Roger W. Corson

Technical Background Summary

- Thirty-six years experience designing and analyzing attitude navigation algorithms for orbital spacecraft (International Space Station & Space Shuttle) flight software.
- Implemented and tested Space Station attitude navigation flight software.
- Analyzed performance of attitude navigation algorithms both preflight and postflight.
- Performed preflight and postflight analysis to develop flight code parameters to optimize flight navigation performance.
- Developed simulation tools for the purpose of analyzing and optimizing spaceflight attitude navigation algorithms.

Education

- **Bachelor of Science in Aerospace Engineering**, *1974*
  Syracuse University, Syracuse, New York
  GPA 3.2/4.0
- **Master of Science in Computer System Design**, *1986*
  University of Houston—Clear Lake, Houston, Texas
  GPA 3.8/4.0
- Completed 27 additional hours of graduate level mathematics and computer science courses at University of Houston—Clear Lake, Houston, Texas

Experience

Engineer, Space Station Program, McDonnell Douglas & Boeing, Houston
1985–2012

- Responsible for Space Station rendezvous guidance and navigation requirements definition (Contract End Item Spec, Software Requirements Spec, etc.) and analysis during the Space Station phase B and initial phase C contracts.
- Phase B Space Station orbital Traffic Management work included: collision avoidance detection algorithm design and analysis; rendezvous guidance and targeting algorithms design and dispersion error analysis; crew equipment and retrieval system targeting and control design and performance study; and development and simulation of fuel efficient formation flying methods for coorbiting vehicles.
- Performed analysis of navigation and control error effects on trajectory targeting dispersions during rendezvous as part of the Traffic Management requirements analysis. Investigated sensitivity of dispersion errors to approach trajectory geometry and devised an innovative scheme for the equitable allocation of contributing error requirements that gave useful results.
- Wrote some proposal content for the Space Station Phase C contract.
- I am one of the founders of and contributors to the Ada Reusable Components Library (ARCLIB). Most of the Space Station GN&C Utilities came from this library.

- Supported the ISS transition effort as a GN&C representative to the C&DH IPT and also by writing requirements for the GN&C attitude determination function.
- Developed the Multiple Object Orbital Dynamics Simulation (MOODS) for navigation analysis, development and testing of flight code, and determining PPLs. I wrote approximately 50% of the 61,000 SLOCs in the MOODS kernel. The MOODS contains not only the orbital dynamics simulation and flight code, but also many reusable statistical and engineering analysis tools.
- Performed validation of some of the MOODS models. Developed a new technique for generating random numbers in Monte Carlo simulation that both assures repeatability and eliminates cycle-to-cycle and model-to-model error correlations.
- Performed preflight ISS attitude navigation system performance analysis using both analytic and Monte Carlo simulation methods to verify the attitude determination requirements and some of the pointing and support performance requirements. Verification of the pointing and support performance requirements required development of new statistical analysis tools not traditionally used in verification.
- Designed, wrote, and tested ISS attitude determination flight code. This includes 2900 lines of Attitude Determination code and approximately 50% of the 2100 lines of navigation utilities. Designed, coded, and tested the attitude Kalman filter and the fixed gain filter for attitude rate. Designed, coded, and tested the attitude determination fault detection, identification, isolation, and recovery flight software.
- When two GPS antennas failed in orbit, I developed an enhancement to the attitude Kalman filter that would allow it to use two antenna (baseline) measurements to estimate attitude.
- When attitude determination capability was lost in both the US segment and the Russian segment, I developed the capability to determine attitude in ground based tools using telemetered Ku band tracking angles. This capability was eventually incorporated into the flight attitude Kalman filter.
- Designed, coded, and tested statistical tools to analyze flight data for the purpose of optimizing the flight PPL values. These tools were used to estimate GPS carrier phase measurement error statistics, RGA rate measurement error statistics, Russian rate error statistics, and Ku band measurement angle error statistics from flight telemetry data.
- Developed, coded, and tested a method for combining data from individual gyros in failed RGAs.
- Developed, coded, and tested a method for recovering attitude Kalman filter states in a backup computer (after failure of a primary) using the gyros in the GPS receivers.
- Designed, coded, and tested flight code to autonomously bias the solar array beta angles and to detect longeron shadowing hazards. This includes 900 lines of Pointing and Support code.

