Exit Presentation

Spring 2012

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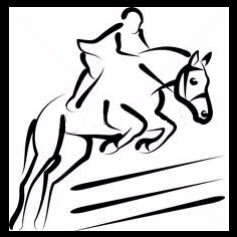
EVA/ XA intern
USRP

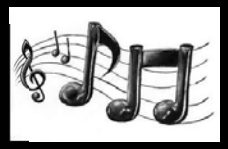
Overview

- Personal Background
- EMU Lessons Learned Database
- Requirements Document
- Skills Acquired
- JSC Experience
- Future Plans
- Acknowledgements
- References

Personal Background

- Grew up in Houston
  - St. Thomas More
  - St. Agnes Academy





Personal Background

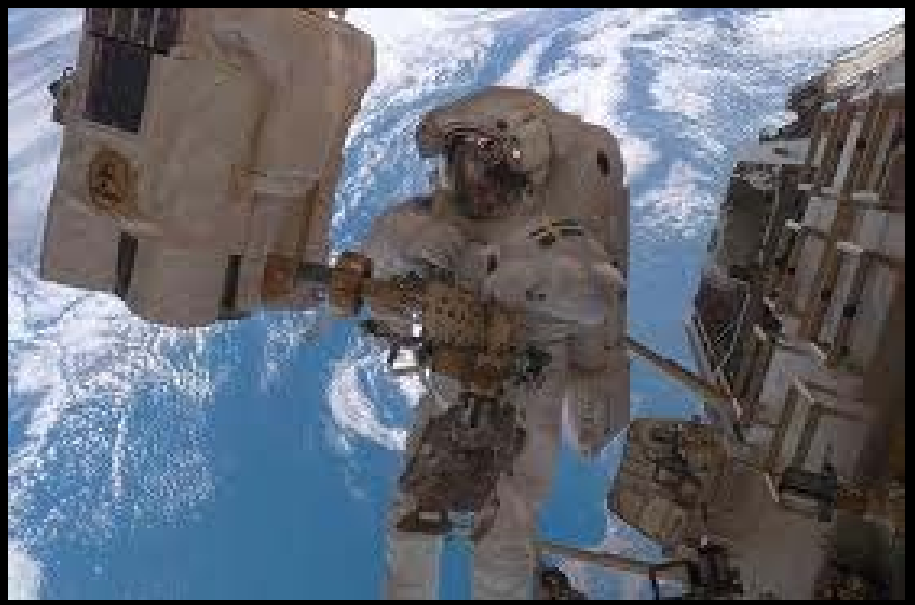
- Currently Attend Texas Tech
  - Major: Mechanical Engineering
  - Minor: Physics and Theater
- When at Tech
  - Solar Racing Team
  - Quidditch

EMU Lessons Learned Database

EMU Lessons Learned Database

Background

- Started by Jake Baker in 2009
  - 7th Intern
- Compilation of Data
  - Failure Investigation and Analysis Reports (FIARs)
- Started in Excel



