Bill Tandy

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Chief Architect & Engineer for projects of all sizes. Over $200 million won as mission architect with a win rate of greater than eighty percent.

EXPERIENCE

BLUE ORIGIN

Senior Manager, Architecture

August 2020 – November 2021

• Chief Architect and Chief Engineer for Orbital Reef, Blue Origin's space station. I converted stakeholder requirements into tasking for the design team, peer reviewed work across all disciplines, guided design theory and outcomes, and spurred tool development to address novel challenges. I focused on the pillars of complete documentation, methodical engineering, integrated approaches, and fast-paced management while creating a supportive team environment. My work directly led to winning a $130 million contract from NASA.

• Verification, Validation, & Certification Lead for the Human Landing System effort through PDR. I integrated efforts from Blue Origin, Lockheed Martin, and Northrop Grumman. Together, we created over a thousand verification event approaches and hundreds of detailed verification plans. I also had primary responsibility for developing the program plan, guidelines, and processes around the verification, validation, and certification effort. My team received no negative marks or requests for correction from NASA.

• Manager of the architecture group in the advanced concepts division. Responsible for coordinating architecting methods, organizing peer reviews, and developing tool infrastructure. Also responsible for writing job descriptions, hiring, promotions, staffing programs, and performance reviews. I am personally motivated to ensure consistent and easy to digest documentation so everyone can continue building on each other’s success.

BALL AEROSPACE & TECHNOLOGIES

Summer 2003, 2004 (Intern)
June 2006 – February 2019 (Full-time)

Mission Architecture

• Architect for over $500 million in mission concepts sensing the electromagnetic spectrum from ultraviolet to infrared to microwave wavelengths for space, air, and ocean environments. Systems were both active (e.g., laser and in situ) and passive (e.g., spectrometers and antennas).

• Managed dozens of people across all engineering disciplines including mechanical, electrical, thermal, software, electrical, radiation, and test to develop technical approaches. I also worked with legal, financial, and corporate strategy departments to develop contracts, staffing, and budgets to support the technical work.

• Lead engineer for trade studies optimizing orbits and constellations, detectors, optics, power collection and storage, communication frequencies and downlink scheduling, structures, thermal and mass budgets, reaction wheels, and more. We used commercial packages (such as STK, MODTRAN, SolidWorks, Thermal Desktop, and OpticStudio) as well as custom Matlab and Python models purpose built for proposals.

• Worked and traveled with Principal Investigators, customers, and their contractors to translate mission goals into requirements. Conferences often involved creating a poster or presented paper to demonstrate topic expertise.

• Detailed Example: Mission Architect for the Environmental Defense Fund's MethaneSat, a passive spectrometer satellite tuned to O2 and CH4 channels in the near infrared. We won the ~$88 million program in a competitive, phased process. Unique to this mission was the need for an innovative "risk sharing" commercial contract. I also worked through Ball's management chain to sell our vision of process tailoring to enable a fast-paced development cycle. This involved meeting with the CEO, Vice Presidents, and myriad stakeholders.

Other proposals include:

- NextGen LandSat: Performed orbit trade studies, including considering the impact of optic and detector options on ground resolution and median target revisiting time. Investigated wavelength options and their ratios for science retrieval. Worked with the Washington D.C. office on strategy. Built a custom model that produced 5-dimensional, interactive plots.

- A FireSat concept: Worked with Howard University to create a non-saturating, rolling detector chain to quantify fire intensity from space on a small satellite bus. Existing systems, such as VIIRS, saturate their pixels, leading to uncertainties about the danger of the fire as well as what materials are burning. Built a fire model with MODTRAN to test system performance.

- Microwave sounder instrument for atmospheric winds and moisture measurements for the military. Paralleled another effort for packaging the same capabilities into a CubeSat platform. Documented all wavelengths, systems, and technologies used to date in microwave sounders. Supported internal and vendor meetings.

- An ocean biology air and sea campaign: Worked with Woods Hole, the University of Florida, and the University of Colorado on an effort to map submesoscale features in the ocean. This involved chartering boats as well as autonomous submarines, wave gliders, and aircraft.

