

*Space Systems Cost Analysis Group*



# **The SSCAG Legacy:**

## **Evolution of a Concept**

Henry Apgar  
MCR Technologies LLC

ICEAA International Training Symposium  
October 17-20, 2016  
Bristol, UK

*Photographs and reference material contributed by Don Mackenzie, Sherry Stukes, and other SSCAG members*

# Birth of a Concept - 1977

*Paraphrased from original SSCAG charter*

SSCAG was created in 1977 as a working group of government, contractor, and academia representatives who would meet periodically to perform work that culminates in the following specific end-products:

- Exhibits or standard annexes incorporated in USAF SMC and NASA procurement documents and solicitations for proposals reflecting common understanding among government and contractor participants;
- Standard terminology, definitions, cost information requirements and formats for contractor proposal responses and data submissions;
- Normalized cost data interchanges among contractor and government sources;
- Findings and recommendations concerning relevant government procurement, management, and source evaluation practices, such as the Parametric Estimating Initiative (PEI).

# Our First Meetings

- June 1977 (Meeting #1) – LMSC (Keith Burbridge) invited (45 attendees) USAF Space Division, et al to one-day seminar to exchange space-oriented cost estimating data and techniques [before there was an ISPA, ICA, SCEA, or ICEAA]
- February 1978 (Meeting #2) – USAF Space Division (General Henry) agreed to sponsor joint government-industry working group; charter meeting attended by two government agencies and 15 companies; Colonel Conlin, first Chair
- International Consortium of Organizations
  - To foster advancement of space systems cost analysis
  - To promote cost analysis techniques and their interchange ... through open discussion among members and delegates
- Three volunteer-hosted meetings per year;
- Added international focus in 1980; overseas meeting every other year



*Keith died on January 24, 1996*

# Where was your first meeting?

Meeting	Date	Host	Location
1	June 1, 1977	LMSC	Sunnyvale, CA
2	February 1, 1978	SAMSO	Los Angeles, CA
3	May 1, 1978	SAMSO	Los Angeles, CA
4	September 1, 1978	McDonnell Douglas	St. Louis, MO
5	January 1, 1979	Harris Corp	Melbourne, FL
6	May 1, 1979	General Dynamics	San Diego, Ca
7	September 1, 1979	Boeing Aerospace	Seattle, WA
8	January 1, 1980	NASA JSC	Houston, TX
9	May 1, 1980	European Space Agency	Noordwijk, Netherlands
10	September 1, 1980	Thiokol	Ogden, UT
11	January 1, 1981	RCA PRICE	Hollywood, CA
12	May 1, 1981	Grumman	Bethpage, NY
13	September 1, 1981	LMSC	Sunnyvale, CA
14	January 1, 1982	Martin Marietta	Denver, CO
15	May 1, 1982	British Aerospace	Stevenage, England
16	September 1, 1982	Planning Research	McLean, VA
17	January 1, 1983	Aerospace Corp	Los Angeles, CA
18	May 1, 1983	NASA JSC	Houston, TX
19	September 1, 1983	Analytic Sciences	McLean, VA
20	February 1, 1984	JPL	Pasadena, CA

# 20<sup>th</sup> meeting – JPL (1984)



# Where was your first meeting?

21	May 1, 1984	Sperry Defense	St. Paul, MN
22	September 1, 1984	MBB Erno	Munich, Germany
23	February 1, 1985	Rockwell International	Downey, CA
24	June 1, 1985	Morton Thiokol	Ogden, UT
25	September 1, 1985	RCA PRICE	Princeton, NJ
26	January 1, 1986	TRW	Redondo Beach, CA
27	June 1, 1986	French Space Agency (CNES)	Toulouse, France
28	September 1, 1986	NASA JSC	Houston, TX
29	January 1, 1987	LMSC	Sunnyvale, CA
30	June 1, 1987	Grumman	Bethpage, NY
31	September 1, 1987	McDonnell Douglas	St. Louis, MO
32	January 1, 1988	Harris Corp	Melbourne, FL
33	July 1, 1988	British Aerospace	Brighton Sussex, England
34	October 1, 1988	Space Division (USAF)	Los Angeles, CA
35	January 1, 1989	TRW	Rancho Bernado, CA
36	June 1, 1989	Air Force Institute of Technology	Dayton, OH
37	September 1, 1989	Mitre	Bedford, MA
38	January 1, 1990	Rand	Santa Monica, CA
39	June 1, 1990	European Space Agency	Noordwijk, Netherlands
40	September 1, 1990	General Dynamics	St. Louis, MO