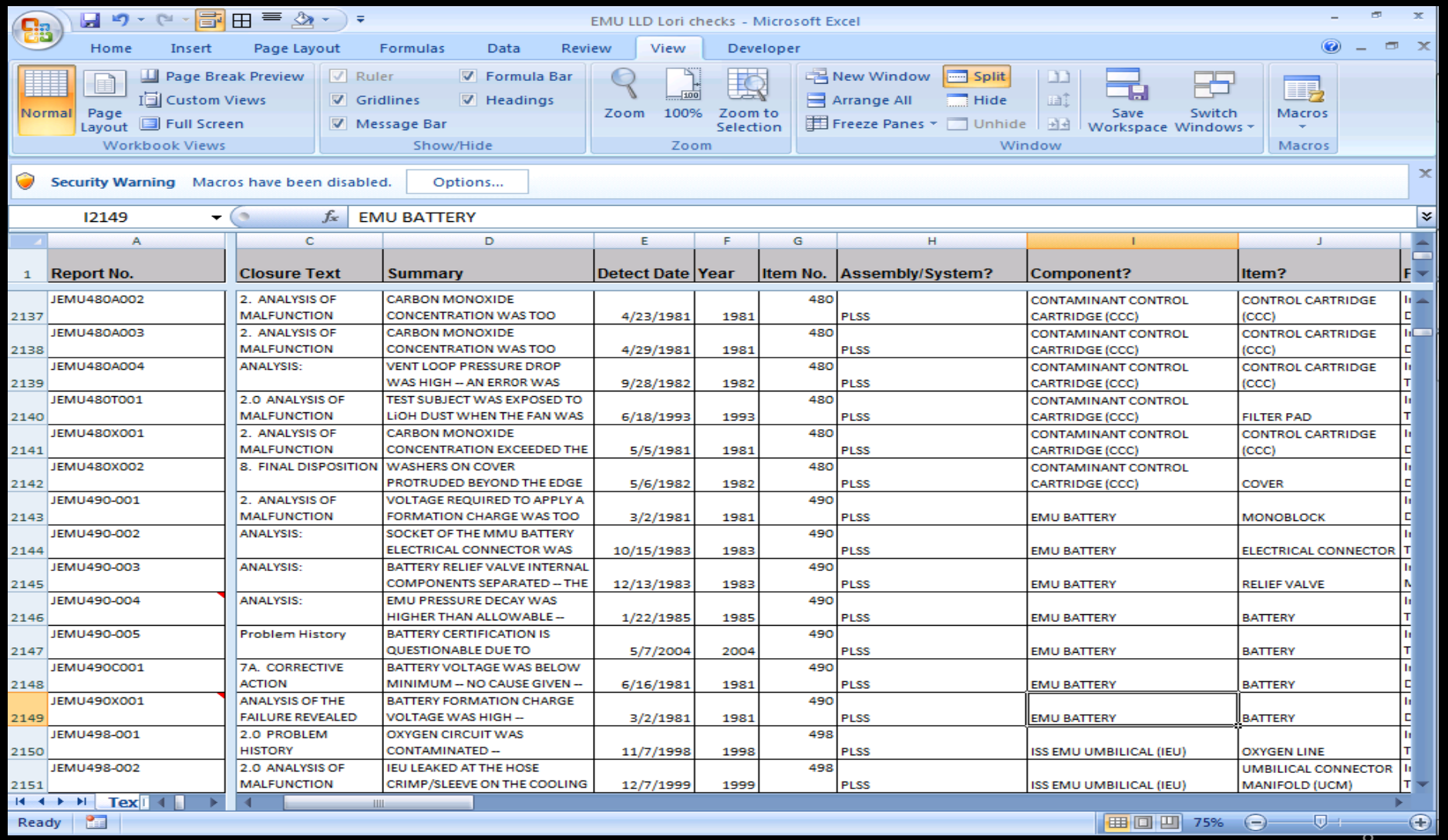
EMU Lessons Learned Database

Purpose

- Development Tool
  - Accessibility to all EMU expertise
- Capture all the Lessons Learned from resolved EMU failures
- Present these lessons in a user-friendly, searchable format
- Provide the ability to analyze trends in data

