



TELEDYNE BROWN ENGINEERING, INC.

A Teledyne Technologies Company

An Engineered Systems Company

www.tbe.com

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* Many images contained
herein courtesy of NASA.

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Parent Company – Teledyne Technologies



**TELEDYNE
TECHNOLOGIES**
I N C O R P O R A T E D

- ◆ Headquartered in Thousand Oaks, California, with locations throughout the United States, the United Kingdom, and Mexico
- ◆ \$1.8B in 2009 revenues
- ◆ A focused set of complementary, high-tech businesses organized into four segments

Teledyne Brown Engineering – History



- ◆ **Established in 1953 to support Dr. Wernher Von Braun's rocket team**
- ◆ **First full-service, high-technology firm in Huntsville, Alabama**
- ◆ **Founded in 1962, Cummings Research Park was named for the company's first President, Milton K. Cummings.**
 - It is now the second-largest research park in the U.S. and the fourth largest in the world.

Full-Spectrum Engineering and Advanced Manufacturing Company



- ◆ **Engineered Systems**
 - Concept definition through product lifecycle
- ◆ **Engineering Services**
 - Support for the customer's system at any phase of the lifecycle
- ◆ **Hardware Manufacturing**
 - Design and analysis through fabrication, assembly and test, production, and installation and operations

Lifecycle Support

Sustainment and Recapitalization



Maintenance



Operations Support



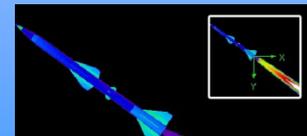
System Integration and Test



Design, Development, and Manufacturing



Engineering Services and Analysis



Concept Definition



Proven Success Since 1953



Aerospace

- Explorer
- Mercury
- Gemini
- Apollo
- Skylab
- Space Shuttle
- Spacelab
- International Space Station (ISS)
- Commercial Orbital Transportation (COTS) Program
- Constellation Program

Defense

- Redstone Rocket
- Nike-X
- C-5 Modules
- Safeguard
- KH-9 Satellite
- Chemical Weapons Demilitarization – Equipment & Ops
- EADSIM
- Air Defense Systems
- Armored Systems Modernization
- Live Agent Biological Test Chamber (BSL-3)
- HWIL Test Facilities & Ops
- Ground-based Midcourse Defense (GMD)
- Integrated Air & Missile Defense
- C4ISR and Optical Signatures
- Joint Material Decontamination System

Energy and Nuclear

- Radiological Lab Services – Commercial, DOE, and DoD Customers
- Nuclear Mechanical Engineering & Fabrication
- Nuclear Waste Containers
- Chemical Processing Equipment
- Cooperative Threat Reduction Program
- Gas Centrifuge Service Modules

TBE's Payload Integration and Hardware Development Support to NASA



◆ Spacelab (1981-2000)

- Supported NASA on 24 missions
 - Supported 140+ payloads
 - Developed and delivered 14 payloads
- Assisted Payload Developers (PDs) with all interface and integration requirements
- Coordinated testing services for PDs at NASA facilities
- Led PDs through the entire flight and ground safety analysis and NASA reviews
- Helped PDs to take full advantage of Spacelab resources
- Facilitated payload crew training and payload operations planning
- Supported command and data handling of Spacelab facilities and payloads
- Facilitated flight readiness by tracking/reporting verification and Certification of Flight Readiness (CoFR)
- Provided NASA with engineering and operations support during each mission

◆ ISS (1995-present)

- Supporting NASA on 24 Increments
 - Supported 80+ payloads
 - Developed and delivered 50 hardware elements
- Assisting PDs with interface and integration requirements
- Coordinating testing services for Microgravity Science Glovebox (MSG) and Materials Science Research Rack (MSRR) payloads at NASA facilities
- Participating in all NASA safety reviews
- Facilitating payload crew training and payload operations planning
- Supporting command and data handling of ISS payload facilities and payloads
- Facilitating flight readiness by tracking/reporting verification and CoFR
- Providing NASA with 24/7 operations support and on-call engineering support

TBE's Support to the NASA ISS Payload Process



NASA's Driving Documents	ISS Increment Definition and Requirements Document • Annex 1 • Annex 5	ISS Payload Interface Requirements Document Facility Investigation Interface Requirements Document	POIC Payload Operations Handbook • Volume 1 • Volume 2	Safety Policy and Requirements for Payloads Using the Space Transportation System	TBE is extremely knowledgeable of NASA's ISS Requirements
	Manifesting	Hardware Development	Operations	Safety	
PD Team Deliverables	<ul style="list-style-type: none"> • Integrated Requirements Sheets • Crew Overview • Science Description 	<ul style="list-style-type: none"> • Hardware • Software • Standalone Test Data • Verification 	<ul style="list-style-type: none"> • Procedure Inputs • Training Hardware • Training Courseware • Resource Needs 	<ul style="list-style-type: none"> • Standalone Safety Data Package • Payload Safety Review Panel (PSRP) Review(s) 	TBE Can Partner With You to Provide These Products
Integration and Operations Team Final Program Products	<ul style="list-style-type: none"> • Payload Tactical Plan (PTP) Inputs • Change Evaluation Form (CEF) Inputs • Payload Data Library (PDL) Inputs • Documentation Delivery Schedule 	<ul style="list-style-type: none"> • Integrated Testing • Human Factors Testing • Integrated Verification • CoFR • Interface Control Document 	<ul style="list-style-type: none"> • Crew Procedures • Training • Operations Nomenclature • User Requirements Collection (URC) Inputs • Schedule Operations • Console Operations 	<ul style="list-style-type: none"> • Integrated Safety Data Package • PSRP Review 	TBE is supporting NASA in producing many of these program products