# 27<sup>th</sup> Meeting – CNES (Toulouse) 1986



# Where was your first meeting?

41	January 1, 1991	JPL	Pasadena, CA
42	June 1, 1991	Air Force Academy	Colorado Springs, CO
43	September 1, 1991	EER	Huntsville, AL
44	January 1, 1992	Aerospace Corp	Los Angeles, CA
45	May 1, 1992	MBB DASA	Munich, Germany
46	September 1, 1992	Boeing Airplane Company	Seattle, WA
47	January 1, 1993	Harris Corp	Melbourne, FL
48	June 1, 1993	Loral Space	Palo Alto, CA
49	October 1, 1993	Grumman	Bethpage, NY
50	February 1, 1994	JPL	Pasadena, CA
51	June 1, 1994	French Space Agency (CNES)	Toulouse, France
52	October 1, 1994	Martin Marietta	Denver, CO
53	January 1, 1995	Thiokol	Ogden, UT
54	June 1, 1995	MCR	Washington, DC
55	October 1, 1995	Tecolote	Santa Barbara, CA
56	January 1, 1996	Phillips Lab	Albuquerque, NM
57	June 1, 1996	Aerospatiale	Cannes, France
58	October 1, 1996	SAIC	McLean, VA
59	February 1, 1997	EER	Santa Barbara, CA
60	June 1, 1997	Space & Missile Systems Center	Los Angeles, CA



# Where was your first meeting?

61	October 1, 1997	LMMS	Sunnyvale, CA
62	January 1, 1998	Boeing	Cocoa Beach, FL
63	June 1, 1998	RAND	Toronto, Canada
64	October 1, 1998	Motorola	Phoenix, AZ
65	January 1, 1999	RCA PRICE	Santa Barbara, CA
66	June 24-25, 1999	Air Force Academy	Colorado Springs, CO
67	October 13-14, 1999	The MITRE Corporation	Bedford, Massachusetts
68	February 17-18, 2000	Tecolote	Ogden, UT
69	May 9-10, 2000	European Space Agency	Noordwijk, Netherlands
70	October 12-13, 2000	Boeing (Airplane Division)	Seattle, WA
71	February 7-8, 2001	Boeing (Rocketdyne)	Canoga Park, CA
72	July 11-12, 2001	Air Force Cost Analysis Agency	Arlington, VA
73	October 16-17, 2001 (Cancelled)	NASA Marshall Space Flight Center	Huntsville, AL
74	February 12-13, 2002	Space and Missiles Systems Center	San Pedro, CA
75	June 25-27, 2002	Italian Space Agency	Frascati, Italy
76	October 22-23, 2002	NASA Langley	Newport News, VA
77	March 4-5, 2003	Lockheed Martin	Sunnyvale, CA
78	July 29-30, 2003	Boeing	Huntington Beach, CA
79	October 29-30, 2003	NASA Marshall Space Flight Center	Huntsville, AL
80	January 28-29, 2004	Northrop Grumman	Redondo Beach, CA

# 80<sup>th</sup> Meeting – Northrop Grumman (2004)



## Space Systems Cost Analysis Group (SSCAG)

Sponsors:

Northrop Grumman Mission Systems  
Office of Cost Estimation and Risk Analysis

Northrop Grumman Space Technology  
Pricing and Cost Estimation

80th Meeting  
January 28 - 29, 2004  
Redondo Beach, California

# Where was your first meeting?

81	May 13-14, 2004	Italian Space Agency	Frascati, Italy
82	November 17-18, 2004	NRO/Wyle Laboratories	Chantilly, VA
83	Feb. 23-24, 2005	Harris Corp.	Melbourne, FL
84	July 20-21, 2005	Tecolote Research	Santa Barbara, CA
85	November 16-17, 2005	Lockheed Martin	Denver, CO
86	March 1-2, 2006	Space & Missile Systems Center	San Pedro, CA
87	May 22-23, 2006	Boeing	Seattle, WA
88	September 19-21, 2006	SCAF/EACE	London, UK
89	January 17-18, 2007	RAND	Santa Monica, CA
90	May 16-17, 2007	Canadian Space Agency	Quebec, Canada
91	September 25-26, 2007	PRICE Systems	Arlington, VA
92	February 6-7, 2008	General Dynamics	Phoenix, AZ
93	May 15-16, 2008	European Space Agency	Noordwijk, Netherlands
94	October 15-16, 2008	Booz Allen	Reston, VA
95	February 4-5, 2009	Galorath	El Segundo, CA
96	May 6-7, 2009	NASA Langley	Hampton, VA
97	September 16-17, 2009	Pratt & Whitney Rocketdyne	Canoga Park, CA
98	January 20-21, 2010	Raytheon Missile Systems	Tucson, AZ
99	May 11-12, 2010	German Space Agency (DLR)	Berlin, Germany
100	September 28-29, 2010	MCR	Herndon, VA



# Where was your first meeting?

101	March 30-31, 2011	JPL	Pasadena, CA
102	September 21-22, 2011	Wyle	Chantilly, VA
103	February 7-8, 2012	Galorath, Inc	El Segundo, CA
104	May 17-18, 2012	Joint with ISPA	Brussels, Belgium
105	October 18-18, 2012	NASA Hq	Wash DC
106	May 14-15, 2013	Boeing	El Segundo, CA
107	October 18-20, 2016	Joint with ICEAA, SCAF, EACE, APM, DACE ACostE, NESMA, IFPUG	Bristol, UK



103<sup>rd</sup> meeting, Feb 2012, El Segundo

# SSCAG Products

We believed that SSCAG needed a legacy

- Glossary, Space Cost-Related Terms
- Subgroup Handbooks:
  - Software Methodology Handbook
  - Hardware Cost Estimating Handbook
  - Risk Handbook
  - Systems Engineering Desk Reference (for cost estimators)
- SSCAG Software Database (SWDB)
- SSCAG O&S Database (OSDB)
- Evaluation Reports
  - Compendium of Cost Analysis Models
  - Rules of Thumb
  - Evaluation of Government Acquisition Initiatives
- SSCAG Document Library (SAIC Huntsville – *still there*)
- FPGA Study (software)
- Annotated Bibliographies (software)
- Standard WBS for Space Systems
- Nonrecurring/Recurring Definitions
- “New Ways of Doing Business” (NWODB) Survey
- Risk Analysis Survey(s)
- Data Collection Guidelines
- SSCAG Directory

All SSCAG products and reports have been preserved in the NASA Redstone Library in Huntsville.



## Example of a SSCAG Product:

# Rules of Thumb Compendium

February 1994 – Claus Meisl, Editor

Spacecraft development costs can be estimated from the first unit production cost by the following multipliers:

Design	Simple Spacecraft	Complex Spacecraft
All new	5 - 7	4
50% new	4	3
10% new	1.2	1.4

A manned space system will cost about 4X the cost of an unmanned system for both development and production cost.

Refurbishment of a protoflight spacecraft to flight-ready condition costs about 20% of the original unit production cost (or about 50% to refurbish a qualification spacecraft).

# SSCAG Brochure

To explain mission  
and membership  
requirements

**SSCAG ACTIVITIES**

- Glossary, Space Cost Related Terms
- Subgroup Handbooks
  - Hardware Cost Estimating Handbook

**SSCAG PROFILE**

A consortium of international (US and NATO allied nations) organizations from government and industry, SSCAG is a working group concerned with the development and production of space systems. SMC represents military concerns and NASA represents the civil space posture.