EMU Lessons Learned Database

Structure



1	Report No.	Closure Text	Summary	Detect Date	Year	Item No.	Assembly/System?	Component?	Item?	F
2137	JEMU480A002	2. ANALYSIS OF MALFUNCTION	CARBON MONOXIDE CONCENTRATION WAS TOO	4/23/1981	1981	480	PLSS	CONTAMINANT CONTROL CARTRIDGE (CCC)	CONTROL CARTRIDGE (CCC)	I C
2138	JEMU480A003	2. ANALYSIS OF MALFUNCTION	CARBON MONOXIDE CONCENTRATION WAS TOO	4/29/1981	1981	480	PLSS	CONTAMINANT CONTROL CARTRIDGE (CCC)	CONTROL CARTRIDGE (CCC)	I C
2139	JEMU480A004	ANALYSIS:	VENT LOOP PRESSURE DROP WAS HIGH -- AN ERROR WAS	9/28/1982	1982	480	PLSS	CONTAMINANT CONTROL CARTRIDGE (CCC)	CONTROL CARTRIDGE (CCC)	I T
2140	JEMU480T001	2.0 ANALYSIS OF MALFUNCTION	TEST SUBJECT WAS EXPOSED TO LiOH DUST WHEN THE FAN WAS	6/18/1993	1993	480	PLSS	CONTAMINANT CONTROL CARTRIDGE (CCC)	FILTER PAD	I T
2141	JEMU480X001	2. ANALYSIS OF MALFUNCTION	CARBON MONOXIDE CONCENTRATION EXCEEDED THE	5/5/1981	1981	480	PLSS	CONTAMINANT CONTROL CARTRIDGE (CCC)	CONTROL CARTRIDGE (CCC)	I C
2142	JEMU480X002	8. FINAL DISPOSITION	WASHERS ON COVER PROTRUDED BEYOND THE EDGE	5/6/1982	1982	480	PLSS	CONTAMINANT CONTROL CARTRIDGE (CCC)	COVER	I C
2143	JEMU490-001	2. ANALYSIS OF MALFUNCTION	VOLTAGE REQUIRED TO APPLY A FORMATION CHARGE WAS TOO	3/2/1981	1981	490	PLSS	EMU BATTERY	MONOBLOCK	I C
2144	JEMU490-002	ANALYSIS:	SOCKET OF THE MMU BATTERY ELECTRICAL CONNECTOR WAS	10/15/1983	1983	490	PLSS	EMU BATTERY	ELECTRICAL CONNECTOR	I T
2145	JEMU490-003	ANALYSIS:	BATTERY RELIEF VALVE INTERNAL COMPONENTS SEPARATED -- THE	12/13/1983	1983	490	PLSS	EMU BATTERY	RELIEF VALVE	I M
2146	JEMU490-004	ANALYSIS:	EMU PRESSURE DECAY WAS HIGHER THAN ALLOWABLE --	1/22/1985	1985	490	PLSS	EMU BATTERY	BATTERY	I T
2147	JEMU490-005	Problem History	BATTERY CERTIFICATION IS QUESTIONABLE DUE TO	5/7/2004	2004	490	PLSS	EMU BATTERY	BATTERY	I T
2148	JEMU490C001	7A. CORRECTIVE ACTION	BATTERY VOLTAGE WAS BELOW MINIMUM -- NO CAUSE GIVEN --	6/16/1981	1981	490	PLSS	EMU BATTERY	BATTERY	I C
2149	JEMU490X001	ANALYSIS OF THE FAILURE REVEALED	BATTERY FORMATION CHARGE VOLTAGE WAS HIGH --	3/2/1981	1981	490	PLSS	EMU BATTERY	BATTERY	I C
2150	JEMU498-001	2.0 PROBLEM HISTORY	OXYGEN CIRCUIT WAS CONTAMINATED --	11/7/1998	1998	498	PLSS	ISS EMU UMBILICAL (IEU)	OXYGEN LINE	I T
2151	JEMU498-002	2.0 ANALYSIS OF MALFUNCTION	IEU LEAKED AT THE HOSE CRIMP/SLEEVE ON THE COOLING	12/7/1999	1999	498	PLSS	ISS EMU UMBILICAL (IEU)	UMBILICAL CONNECTOR MANIFOLD (UCM)	I T

EMU Lessons Learned Database

Structure – Bucket Categories

Found

In Development?

In Manufacturing/Installation?

In Repair/Maintenance?

In Testing/Processing?

In Operation?

Class

Class I or II Hardware?

Class III Hardware?

Flight Crew/Ground Support Equipment?

