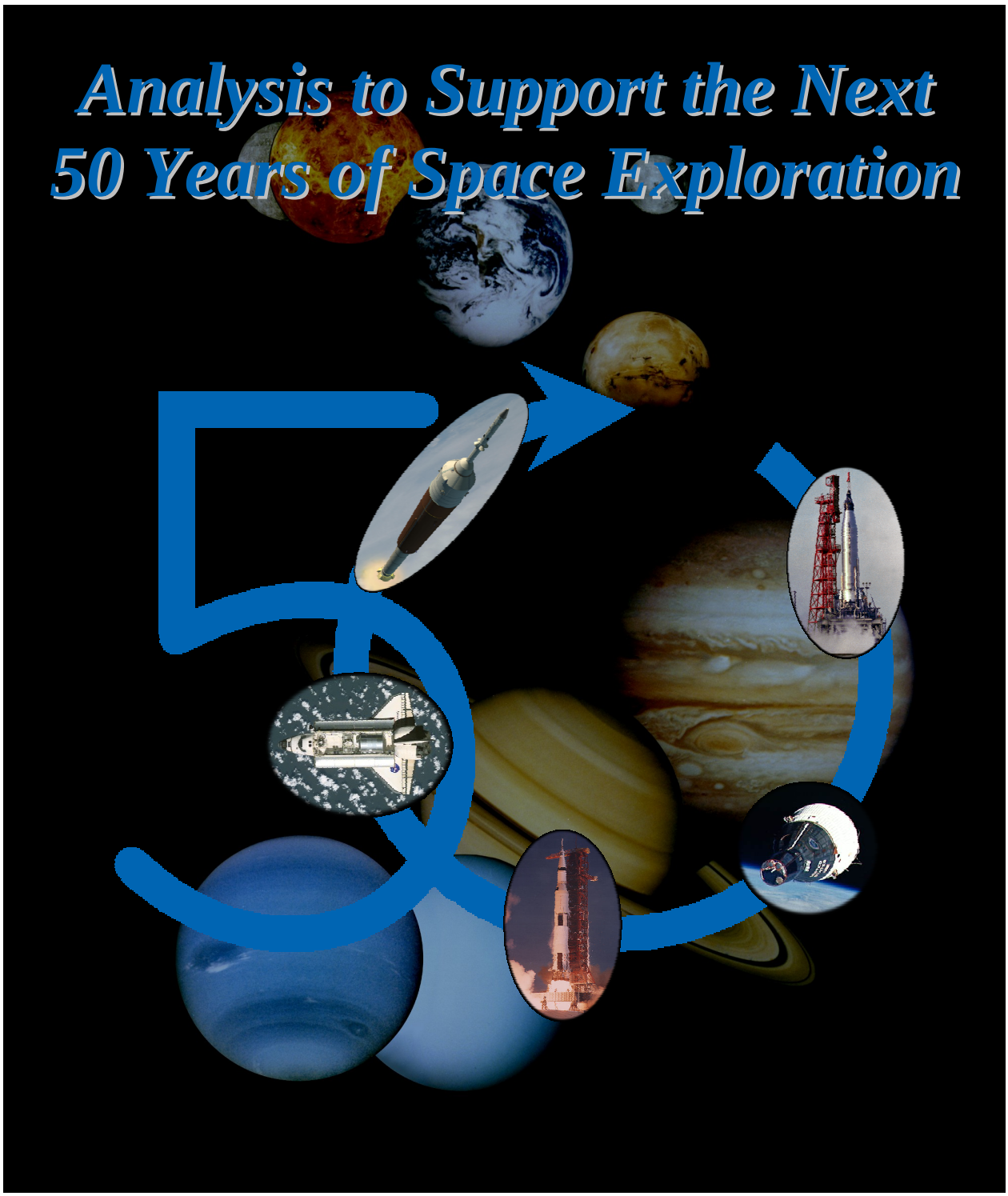
# Thermal & Fluids Analysis Workshop 2008

**August 18 -22, 2008**
**San Jose State University, San Jose, CA**
**Hosted By**
**NASA Ames Research Center**
**&**
**San Jose State University**
**Aerospace Engineering, College of Engineering**

## *Analysis to Support the Next 50 Years of Space Exploration*



# Organizing Committee

| | |
|---|---|
| Conference Chairs: | Tom Squire, NASA Ames Research Center<br>Marla Arcadi, ELORET Corporation |
| SJSU Coordinator: | Dr. Periklis Papadopoulos, San Jose State University |
| Paper Sessions: | Parul Agrawal, ELORET Corporation |
| Vendor Coordinator: | Kerry Trumble, NASA Ames Research Center |
| Tour Coordinator: | Ernie Fretter, NASA Ames Research Center |
| SJSU Student Coordinator: | Kenny Boronowsky |
| SJSU Student Volunteers: | Dai Dinh<br>Paul R Linggi<br>Bhavya Tottempudi<br>Zion W. Young<br>David J. Fernandez<br>Ramon Martinez<br>Cassandra B VanOutryve |
| SJSU IT Support Staff: | Kindness Israel, San Jose State University<br>Scott Pham, San Jose State University<br>Irma Alarcon, San Jose State University |

Paper Session Chairs:

| | |
|---|---|
| Thermal Analysis | Kaitlin Liles (NASA LaRC) |
| Aerothermal/CFD Analysis | Xiao-yen Wang (NASA GRC) |
| Interdisciplinary | Glenn Tsuyuki (NASA JPL) |
| Modeling of Thermal Tests | Steven Sepka (ELORET Corp.) |
| Student Session | Dr. Periklis Papadopoulos (SJSU)<br>Dr. Nikos Mourtos (SJSU) |
| Exploration/MSL Mission | Stephen Miller (NASA JSC) |

| | |
|---|---|
| Legal Counsel: | Kevin Kouba, NASA Ames Research Center<br>Robert Padilla, NASA Ames Research Center |
| Contractor Support: | Ronnee Gonzalez, NASA Ames Research Center<br>Lana Jones Clemon, NASA Ames Research Center |
| Procurement Support: | Gloria Hermosillo, Powertek Corporation<br>Chris Youngquist, Powertek Corporation<br>Leticha Hawkins, NASA Ames Research Center |

## NASA Ames Space Technology Division Management

Dr. Charles Smith
Chief, Space Technology Division, NASA ARC

Dr. Sylvia Johnson
Chief, Thermal Protection Materials & Systems Branch, NASA ARC

## Special Thanks

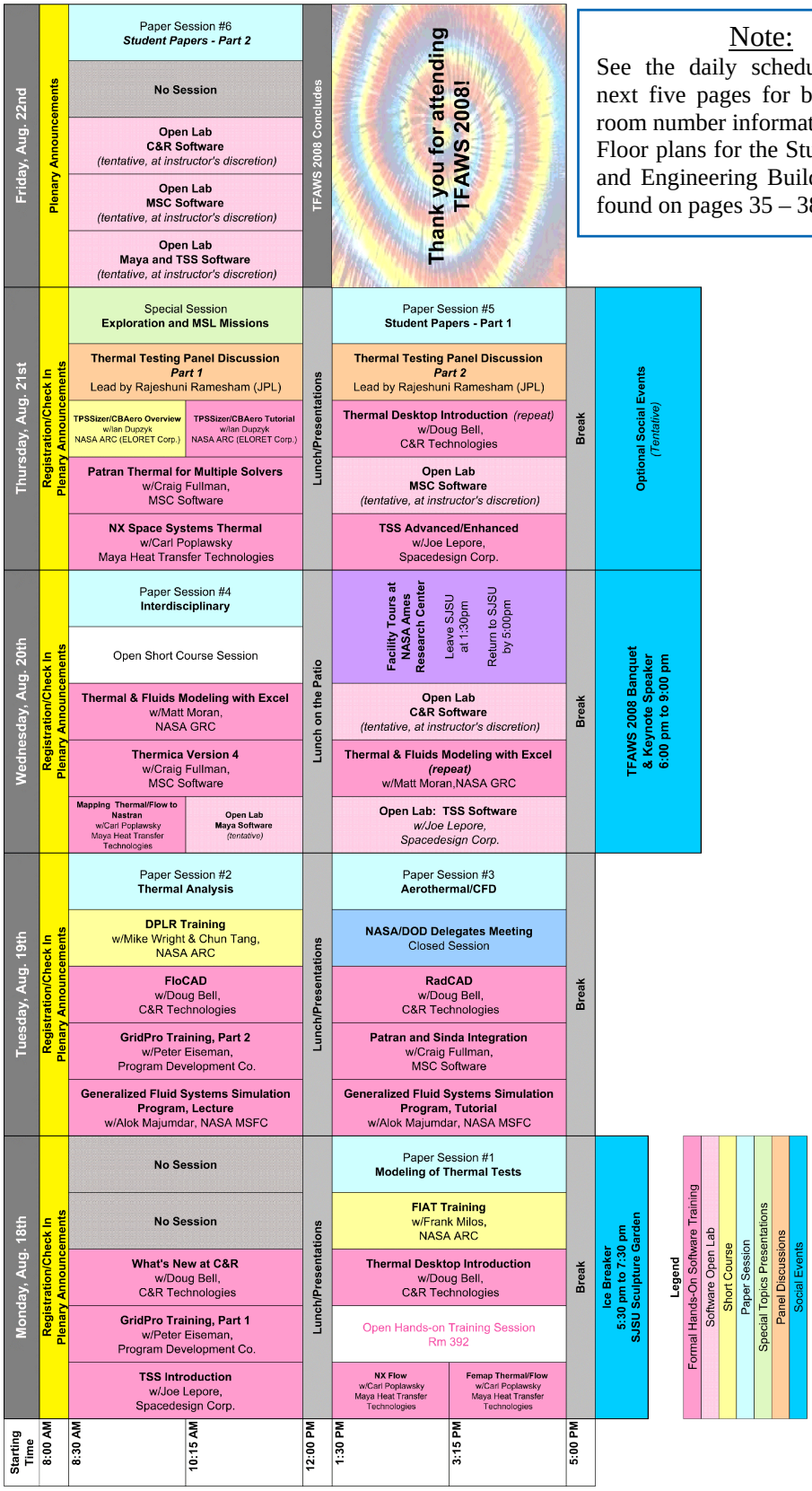
Dr. S. Pete Worden - Director, NASA Ames Research Center

Dr. Eugene L. Tu - Director, Exploration Technology Directorate, NASA ARC

# Table of Contents

# Workshop Schedules

## Weekly Schedule




**Note:**

See the daily schedules on the next five pages for building and room number information.
Floor plans for the Student Union and Engineering Building can be found on pages 35 – 38.

# Workshop Schedules

## Monday Schedule – August 18, 2008

| Start Time | Session<br>Instructor/Session Chair/Leader<br>*Building/Room* | | | | |
|---|---|---|---|---|---|
| 8:00 AM | **Registration/Check-In**<br>**Plenary Announcements**<br>Tom Squire & Marla Arcadi<br>*Student Union, Main Ballroom* | | | | |
| 8:30 AM | **TSS Introduction**<br>Instructor:<br>Joe Lepore<br>(Spacedesign Corp.)<br>*Engineering Building, Room 387* | **GridPro Training, Part 1**<br>Instructor:<br>Peter Eiseman<br>(Program Development Company)<br>*Engineering Building, Room 392* | **What's New at C&R**<br>Instructor:<br>Doug Bell<br>(C&R Technologies)<br>*Engineering Building, Room 394* | **No Session** | **No Session** |
| 12:00 AM | **Lunch/NASA Center Presentations**<br>hosted by Tom Squire & Marla Arcadi<br>*Student Union, Main Ballroom* | | | | |
| 1:30 PM | **NX Flow**<br>Instructor:<br>Carl Poplawsky<br>(Maya Heat Transfer Technologies)<br>*Engineering Building, Room 387* | Open Hands-On Training Session | **Thermal Desktop Introduction**<br>Instructor:<br>Doug Bell<br>(C&R Technologies) | **FIAT Lecture and Training**<br>Speaker:<br>Frank Milos<br>(NASA Ames)<br>*Student Union, Ohlone Room* | Paper Session #1<br>**Modeling of Thermal Tests**<br>Session Chair:<br>Steven Sepka<br>(ELORET Corp.)<br>*Engineering Building, Auditorium 1st Floor Room 189* |
| 3:15 PM | **Femap Thermal/Flow**<br>Instructor:<br>Carl Poplawsky<br>(Maya Heat Transfer Technologies)<br>*Engineering Building, Room 387* | *Engineering Building, Room 392* | *Engineering Building, Room 394* | | |
| 5:00 PM | **Break** | | | | |
| 5:30 PM | **Ice Breaker**<br>**(Food, drinks and live entertainment)**<br>5:30 pm to 7:30 pm<br>*SJSU Sculpture Garden*<br>*by the statue of the 1968 Olympic gold and bronze medal winners* | | | | |

