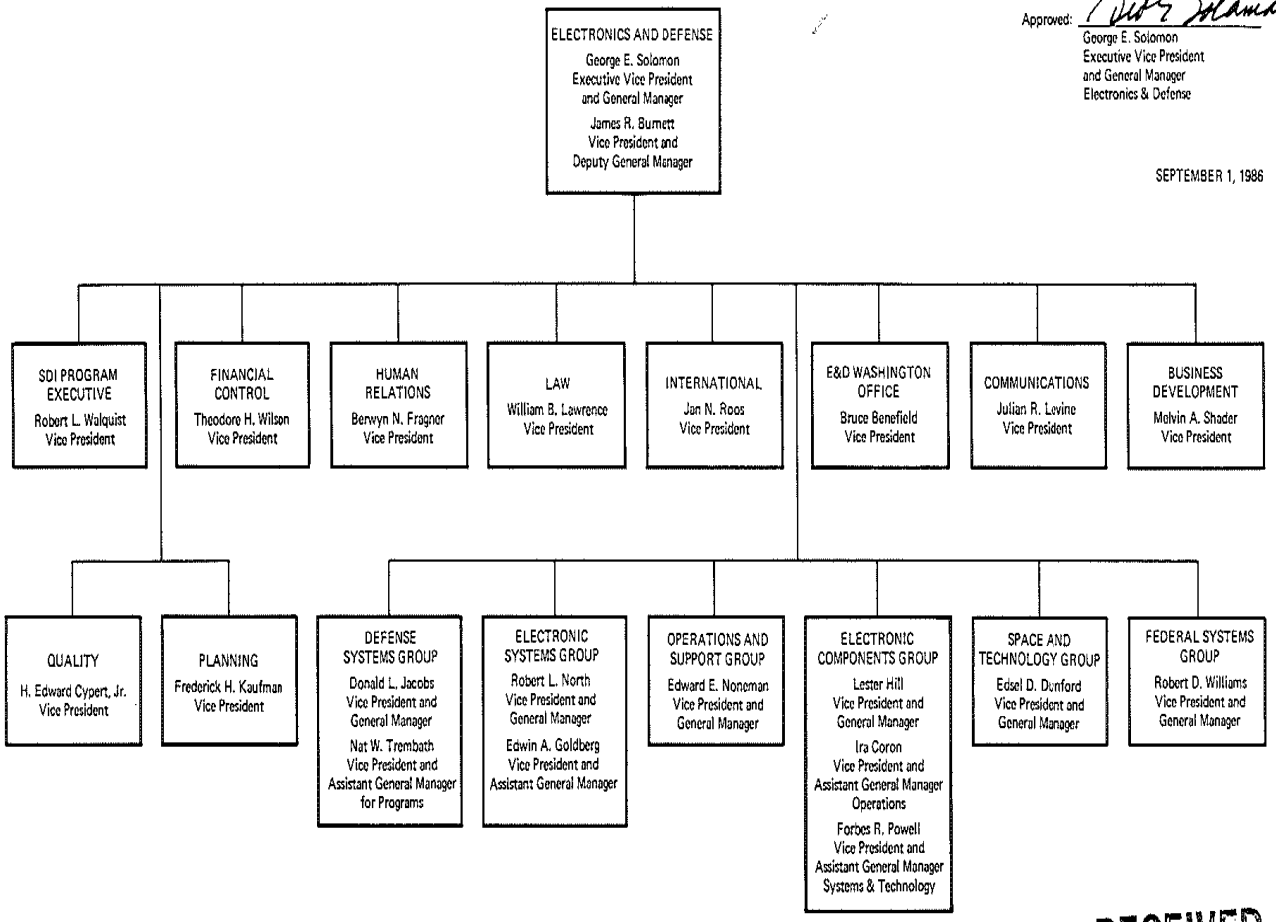
Appendix J

TRW Electronics and Defense Sector, 1986

TRW Electronics and Defense Sector

Approved: George E. Solomon
George E. Solomon
Executive Vice President
and General Manager
Electronics & Defense