- Methane mapping campaigns: Worked with customers to estimate costs of operations including aircraft time, fuel, labor, and related expenses. Developed flight plans, procedures, worked with the FAA, and either flew campaigns myself or trained operators.

- Classified projects

Airborne Operations

• Supported Principal Investigators' need to test their instrument for path-to-space requirements by translating their testing goals into flight campaigns around North America, including the Arctic.

• Directed end-to-end science campaigns including aircraft and airfield selection, pilot training, FAA documentation, payload installation, flight planning, instrument operations, in-air navigation, and budgeting.

• Prepared route plans, survey definitions, navigation files, aircraft-to-instrument electrical and structural interface definitions, time-of-day optimization for certain classes of instruments, fuel estimates, Applanix configuration, and the myriad tasks required to safely execute the mission.

• Over 900 hours of in-flight instrument operations in tight spaces, in temperature and pressure altitude extremes requiring O2 masks, and under stiff financial pressure to get it right the first time.

• Developed post-flight processing software in Matlab and Python to autonomously document the day's efforts and update stakeholders with graphics and plots. Extensions of the code base were used to process subsets of instrument data in the field to ensure instrument performance.

Research & Development

• Organized and supported dozens of research teams to develop path-to-space concepts. Total value of company money exceeds two million dollars, mostly in $25,000 to $50,000 efforts. Most projects resulted in proposals to funding agencies and more than half have been used in production systems.

- Rapidly developed subject expertise in new knowledge domains to meet program needs.

- Integrated custom code with commercial and open-source libraries to model and optimize solutions. Example commercial interfaces include STK, NASTRAN, MODTRAN, and Google Earth. Example open-source libraries include the Robot Operating System (ROS), Point Cloud Library, OpenCV, and the OpenGL graphic rendering engine.

- Designed, manufactured, assembled, and tested structures, optics, electronics, radios, mechanisms, GPS, steering mirrors, heaters, and the myriad support systems for unique systems.

- Fostered relationships with universities and their graduate students to ensure access to cutting-edge research and trends before results were released to the general public.

- Example projects include:

    - Ball Experimental Sea Surface Temperature (BESST): BESST is a microbolometer operating in the 8um to 10um range. It is calibrated with two onboard blackbodies. A rotating mirror changes the field of the view of the detector to different targets. I wrote the threaded C# control code, wired and programmed an interfaced Arduino to read thermistors, and updated the data analysis code in Matlab. I then served as instrument operator on field and airborne deployments around the country. This instrument became CIRiS, Ball's first CubeSat program that was released from the space station in the spring of 2020. I served as the microbolometer expert and systems engineer. A follow-on program called L-CIRiS has been funded to investigate the moon's surface minerals as part of the Artemis program.

    - Invented new machine vision algorithms over a series of projects to automate the mapping and navigation of space structures and objects. A typical effort worked with lidar point cloud data from sensors, such as the "Sensor Test for Orion Relative Navigation Risk Mitigation" (STORRM) system or

Ball's TotalSight Flash LIDAR, to build 3D representations of objects, determine relative orientation using quaternions, and plot navigation paths to targets of interest. Example applications included docking with the space station, the Hubble telescope, and discarded rocket stages. A follow-on project mapped asteroids and planned grappling approaches. Significant effort was invested in rapid and intelligent noise reduction. In simulation software and physical environments, my code demonstrated successful operations in greater than 95% of scenarios and ran in real-time, despite being written with Matlab scripts instead of compiled C. The core of my approach was built on pyramids of probabilities and included neural networks, eigenvectors, edge and feature detection, surface fitting, iterative closest point, feature ratios, and future prediction chains.