**Legend**

- Hands-On Software Training
- Software Open Lab
- Short Course
- Paper Session
- Special Topics Presentations
- Panel Discussions
- Social Events

**Note:**
See pages 35 - 38 for floor plans of the Student Union and Engineering Building.

# Workshop Schedules

## Tuesday Schedule – August 19, 2008

| Start Time | Session<br>Instructor/Session Chair/Leader<br>*Building/Room* | | | | |
|---|---|---|---|---|---|
| 8:00 AM | **Registration/Check-In**<br>**Plenary Announcements**<br>Tom Squire & Marla Arcadi<br>*Student Union, Main Ballroom* | | | | |
| 8:30 AM | **Generalized Fluid Systems Simulation Program: Lecture Session**<br>Instructor: Alok Majumdar (NASA Marshall)<br>*Engineering Building, Room 387* | **GridPro Training, Part 2**<br>Instructor: Peter Eiseman (Program Development Company)<br>*Engineering Building, Room 392* | **FloCAD**<br>Instructor: Doug Bell (C&R Technologies)<br>*Engineering Building, Room 394* | **DPLR Lecture and Training**<br>Speakers: Mike Wright & Chun Tang (NASA Ames)<br>*Student Union, Ohlone Room* | Paper Session #2<br>**Thermal Analysis**<br>Session Chair: Kaitlin Liles (NASA Langley)<br>*Engineering Building, Auditorium 1st Floor Room 189* |
| 12:00 AM | **Lunch/NASA Center Presentations**<br>hosted by Tom Squire & Marla Arcadi<br>*Student Union, Main Ballroom* | | | | |
| 1:30 PM | **Generalized Fluid Systems Simulation Program: Tutorial Session**<br>Instructor: Alok Majumdar (NASA Marshall)<br>*Engineering Building, Room 387* | **Patran and Sinda Integration**<br>Instructor: Craig Fullman MSC Software<br>*Engineering Building, Room 392* | **RadCAD**<br>Instructor: Doug Bell (C&R Technologies)<br>*Engineering Building, Room 394* | **NASA/DOD Delegates Meeting**<br>***Closed Session***<br>*Student Union, Pacifica Room* | Paper Session #3<br>**Aerothermal/CFD**<br>Session Chair: Xiao-Yen Wang (NASA Glenn)<br>*Engineering Building, Auditorium 1st Floor Room 189* |
| 5:00 PM | **Break** | | | | |

**Legend**

- Hands-On Software Training
- Software Open Lab
- Short Course
- Paper Session
- Special Topics Presentations
- Panel Discussions
- Social Events

**Note:**
See pages 35 - 38 for floor plans of the Student Union and Engineering Building.

# Workshop Schedules

## Wednesday Schedule – August 20, 2008

| Start Time | Session<br>Instructor/Session Chair/Leader<br>*Building/Room* | | | | |
|---|---|---|---|---|---|
| 8:00 AM | **Registration/Check-In**<br>**Plenary Announcements**<br>Tom Squire & Marla Arcadi<br>*Student Union, Main Ballroom* | | | | |
| 8:30 AM | **Mapping Thermal/Flow to Nastran Model**<br>Instructor:<br>Carl Poplawsky<br>(Maya Heat Transfer Technologies)<br>*Engineering Building, Room 387* | **Thermica Spacecraft Thermal Design Version 4**<br>Instructor:<br>Craig Fullman<br>(MSC Software)<br>*Engineering Building, Room 392* | **Thermal and Fluid System Modeling with Excel/VBA**<br>Instructor:<br>Matt Moran<br>(NASA Glenn)<br>*Engineering Building, Room 394* | Open Short Course Session | Paper Session #4<br>**Interdisciplinary**<br>Session Chair:<br>Glenn Tsuyuki<br>(JPL)<br>*Engineering Building, Auditorium 1st Floor Room 189* |
| 10:15 AM | **Open Lab Maya Software**<br>Instructor:<br>Carl Poplawsky<br>(Maya Heat Transfer Technologies)<br>*Engineering Building, Room 387* | | | | |
| 12:00 AM | **Lunch on the Patio**<br>*Student Union, Outdoor Amphitheater* | | | | |
| 1:30 PM | **Open Lab for TSS Software**<br>Instructor:<br>Joe Lepore<br>(Spacedesign Corp.)<br>*Engineering Building, Room 387* | **Thermal and Fluid System Modeling with Excel/VBA**<br>*(repeat)*<br>Instructor:<br>Matt Moran<br>(NASA Glenn)<br>*Engineering Building, Room 392* | **Open Lab C&R Software**<br>Tentative, at instructor's discretion<br>*Engineering Building, Room 394* | **Facility Tours at NASA Ames Research Center**<br>Leave SJSU at 1:30pm<br>Return to SJSU by 5:00pm<br>*Tour participants meet in the parking lot near the Student Union at 1:30pm to board the buses.*<br>*The tour is limited to 80 visitors, first come, first served.* | |
| 5:00 PM | **Break** | | | | |
| 6:30 PM | **TFAWS 2008 Banquet**<br>**Keynote Speaker: Dr. S. Pete Worden, Director NASA Ames Research Center**<br>6:00pm to 9:00pm<br>*The Rotunda at San Jose City Hall* | | | | |

| Legend |
|---|
| Hands-On Software Training |
| Software Open Lab |
| Short Course |
| Paper Session |
| Special Topics Presentations |
| Panel Discussions |
| Social Events |

Note:
See pages 35 - 38 for floor plans of the Student Union and Engineering Building.

*Special thanks to MSC Software for helping to sponsor Wednesday's picnic lunch*

# Thursday Schedule – August 21, 2008

| Start Time | Session<br>Instructor/Session Chair/Leader<br>*Building/Room* | | | | |
|---|---|---|---|---|---|
| 8:00 AM | **Registration/Check-In**<br>**Plenary Announcements**<br>Tom Squire & Marla Arcadi<br>*Student Union, Main Ballroom* | | | | |
| 8:30 AM | **NX Space Systems Thermal**<br>Instructor:<br>Carl Poplawsky<br>(Maya Heat Transfer Technologies)<br>*Engineering Building, Room 387* | **Patran Thermal for Multiple Solvers**<br>Instructor:<br>Craig Fullman<br>(MSC Software)<br>*Engineering Building, Room 392* | **TPSSizer/CBAERO Overview**<br>Ian Dupzyk<br>(ELORET Corp.)<br>*Engineering Building, Room 394* | **Thermal Testing Panel Discussion *Part 1***<br>Leader:<br>Rajeshuni Ramesham<br>(JPL)<br>*Student Union, Pacifica Room* | Special Session<br>**Exploration and MSL Missions**<br>Session Chair:<br>Stephen Miller<br>(NASA Johnson)<br>*Engineering Building, Auditorium 1st Floor Room 189* |
| 10:15 AM | | | **TPSSizer/CBAERO Tutorial**<br>Ian Dupzyk<br>(ELORET Corp.)<br>*Engineering Building, Room 394* | | |
| 12:00 AM | **Lunch/NASA Center Presentations**<br>hosted by Tom Squire & Marla Arcadi<br>*Student Union, Main Ballroom* | | | | |
| 1:30 PM | **TSS Advanced/ Enhanced**<br>Instructor:<br>Joe Lepore<br>(Spacedesign Corp.)<br>*Engineering Building, Room 387* | **Open Lab MSC Software**<br>Tentative, at instructor's discretion<br>*Engineering Building, Room 392* | **Thermal Desktop Introduction** *(repeat)*<br>Instructor:<br>Doug Bell<br>(C&R Technologies)<br>*Engineering Building, Room 394* | **Thermal Testing Panel Discussion *Part 2***<br>Leader:<br>Rajeshuni Ramesham<br>(JPL)<br>*Student Union, Pacifica Room* | Paper Session #5<br>**Student Papers Part 1**<br>Session Chair:<br>Dr. Periklis Papadopoulos<br>(SJSU)<br>*Engineering Building, Auditorium 1st Floor Room 189* |
| 5:00 PM | **Break** | | | | |

**Legend**

- Hands-On Software Training
- Software Open Lab
- Short Course
- Paper Session
- Special Topics Presentations
- Panel Discussions
- Social Events

**Note:**
See pages 35 - 38 for floor plans of the Student Union and Engineering Building.

# Friday Schedule – August 22, 2008

| Start Time | Session<br>Instructor/Session Chair/Leader<br>*Building/Room* | | | | |
|---|---|---|---|---|---|
| 8:00 AM | **Plenary Announcements**<br>Tom Squire & Marla Arcadi<br>*Student Union, Main Ballroom* | | | | |
| 8:30 AM | **Open Lab**<br>**Maya Software and TSS Software**<br>Tentative, at instructor's discretion<br>*Engineering Building, Room 387* | **Open Lab**<br>**MSC Software**<br>Tentative, at instructor's discretion<br>*Engineering Building, Room 392* | **Open Lab**<br>**C&R Software**<br>Tentative, at instructor's discretion<br>*Engineering Building, Room 394* | No Session | Paper Session #6<br>**Student Papers Part 2**<br>Session Chair: Dr. Nikos Mourtos (SJSU)<br>*Engineering Building, Auditorium 1st Floor Room 189* |
| 12:00 AM | **TFAWS 2008 Concludes** | | | | |


**Legend**

| |
|---|
| Hands-On Software Training |
| Software Open Lab |
| Short Course |
| Paper Session |
| Special Topics Presentations |
| Panel Discussions |
| Social Events |

Note:
See pages 35 - 38 for floor plans of the Student Union and Engineering Building.

# Monday Morning, August 18th, 2008

## TSS – Thermal Synthesizer System Introduction

***Spacedesign Corp.***

This class is a hands-on session that teaches some of the basics needed to use TSS. Course modules are: a) Model input methods including the use of CAD Input, b) Methodology and how to use Radk and Heatrate to calculate radiation exchange, c) Using script files to make movies for presenting TSS results, d) Methodology and detailed description of the procedure to model a spinning spacecraft.

## GridPro Training, Part 1

***Program Development Company***

The two sessions will give basic training in GridPro, covering its philosophy and operation as well as doing so on cases of interest to the participants. GridPro is often used in geometrically complex aerothermodynamic simulations where the resulting volumetric grid smoothness and orthogonallity has greatly helped to rapidly deliver accurate CFD results.

GridPro generates block-structured grids where the user is focused upon the pattern of grid points rather than on detailed geometric constructions. While interactive graphics helps in establishing the patterns, the grid generator is a batch job that automatically generates the grids

With GridPro the key action is the grid point pattern creation for given classes of cases. As codified by the topology input language (TIL), each generated grid is automatically done with template (TIL Code) that can be reused on similar cases or reused as modules in more complex cases.

Our training will start with identifying good pattern choices (topologies) and then on how to implement such choices. This will be illustrated with some standard generic examples and will evolve towards examples that are more directly related to the interests of TFAWS.

## What's New at C&R Technologies?

***C&R Technologies***

Topics covered will be:

- AeroTPS, the interface to ATAC for coupled aeroheating, ablation and thermal response calculations
- The Thermal Desktop Mesher
- Mapper objects for mapping temperatures to finite element models
- AMG solution method in SINDA/FLUINT
- The new Sinaps
- Other recent advances for C&R applications.

Attendees will have some hands-on opportunities.

## Monday Afternoon, August 18th, 2008

### NX Flow
***MAYA Heat Transfer Technologies***

The Siemens PLM NX Flow software leverages the TMG-Flow computational fluid dynamics (CFD) solver from MAYA (www.mayahtt.com) to accurately and efficiently simulate fluid flow phenomenon. This workshop will feature hands-on tutorials to introduce the attendees to NX Flow. The attendees will follow tutorial instructions to simulate various CFD phenomenon of interest to the NASA community. In addition, a tutorial of the NX Electronic Systems Cooling software will also be featured for cooling of electronic equipment.

### Femap Thermal/Flow
***MAYA Heat Transfer Technologies***

The Siemens PLM Femap Advanced Thermal software is a space industry application leveraging the entire range of numerical capabilities found within the TMG solver from MAYA (www.mayahtt.com). It provides a comprehensive set of tools to simulate orbital heating simulation within the Femap environment. This workshop will provide hands-on tutorials for the attendees to simulate transient on-orbit articulated spacecraft using Femap TMG

### Thermal Desktop Introduction
### C&R Technologies

An introduction to thermal modeling using Thermal Desktop. Attendees will create simple thermal models, solve for temperatures, postprocess results, parameterize models, and run parametric solutions. Topics covered will be: Thermal Desktop solids, surfaces, and thermal network objects; thermophysical properties; symbols and expressions; defining thermal solutions; postprocessing; and basic AutoCAD functionality.