Solution

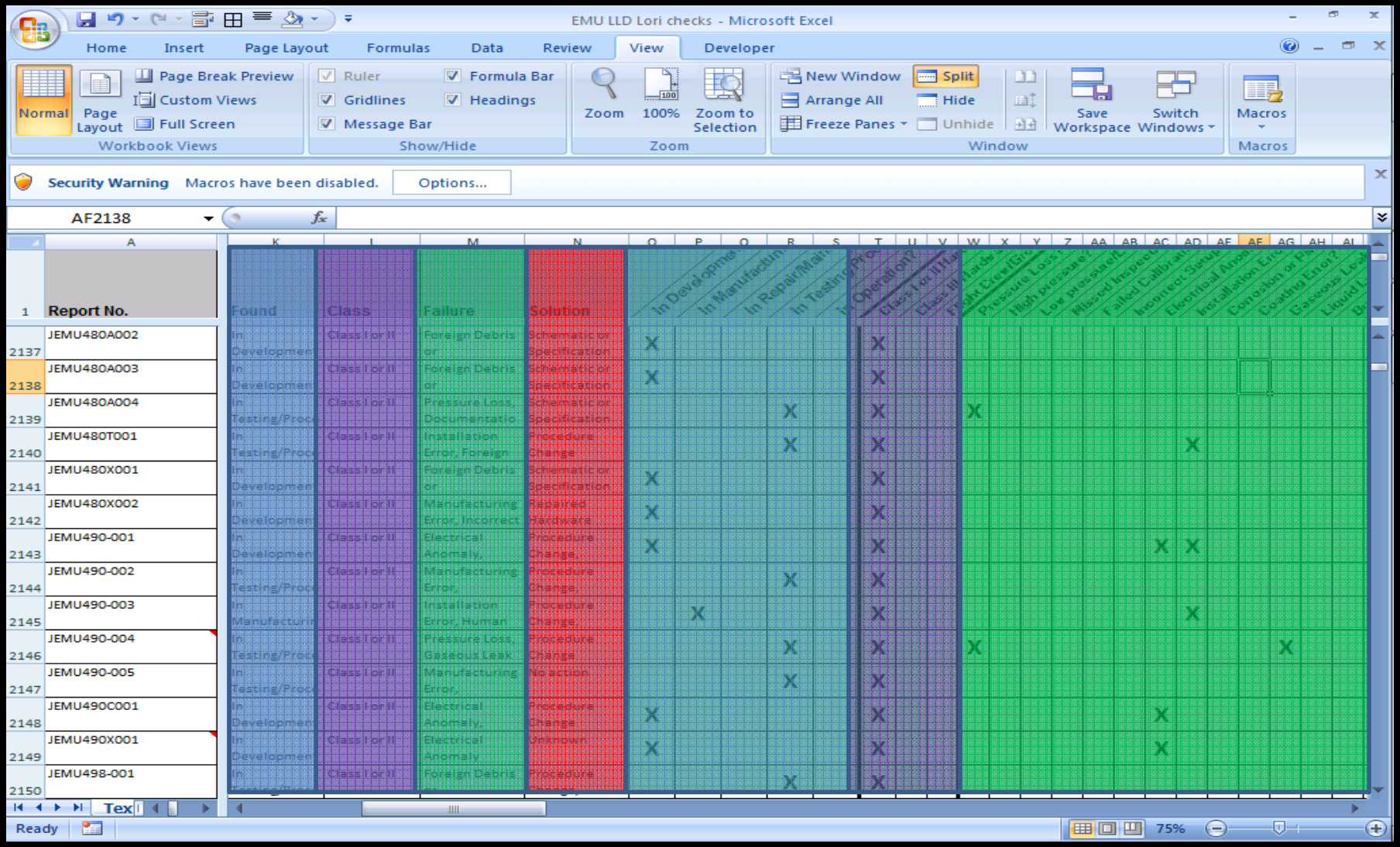
Design new hardware?
Procedure Change?
Inspection Change?
Replaced hardware?
No action?*
Schematic or Specification change?
Cleaned Hardware?
Repaired Hardware
Hardware Downgraded?
Manufacturing change?
Train/Notify Technicians?
Screen/Test Hardware?
Add adhesive/lubricant/etc?
Pushed to parent FIAR?
Written in Error
Unknown
*Reason for no action?

Failure

Pressure Loss?
High pressure?
Low pressure/Low Flow?
Missed Inspection?
Failed Calibration?
Incorrect Setup?
Electrical Anomaly?
Installation Error?
Corrosion or Pitting?
Coating Error?
Gaseous Leak?
Liquid Leak?
Button/zipper/latch/etc?
Screws/washers/nuts/bolts/ pins/springs/etc.?
Tubing?
Human error?
Discoloration?
Lubrication?
Foreign Debris or Contamination?
Inadequate Cleaning?
Expected wear?
Manufacturing Error?
Damaged Structure?
Incorrect part or material?
Inappropriate Handling?
Material Degradation?
Incorrect Dimensions?
Inadvertent Contact?
Cosmetic Anomaly?
Adhesive Failure?
Inappropriate Torque?
Missing component?
Fabric Error?
Design Error?
Installation Procedure Clarity?
Documentation Error?
Environmental (humidity, temperature, etc.)?
First problem occurrence?
Inadequate Training?
Expired Hardware?
Excessive Loading?
Unknown