- Methane Monitor: This is a differential absorption lidar operating two lasers tuned on and off a methane absorption peak near 1,645 nm. The differences in absorption are used to quantify methane quantities. The instrument is carried in small aircraft flying at 1,000 meters above the ground. An electromagnetic voice coil mirror scans a 30-degree path at 20 Hz. This was a small team funded by the Department of Transportation. I provided laser, mechanical, and programming support during the design phase and lab, field, and campaign support in its assembly and operational phase. A large part of my PhD dissertation involved understanding every part of the instrument and seeking ways to improve and shrink it.

- Developed neural network algorithms for the Methane Monitor instrument to detect, quantify, and report methane plumes in real-time. These algorithms are the subject of an awarded patent.

- Scripted highly parallel Matlab data analysis code for server clusters, reducing analysis time from eighteen hours to one. Inputs were "Level 0" data such as raw sensor readings, RGB camera readouts, GPS locations, gimbal pointing vectors, digital elevation maps, and instrument configuration settings. Outputs were "Level 1" through "Level 4" geolocated and corrected sensor images, Google Earth KML files, automatic target quantification, ARC GIS files, and summary reports.

- Supported high altitude balloon experiments with primary responsibility for air-to-ground communications and secondary support for the structural analysis and embedded C control code. The two-way communication system operated on the civilian 900 MHz and 2.4 GHz channels at up to 100,000 feet and used pointed antennas on ground vehicles. The structure had to protect expensive gimbal and camera systems from ground impact after the balloon burst. The code set controlled the cameras, gimbal, heaters, and communications.

- Binary Asteroid In-situ Explorer: The mission concept was a series of probes designed to fly as a set to an asteroid, land, then explode one by one. Surviving probes would measure accelerations from the explosions. The data would be used to characterize the internal structure of the asteroid. I developed the embedded C code, integrated and tested the communication systems, and assembled and tested the structure, including novel spring release mechanisms. My code ran on a purpose-built board with programmable memory. It controlled all aspects of the probe including communications, internal health monitoring, accelerometer data transfer, storage, and the explosion sequence.

- Invented and tested a new mechanical approach to shock mitigation for satellite subsystems. The method involved aligning force vectors with tensioned structures, then aligning shock sensitive systems orthogonally to these structures. In testing, it reduced shock loads by up to 80%. Parallel with this effort was an investigation into "pseudo-velocity" shock analysis methods, which puts an emphasis on velocity changes at each frequency rather than the level of acceleration.

- Provided multi-discipline support for carbon nanotube blackbodies. The research sought extremely low reflectivity (emissivity greater than 0.995) surfaces with high area uniformity for use in infrared systems. I worked the mechanical, thermal, and data analysis fronts, as well as became an end user as a Mission Architect.

- Created membrane mechanisms using piezoelectric materials, magnetic fields, and memory wire for large scale, deformable, space-based membrane surfaces. We flew the suite of samples on Zero-G Corporations' parabolic flying 727.

- Classified research projects

Structural Analysis

• Cradle-to-grave, full-stack structural analysis for space systems worth tens of millions of dollars in raw part cost and billions in mission impact. Systems I have signed off have never failed when manufactured to specification.

• Analysis topics include preliminary design with free-body and Roark hand calculations, static and dynamic loads, fatigue/crack propagation, bonding, path optimization, mechanism life cycles, optics/Zernike/STOP, thermal loads and displacements, composites, fasteners, welds, pressure vessels and tubing, and the myriad supporting topics.

- Responsible for the full suite of tests including thermal, shock, sine, and random vibration level definition, accelerometer placement, in-lab control of test operations, real-time analysis and test modification, and report generation.

- Example high-value programs include:

  - James Webb Space Telescope: Lead structural engineer for the Aft Optics Bench (AOB) and its mirrors. The AOB is the protruding black structure in the center of the gold mirrors. It holds two large mirrors, including a fine steering mirror. This was particularly challenging to optimize due to the extreme fracture sensitivity of the "Hot Isostatic Press" beryllium.

  - MOIRE: Lead for the DARPA-funded, 100-meter deployable Fresnel lens space telescope. Over 200 mechanisms and deployable structures were included in the analysis. I also wrote novel Monte Carlo Matlab code to generate random but smoothly distributed material properties to test a range of potential manufacturing outcomes. I was co-awarded a patent for the deployment mechanism.