## Tuesday Morning, August 19th, 2008

## Generalized Fluid System Simulation Program
## Part 1: Lecture
### *NASA MSFC*

GFSSP is a general-purpose computer program developed at Marshall Space Flight Center (http://gfssp.msfc.nasa.gov/) for analyzing steady state and time-dependent flow rates, pressures, temperatures, and concentrations in a complex flow network. This Hands-on course quickly teaches new users to use GFSSP to solve engineering flow network problems through lectures and tutorial problems. The program is capable of modeling phase changes, compressibility, conjugate (solid to fluid) heat transfer, mixture thermodynamics, pumps, compressors and external body forces such as gravity and centrifugal. The program is integrated with state of the art thermodynamic property programs for computing real fluid properties of all cryogenic propellants and commonly used fluids. GFSSP is also capable of modeling fluid components such as pipe, orifice, bends, valves, regulators and Joule-Thompson devices. The graphical user interface allows users to build their models using "point, drag and click" method. The program employs a finite volume formulation of mass, momentum, and energy conservation equations in conjunction with the thermodynamic equations of state for real fluids as well as energy conservation equations for the solid. GFSSP has been used in many NASA programs including Space Shuttle Main Engine, Space Station, and currently being extensively used in the design of Main Propulsion System of Ares I. GFSSP is available for any work supported by US Government.

Part 1 will be a lecture that covers the following topics:

1. Introduction & Overview
2. Graphical User Interface
3. Mathematical Formulation
4. User Subroutine
5. Pressurization, Water hammer and Conjugate Heat Transfer

## GridPro Training, Part 2
### *Program Development Company*

*See description on page10.*

## FloCAD
## C&R Technologies

An introduction to coupled thermal/fluid analysis using FloCAD in Thermal Desktop. Attendees will build two models: a simple coupled thermal model with fluid flow; and a heatpipe connecting two thermal objects. Topics covered will be: fluid network objects; pipes; a listing of capabilities not covered in the session.

## Tuesday Afternoon, August 19th, 2008

### Generalized Fluid System Simulation Program
### Part 2: Tutorials
### *NASA MSFC*

GFSSP is a general-purpose computer program developed at Marshall Space Flight Center (http://gfssp.msfc.nasa.gov/) for analyzing steady state and time-dependent flow rates, pressures, temperatures, and concentrations in a complex flow network. This Hands-on course quickly teaches new users to use GFSSP to solve engineering flow network problems through lectures and tutorial problems. The program is capable of modeling phase changes, compressibility, conjugate (solid to fluid) heat transfer, mixture thermodynamics, pumps, compressors and external body forces such as gravity and centrifugal. The program is integrated with state of the art thermodynamic property programs for computing real fluid properties of all cryogenic propellants and commonly used fluids. GFSSP is also capable of modeling fluid components such as pipe, orifice, bends, valves, regulators and Joule-Thompson devices. The graphical user interface allows users to build their models using "point, drag and click" method. The program employs a finite volume formulation of mass, momentum, and energy conservation equations in conjunction with the thermodynamic equations of state for real fluids as well as energy conservation equations for the solid. GFSSP has been used in many NASA programs including Space Shuttle Main Engine, Space Station, and currently being extensively used in the design of Main Propulsion System of Ares I. GFSSP is available for any work supported by US Government.

Part 2 will include the following tutorials:

1. Simulation of a Flow System Consisting of a pump, valve and pipeline
2. Simulation of Compressible Flow in a Converging-Diverging Nozzle
3. Simulation of the Blowdown of a pressurized Tank
4. Valve Controlled Pressurization of a Propellant Tank
5. Simulation of Fluid Transient following sudden valve closure
6. Chilldown of a cryogenic transfer line

### Patran and Sinda Integration
### *MSC Software*

*(Course description not available at time of printing)*

### RadCAD
### C&R Technologies

An introduction to radiation and environmental heating using RadCAD within Thermal Desktop. Attendees will build a simple thermal model, define radiation analysis groups, define a heating environment, define trackers, calculate radiation exchange and environmental heat rates, and solve for temperatures. Topics covered will be: radiation calculation methods used by Thermal Desktop; optical properties; radiation analysis groups; environmental heating; trackers; and radiation calculation settings.

## Wednesday Morning, August 20th, 2008

### Mapping T & P from Thermal/Flow Model to Nastran Model

*MAYA Heat Transfer Technologies*

The process of simulating transient thermo-elastic interactions within complex structures will be discussed. The challenges of staggered multi-disciplinary analysis as well as the NX solution to these challenges will be presented. A hands-on tutorial will walk the attendees through the process of multi-disciplinary interaction simulation where temperature results from the NX Space Systems Thermal solution will be used as a pre-stress condition for a structural thermo-elastic analysis using NX Nastran (or MSC.Nastran, ANSYS, or ABAQUS) as well as NX Flow to Nastran, ANSYS, or ABAQUS structural models.

### Thermica Spacecraft Thermal Design Version 4

*MSC Software*

Thermica version 4 is a comprehensive spacecraft thermal design system that transparently incorporates the SINDA/G thermal analyzer into a powerful state-of-the-art graphical user environment. Thermica was designed by spacecraft thermal engineers and is used worldwide today.

This introduction covers the model builder, which can use CATIA or other CAD files in the model building process. Models can be built interactively with or without the use of CAD geometry. After the model is built, the orbit will be defined along with any moving bodies, such as solar panels that track the sun. Finally a full SINDA/G model will be constructed and results post-processed on animated views of the spacecraft in orbit.

### Thermal and Fluid System Modeling with Excel/VBA

*Isotherm Technology LLC & NASA Glen Research Center*

- Principles & practices for creating integrated thermal and fluid system models using Excel and Visual Basic for Applications (VBA)
- Modeling techniques & tips focused on thermal and fluid engineering not found in any other seminar, book, or other resource
- Step-by-step approaches for building thermal and fluid models with application examples from the fields of electronics thermal management, cryogenics, MEMS/microsystems, thermodynamics, and heat exchangers based on the instructor's past projects

# Hands-On Software Training

## Wednesday Afternoon, August 20th, 2008

### Tentative Open Lab Sessions

*Check for announcements*

## Thursday Morning, August 21st, 2008

### NX Space Systems Thermal

***MAYA Heat Transfer Technologies***

The Siemens PLM NX Space Systems Thermal software is a space industry application leveraging the entire range of numerical capabilities found within the TMG-Thermal solver from MAYA (www.mayahtt.com). It provides a comprehensive set of tools to simulate orbital heating simulation within the NX Advanced Simulation environment. This workshop will provide hands-on tutorials for the attendees to simulate transient on-orbit spacecraft (with solar panel deployment) using NX Space Systems Thermal. The new NX interface helps resolve thermal engineering challenges early in the design process. It is an indispensable tool for understanding the physics of orbital heat transfer for all space-bound as well as interplanetary-bound vehicles. NX Space Systems Thermal is ideal for modeling orbital vehicle applications with complex geometry. Within NX Space Systems Thermal, your 10 thermal nodes model for conceptual studies up to the million faces model for detailed analysis can be easily built. Using NX Space Systems Thermal, the students will follow step-by-step vignette examples of various spacecraft thermal analysis. Topics covered will include importing CAD geometry or building geometry, assembly meshing, creating thermal couplings between disjoint meshes, applying boundary conditions, specifying orbital parameters (with orbit visualize), specifying radiation environment, and post-processing of transient on-orbit thermal results. Special emphasis will be placed on the advanced NX Space Systems Thermal features and capabilities including ray tracing, Monte-Carlo methods, nongray radiation, thermal refraction in thin & thick lenses, etc.

### Patran Thermal Analysis for Multiple Solvers

***MSC Software***

This course provides an introduction to building thermal models and post-processing results in MSC Patran. The student will create an analysis model in MSC Patran, assign properties and boundary conditions, and submit the analysis to MSC Patran Thermal, Nastran, MSC Sinda, and Marc. The hands-on exercise will also illustrate the mapping of temperature results as loads to a structural analysis with similar or dissimilar mesh. The basic modeling process demonstrated in this course is relevant to other thermal preferences available in MSC Patran.

## TPSSizer and CBAERO Overview and Tutorial

***NASA Ames Research Center***

*Note: This session is a combined Short Course and Hands-On Software Training.*

CBAERO (**C**onfiguration **B**ased **Aero**dynamics) is a fast, engineering level tool used to generate large aerothermal databases from an unstructured surface mesh. CBAERO uses a fast panel method for low speed and Modified Newtonian or Tangent Cone/Wedge for super- to hypersonic speeds and can be anchored against CFD. TPSSizer is a tool used to select and size appropriate thermal protection materials based on maximum temperature experienced and maximum integrated heat load during a trajectory or set of trajectories. When used in conjunction these programs form a suite of tools allowing end to end aerothermal and TPS sizing and response for both ablative and tile systems.

This training course will provide background on CBAERO and TPSSizer including its capabilities and performance. In addition, there will also be a hands-on portion of the course where one or more example cases will be setup and analyzed.

# Thursday Afternoon, August 21st, 2008

## TSS – Thermal Synthesizer System Advanced/Enchanced

***Spacedesign Corp.***

This class is a hands-on session which focuses on more advanced TSS techniques/features, along with some of our latest enhancements. Course modules are: a) Using Boolean operations to define and analyze a geometry, b) Including participating media in analysis calculations, c) Using Sinda/Fluint v4.1C, d) Radiation pressure methodology and use, e) Lunar CSR modeling, f) Using Mesh and Concap to mesh geometry parts and easily attach solid elements to radiation surfaces, g) Using our new Windows-native Transfer application to move CAD models to/from TSS, h) Using the new native-Windows TSS v13.

## Thermal Desktop Introduction *(repeat)*

## C&R Technologies

*See description on page 11.*

# Paper Sessions – Modeling of Thermal Tests

## Monday Afternoon, August 18th, 2008

### Session Chair: Steven Sepka (ELORET Corp.)

| Time | Paper Number | Title & Author(s) |
|---|---|---|
| 1:30 pm | TFAWS-08-1001 | ***"Thermal Capacitance (slug) Calorimeter Theory Including Heat Losses and Other Decaying Processes,"*** T. Mark Hightower* (*NASA ARC*), Ricardo A. Olivares (*NASA ARC*), and Daniel Philippidis (*Educational Associates/NASA*) |
| 2:00 pm | TFAWS-08-1002 | ***"Arc-jet Test Heat Flux Measurement Uncertainty,"*** D.A. Stewart* (*NASA ARC*), T. Gokcen (*ELORET Corp*.), and Y.K. Chen (*NASA ARC*) |
| 2:30 pm | TFAWS-08-1003 | ***"Design and Thermal-Structural Analysis of PICA Coupons for Solar-Tower Test,"*** Parul Agrawal* (*ELORET Corp*.), Thomas H. Squire (*NASA ARC*), and Daniel M Empey (*Sierra Lobo, Inc*.) |
| 3:00 pm | TFAWS-08-1004 | ***"Thermal Modeling of In-depth Thermocouple Response in Ablative Heatshield Materials,"*** Jose A. Santos* (*Sierra Lobo, Inc*.), Robin A. S. Beck (*NASA ARC*), and Timothy K. Risch (*NASA DFRC*) |
| 3:30 pm | TFAWS-08-1024 | ***"Thermal Stress Analysis of TPS using Marc"*** Ted B. Wertheimer (*MSC Software Inc*.) |
| 4:00 pm | | |
| 4:30 pm | | |

* *presenter*

# Paper Sessions – Thermal Analysis

## Tuesday Morning, August 19th, 2008

### Session Chair: Kaitlin Liles (NASA Langley Research Center)

| Time | Paper Number | Title & Author(s) |
|---|---|---|
| 8:30 am | TFAWS-08-1005 | ***"Summary of Thermal Utility Programs Available at Goddard Space Flight Center,"*** Hume Peabody* (*NASA GSFC*) |
| 9:00 am | TFAWS-08-1006 | ***"Propellant Bulk Temperature Modeling for the Orion Launch Abort System,"*** Justin Fox* (*Orbital Sciences Corp*.) and Joseph Bonafede (*ARES Gov. Services*) |
| 9:30 am | TFAWS-08-1007 | ***"Crew Exploration Vehicle Composite Pressure Vessel Thermal Assessment,"*** L.Y. Carrillo* (*NASA JSC*), A.R. Alvarez-Hernandez (*NASA JSC*), and S.L. Rickman (*NASA JSC*) |
| 10:00 am | TFAWS-08-1008 | ***"Ascent Heating Thermal Analysis on CEV SA Fairings and CEV/CLV Interface,"*** XiaoYen Wang* (*NASA GRC*), James Yuko (*NASA GRC*), and Brian Motil (*NASA GRC*) |
| 10:30 am | TFAWS-08-1009 | ***"Upper Stage Tank Thermodynamic Modeling Using SINDA/FLUINT,"*** Paul Schallhorn (*NASA KSC*), D. Michael Campbell* (*Analex Corporation*), Jorge Piquero (*Analex Corporation*), Cindy Fortenberry (*Analex Corporation*), Lisa Grob (*Edge Space Systems*), Xiaoyi Li (*Analex Corporation*), and Sukhdeep Chase (*Analex Corporation*) |
| 11:00 am | | |
| 11:30 am | | |