**SSCAG CHARTER**

SSCAG was chartered by the US Air Force Space & Missile Systems Center (SMC) to promote cost analysis research and provide a forum for government and industry to discuss and resolve cost analysis issues. The charter includes:

- Organization Chart
- Aims and Objectives
- Principles
- Host Company Responsibilities
- Requirements for Participation in the SSCAG

**OPERATING PROCEDURES**

- Organizational Functions
- Procedures and Objectives
- Host Organization Responsibilities
- Correspondence Etiquette
- Presentation of Papers
- Publications Support
- Attendance Requirements
- Voting Procedures

**PROCEDURE AMENDMENTS**

Amendments to the operating procedures are added as required. Primary delegates vote on the amendments. Motions are carried by a simple majority.

**THE SSCAG ADVANTAGE**

SSCAG provides a unique technical base from which to gather data and opinions. The membership comprises customers, reviewers, contractors, subcontractors, and model builders from government and industry. A particular benefit of membership is the expertise available for the determination of space systems effectiveness.

**MEETINGS**

- Three annual group sessions are hosted by member organizations within the US.
- Every second year, a plenary session is hosted by a member organization at a non-US location.
- A pre-registration package and agenda is mailed one month before each meeting.
- An annual publication fee is charged to offset the cost of compilation, preparation and mailing of all documentation.
- Publications include: all SSCAG work in progress:
  - Databases
  - Member Surveys
  - Handbooks
  - Model Reviews

**SSCAG ADMINISTRATION**

SSCAG administration is by the Steering Group with guidance from the Charter and Operating Procedures. Members are:

- SSCAG Steering Group Chair
- SSCAG Co-Chairs: USAF SMC, NASA HQ
- SSCAG European Liaison: ESA ESTEC
- SSCAG Subgroup Chairs
- SSCAG Secretary

The function of the Steering Group is to represent the best interests of all member corporations and to ensure equitable division of labor throughout the delegate body.

**SSCAG SUBGROUPS**

- Hardware Methodology
- Software Methodology
- Risk Analysis
- Operations and Support

Delegates elect to work with a subgroup according to interest and expertise. Delegates are at liberty to participate in other subgroup activities, and contribute expertise, as time permits.

**LEADERSHIP**

**AIR FORCE SMC - SSCAG CO-CHAIR**

Anthony Finefield  
Chief, Cost Division  
AF Space & Missile Systems Center  
Los Angeles AFB California

**NASA - SSCAG CO-CHAIR**

David Pine  
Deputy Director  
Independent Program Assessment Office  
Langley Research Center  
Hampton Virginia

**SSCAG EUROPEAN LIAISON**

David Greves  
Head, Cost Analysis Division  
European Space Agency (ESA ESTEC)  
The Netherlands

**SSCAG SECRETARY**

Henry Appgar  
MCR Federal, Inc  
Thousand Oaks California

**SSCAG SUBGROUP CHAIRS**

Hardware Methodology  
Robert Bailey, Motorola  
Steve Ottrosa, Boeing

Software Methodology  
Sherry Stukes, MCR Federal  
Marilee Wheaton, Aerospace  
Randall Jensen, SEI

Risk Analysis  
Guy Jette, USAF AFRL

Operations and Support  
Edwin Dean, DFV Group



THIS IS SSCAG  
Space  
Systems  
Cost  
Analysis  
GROUP

Chartered in 1977 to support  
the Space cost analysis  
community

# International Meetings – Brighton (1988)

- Fifth overseas meeting
- Hosted by British Aerospace
- Hotel Brighton Metropole (on the English Channel)
- Joint with ISPA (their first overseas meeting)



# International Meetings – Munich (1984, 1992)

- Hotel Bayerischer Hof
- Hosted by MBB
- Joint with ISPA
- Touring by Glass Train