  - Ozone monitoring OMPS and LIMB instruments: Lead role through two builds for these titanium structures.

  - GEMS/TEMPO pollution monitoring instruments: Carbon fiber bonded tube structure

  - Pluto New Horizons Mission: Structural, thermal, optical (STOP) analysis

  - Joint Polar Satellite System Gimbals: Provided extensive on-site support for a struggling vendor

  - Classified systems: These were major, multiple year efforts.

• Wrote over five hundred thousand lines of Matlab code for the department to automate finite element and material generation, process post-run data, and generate reports, saving the department thousands of hours each year.

Three examples:

- Frequency Response Analysis Program: Wrote an extensive library and user interface in Matlab to rapidly iterate structural vibration analyses. The program imports stiffness and mass matrices from NASTRAN and allows users to change vibration types (such as sine or random), load levels, applied load directions, recovered response directions, damping levels, and nodes/elements of interest.

- Automatic Fastener Processing: The traditional Ball approach was to import the finite element load summary into Excel and look for maximum values for each type of fastener. These would then be typed into another Excel workbook. I updated the approach by importing the loads into Matlab, setting up NASA's full fastener specification, added Ball's in-house variations, and auto-processed loads into a full report and summary.

- Electronic board and component analysis: The failure to properly stake electronic components has been a source of mission failure for several space systems. I was asked to lead the analysis effort to understand the underlying physics of each type of component and automate analysis with non-linear, but simple equations. The result is now used for every electronic board and component that Ball Aerospace flies. It has cut failures due to vibration for the categorized parts to zero.

• Finite Element Model development tool experience includes I-DEAS, NX, SolidWorks, FEMAP, LS-DYNA, and my own custom code that analyzed STEP files and auto-meshed them with Matlab. I also wrote finite element optimization algorithms that iterated meshes and load paths using a strain energy approach.

• Finite Element Analysis solver experience primarily based on NASTRAN (NX and MSC). Familiarity with ANSYS, ABAQUS, and LS-DYNA.

• Standardization of Analysis: I condensed tribal knowledge, trade studies, and reports into a "How Ball does Analysis" class. I produced an illustrated textbook of nearly 200 pages and the supporting course materials.

• Group lead: documented quarterly and annual performance, reviewed resumes, interviewed candidates, and participated in the year-end ranking and promotion meetings.

EDUCATION

PhD, Aerospace Engineering, Remote Sensing, CU Boulder
December 2017

- Emphasis on remote sensing technologies and the science that drives instrument requirements
- Dissertation: "Practical design guidelines for fugitive gas detection from unmanned aerial vehicles"
- 2015 Department of Transportation's Hazardous Pipeline Grant Recipient: Awarded $300,000 to investigate a concept for a small-scale, remote sensor for natural gas leaks.
- Caltech/JPL 2015 Space Challenge Team Leader
- NIA/NASA 2015 RASC-AL winning team for a graduate-level lunar architecture concept

MS, Aerospace Engineering, Structures and Materials, UT Austin
June 2006

- Thesis: "Controlling Fiber/Matrix Adhesion with Binary Self-Assembled Monolayers". The work used special chemical treatments of composite fibers to make them more robust against failure.
- Continued leadership of the unmanned aerial vehicles department expanding membership to over 40 active members building three aircraft a year

BS, Aerospace Engineering, UT Austin
June 2004

- Built and led a team for NASA's zero-g student campaign. Designed, assembled, and operated an experiment focused on particle damping for vibrating structures.
- Leader for the new, student-led unmanned aerial vehicle department my junior and senior years. Tasks included complete control of the design, assembly, test, and competition phases of each academic year. I also managed finances and travel coordination for the team.

San Antonio College, Olmos Park, TX
Coursework in Computer Science prior to transferring to UT Austin for Aerospace Engineering

PUBLICATIONS & PATENTS

Primary Authorship

“Progress in Wide Area Methane Mapping for Application in the Energy Sector”, Optics and Photonics for Energy and the Environment. Optical Society of America, 2017.