SEPTEMBER 1, 1986



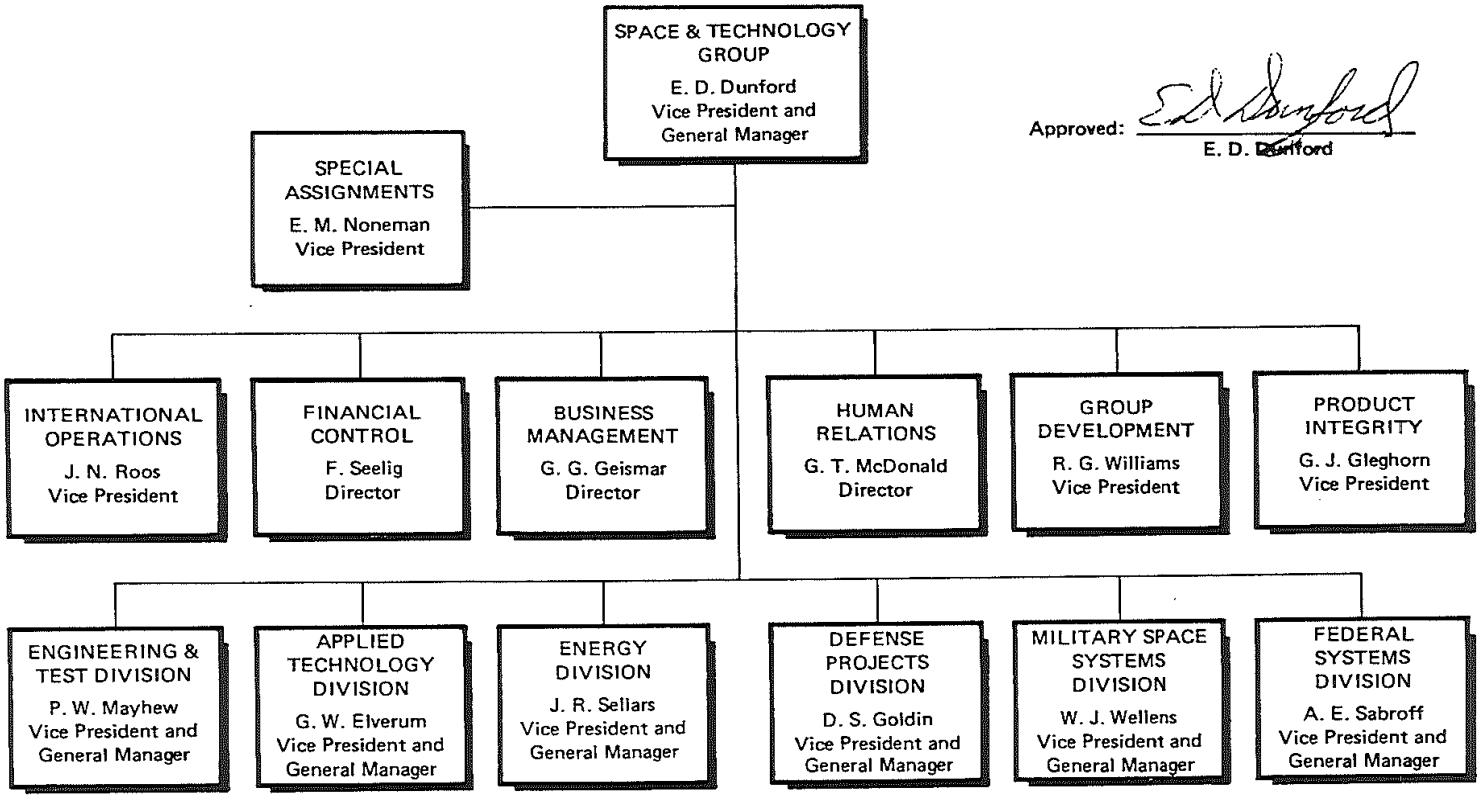
RECEIVED

Appendix K

TRW Space and Technology Group, 1985

TRW Space &
Technology Group

TRW



Approved: Ed Dunford