* *presenter*

# Paper Sessions – Aerothermal/CFD

## Tuesday Afternoon, August 19th, 2008

### Session Chair: Xiao-yen Wang (NASA Glenn Research Center)

| Time | Paper Number | Title & Author(s) |
|---|---|---|
| 1:30 pm | TFAWS-08-1010 | ***"Study of Unsteady Flow in a Transonic Compressor at Near Stall Operation with a Large Eddy Simulation,"*** Chunill Hah* (*NASA GRC*) |
| 2:00 pm | TFAWS-08-1011 | ***"A Wind-Us CFD Investigation of an Airfoil Using an Unstructured Grid to Compare with an Experiment, and with Using Structured Grids,"*** Richard H. Cavicchi* (*NASA GRC*) |
| 2:30 pm | TFAWS-08-1012 | ***"Generation of Unstructured Hexagon-Dominated Conforming Mesh Using Two-boundary Marching Methods,"*** Thomas Wey* (*NASA GRC*) |
| 3:00 pm | TFAWS-08-1013 | ***"CFD Simulation of J-2X Engine Exhaust in the Center-Body Diffuser at B2 Facility,"*** XiaoYen Wang* (*NASA GRC*), Thomas Wey (*NASA GRC*), and Robert Buehrle (*NASA GRC*) |
| 3:30 pm | TFAWS-08-1014 | ***"Examples of Computational Fluid Dynamics (CFD) Mission Applications within the Launch Services Program at NASA-KSC: Fuel Slosh and Rocket Motor Plume,"*** Xiaoyi Li* (*Analex Corporation*) and Gary J. O'Neil (*NASA KSC*) |
| 4:00 pm | | |
| 4:30 pm | | |

* *presenter*

# Paper Sessions – Interdisciplinary

## Wednesday Morning, August 20th, 2008

### Session Chair: Glenn Tsuyuki (Jet Propulsion Laboratory)

| Time | Paper Number | Title & Author(s) |
|---|---|---|
| 8:30 am | TFAWS-08-1020 | ***"Crew Launch Vehicle Mobile Launcher Solid Rocket Motor Plume Induced Environment,"***<br>Bruce Vu* (*NASA KSC*) and Peter Sulyma (*NASA MSFC*) |
| 9:00 am | TFAWS-08-1021 | ***"A Smart Thermal Block Diagram Tool,"***<br>Glenn Tsuyuki* (*JPL*), Robert Miyake (*JPL*), Ramachandra Manvi (*JPL*), and Kyle Dodge (*JPL*) |
| 9:30 am | TFAWS-08-1023 | ***"Analysis Driven Multi-Technology Systems Engineering Using Cielo,"***<br>Mike Chainyk* (*JPL*), Claus Hoff (*JPL*), Eric Larour (*JPL*), Greg Moore (*JPL*), and John Schiermerier (*JPL*) |
| 10:00 am | ~~TFAWS-08-1022~~<br>Withdrawn | ~~***"The Multiphase Combustion Flow Simulation in the Bipropellant Thruster with Detail Kinetic Reaction Model,"***~~<br>~~Kaori Ohminami*, Hiroyuki Ogawa, Kuninori Uesugi~~ |
| 10:30 am | | |
| 11:00 am | | |
| 11:30 am | | |

* *presenter*

# Paper Sessions – Student Papers

## Thursday Afternoon, August 21st, 2008

### Session Chair: Dr. Periklis Papadopoulos (San Jose State University)

| Time | Paper Number | Title & Author(s) |
|---|---|---|
| 1:30 pm | TFAWS-08-1026 | ***"Micro Satellites De-Orbiting Analysis,"***<br>Z. Young* (*SJSU*), K. Boronowsky (*SJSU*), Y. Najafi (*SJSU*), R. Twiggs (Stanford University) and P. Papadopoulos (*SJSU*) |
| 2:00 pm | TFAWS-08-1027 | ***"Thermal Modeling for ATROMOS Mars Polar Lander's Science Station,"***<br>E. Hartman* (*SJSU*), S. Shah (*SJSU/LORAL Space Systems*), M. Murbach (*NASA Ames*), and P. Papadopoulos (*SJSU*) |
| 2:30 pm | TFAWS-08-1028 | ***"Design and Flight Testing of the ARLISS Rocket and CFD Modeling of the Nosecone Region,"***<br>A. Deeptanshu* (*SJSU*), P. Nerio (*SJSU*), A. Epps (*SJSU*), T. Rouse* (*AeroPac*), and P. Papadopoulos (*SJSU*) |
| 3:00 pm | TFAWS-08-1029 | ***"Virtual Classroom: Worldwide Real-time Experimental Collaboration,"***<br>K. Biba* (*AeroPac*), M. Butin* (*SJSU*), B. Belley (*SJSU*), Z. Young (*SJSU*), P. Hopkins (*AeroPac*), N. Pelster (*AeroPac*), R. Twiggs (*Stanford University*), and P. Papadopoulos (*SJSU*) |
| 3:30 pm | TFAWS-08-1030 | ***"X-Jet Ultrasonic Ablation Thickness Profile Gauging Instrumentation Design, Testing and Analysis,"***<br>J. Mogannam* (*SJSU/LORAL Space Systems*), R. Benzio* (*SJSU*), D. Dinh (*SJSU*), J. Wooner (*SJSU*), Y. Najafi (*SJSU*), M. Urquhart (*SJSU*), A. Vallejo (*SJSU*), N. Mansour (*NASA Ames*), A. Cassell (*NASA Ames*), and P. Papadopoulos (*SJSU*) |
| 4:00 pm | | |
| 4:30 pm | | |

* *presenter*

# Paper Sessions – Student Papers

## Friday Morning, August 22nd, 2008

### Session Chair: Dr. Nikos Mourtos (San Jose State University)

| Time | Paper Number | Title & Author(s) |
|---|---|---|
| 8:30 am | TFAWS-08-1031 | ***"High-heat Shield Design Conceptual Study Using Phase Change Materials,"*** A. H. Djamshidpour* (*SJSU/LORAL Space Systems*), B. Yendler (*Lockheed Martin Corp*.), and P. Papadopoulos (*SJSU*) |
| 9:00 am | TFAWS-08-1032 | ***"PolarBot: Exploration Robot in Extreme Environments,"*** N. Pham* (*SJSU/Northrop Grumman*), S. Shah (*SJSU/LORAL Space Systems*), R. Twiggs (*Stanford University*), and S. Chetty (*Stanford University*) |
| 9:30 am | TFAWS-08-1033 | ***"Double Wedge Shock Wave Interaction Flow Characterization,"*** S. Shah* (*SJSU/LORAL Space Systems*), R. Martinez (*SJSU*), N. Fernandez (*SJSU/Boeing Corp.*), and N. Mourtos (*SJSU*) |
| 10:00 am | TFAWS-08-1034 | ***"Flow Characterization over a NACA-0012 Airfoil,"*** O. Quijano* (*SJSU/Nielsen Engineering*) and N. Mourtos (*SJSU*) |
| 10:30 am | TFAWS-08-1025 | ***"Space Shuttle LOX Bleed System Analysis,"*** A. Firooznam* (*SJSU/Lockheed Martin Corp.*) and P. Papadopoulos (*SJSU*) |
| 11:00 am | | |
| 11:30 am | | |

* *presenter*

# Special Paper Sessions – Exploration/MSL Missions

## Thursday Morning, August 21st, 2008

### Session Chair: Stephen Miller (NASA Johnson Space Center)

| Time | Paper Number | Title & Author(s) |
|---|---|---|
| 8:30 am | TFAWS-08-1015 | ***"Challenges of the Mars Science Laboratory Heatshield,"*** Helen H. Hwang* (*NASA ARC*), Robin A. Beck (*NASA ARC*), and David M. Driver (*NASA ARC*) |
| 9:00 am | TFAWS-08-1016 | ***"NASA Crew Exploration Vehicle, Thermal Protection System, Lessons Learned,"*** James Reuther* (*NASA ARC*) |
| 9:30 am | TFAWS-08-1017 | ***"Ground Plane and Near-Surface Thermal Analysis for NASA's Constellation Program,"*** Joe Gasbarre (*NASA LaRC*), Tory Scola (*NASA LaRC*), Ruth Amundsen* (*NASA LaRC*), Frank Leahy (*NASA MSFC*), and John Sharp (*NASA MSFC*) |
| 10:00 am | TFAWS-08-1018 | ***"Thermal Model Development for Ares 1-X,"*** Ruth M. Amundsen* (*NASA LaRC*) and Joe Del Corso (*NASA LaRC*) |
| 10:30 am | TFAWS-08-1019 | ***"Effects of Re-entry and Post-Landing Heating on the Orion Crew Module Cabin Air Temperature,"*** Stephen. W. Miller* (*NASA JSC*) and Angel Alvarez-Hernandez (*NASA JSC*) |
| 11:00 am | | |
| 11:30 am | | |

* *presenter*

## Monday Afternoon, August 18th, 2008

### FIAT Training

***Frank Milos, NASA Ames Research Center***

An introduction to the Fully Implicit Ablation and Thermal Analysis (FIAT) Program. FIAT is a NASA-developed computer program for simulation of one-dimensional thermal energy transport in a multilayer stack of isotropic materials and structures, which can ablate from the front surface and decompose in depth. The short course will include background on the modeling physics and instructions on how to set up and run an analysis.

## Tuesday Morning, August 19th, 2008

### DPLR Lecture and Training

***Mike Wright and Chun Tang, NASA Ames Research Center***

An introduction to the Data Parallel Line Relaxation (DPLR) Program. DPLR is a finite-rate thermal and chemical non-equilibrium Navier-Stokes computational fluid dynamics code. Used for computing aerothermodynamic properties of reentry vehicles, as well as simulations of arc-jet, shock tube, ballistic range, and shock tunnel experiments.

## Thursday Morning, August 21st, 2008

### TPSSizer and CBAERO Overview and Tutorial

***Ian Dupzyk, NASA Ames Research Center***

*Note: This session is a combined Short Course and Hands-On Software Training*

(CBAERO (**C**onfiguration **B**ased **Aero**dynamics) is a fast, engineering level tool used to generate large aerothermal databases from an unstructured surface mesh. CBAERO uses a fast panel method for low speed and Modified Newtonian or Tangent Cone/Wedge for super- to hypersonic speeds and can be anchored against CFD. TPSSizer is a tool used to select and size appropriate thermal protection materials based on maximum temperature experienced and maximum integrated heat load during a trajectory or set of trajectories. When used in conjunction these programs form a suite of tools allowing end to end aerothermal and TPS sizing and response for both ablative and tile systems.

This training course will provide background on CBAERO and TPSSizer including its capabilities and performance. In addition, there will also be a hands-on portion of the course where one or more example cases will be setup and analyzed.

## Thursday Morning & Afternoon, August 21st, 2008

### Thermal Testing Practices at Assembly and System Levels

*Moderators: Rajeshuni Ramesham, Kinfung Man, and Arturo Avila (JPL)*

**Outline**

- Presentations on the thermal testing practices adapted by the respective NASA centers and industrial partners.
- Discuss thermal test key parameters such as number of thermal cycles, dwell time, temperature margins, test media, etc.
- Discuss the rationale for the key thermal test parameters.
- Tailoring the key parameters for different types of missions e.g. Earth orbiter, planetary orbiter, landers, rovers, deep space missions, long and short duration missions, etc.
- Tailoring the key parameters for different types of hardware e.g. electronics, instruments/payloads, mechanisms, etc.
- Discuss the test data/heritage data that supports or challenges thermal test practices.
- Discuss the nature of functional testing & operational (on-time) at hot & cold extremes.
- Discuss the methods and purpose of environmental simulation
- Open discussion on other thermal test topics.