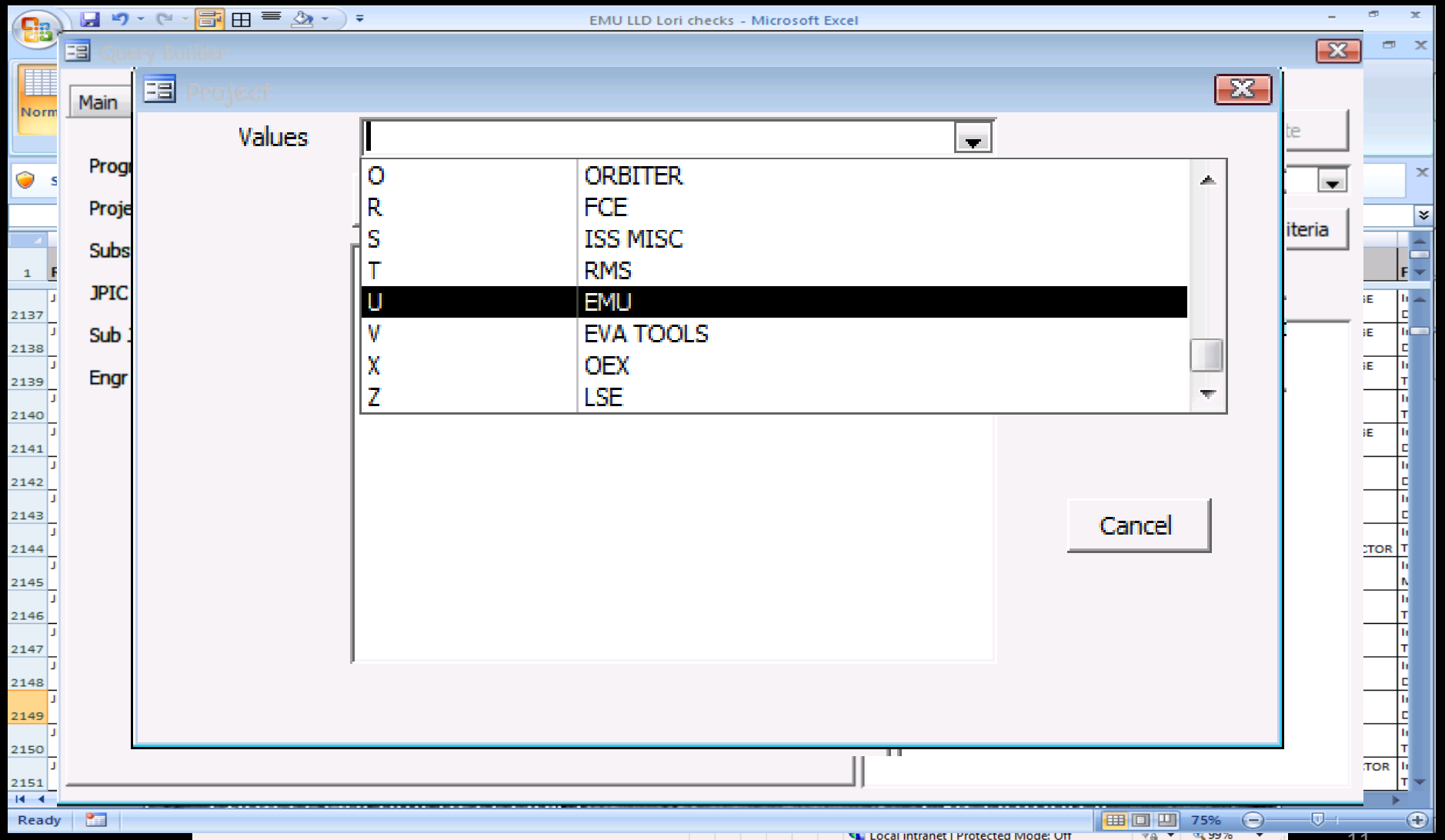
EMU Lessons Learned Database

Structure



EMU Lessons Learned Database

Creating an Entry



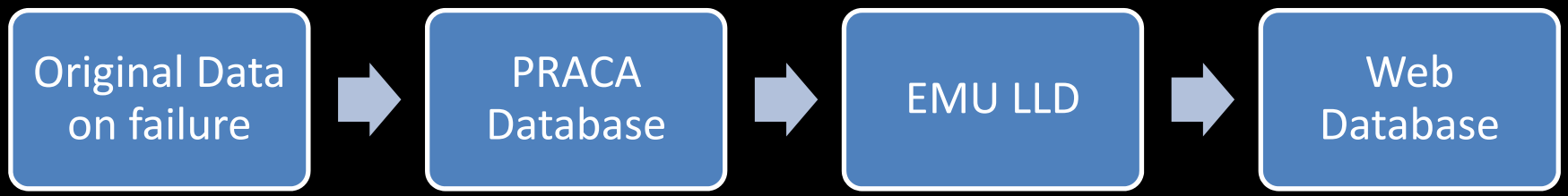
EMU Lessons Learned Database

Current Status of FIAR updates