E. D. Dunford

MAY 1985
FORM APPROVAL BP

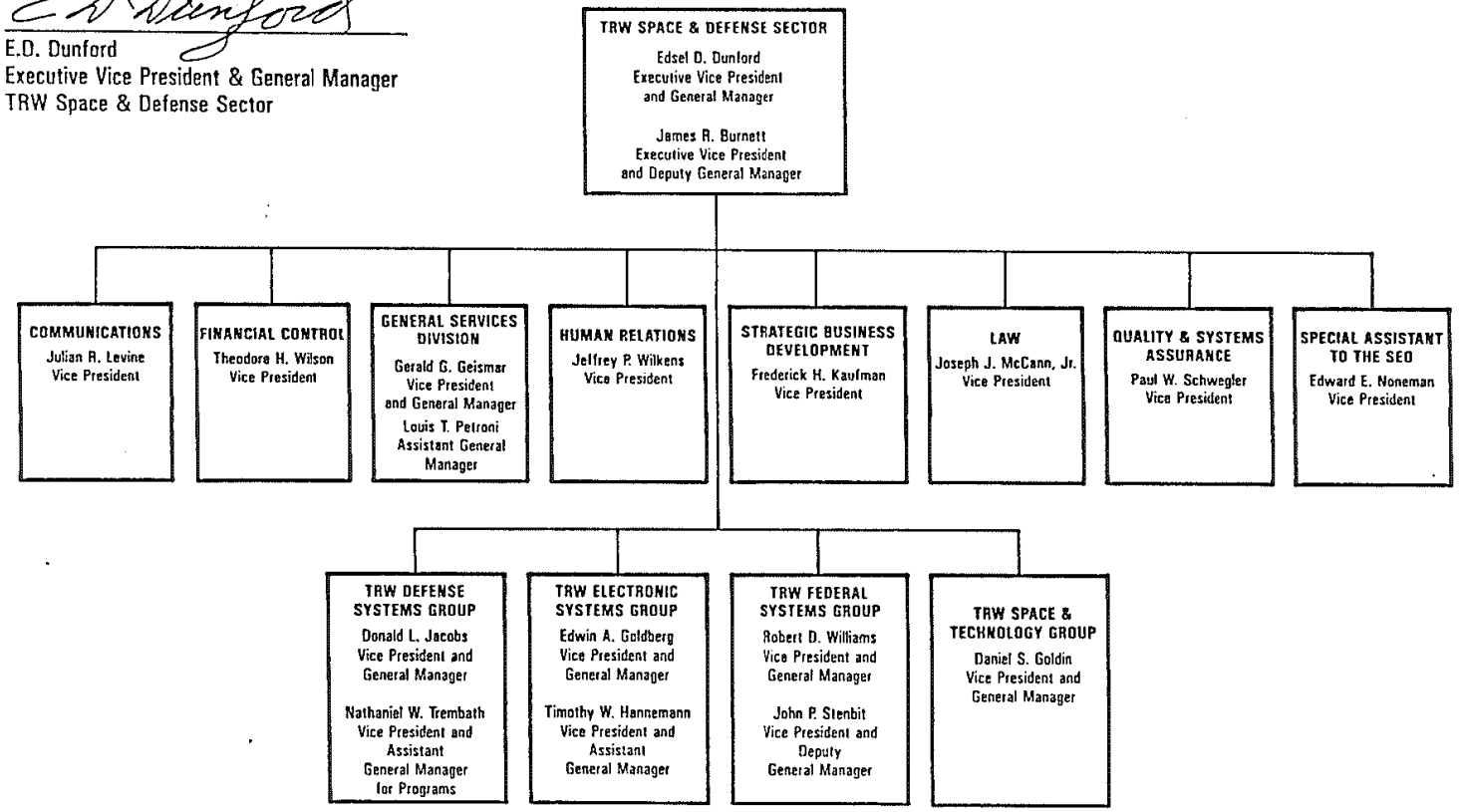
Appendix L

TRW Space and Defense Sector, 1989

TRW Space & Defense Sector

March 1, 1989