**List of Panel Members from NASA Centers and Industrial partners:**

1. John R. Sharp, Marshal Space Flight Center/EV34, NASA, Confirmed
2. Chris B. Kostyk, Dryden Flight Research Center, NASA, Confirmed
3. Gary J. O'Neil Kennedy Space Center, NASA, Confirmed
4. Laurie Walls Kennedy Space Center, NASA, Confirmed
5. Steve Sepka, Ames Research Center, NASA Confirmed
6. Kaitlin Keim Liles, Langley Research Center, NASA, Confirmed
7. Gary B. Johnson, Lyndon B. Johnson Space Center NASA,Confirmed
8. Andrew E. Hong, Lyndon B. Johnson Space Center NASA,Confirmed
9. Aaron Hetherington, Lyndon B. Johnson Space Center, NASA, Confirmed
10. Hume Peabody, Goddard Space Flight Center, NASA, Confirmed
11. Eric W. Grob Goddard Space Flight Center NASA, Confirmed
12. Glenn Tsuyuki, Jet Propulsion Laboratory, NASA, Confirmed
13. Christine Farguson, Jet Propulsion Laboratory, NASA, Confirmed
14. John W. Welch, Aerospace Corporation, USAF, Confirmed

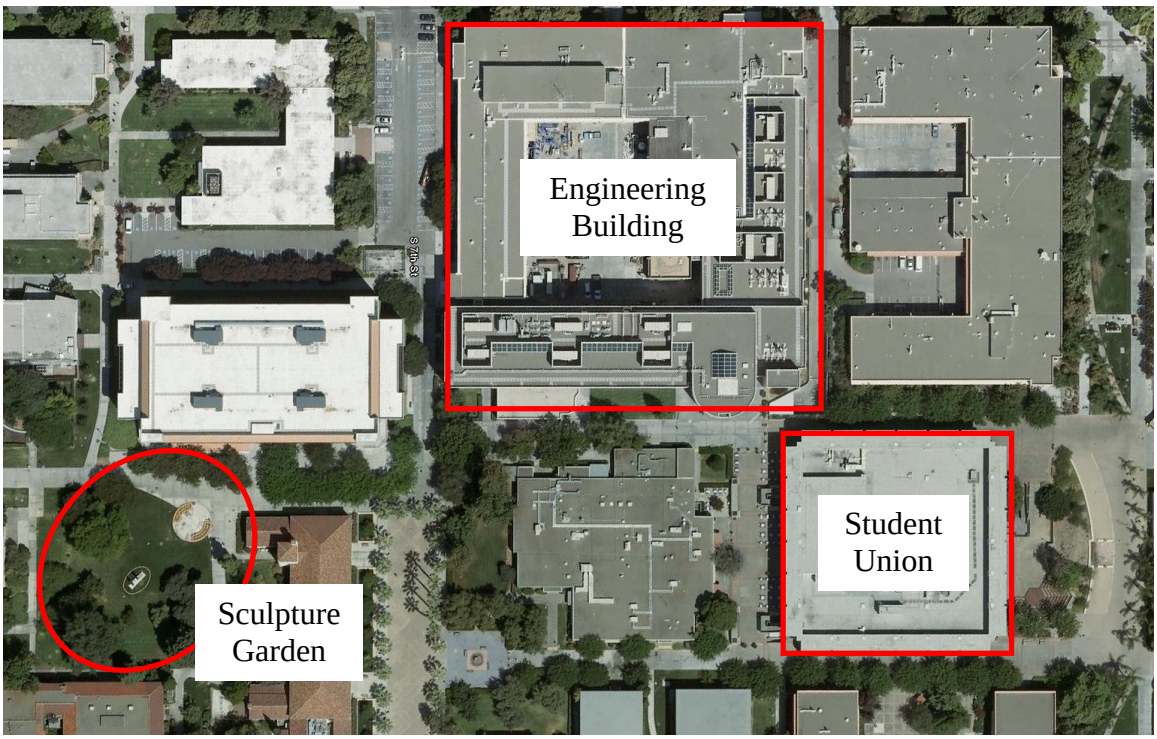
# Ice Breaker

## Sculpture Garden – Monday Evening, 5:30 to 7:30 pm

The TFAWS Ice Breaker will take place Monday afternoon beginning at 5:30 pm at the Sculpture Garden on the campus of San Jose State University, just across the mall from the Engineering Building.

We welcome everyone to come mingle and network with the other TFAWS attendees. Appetizers, soft drinks, wine and beer will be served.

At the heart of the Sculpture Garden is the 20-foot sculpture "Salute in Bronze". Designed by artist Rigo 23, the sculpture depicts the pivotal moment in history when Tommie Smith and John Carlos, teammates from San Jose State University, took a stand for human rights on the victory podium at the 1968 Olympic games in Mexico City – a silent protest that was seen around the world. The Smith/Carlos figures are clothed in hand-cut ceramic tiles, modeled in fiberglass and sustained by a steel structure. Their likenesses are cast in bronze. Besides the innovative use of materials, Rigo used state-of-the-art 3D scanning technology and computer-assisted virtual imaging to take actual full-body scans of the athletes.




*Special thanks to MAYA Heat Transfer Technologies for helping to sponsor the Ice Breaker*

# NASA Ames Research Center Tour

## Wednesday Afternoon , August 20th, 2008

### About Ames

NASA Ames Research Center, located at Moffett Field, California, was founded Dec. 20, 1939 as an aircraft research laboratory by the National Advisory Committee for Aeronautics (NACA) and in 1958 it became part of the National Aeronautics and Space Administration.

Ames Research Center, one of 10 NASA field installations, is located in the heart of California's Silicon Valley at the core of the research cluster of high-tech companies, universities and laboratories that define the region's character. With over $3.0 billion in capital equipment, 2,300 research personnel and a $600 million annual budget, Ames' economic impact is significant. Ames plays a critical role in virtually all NASA missions in support of America's space and aeronautics programs.

As a leader in information technology research with a focus on supercomputing, networking and intelligent systems, Ames conducts the critical R&D and develops the enabling technologies that make NASA missions possible. Ames also is a leader in nanotechnology, fundamental space biology, biotechnology, aerospace and thermal protection systems, and human factors research. Ames research in astrobiology focuses on the effects of gravity on living things, and the nature and distribution of stars, planets and life in the universe.

In addition, Ames works collaboratively with the FAA, conducting research in air traffic management to make safer, cheaper and more efficient air travel a reality. Ames engages in information and education outreach, forms collaborative partnerships, and fosters commercial application of NASA technologies. Ames is developing NASA Research Park, an integrated, dynamic research and education community created to cultivate diverse partnerships with academia, industry and non-profit organizations in support of NASA's mission.

### Tour Outline

The Ames tour must be limited to 80 visitors and will be divided into two separate tracks, due to time constraints and limits on the number of guests who can visit any individual facility. TFAWS attendees must chose one or the other tour track. All visitors will start at the Ames Exploration Visitor's Center. From there the visitors will be divided into the two tracks and buses will take the visitors to their first stop. Some walking between facilities will be required, so bring comfortable shoes.

Track 1 is the "testing tour" and includes a visit by all to the 80x120 foot NFAC wind tunnel. Half of the Track 1 tour will then visit the Unitary wind tunnel and the other half the Arc-Jet Complex. *This Track may be limited to US citizens only*, an announcement will be made at the workshop. Visitors taking the "testing" tour must wear closed-toed shoes; no handicap access is available. The wind tunnel tour also involves climbing several flights of stairs.

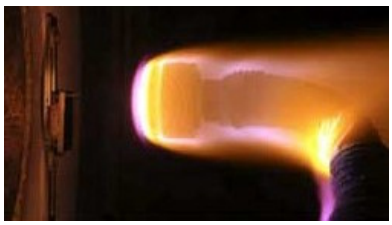
Track 2 is the "computational/simulation tour" and includes a visit by all to the Vertical Motion Simulator. Half of the Track 2 tour will then visit the NAS/Hyperwall and the other half the Future Flight Central.

# NASA Ames Research Center Tour

## Facility Tour Track 1 – Testing Facilities

The **National Full-Scale Aerodynamics Complex (NFAC)** 40x80 foot and 80x120 foot wind tunnels at NASA Ames Research Center were built in 1944 to support research in aerodynamics, structural dynamics and acoustics. They are primarily used for determining the low and medium-speed aerodynamic characteristics of high-performance aircraft, rotorcraft, and fixed wing, powered-lift V/STOL aircraft. The facility is now operated by the Air Force and Arnold Engineering Development Center (AEDC).

The **9x7 Foot Supersonic Wind Tunnel** (SWT) is part of the Unitary Plan Wind Tunnel complex at NASA Ames Research Center, where generations of commercial and military aircraft and NASA space vehicles, including the space shuttle, have been designed and tested. The 9x7 SWT is a closed-return, variable-density tunnel with an asymmetric, sliding-block nozzle. It is one of two separate test sections powered by a common drive system. Interchangeability of models among the Unitary test sections allows testing across a wide range of conditions. Airflow is generated by an 11-stage, axial-flow compressor powered by four variable-speed, wound-rotor, induction motors. The 9x7 continues to provide aerodynamic data for NASA's manned spaceflight efforts, including the Constellation Program, whose goal it is to create the rockets and spacecraft necessary to take explorers to Earth orbit, the Moon and, eventually, to Mars.

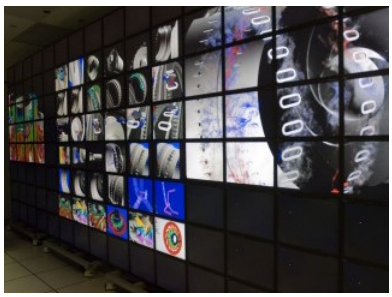


The **Arc-Jet Complex** exists to create environments through the use of arc-jet facilities for the testing of heat shield materials and thermal protection system components for planetary entry vehicles, planetary probes, or hypersonic flight vehicles under the aerothermodynamic heating conditions that they will encounter during flight operation. The Ames Arc Jet Complex has nine available test bays located in two separate laboratory buildings. At the present time, three bays contain operative Arc Jet units of differing configurations that are serviced by common facility support equipment. This support equipment includes two DC power supplies, a steam ejector vacuum system, a de-ionized water cooling system, high pressure gas systems, a data acquisition system and other auxiliary systems. The magnitude and capacity of these support systems is a primary reason why the Ames Arc Jet Complex is unique in the aerospace testing world. In particular, the 150 MW power supply can deliver 75 MW for a 30 minute duration or 150 MW for a 15 second duration. This power capability in combination with the 5 stage steam ejector vacuum system enables facility operations that can simulate high altitude atmospheric flight on relatively large size test objects. The arc heater units themselves are of both the segmented (or constricted) design and the Huels type design. When combined with a variety of nozzles of both conical and semi elliptical cross sections, the resulting facility capabilities offer wide versatility for testing both large flat-surface test objects as well as stagnation flow models that are fully immersed in the test stream.

# NASA Ames Research Center Tour

## Facility Tour Track 2 – Computational/Simulation Facilities

The **Vertical Motion Simulator (VMS)** offers much that is unique, two capabilities stand out. First, engineers can customize the system to simulate any aerospace vehicle, whether existing or in the design stage. Existing vehicles that have been simulated include a blimp, helicopters, fighter jets, and the Space Shuttle Orbiter. One aircraft being designed that is being considered for simulation at the VMS is a next-generation transport capable of flying in near-earth orbit. Second, simulations occur with high fidelity; that is, the simulator reproduces the flight characteristics of an aircraft with a high degree of accuracy. This entails delivering realistic cues to the pilot in real time, so that the pilot perceives that the simulated aircraft responds just as quickly as a real aircraft. The VMS provides exceptional flexibility in the aircraft it simulates in part because of the Interchangeable Cab (ICAB). The interior of the ICAB can be modified to represent the cockpit of any aerospace vehicle. First, the canopy of the cab is lifted off and much of the equipment removed. Then, in a process called "cab build-up," the empty cab is customized by installing the flight controls, flight instruments, and aircraft seats specified by the researcher.



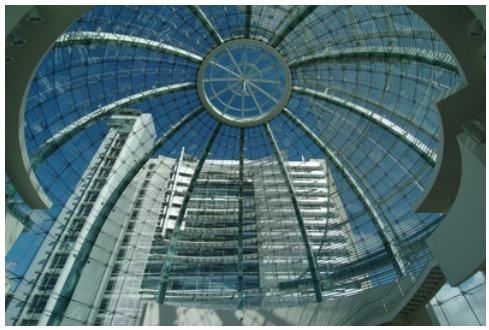
**NASA's Hyperwall-2** system, unveiled at Ames Research Center, offers the power to visualize highly complex information in a way that's easier for the human mind to grasp. Developed by scientists and engineers in the NASA Advanced Supercomputing (NAS) Division at Ames, the 128-screen hyperwall-2, capable of rendering one quarter billion pixel graphics, is the world's highest resolution scientific visualization and data exploration environment. The new tool enables scientists to quickly explore datasets that otherwise would take many years to analyze. The 23-foot-wide by 10-foot tall liquid crystal display wall is being used to view, analyze, and communicate results from NASA's high-fidelity modeling and simulation projects supporting the safety of new space exploration vehicle designs, atmospheric re-entry analysis for the space shuttle, earthquakes, climate change, global weather and black hole collisions.