# International Meetings – Cannes (1996)

- Hotel Gray d'Albion
- Hosted by Aerospatiale
- Common with ISPA
- Earlier, Toulouse (hosted by CNES) in 1986, 1994

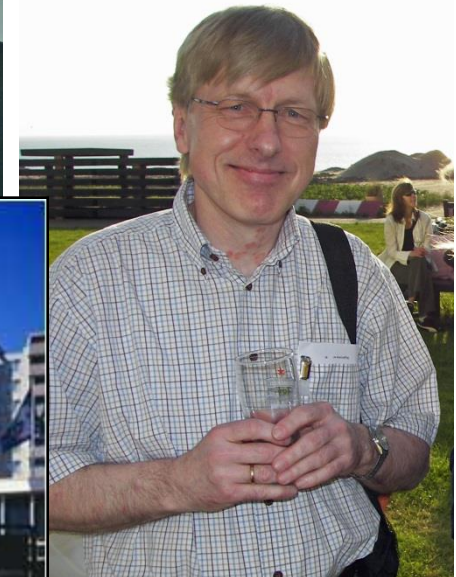




# International Meetings - Noordwijk (1980, 1990, 2000, 2008)



- Huis ter Duin - “House on the Dunes” (except for 1990, when it had just burned down)
- Hosted by ESA; joint with ISPA/SCAF/EACE/SSCAG
- Tulip Tours



# International Meetings - Frascati (2002, 2004)



- Hosted by Italian Space Agency (ESA)
- Joint with ISPA
- Hotel Villa Vecchia (former convent)





# International Meetings London (2006)

- Joint with SCAF and EACEWG
- Royal Institute of Naval Architectures Venue
- Thames evening cruise to see London by night



# International Meetings - Berlin (2010)



- Joint with SCAF and EACE
- Hosted by German Space Agency (FLR)



# International Meetings - Brussels (2012)



- Joint with ISPA
- Hosted by MCR in Brussels



# 1984 Annual Report

(The first one)

Five Subgroups - chairs and products that year were:

- Co-chairs
  - Col Dan Fitzgerald
  - Dr. Hum Mandell
- Now at 60 organizations
- “Instant Mail” service provided by RCA PRICE
- Administration
  - Keith Burbridge, Secretary
  - SSCAG Directory, 5<sup>th</sup> Ed
- Data Acquisition
  - Jim Dryden, chair
  - Cost Analyst’s Handbook (700 pages)
- Methodology
  - Grant Lindsay, chair
  - Handbook of Space Systems Cost Analysis Techniques
- Software
  - Hank Apgar, chair
  - Compendium of Software Estimating Papers
- Standardization
  - Gerry Hyman, chair
  - Standard Space WBS
  - Standard Space RFP

# 1992 Annual Report

(The last one)

Five Subgroups – chairs and products that year

- Co-chairs
  - Dave Hansen
  - Joe Hamaker
- Now at 58 organizations
- Steering
  - “Who’s Who in SSCAG” to replace Annual Report
- Data
  - Duke Obrien, chair
  - Cost Data Handbook
  - SSCAG Library
- Hardware
  - Chuck Lapinski, chair
  - Hardware Cost Estimating Models and Database Compendium
  - Concurrent Engineering Guidelines
- Software
  - Dan Galorath, chair
  - Software Methodology Handbook
- Risk
  - Richard Murphy, chair
  - Mackenzie Risk Model
  - FRISK review and applications

# 1983 Yearbook

## Photo and Bio for each member



**NAME:** Henry Keith Burbridge  
(Permanent Secretary SSCAG)

**AFFILIATION:** BFH Parametrics

**TITLE:** President

**DEPARTMENTAL POSITION:** Chief Corporate Executive

**RESPONSIBILITY:** Operate and manage a consortium of consultants in the provision of system and cost analysis using mathematical models.