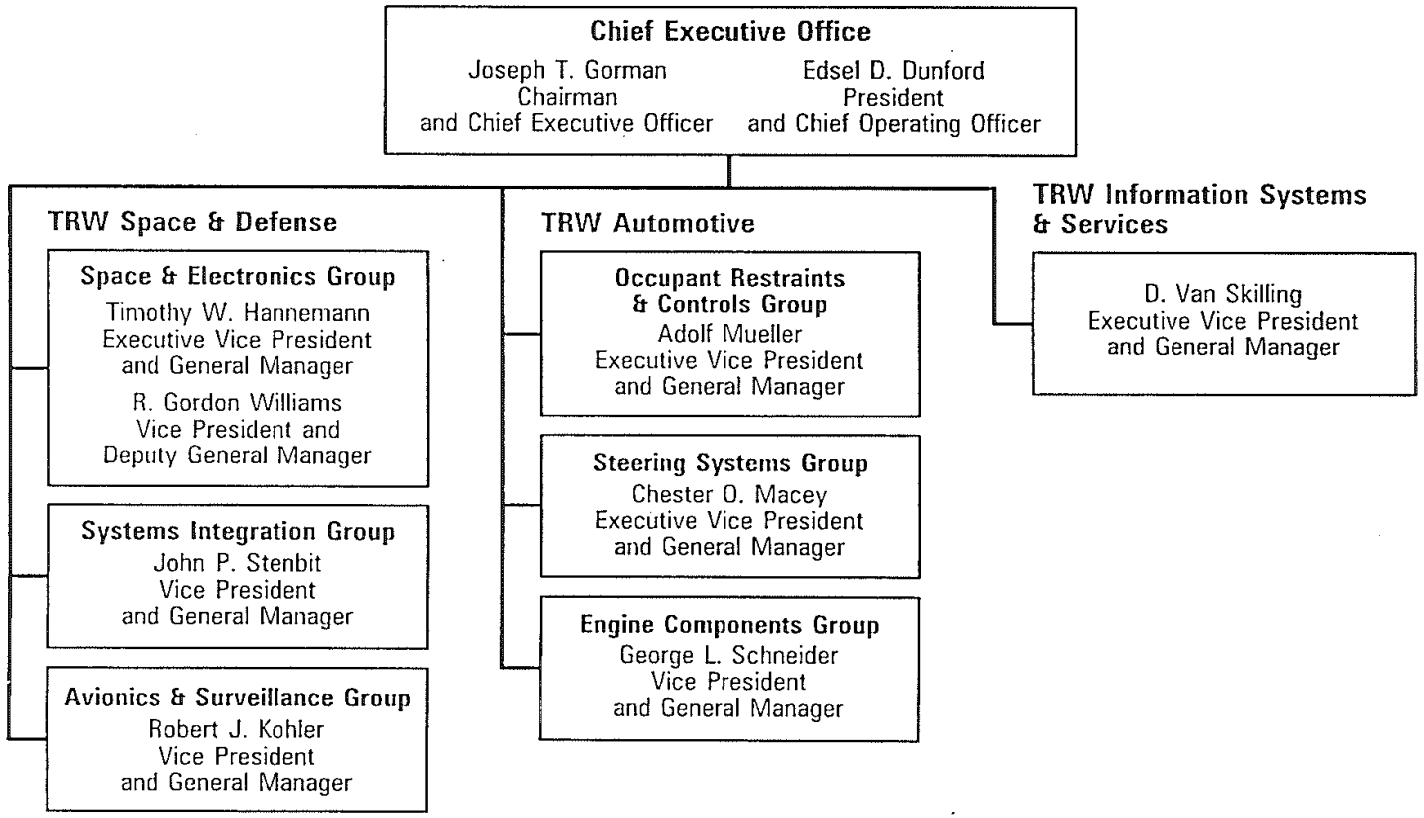
E.D. Dunford
Executive Vice President & General Manager
TRW Space & Defense Sector



Appendix M

TRW Inc., 1993

TRW Inc.