ALL FIARS TO DATE HAVE BEEN PUT INTO THE EXCEL SPREADSHEET!

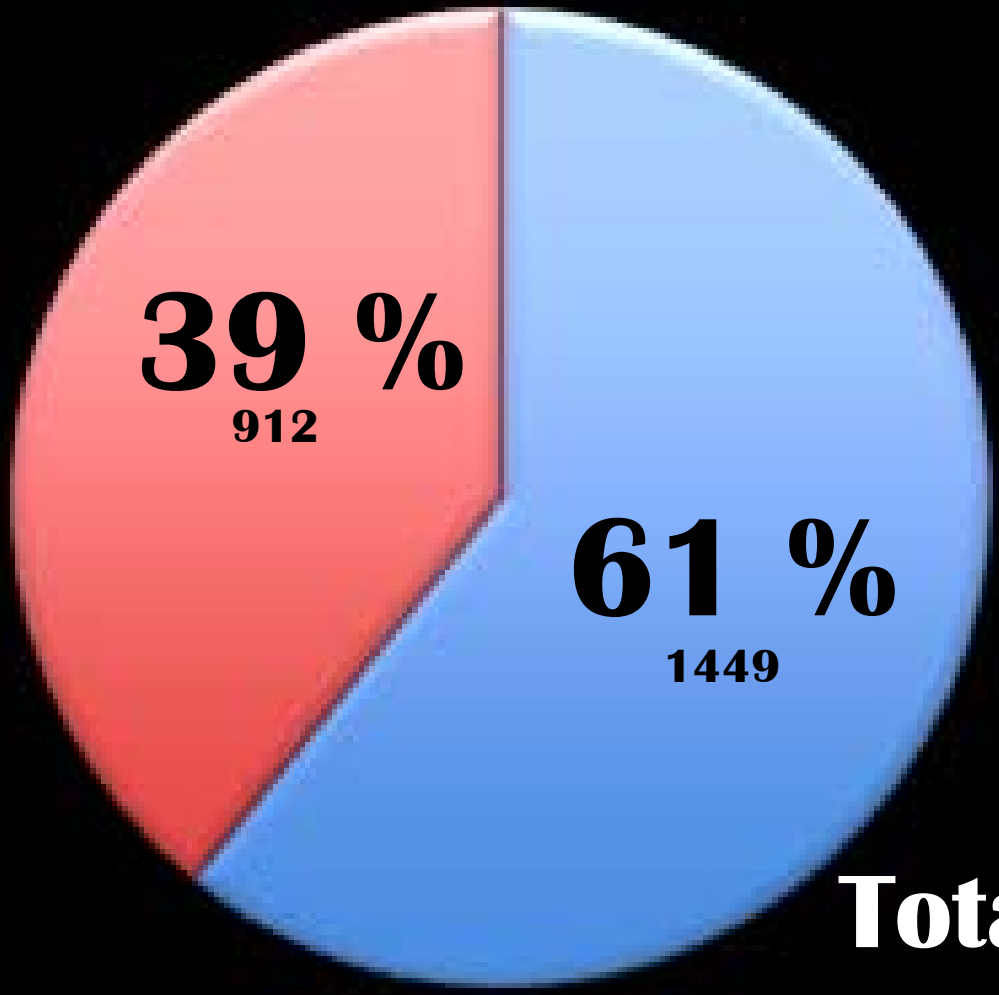
EMU Lessons Learned Database

Data Flow



EMU Lessons Learned Database

What can we learn from the spreadsheet?