"Analysis of the impact of wavelength separation on reflectivity error for differential absorption lidar using the ASTER spectral library," J. Appl. Remote Sens. 11(3), 036008, 2017

“MOIRE Gossamer Space Telescope – Membrane Analysis,” 55th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, Paper 1741001, 2014

“MOIRE Gossamer Space Telescope – Challenges and Solutions in Large Scale Testing,” 54th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, Paper 1514119, 2013

“MOIRE Gossamer Space Telescope – Structural Challenges and Solutions,” 53rd AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, Paper 1224028, 2012

Co-Authorship

Comparing the theoretical performances of 1.65-and 3.3-μm differential absorption lidar systems used for airborne remote sensing of natural gas leaks, Journal of Applied Remote Sensing 12.2, 2018

“Submesoscale Sea Surface Temperature Variability from UAV and Satellite Measurements”, MDPI Remote Sensing, 2017

"Wide area methane emissions mapping with airborne IPDA lidar", Proc. SPIE 10406, Lidar Remote Sensing for Environmental Monitoring, 2017

“A Microbolometer Airborne Calibrated Infrared Radiometer: The Ball Experimental Sea Surface Temperature (BESST) Radiometer,” IEEE Transactions on Geoscience and Remote Sensing, Volume 52, Issue 12, May 2014

"Simulation Results of Rendezvous and Docking with the International Space Station Using Only 3D Range Images" AAS Guidance, Navigation and Control Conference, 2012

"Small Surface Probes for Solar System Exploration", International Microelectronics and Packaging Society, 2010

"Adhesive Characterization and Testing for Cryogenic High Shock Electronics Applications", Society for the Advancement of Material Process Engineering, 2009

"Shock Testing and a Tool for Predicting Shock Damage Potential", Spacecraft and Launch Vehicle Dynamic Environment, 2009

"Cryogenic Design and Predicted Performance of the James Webb Space Telescope Beryllium Aft Optics Subsystem Optical Bench", International Society for Optics and Photonics, 2007

"Controlling Fiber/Matrix Adhesion with Binary Self-Assembled Monolayers", Proceedings of the 28th Riso International Symposium on Materials Science, 2007

Patents

US9709793B1 – Deployable Structure
Covers the unique folding structure of the MOIRE telescope

US10921245B1 – Method and Systems for Remote Emission Detection and Rate Determination
Applies neural network approaches to sensor readings for real-time detection of gas plumes

ADDITIONAL INFORMATION

Skills and Interests

- Programming:
  - Matlab – 1,000,000+ lines written
  - HTML, JavaScript – 250,000+ lines written
  - Python, SQL – 100,000+ lines written
  - C, C++, C# - 50,000+ lines written

- Software:
  - Mechanical: I-DEAS/NX, NASTRAN, SolidWorks, Inventor, FEMAP, LS-DYNA, NASGRO
  - Programming: Visual Studio, Git, Notepad++
  - Technical: MODTRAN, OpticStudio, STK, Google Earth, Applanix

  - Libraries & Engines: OpenGL, Robot Operating System, OpenCV, jQuery, Moment, THREE, Pixi
  - General: Microsoft Office, Agile

- Adventure:
  - Instrument Flight Rules (IFR) certified pilot
  - SCUBA with advanced certifications
  - Thru-hiked 1,000+ miles on New Zealand's north island

Community Engagement

- 9-Year FIRST Robotics Mentor (Boulder High School and Casa de la Esperanza)
- 5-Year competitive-level youth soccer coach (Boulder area)
- 9-Year LiveStrong cancer foundation event management volunteer
- Co-lead of a university team cycling 5,000 miles from Austin, TX to Anchorage, AK. We raised over $100,000 for the MD Anderson hospital in Texas.
- Fundraising lead for the Sun Water solar powered water pumps for developing countries. Raised $30,000 and managed public relations and outreach with the NY Times, Exxon, and other large organizations.