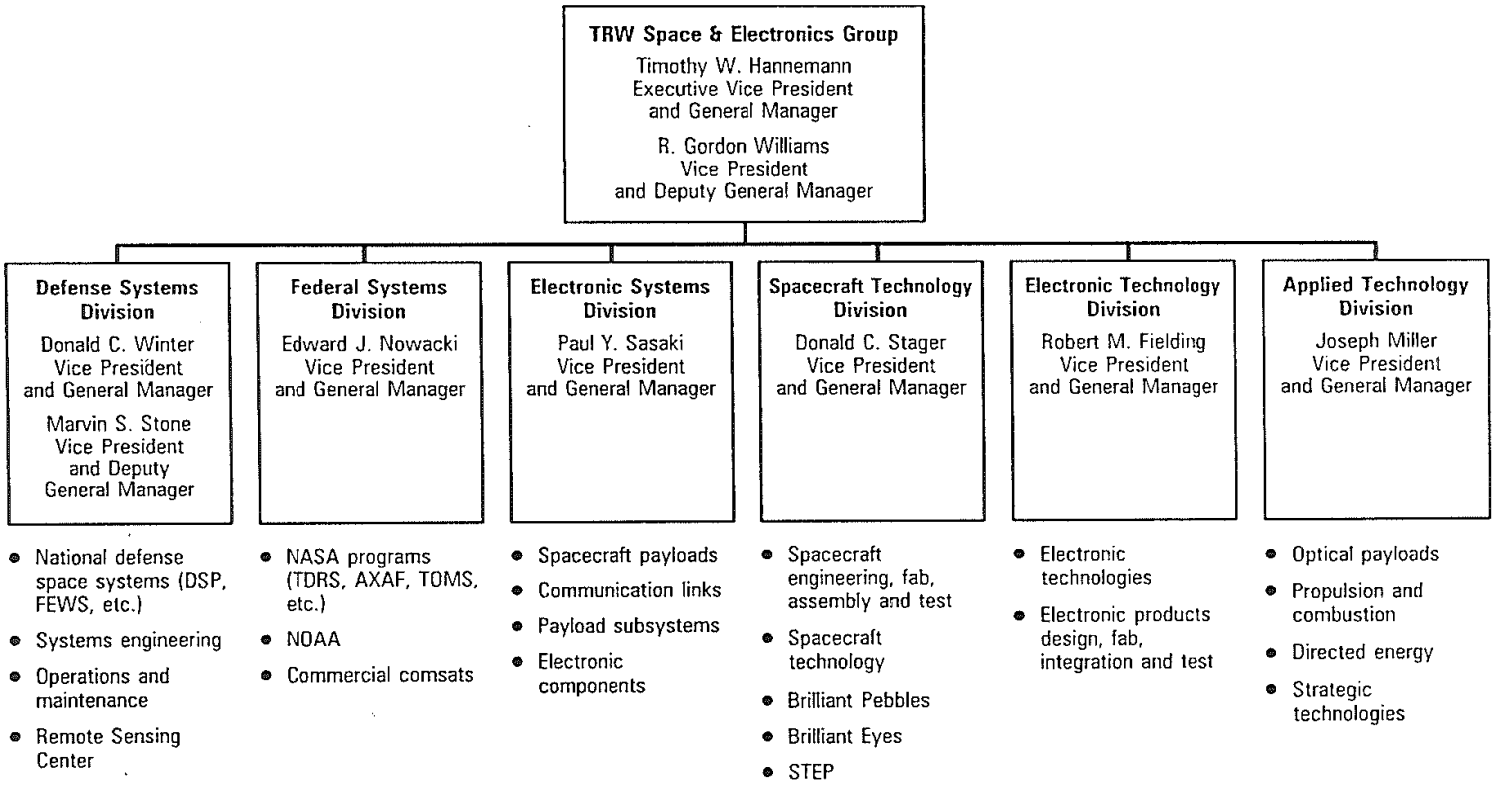
15apr93-6 AE239.02

Photo Services #265003-93

Appendix N

TRW Space and Electronics Group, 1993

TRW Space & Electronics Group