**NASA's "FutureFlight Central**," the world's first full-scale virtual airport control tower, opened Dec. 13, 1999, at NASA Ames Research Center, Moffett Field, CA. Constructed at a cost of $10 million, the two-story facility was jointly funded by NASA and the Federal Aviation Administration (FAA). The facility is designed to test - under realistic airport conditions and configurations - ways to solve potential air and ground traffic problems at commercial airports. The facility provides an opportunity for airlines and airports to mitigate passenger delays by fine tuning airport hub operations, gate management, ramp movement procedures, and various other airport improvements. Twelve rear projection screens provide a seamless 360-degree, high-resolution view of the airport or other scenes being depicted. The imaging system, powered by supercomputers, provides a realistic view of weather conditions, environmental and seasonal effects and the movement of up to 200 active aircraft and ground vehicles.

# TFAWS Banquet – Location and Times

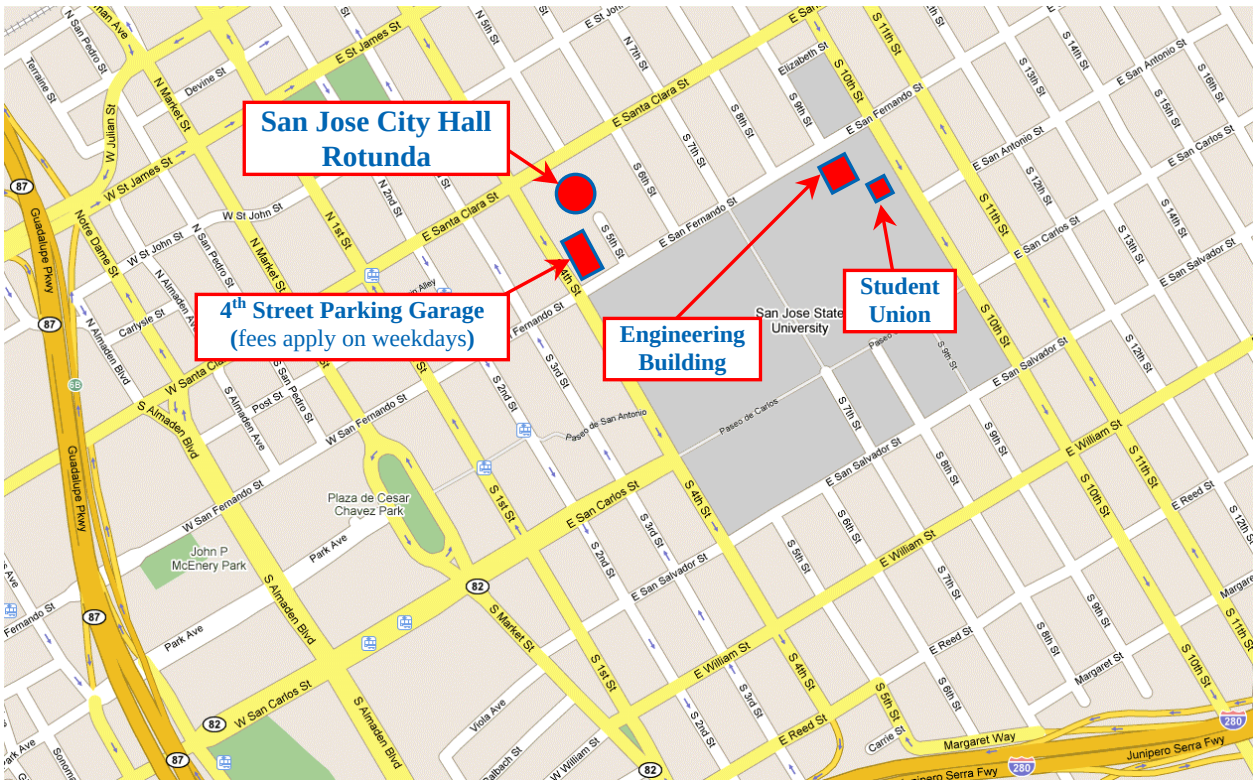
## San Jose City Hall Rotunda – Wednesday Evening, 6:00 to 9:00 pm

The TFAWS banquet dinner will be held in the rotunda of the new San Jose City Hall on Wednesday evening beginning at 6:00 pm and continuing until 9:00 pm. The San Jose City Hall Rotunda is located at 200 East Santa Clara Street in San Jose, just one block from the campus of San Jose State University. Please enter through the side doors that face the City Hall tower. Metered parking is often available on the street. There is also a parking garage adjacent to City Hall on 4th street.



A reception with soft drinks, wine and beer will start at 6:00 pm. Live entertainment will be provided by the Ames Jazz Combo. Dinner will begin at 7:00 pm.

Our special keynote speaker will be **Dr. S. Pete Worden**, Director of the NASA Ames Research Center.




*Special thanks to C&R Technologies for helping to sponsor the dinner reception*

# Dr. S. Pete Worden

***Director, NASA Ames Research Center***

Dr. S. Pete Worden (Brig. Gen., USAF, ret.) is the NASA Ames Research Center Director. Prior to becoming Director, Dr. Worden was a Research Professor of Astronomy, Optical Sciences and Planetary Sciences at the University of Arizona where his primary research direction was the development of large space optics for national security and scientific purposes and near-earth asteroids. Additionally he worked on topics related to space exploration and solar-type activity in nearby stars. He is a recognized expert on space issues—both civil and military. Dr. Worden has authored or co-authored more than 150 scientific technical papers in astrophysics, space sciences, and strategic studies. Moreover, he served as a scientific co-investigator for two NASA space science missions.

In addition to his former position with the University of Arizona, Dr. Worden served as a consultant to the Defense Advanced Research Projects Agency (DARPA) on space-related issues. During the 2004 Congressional Session Dr. Worden worked as a Congressional Fellow with the Office of Senator Sam Brownback (R-KS), where he served as Senator Brownback's chief advisor on NASA and space issues.

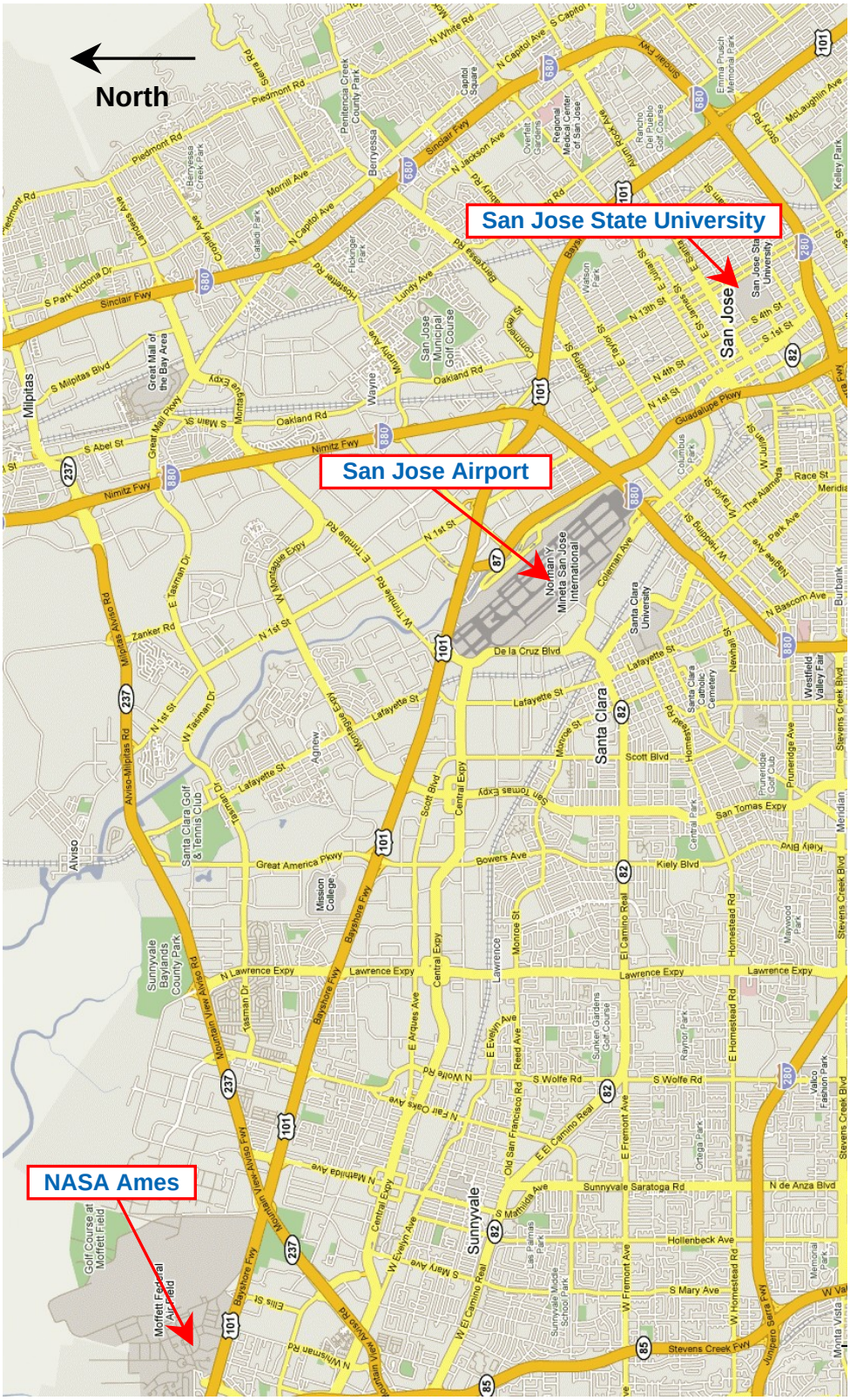
Dr. Worden retired in 2004 after 29 years of active service in the United States Air Force. His final position was Director of Development and Transformation, Space and Missile Systems Center, Air Force Space Command, Los Angeles Air Force Base, CA. In this position he was responsible for developing new directions for Air Force Space Command programs and was instrumental in initiating a major Responsive Space Program designed to produce space systems and launchers capable of tailored military effects on timescales of hours.

Dr. Worden was commissioned in 1971 after receiving a Bachelor of Science degree from the University of Michigan. He entered the Air Force in 1975 after graduating from the University of Arizona with a doctorate in astronomy. Throughout the 1980s and early 1990s, Dr. Worden served in every phase of development, international negotiations and implementation of the Strategic Defense Initiative, a primary component in ending the Cold War. He twice served in the Executive Office of the President. As the staff officer for initiatives in the George Bush administration's National Space Council, Dr. Worden spearheaded efforts to revitalize U.S. civil space exploration and earth monitoring programs.

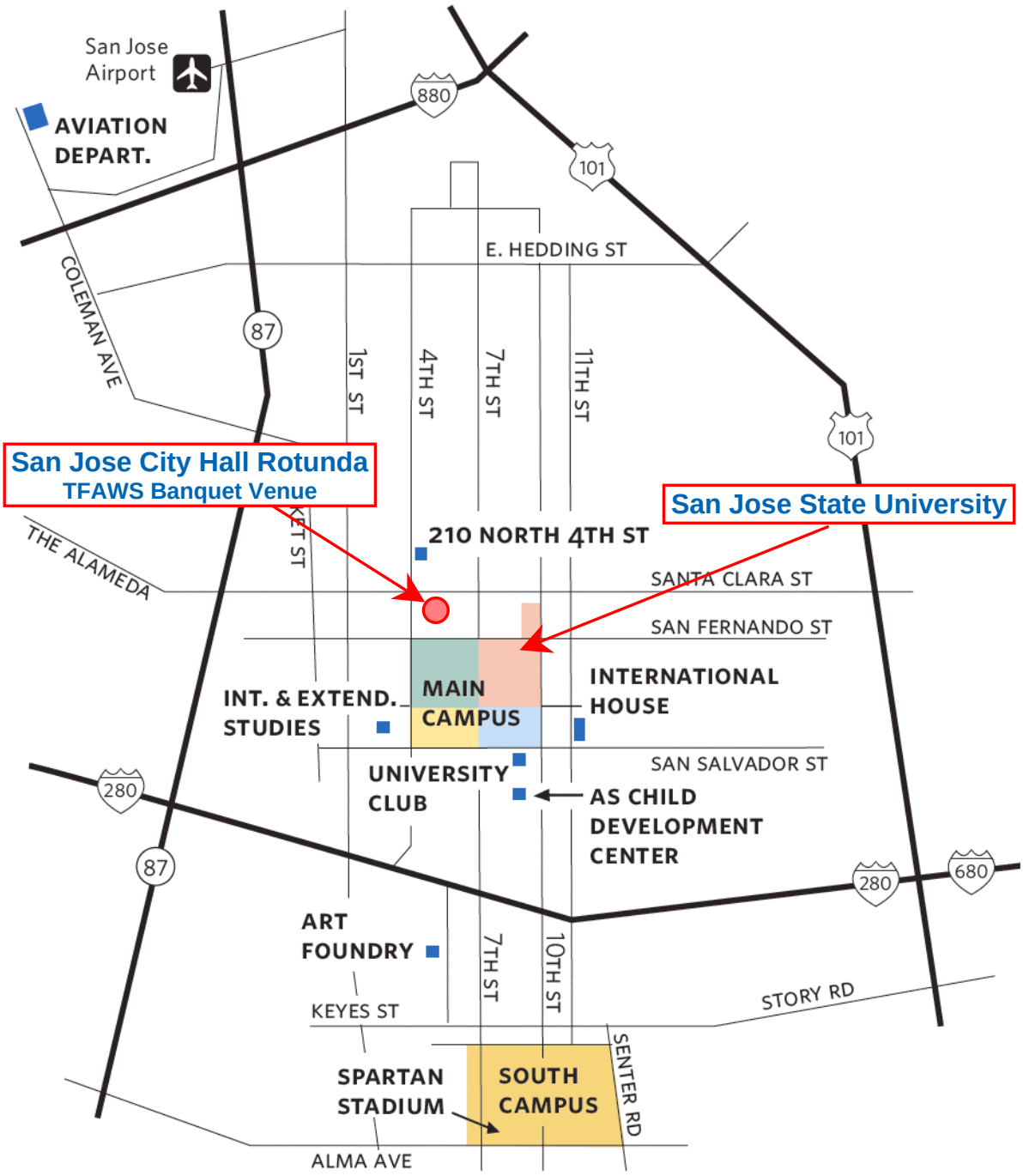
Dr. Worden commanded the 50th Space Wing that is responsible for more than 60 Department of Defense satellites and more than 6,000 people at 23 worldwide locations. He then served as Deputy Director for Requirements at Headquarters Air Force Space Command, as well as the Deputy Director for Command and Control with the Office of the Deputy Chief of Staff for Air and Space Operations at Air Force headquarters. Prior to assuming his current position, Dr. Worden was responsible for policy and direction of five mission areas: force enhancement, space support, space control, force application and computer network defense.

