NASA SUPPLY CHAIN 2012 CONFERENCE

PROJECT MANAGEMENT AND PRODUCT QUALITY IN LEAN ORGANIZATIONS

Tom Macdonald

Vice President Aerospace Division

Adcole Corporation

669 Forest Street

Marlborough, Massachusetts

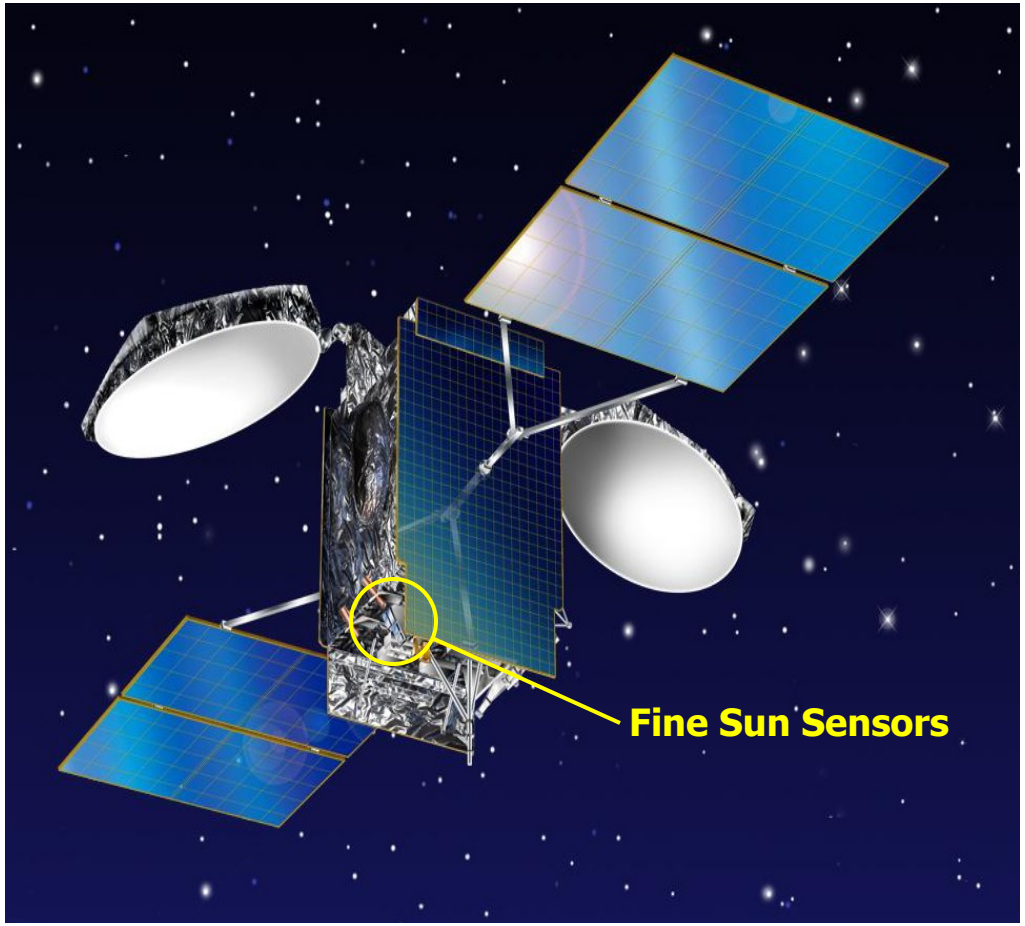
Adcole Corporation

- Established 1957, Privately Held, a Small Business

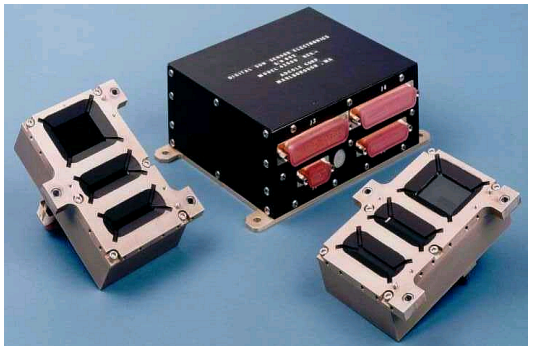
- World Leader in two “niche” Markets
  - Sun Sensors for Space Applications
  - Gaging Machines for the Automotive Industry: measure camshafts, crankshafts to sub micron tolerances