15apr93-1 AE237.63

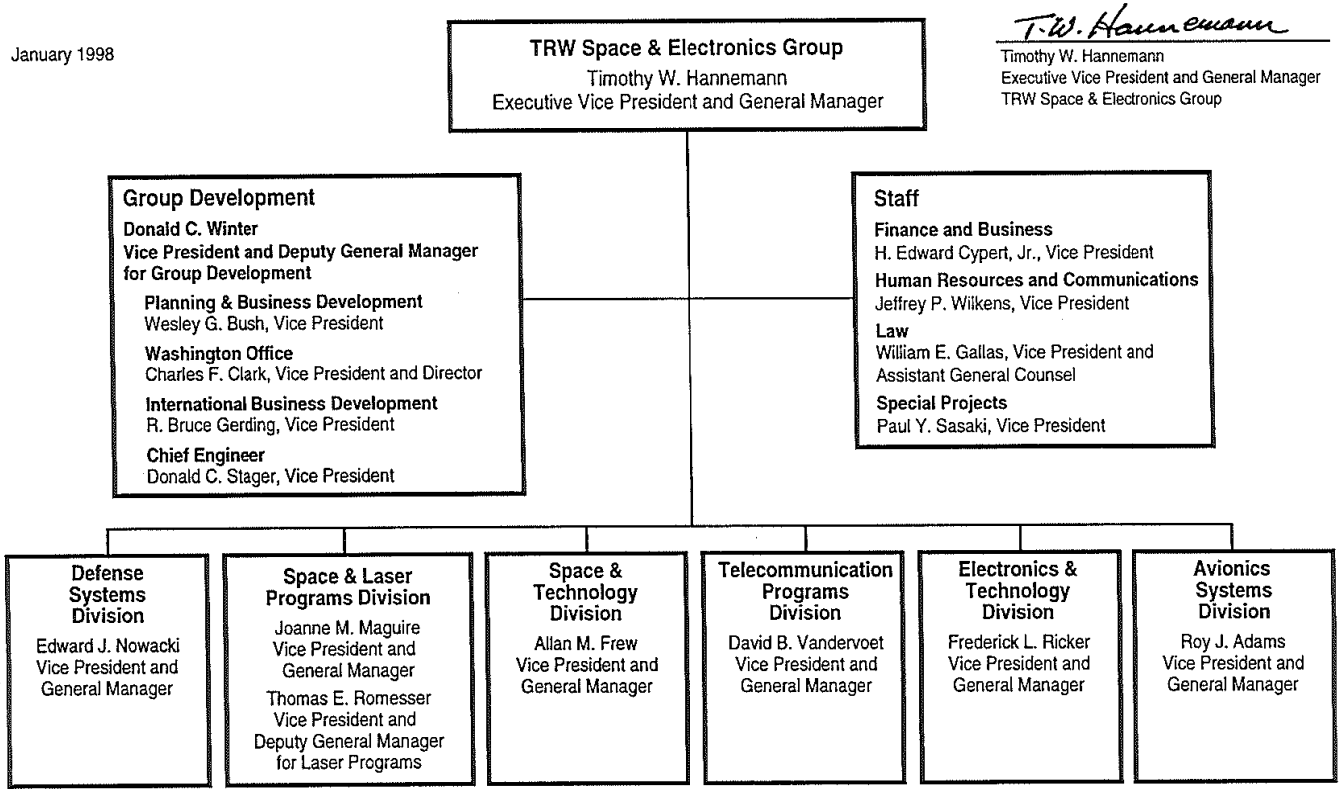
Photo Services #265020-93

Appendix O

TRW Space and Electronics Group, 1998

TRW Space & Electronics Group