Dr. Worden has written or co-written more than 150 scientific technical papers in astrophysics, space sciences and strategic studies. He was a scientific co-investigator for two NASA space science missions. He and his wife Nancy reside in Placitas, New Mexico.

## Regional San Jose Area



## Local San Jose Area

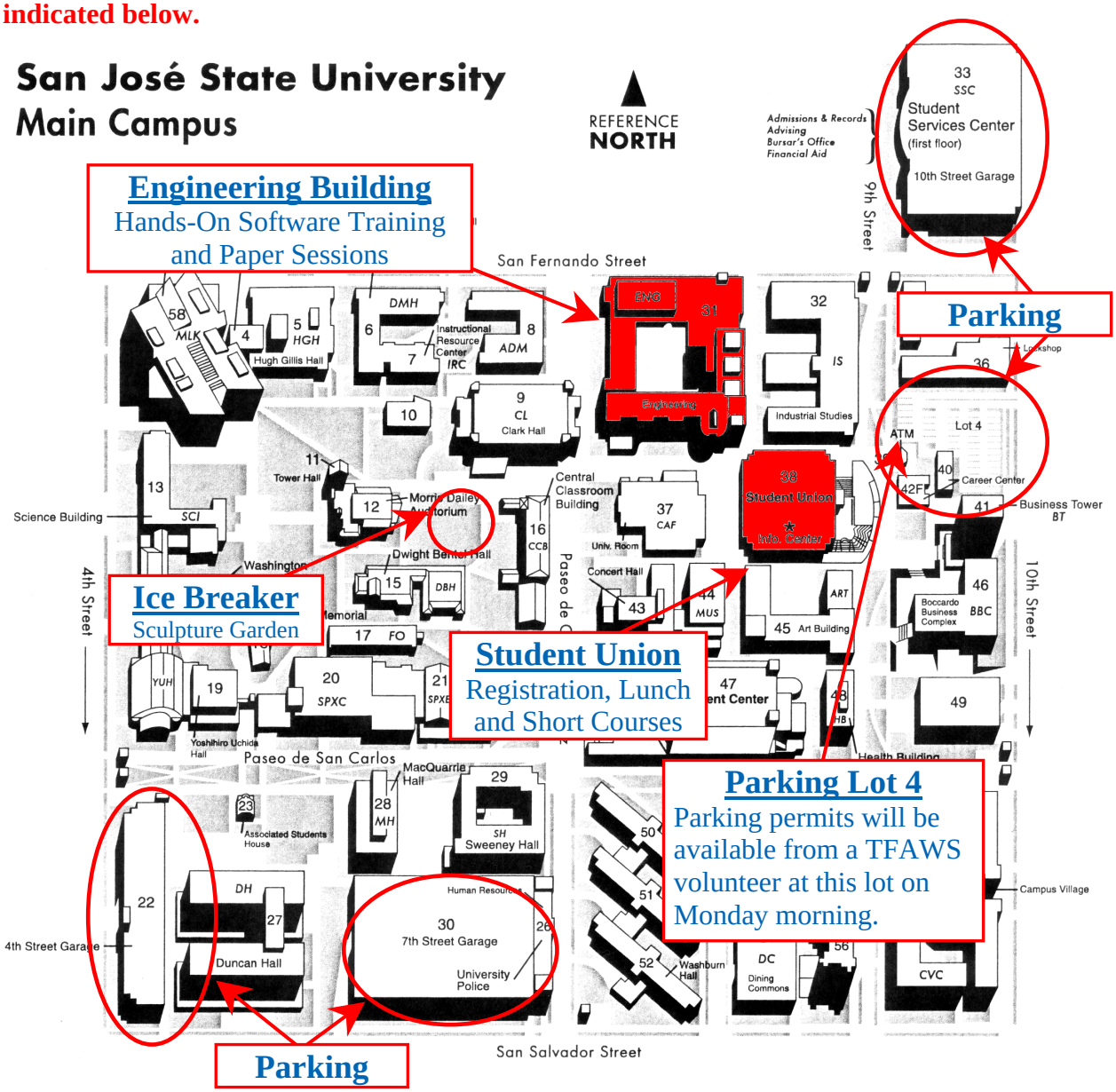


# Maps

## San Jose State Campus

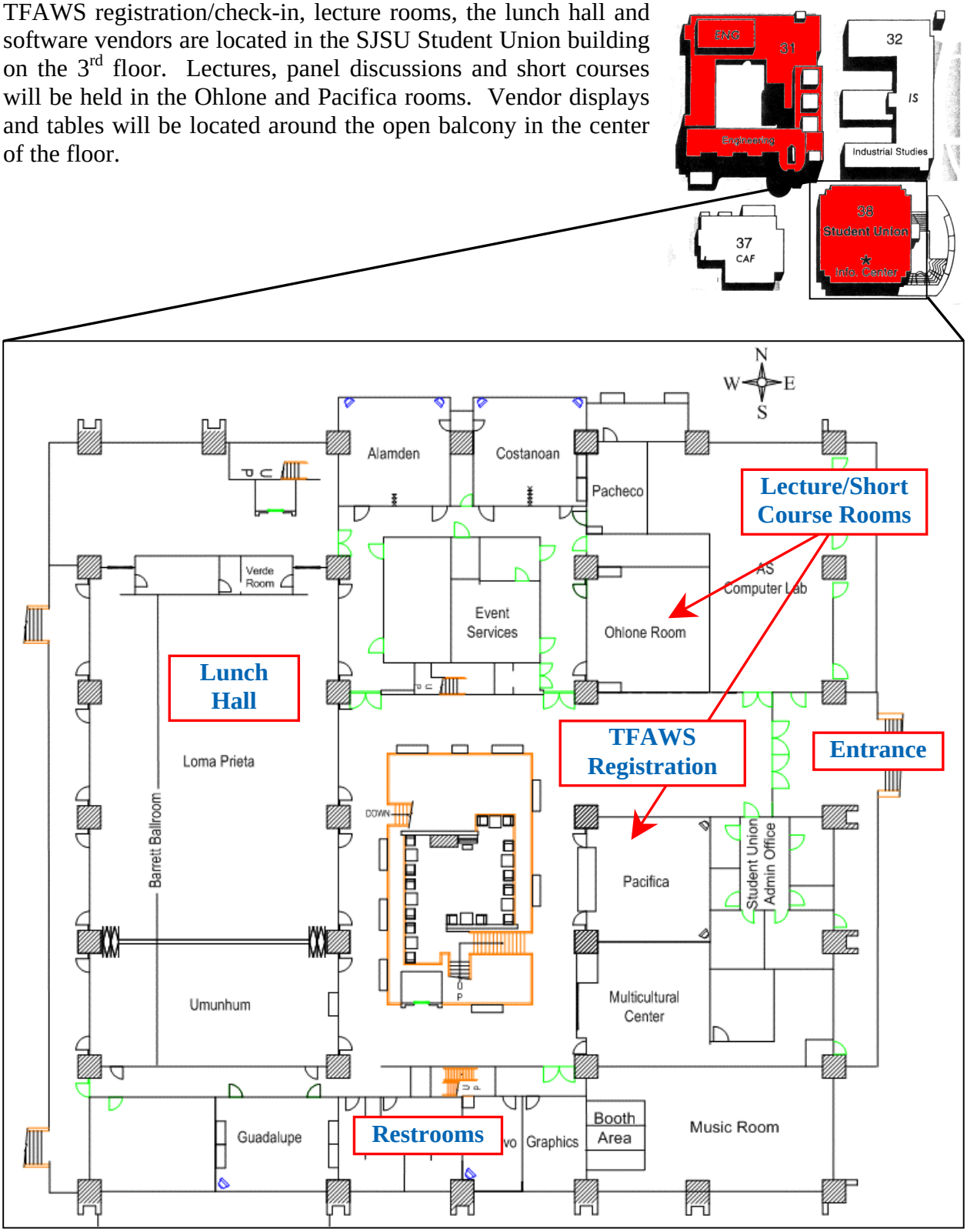
TFAWS will be held in the Student Union and Engineering buildings. Check-in, lecture rooms, lunch hall and vendor displays are in the Student Union. Paper sessions and hands-on software training classes will be held in the Engineering Building. The Monday evening Ice Breaker will be outdoors at the Sculpture Garden, next to the statue of the 1968 Olympic gold and bronze medal winners.

**TFAWS attendees may park in the 4th Street, 7th Street or 10th Street garages, or Lot 4. All of the parking areas require permits. On Monday a TFAWS volunteer will be located near Lot 4 to hand out parking permits. Attendees may also pick up a permit at the registration desk and place it in their car. The parking permits are valid in any of the garages or lots indicated below.**



## Student Union – 3rd Floor

TFAWS registration/check-in, lecture rooms, the lunch hall and software vendors are located in the SJSU Student Union building on the 3rd floor. Lectures, panel discussions and short courses will be held in the Ohlone and Pacifica rooms. Vendor displays and tables will be located around the open balcony in the center of the floor.