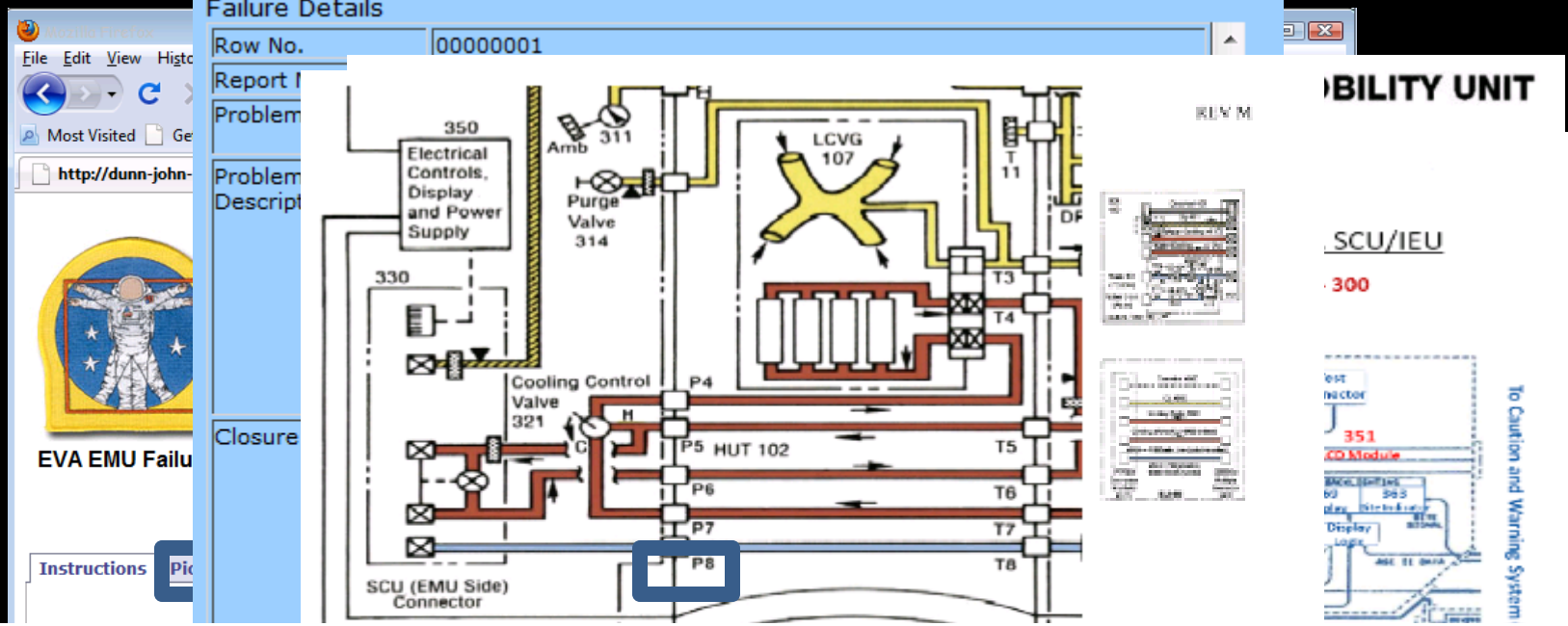


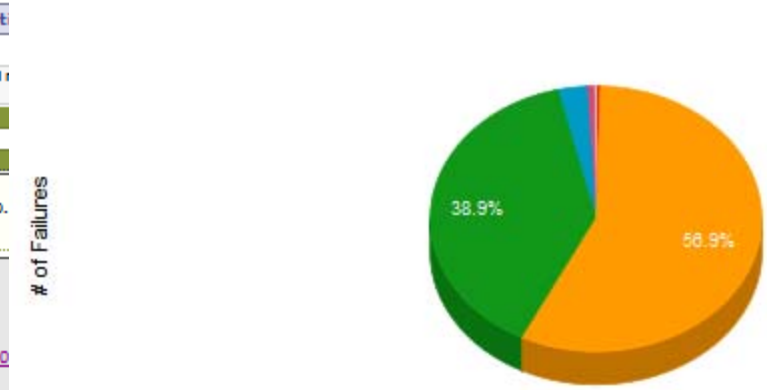
- Files reviewed and input into web database
- Files that need to be reviewed