Engineer, Space Shuttle Program, McDonnell Douglas, Houston

1975–1985

- Assisted in the development of Space Shuttle onboard software required to align the Inertial Measurement Unit (IMU) platforms to desired reference orientations using star direction measurements obtained with either the Star Tracker (ST) or Crew Optical Alignment Sight (COAS) instruments. This work included design, development, testing, and evaluation of software algorithms for celestial attitude navigation.
- Assisted in the definition of crew displays, crew procedures, and crew training materials for attitude determination and alignment.
- Built and maintained several simulation programs. Researched the ST, COAS, and IMU hardware sensor specifications to define mathematical models for use in computer simulation. Designed, implemented, integrated, and tested avionics sensor models (ST & COAS) for the simulation. Integrated an existing IMU model and lunar and solar ephemeris models into the simulation. Designed, implemented and tested prototype Shuttle attitude determination and IMU alignment flight software into the simulation programs. Simulation programs were used for functional verification, performance analysis, and development and evaluation of new algorithms and associated crew procedures.
- Participated in integrated hardware and software testing of the attitude determination system in the SAIL simulation facility.
- Developed test requirements for verifying the attitude determination capability in the SMS simulator that is used for crew training.
- Monitored IBM software design activity, participated in their document reviews, and did HAL code audits.
- Performed preflight Shuttle attitude navigation system performance analysis using both analytic and Monte Carlo simulation methods. Some findings led to corrections to the software requirements; modified the Star Tracker and IMU FSSRs as required.
- Performed post-flight Shuttle attitude navigation system performance analysis. Designed analysis programs to evaluate the actual navigation system performance post-flight using statistical estimation techniques. These tools included: the IMU attitude measurement error variance Maximum Likelihood Estimator (MLE), the IMU drift error variance MLE, and the Star Tracker measurement error variance MLE. These tools used flight data to determine fault check I-loads for subsequent flights and to monitor sensor health performance.
- Wrote extensive documentation of both the preflight and the post-flight alignment system performance analyses. At least 16 of these papers were published by NASA as Internal Notes.
- Developed and analyzed an alternate method of star measurement data averaging when IMU gimbal angle trajectories are nonlinear (gimbal flip).
- Evaluated the star-of-opportunity tracking mode as an alternate method of IMU alignment star acquisition. This improvement simplified crew operations.
- Trained for real time flight console support for ascent navigation and supporting the analysis of IMU Redundancy Management flight software.

- Managed a task of about four people for nine months. The group was responsible for Shuttle attitude determination system post-flight analysis; Shuttle approach and landing pre-flight and post-flight analysis; building and maintaining a data base of TACAN stations to support orbit navigation DTOs; and building the TONSIL data base to streamline the process of maintaining and generating all Shuttle I-loads. I designed and implemented the conjugate gradient descent minimization algorithm that was used for generating NAVDAD aero model I-loads in the TONSIL data base.
- Worked on several proposals.

Computer Systems, Simulations, Tools and Programming Languages Used

- Windows, Macintosh, DEC VAX/Alpha, HP/UNIX, Sun workstations, Apollo workstations, UNIVAC 1100 series, IBM 370, DEC PDP-11, and S-100 computers
- Ada, FORTRAN V, Matrix X, HAL, APL, BASIC, Pascal, and assembly languages (PDP–11, Z–80, & M68000)
- 4^{th} Dimension data base
- Multiple Object Orbital Dynamics Simulation (MOODS), IMUCAL
- Shuttle SAIL & SMS and Space Station GITF, IGL, & MADE

Awards

- 1981—Space Flight Awareness award for first Shuttle flight
- 2006—Space Flight Awareness award
- 2009—NASA Distinguished Public Service Medal