**EXPERIENCE:** 10 years Commercial Electronics Industry  
24 years Aerospace Industry (18 space oriented, 12 cost analysis)  
3 years Consulting Engineering Company Owner



**NAME:** Henry Apgar

**AFFILIATION:** The Aerospace Corporation

**TITLE:** Project Engineer

**DEPARTMENTAL POSITION:** Resource Cost Analysis Office  
Advanced Systems Technology Division



**NAME:** James D. Fitzgerald

**AFFILIATION:** U.S. Air Force  
Los Angeles Air Force Station

**TITLE:** Director

**DEPARTMENTAL POSITION:** Directorate of Cost & Management Analysis  
Deputy for Comptroller

**RESPONSIBILITY:** Responsible for:  
1) development and quality of program cost estimates for all Space Division programs; (2) the development and presentation of Independent Cost Analyses; (3) the development and presentation of Space Cost analysis research



**NAME:** Peter B. Korda

**AFFILIATION:** RCA - PRICE Systems

**TITLE:** Manager, West Coast Operations

**DEPARTMENTAL POSITION:** Manages all PRICE Systems in the Western Region

**RESPONSIBILITY:** Consults with PRICE clients, conducts management seminars on parametric estimates, new model features. Performs marketing in Western Region.

**EXPERIENCE:** 34 years Aerospace Industry  
12 years Cost Analysis/Cost Estimating

**EDUCATION:** B.S. Mechanical Engineering  
M.S. courses completed in Electronic Engineering  
Cost Analyst



**NAME:** Humboldt C. Mandell, Jr.

**AFFILIATION:** National Aeronautics & Space Administration  
Lyndon B. Johnson Space Center  
Houston, TX

**TITLE:** Manager

**DEPARTMENTAL POSITION:** Operations Analysis Office  
Applications Analysis Office  
Payloads Analysis Office

**RESPONSIBILITY:** Manager of Operations Analysis Office, Johnson Space Center. Has agency responsibility for development of advanced manned spacecraft, for performing cost developing economic and cost benefit studies for JSC Space Station

# Supporting Organizations (2010)

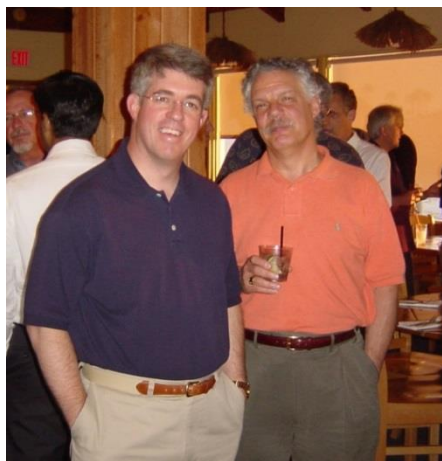
- USAF SMC
- NASA HQ
- NASA Centers: IPAO, KSC, LaRC, MSFC
- ESA
- AFCAA
- JPL
- MCR
- USC
- SAIC
- Wyle
- NCCA
- MDA
- Hopkins Consulting
- Burgess Consulting
- MacKenzie Consulting
- Design for Value, Inc.
- Booz Allen
- Ball
- German Space Agency
- Quaternion
- LMI
- P&W Rocketdyne
- Raytheon
- NRO Cost Group
- ACSG (David Pine)
- Naval Center for Cost Analysis
- Aerospace
- Boeing
- Lockheed
- Northrop Grumman
- Tecolote
- PRICE Systems
- Galorath
- Harris
- RAND
- MITRE
- ODNI
- Software Tech Support Center (Ogden)
- Scitor

# The Travel Side





# The Social Side (1)





# The Social Side (2)





# The Social Side(3)



# The Ascent of SSCAG

- Recognized growing global interest in space programs (in US and Europe) for surveillance, communications, intelligence gathering, and broadcasting
- Provided an open platform for exchange of ideas not currently available in government or industry; good for networking; enjoyed credibility; got best speakers
- Assured a unique international format, with minimal administrative overhead and maximum professional involvement
- Benefited from unusually strong professional leadership which motivated support from sponsoring organizational members and participation by delegates.
- Encouraged conference partnerships with other societies, especially ISPA