January 1998



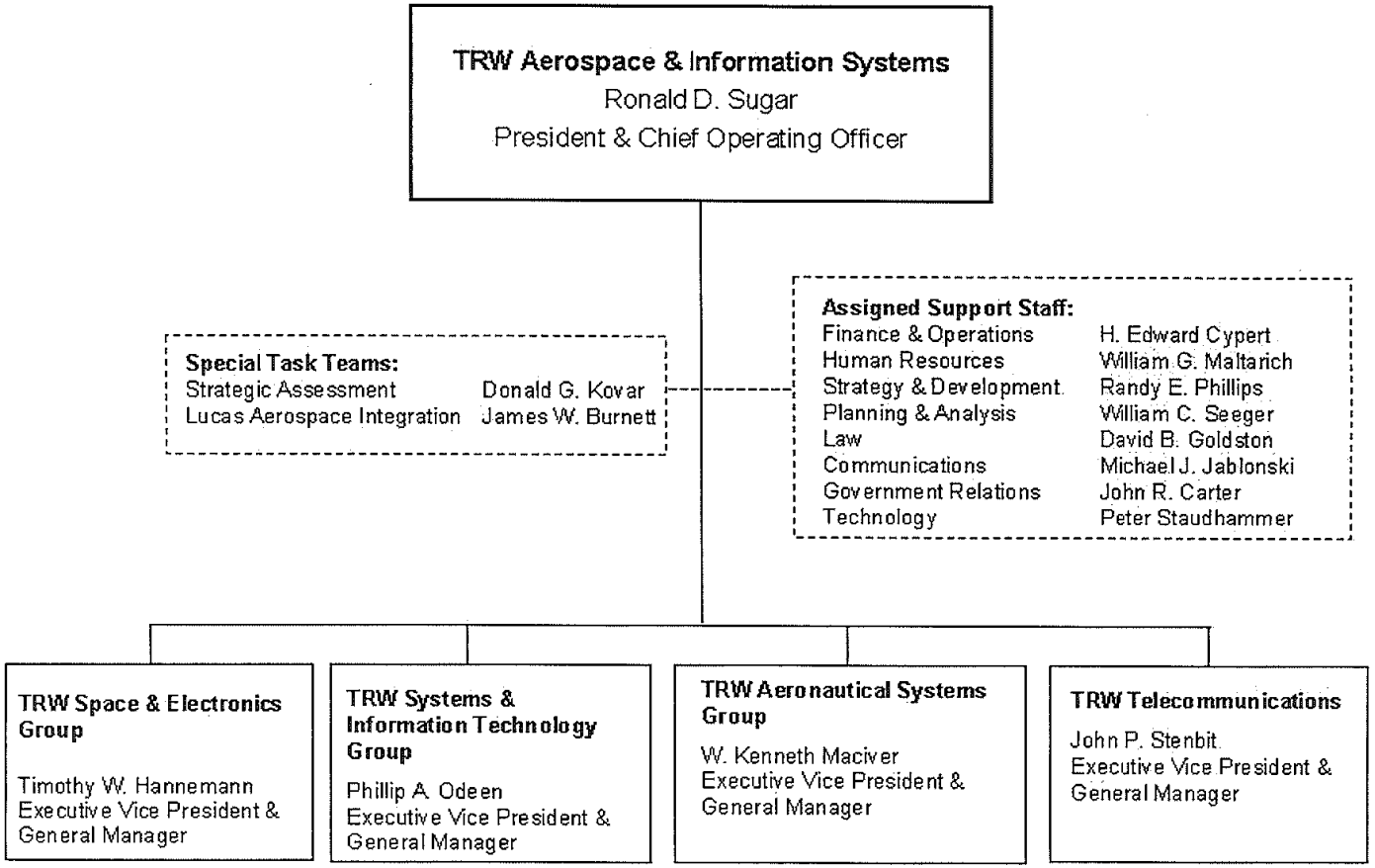
T.W. Hannemann

Timothy W. Hannemann
Executive Vice President and General Manager
TRW Space & Electronics Group