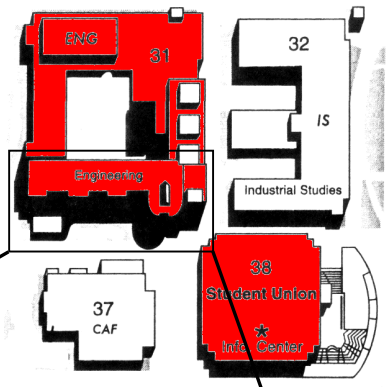


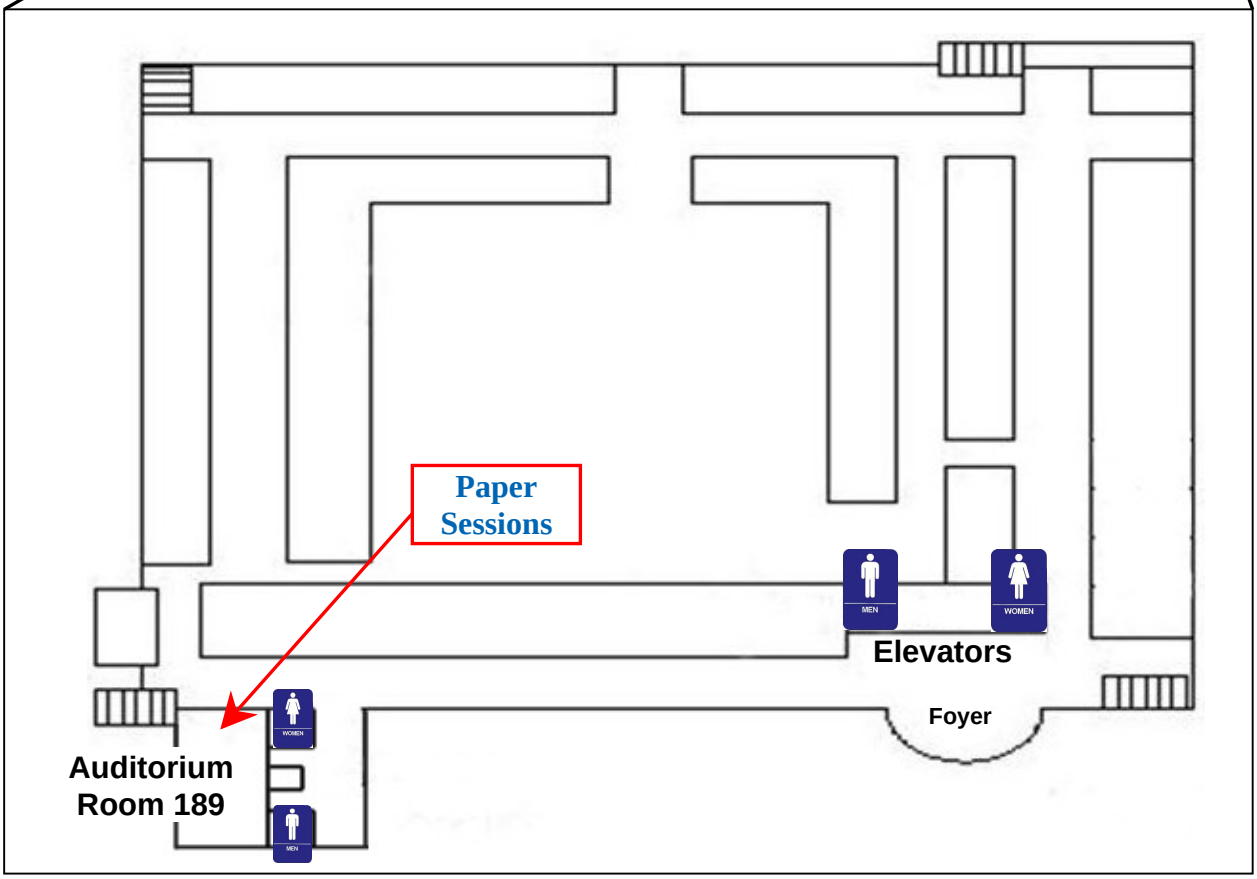
# Maps

## Engineering Building – First Floor

Hands-on software training and paper sessions will take place in the Engineering Building. Paper sessions will be in the Auditorium on the first floor, Room 189. There is a lunch/break room located on the second floor Room 285/287, the Alumni Room. On most days, drinks and snacks will be available in the Alumni Room for mid-morning and mid-afternoon breaks.

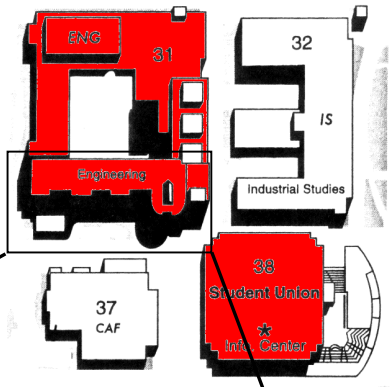
*Please, not food or drinks in the Auditorium.*

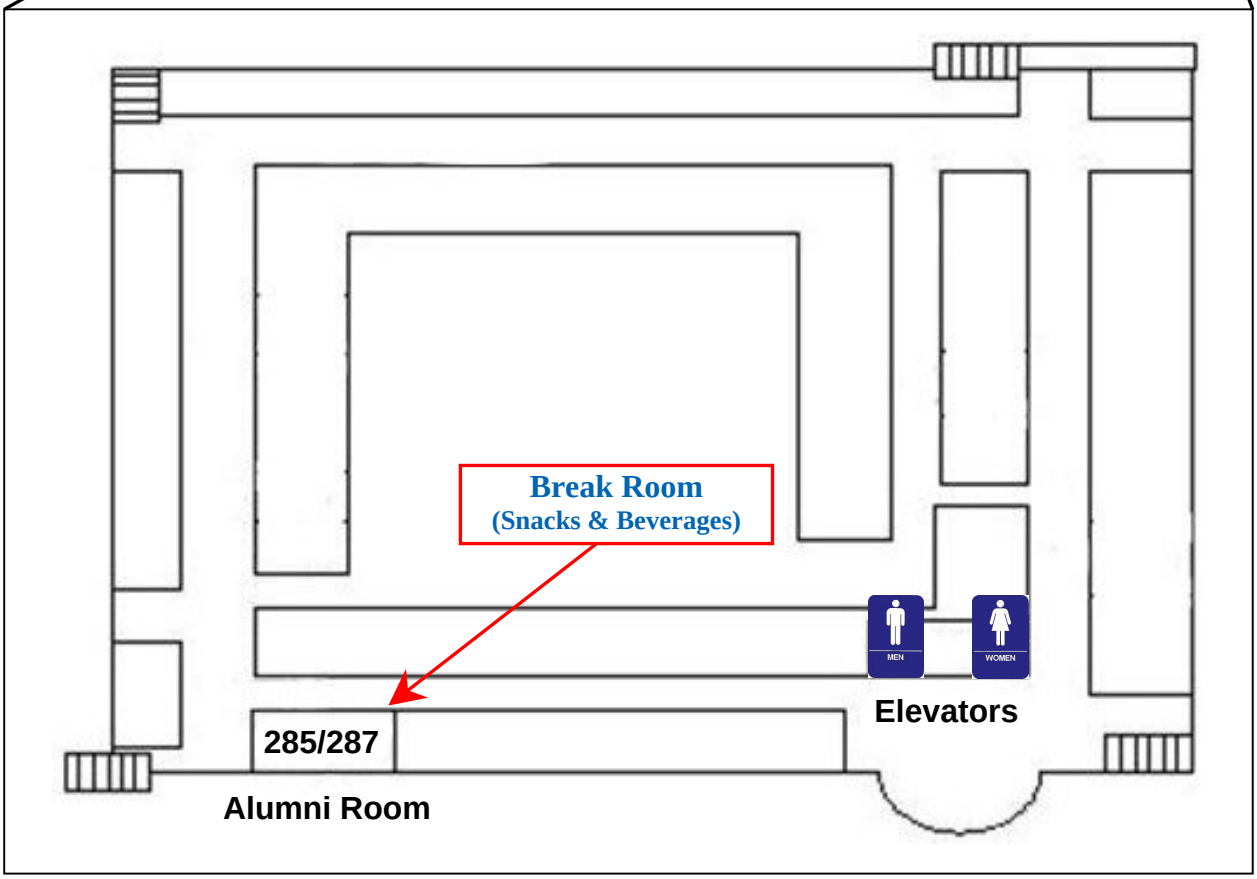


## Engineering Building – Second Floor

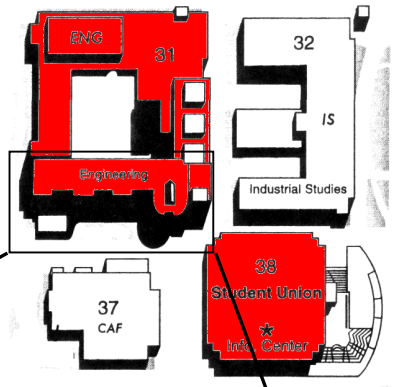
Hands-on software training and paper sessions will take place in the Engineering Building. There is a lunch/break room located on the second floor Room 285/287, the Alumni Room. On most days, drinks and snacks will be available in the Alumni Room for mid-morning and mid-afternoon breaks.

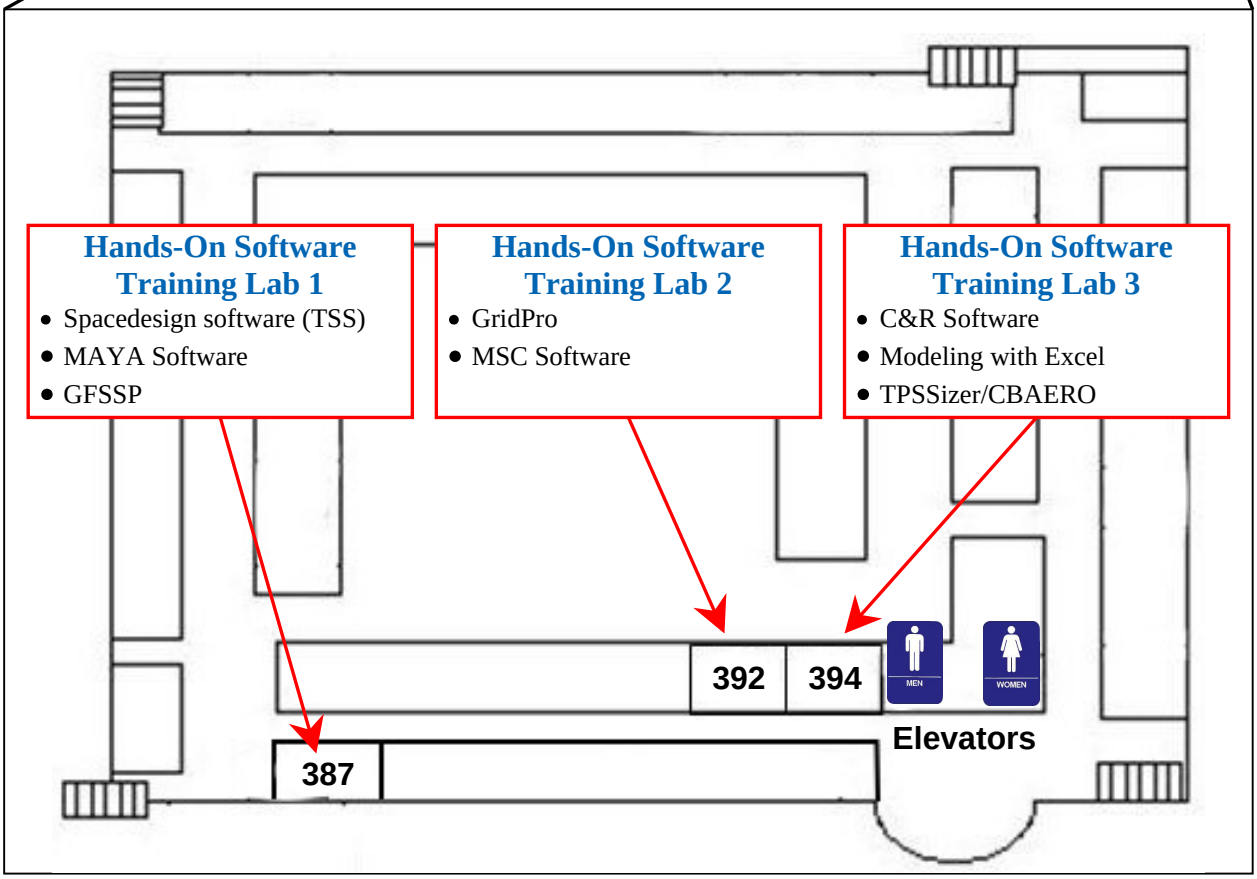


## Engineering Building – Third Floor

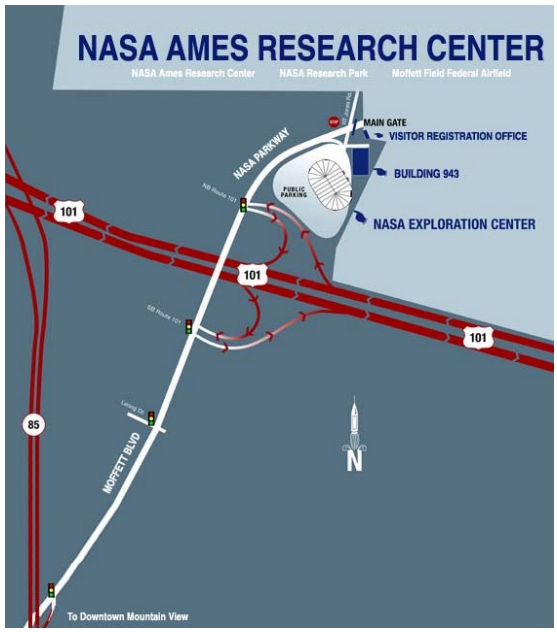
Hands-on software training and paper sessions will take place in the Engineering Building. The software training classrooms are in 387, 392 and 394. They are all located along the same hallway. There is a lunch/break room located on the second floor Room 285/287, the Alumni Room. On most days, drinks and snacks will be available in the Alumni Room for mid-morning and mid-afternoon breaks.



# Maps

## NASA Ames Research Center


## Driving Directions

From San Jose State University:

1. Head southeast on either 4th street or 10th street
2. Take the ramp onto I-280 North
3. Take the exit onto CA-87 N/Guadalupe Pkwy
4. Take exit 9B on the left to merge onto US-101 N toward San Francisco
5. Take exit 398 for Moffett Blvd toward NASA Pkwy
6. Turn right at the traffic light onto Moffett Blvd
7. Proceed to the main gate (the Exploration Center will be on your right, just before the main gate)
8. The guard will direct you to either badging, parking or your destination in the NASA Research Park. Be prepared to show a driver's license to proceed into the NASA Research Park.

# Notes

# Notes

# Notes