- 130 Employees at Marlborough Facility, <40 in Aerospace Division

Adcole Aerospace Division
Sun Sensor Applications

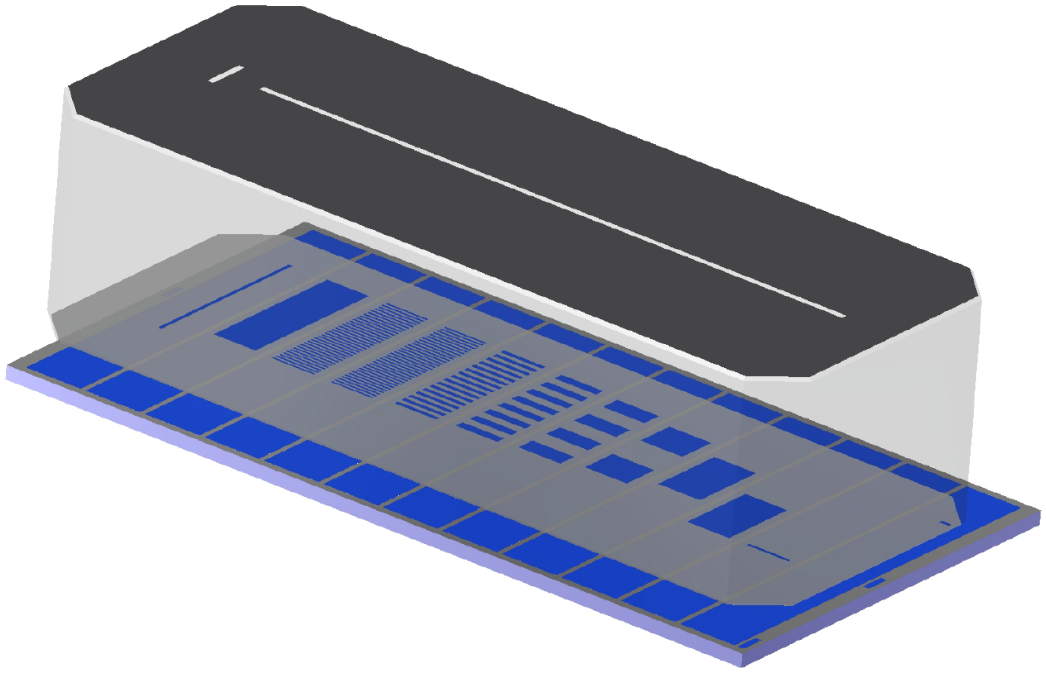


- ***Spacecraft Attitude Control***
- ***Instrument Pointing***
- ***Solar Array Pointing***



Sun Sensor Operation

- The Sun Sensor Head consists of patterned optics which modulate the incident sunlight, and multisegment solar cells which convert the incident illumination into a short circuit current.

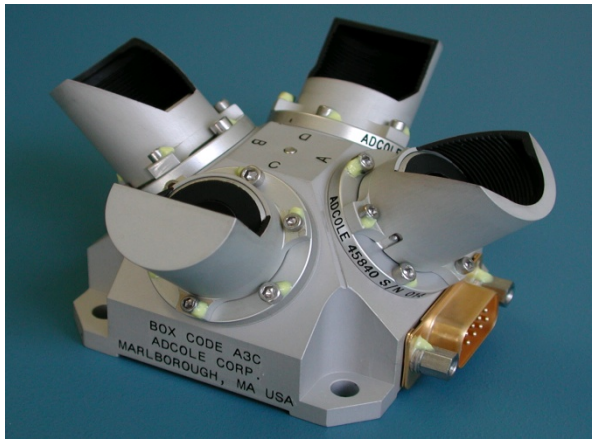


Simplicity of optical design provides high reliability and is tolerant of extreme radiation and thermal environments

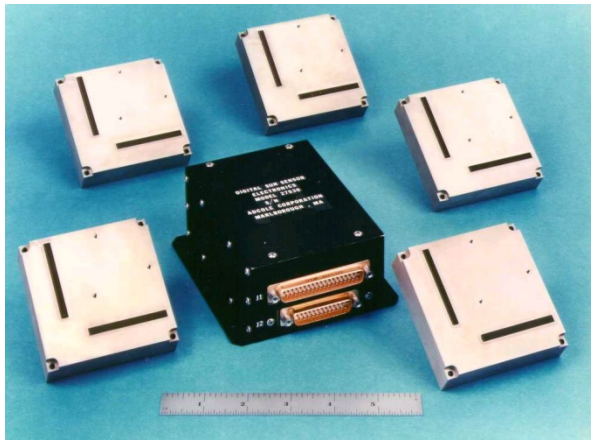
Electronics Processing

- The Electronics unit receives the Sensor Head signals and outputs digital sun angle data
- Typical Electronics unit contains the following:
  - Power supply with EMI filtering
  - Multiplexer for multiple Sun Sensor Heads
  - Fine and Coarse angle processors
  - Standard or custom data interface