Appendix P

TRW Aerospace and Information Systems Sector, 1999

TRW Aerospace & Information Systems Sector

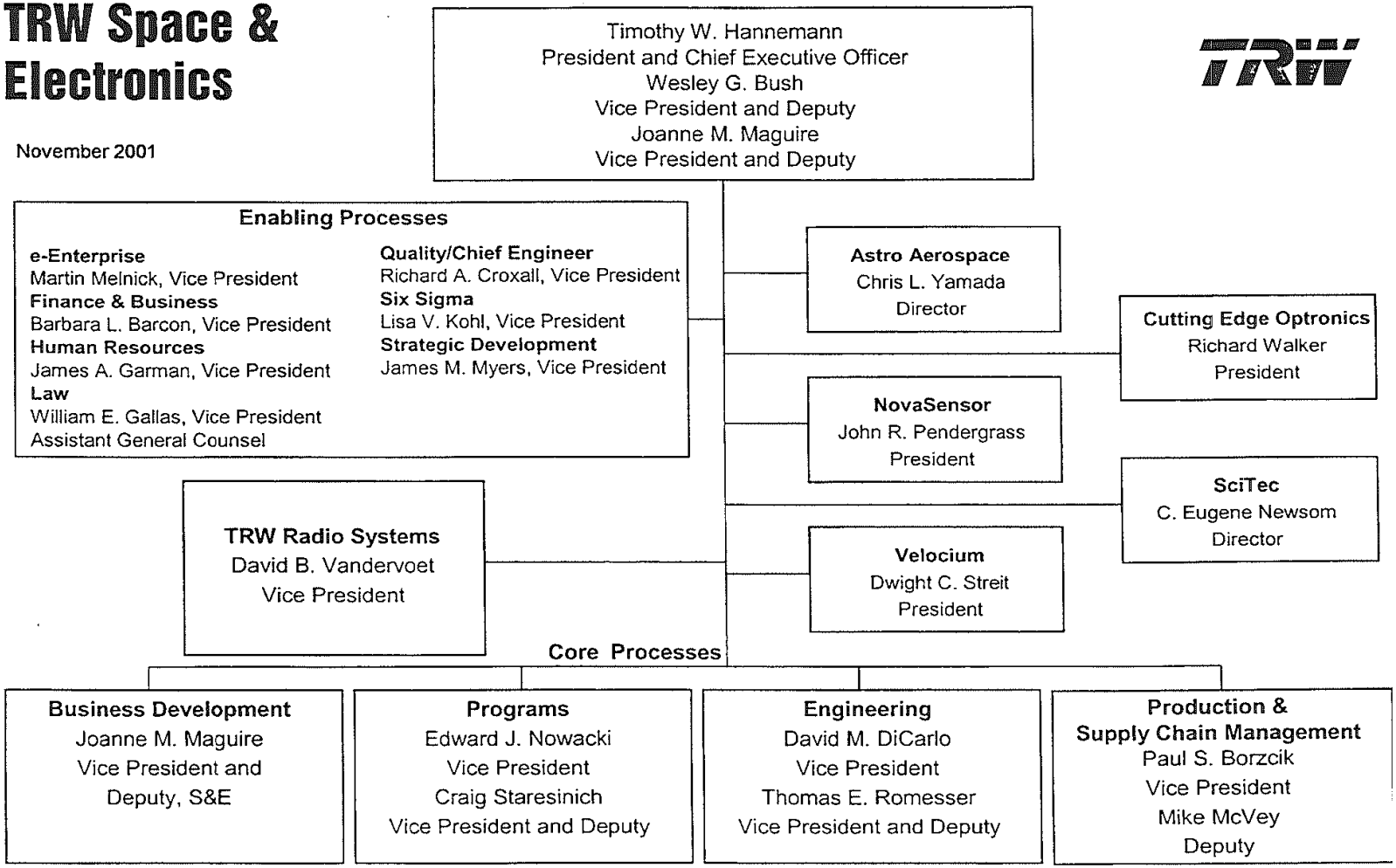


Appendix Q

TRW Space and Electronics, 2001

TRW Space & Electronics

November 2001



Appendix R

Northrop Grumman Space Technology, 2003

NORTHROP GRUMMAN
Space Technology

President
Wes Bush

April 2003

Radio Systems
Dave Vandervoet

NPOESS
Fred Ricker

Nuclear Space Initiative
Craig Staresinich

Sector Enabling Processes

Business Management
Molly Ficarra

Human Resources
Jim Garman

Planning & Administration
Bruce Gerding

Six Sigma
Lisa Kohl

Mission Assur. & Chief Engineer
Dick Croxall

Communications
Dan McClain

Corporate Enabling Processes

Law
Bill Gallas

Internal Information Svcs.
Brad Furukawa

Internal Audit
Wade Brylow

Core Processes

Programs
Ed Nowacki

Business Development
Jeff Grant

Technology Development
Tom Romesser

Engineering
Dave DiCarlo

Production & Supply Chain
Mike McVey

For Customer/internal Company use only

Appendix S

Table of Contents
Davis Dyer, *TRW — Pioneering Technology + Innovation since 1900*

Dyer, Davis, "TRW- Pioneering Technology + Innovation Since 1900," Harvard Business School Press, 1998

References

1. Dyer, Davis, *TRW- Pioneering Technology + Innovation Since 1900,* Harvard Business School Press, 1998

2. Ramo, Simon, *The Business of Science – Winning and Losing in the High-Tech Age,* Hill and Wand, 1988.

3. Jacobson, Timothy, *TRW 1901-2001, A Tradition of Innovation,* TRW Inc., 2001

4. Cohen, C. Budd et al, "Evolution of TRW Defense Business Lines from Ramo-Wooldridge Guided Missiles Research Division (GMRD)", Briefing to J.T. Gorman, March 26, 1986

5. "Northrop Grumman Spacecraft Guide," NGST, ST Marketing Communications, May 2005

6. Murphy, Charles, "The Blowup at Hughes Aircraft," Fortune Magazine, February 1954

7. Various Corporate Publications, Northrop Grumman Space Technology Archives, May 2005

Acknowledgements

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