TBE's Science Facility Operations Support to NASA



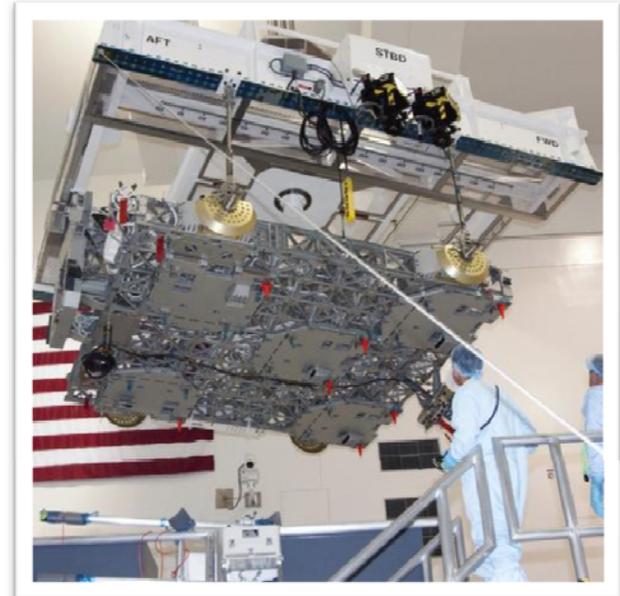
**Eight
EXPRESS Racks**
(180,795 hours)



**Three
Minus Eighty-
Degree Laboratory
Freezers for ISS
(MELFI)**
(40,213 hours)

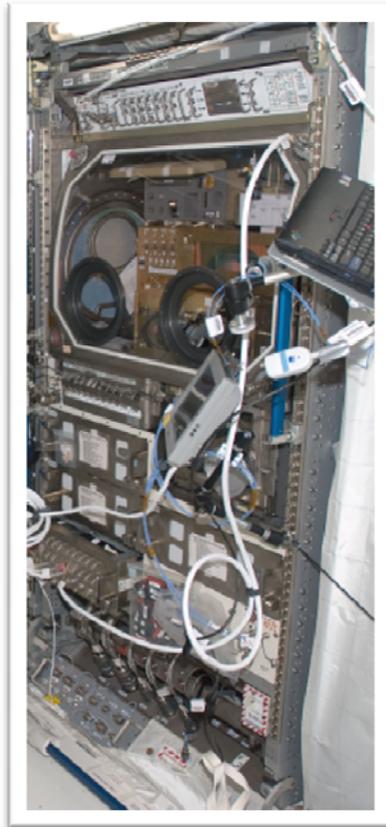


**Window Observational
Research Facility
(WORF)**



**Four EXPRESS Logistics Carriers
(ELCs)**

TBE's Science Facility Integration and Operation Support to NASA



Microgravity Science Glovebox (MSG)
(7,000 hours)



Materials Science Research Rack (MSRR)
(550 hours)

TBE's Integrated Testing Support to ISS



TBE provides operations support to the Payload Rack Checkout Unit (PRCU) located in Marshall Space Flight Center's (MSFC's) Space Systems Integration and Test Facility (SSITF).

Our personnel:

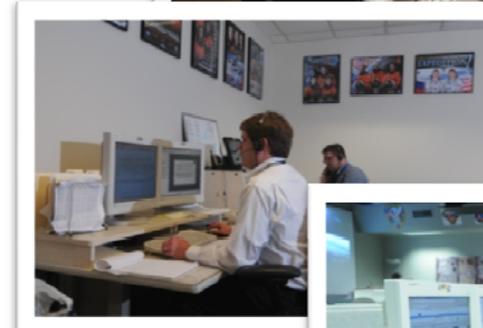
- ◆ Perform integrated verification testing of payload flight hardware and software with the flight-like ground facility racks (EXPRESS, WORF, MSG, and MSSR)
- ◆ Develop test plans, test procedures, and test reports for all integrated tests
- ◆ Perform end-to-end testing of payload command and data handling systems with the flight-like facilities and the Huntsville Operations Support Center (HOSC) systems
- ◆ Support crew procedure validation
- ◆ Support human factors review
- ◆ Label hardware items