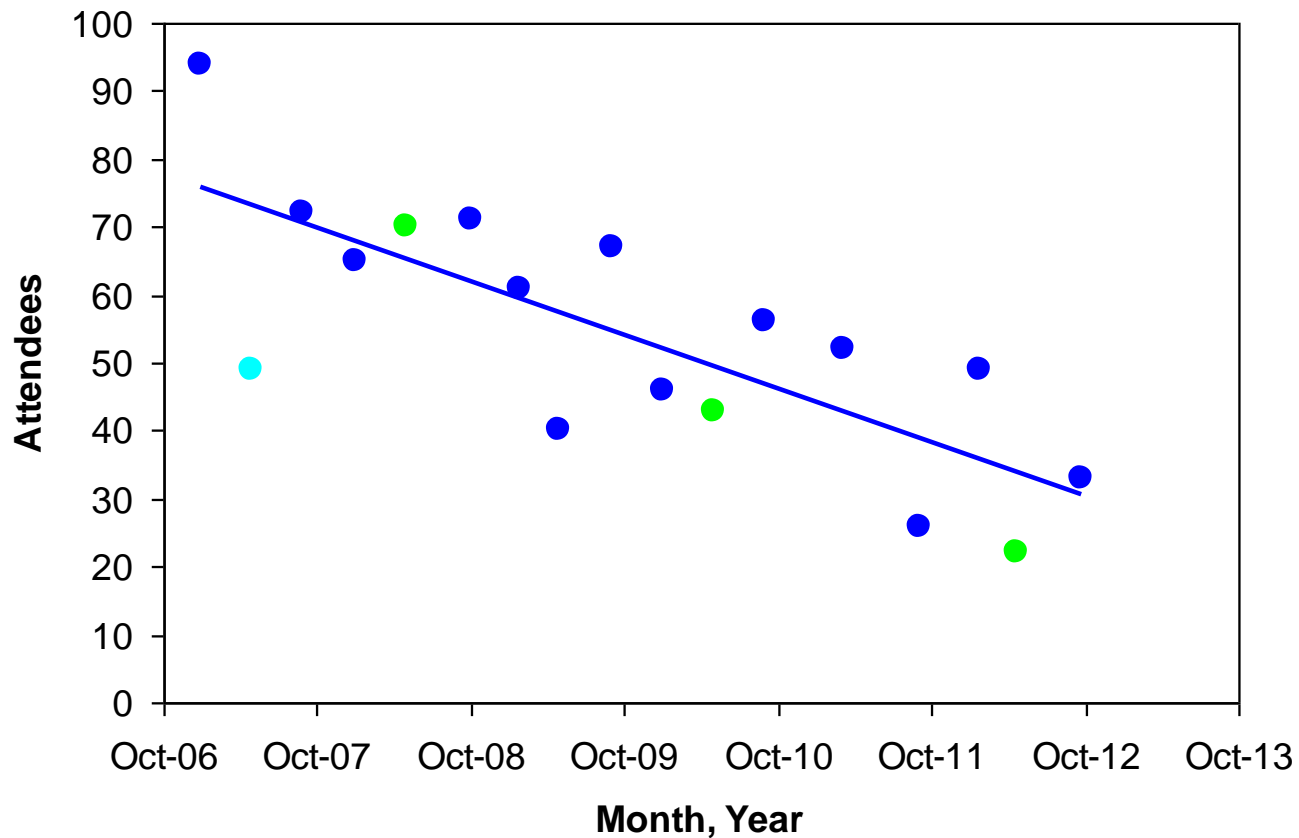
# SSCAG Leadership Made a Difference





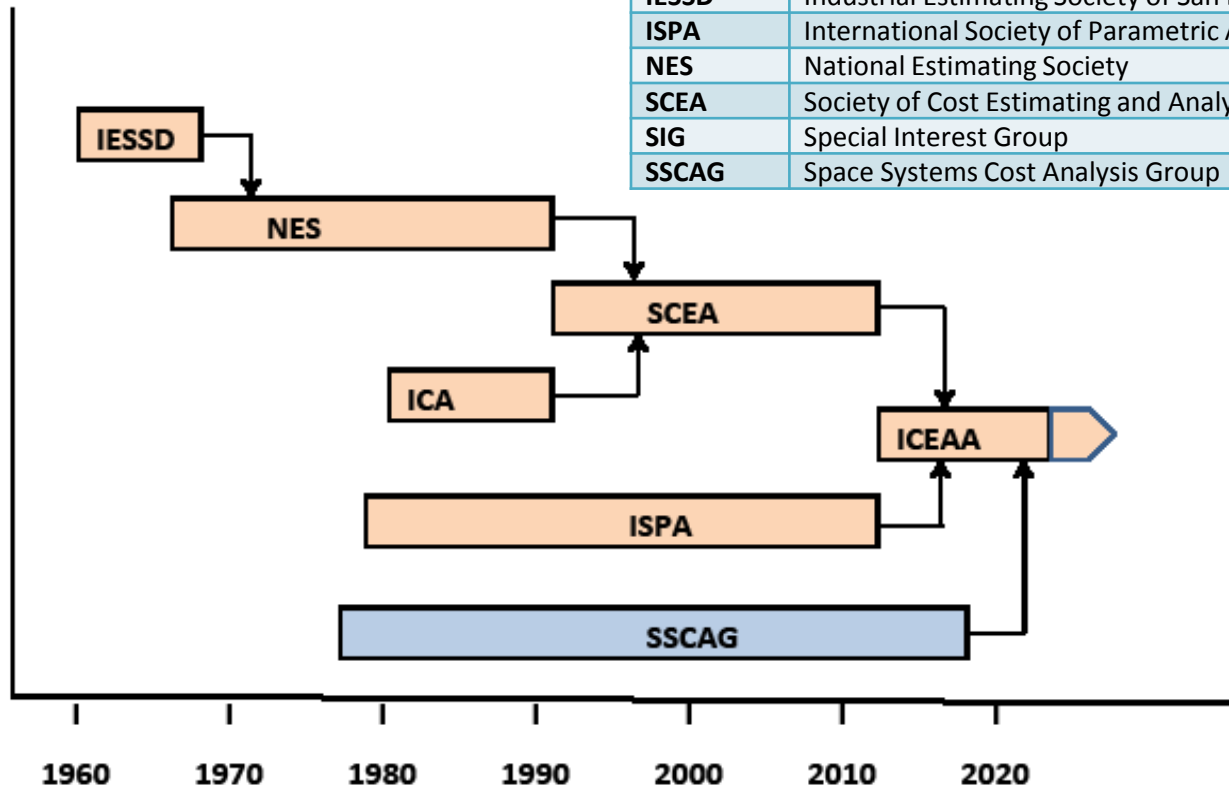
# The Decline of SSCAG

- Since 2006, total attendance has been declining in all member categories; largest participating group was SETA contractors. (Green international; blue US)



# Comparing Society Lifetimes

ICA	Institute of Cost Analysis
ICEAA	International Cost Estimating and Analysis Association
IESSD	Industrial Estimating Society of San Diego
ISPA	International Society of Parametric Analysts
NES	National Estimating Society
SCEA	Society of Cost Estimating and Analysis
SIG	Special Interest Group
SSCAG	Space Systems Cost Analysis Group



- SSCAG is only society with a forty-year life!
- The legacy will live on as an ICEAA SIG

# Triumph of the Concept

But, It's Time to Move on

- We satisfied the need for a non-advocate, grass-roots, product-oriented, forum-based international working group of senior government and industry space systems estimators
- SSCAG offered flexibility and responsiveness
  - New subgroups created as needed
  - Products to meet contemporary needs
  - Transition into ICEAA SIG (October 2016)
  - The legacy endures...
  - Space Estimating Track



# So, time to turn in your badge...