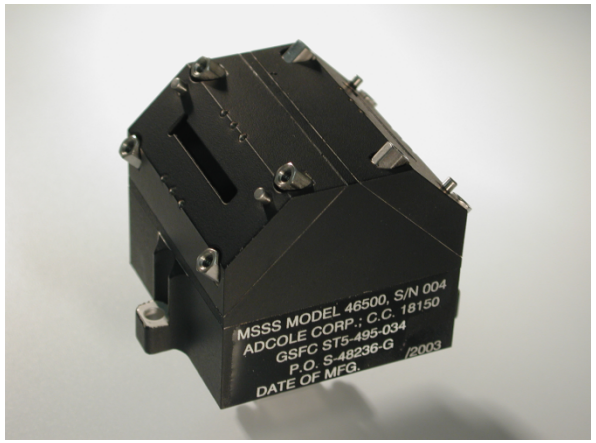
Sun Sensor Product Family



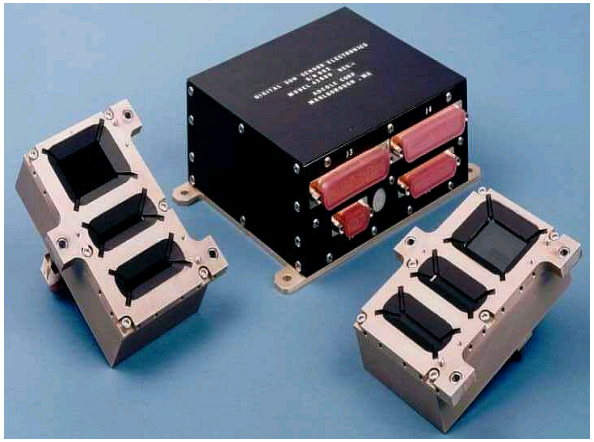
analog sun sensor - wide FOV
low accuracy



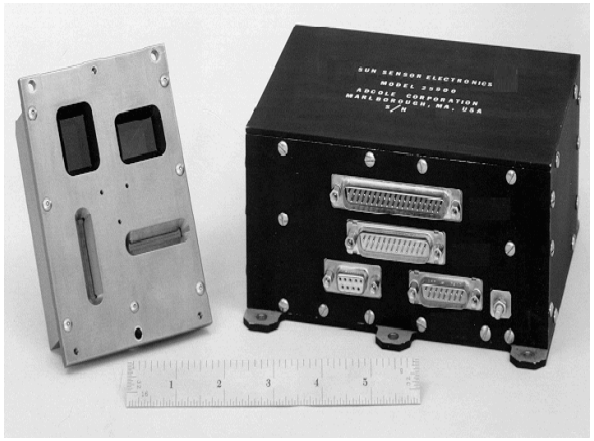
digital sun sensor - wide FOV
moderate accuracy



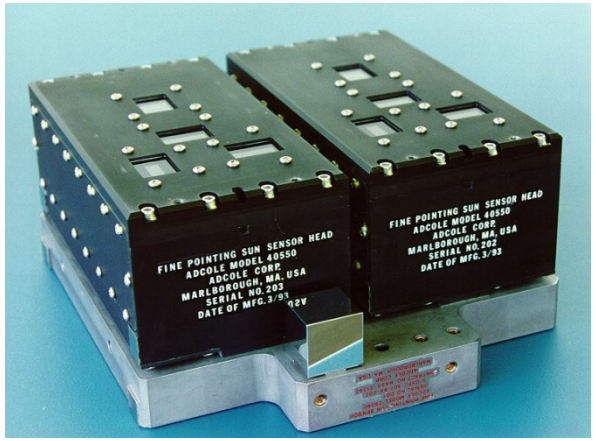
spinning sun sensor for spin-
stabilized spacecraft



fine sun sensor – wide FOV
high accuracy



2 axis fine sun sensor – wide FOV
high accuracy



fine pointing sun sensor – narrow
FOV, very high accuracy

Sun Sensor Heritage: NASA/JPL

- **MARS MISSIONS:**

  -MARS SURVEYOR

  -MARS PATHFINDER

  -MRO

  -**MARS EXPLORATION ROVERS**

  -**MARS SCIENCE LAB**

  -**MAVEN**

- **OTHER INTERPLANETARY MISSIONS:**

  - CASSINI TO SATURN

  - **MESSENGER TO MERCURY**

  - **NEW HORIZONS TO PLUTO**

  - **JUNO TO JUPITER**

- **NASA SCIENTIFIC SATELLITES:**

  -NUMEROUS INCLUDING:

  IUE, EOS, GRO, EUVE, SOLAR MAX, TOPEX, MAGSAT, ERBS, SMEX, COBE, SOHO, SORCE, XTE, CHANDRA, TRMM, ST-5, LRO/ LCROSS, THEMIS**, SDO, STEREO, RBSP, GRAIL, GPM**

- **WEATHER/DATA SATELLITES:**

  -TIROS/DMSP

  -**TDRSS**

  -**GOES**

Business Segments

- US Commercial Communication Satellites
  - Always schedule and price critical, require maximum use of standard documentation, little or no non recurring effort
- NASA/JPL
  - Current Programs include **MMS, GOES, TDRSS, SMAP, SOLAR PROBE PLUS**
  - Typically have unique operational and/or environmental requirements driving significant design modifications
- US Military
  - GPS, AEHF, SBIRS, etc
  - Typically have significant analysis and documentation requirements plus unique survivability requirements
- Foreign: Commercial, JAXA, etc.
  - Communication restrictions, ITAR compliance, US vs Non US Derived programmatic requirements

Lean Management: Adcole Philosophy

Adcole's Goal on Every Program is to be the supplier that our customer does not have to worry about.

- Keep it Simple
- Personal Responsibility
  - Typical of many small companies, successful management is more dependent on people than on management procedures or templates
- Responsiveness:
  - Positive long term relationships with customers are built on a day by day basis.

Lean Management: Adcole Philosophy

- Most programs ultimately have the same key areas critical to successful implementation:
  - Design/Analysis
  - EEE Parts, and Materials and Processes: Compliance to Program Requirements
  - Manufacturing: Workmanship Standards, Program Unique Requirements, etc
  - Testing: Compliance/Verification of imposed requirements

Program Implementation: Design/Analysis

- Philosophy: No Bid or push back on Plans such as Reliability Plan, Producibility Plan, Management Plans, etc. Emphasize analyses.

- Key analyses done on all programs:

  - Worst Case Analysis
  - Radiation/Survivability Analysis
  - Part Stress Analysis
  - Reliability Analysis
  - EMC Assessment
  - FMECA
  - Mission Unique Analyses: Planetary Albedo, Thermal Analyses/Models, etc.

- Teamwork: Take advantage of experienced workforce to optimize design for manufacture and testability.

  - Inputs from inspectors, assembly and test techs on all new designs

Program Implementation
EEE Parts

- Design Philosophy: Maximize use of rad hard SMD Level V or JANS parts, avoid hybrids whenever possible

- Identify non standard SCD parts in proposal phase and offer most attractive pricing based on use of existing part specifications-justify via flight heritage

- EEE Part Program Plan: For each program, Adcole creates one document in a standard format:

  – Defines As-Procured P/N, Procurement Spec, MFR, post receipt processing such as DPA, Rad Testing, XRF Testing, unique parameter screening, etc

  – Require Customer Approval

  – Incoming Inspection will only release parts to stock that meet all requirements of this document.

Program Implementation: Quality Assurance and Manufacturing

- Assigned QA Engineer responsible for all phases of program from RFP/Proposal to hardware delivery
- Use Adcole AS9100 QA Manual with compliance matrix as QA Program Plan
- Each deliverable hardware item (Sensor Head or Electronics unit) has a unique "Manufacturing, Inspection and Test Flow Plan"
  - Includes all program unique requirements: MIPs, Photos, special inspections, XRF testing, etc.
  - Reviewed in detail "face to face" with customer at PDR/CDR/MRR.
  - All routing tags and build paperwork is generated from the approved Flow Plan.

Management Controls: Schedules, Risk Management

- Keep it simple: Smaller but understandable schedules are more effective than overly complicated presentations that are difficult to follow or understand

- Risk Management is inherent in good program management and status communications with customer. At Adcole, it is not a separate entity or function.

- There is no substitute for open communication with the customer.

  – Many programs are scheduled serially through our assembly and test areas. A delay on Program A can directly affect Program B. Best way to deal with this is to have a relationship where customer can be open about "real need", and Adcole can be open about "big picture" of all programs competing for same internal resources.

Cost Driver for Small Companies

- Requirements for Compliance Verification:
  - Documenting Compliance to the Sun Sensor Product Specification and all direct requirements is standard and no problem.
  - With “DOORS” and similar databases, 100% of applicable spacecraft level requirements can now be linked to subcontractor requirements
  - Providing “evidence of verification” for every requirement regardless of whether it is significant or not is an expensive and time consuming effort.

Summary: Lean Management in Small Companies

- Small Companies: Culture and people are critical. Stability of the work force is a good indicator of the health of the organization.
- Typically have very good depth of knowledge, not as good breadth of knowledge compared to larger organizations
- Small organizations should be more responsive and flexible than large organizations
- Lean management is a way of life due to lack of large support staffs