TBE's Operations Support to ISS



- ◆ **TBE's operations support to the NASA ISS program includes:**
 - Providing real-time, 24-hour monitoring of ISS payload systems
 - Managing the execution of on-orbit ISS payloads and payload support systems
 - Providing remote access to Payload Investigators worldwide
- ◆ **Standard services provided by the operations team include:**
 - Staffing console positions 24/7 in support of the execution of ISS payload operations
 - Payload timeline development and execution
 - Payload commanding and data management
 - Payload procedure development and maintenance
 - Payload training (for crew and ground operators)

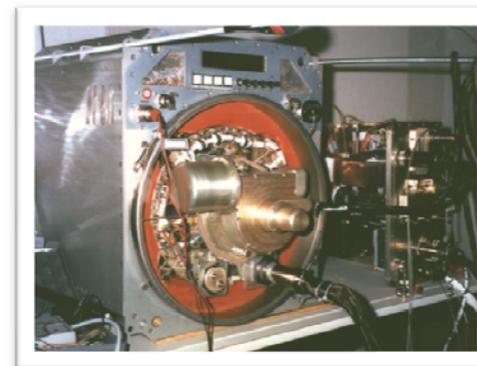


Hardware Development Services

THINK IT
BUILD IT



- ◆ TBE can provide PDs with a multitude of payload hardware development services, including:
 - Interfacing/secondary structure and attachment hardware
 - Mechanical interfacing hardware
 - Sample containment vessels for fluid processing
 - Cables (power, data, video)
 - Data acquisition and processing electronics
 - Combustible gas farms for furnaces
 - Active thermal control systems
 - Training, ground support and prototype hardware



Engineering Integration and Test Services



- ◆ **Development/coordination/delivery of engineering integration products for PDs to expedite access to space:**
 - Hardware/software interface definition development
 - External review support and independent design evaluation
 - Verification planning documentation
- ◆ **Hardware design and verification products/analyses**
 - Drawings, including Configuration management (CM) controlled
 - Engineering analyses: thermal, electrical, digital/analog signals, stress, dynamics, fracture
 - Materials analysis, including compatibility, toxicity, off-gassing, and associated testing
- ◆ **Phased safety/hazard reports/analyses**
- ◆ **CoFR compliance documentation and coordination**
- ◆ **Facilitate testing in the following areas:**
 - EMI/EMC testing support
 - Vibration testing support
 - Thermal vacuum and off-gas testing support
 - Acoustic testing support
 - Fabrication of test fixtures, cables, ground support equipment (GSE), etc.



Operations Integration Services



♦ Operations support services that TBE can provide to PDs include:

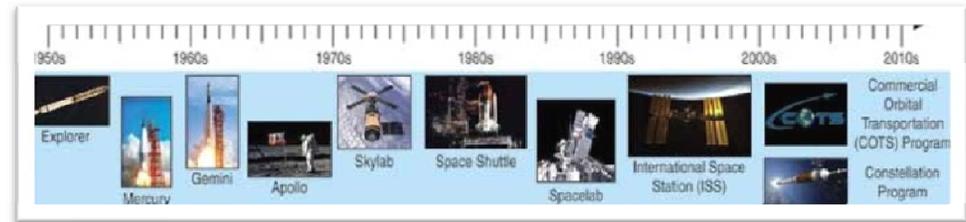
- Remote command and telemetry development using the Telescience Resource Toolkit (TReK)
- Training courseware and curriculum development
- Trainer hardware and software development
- Operational concept development
- Human factors engineering development
- Payload crew display development
- Payload safety/hazard reports/analyses
- Payload CoFR compliance documentation and coordination
- Provide real-time console support on behalf of the PD



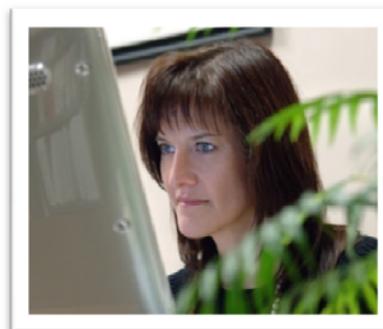
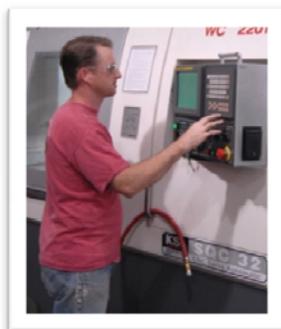
Summary



- ◆ **TBE has over 50 years of experience supporting NASA programs and 35 years supporting NASA space science.**



- ◆ **TBE is an integral part of the existing ISS Payload Integration and Operations process, and we can partner with new Payload Investigators to provide a variety of services.**
- ◆ **Our value proposition: We offer large company capabilities at mid-sized company value and flexibility.**
- ◆ **The value to the Payload Investigator: TBE has the processes, people, skills, tools, and experience to take your payload from concept to end of mission successfully.**





A Proven Foundation for the Future



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