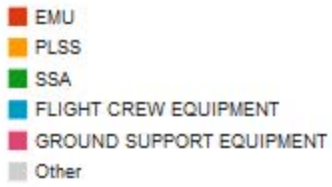
Total FIARS - 2361

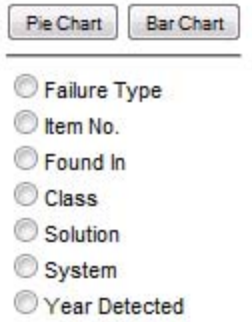
EMU Lessons Learned Database

Webpage



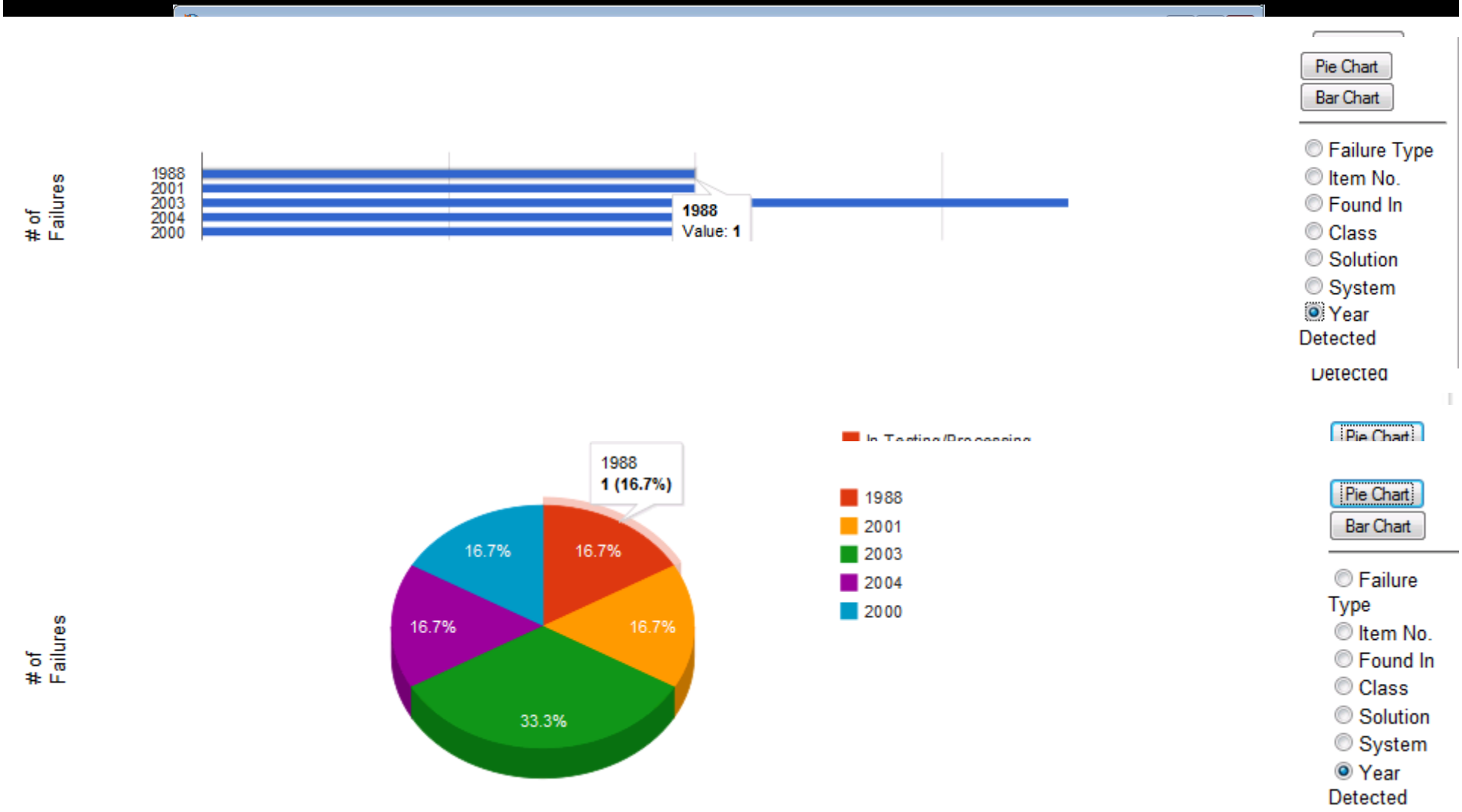




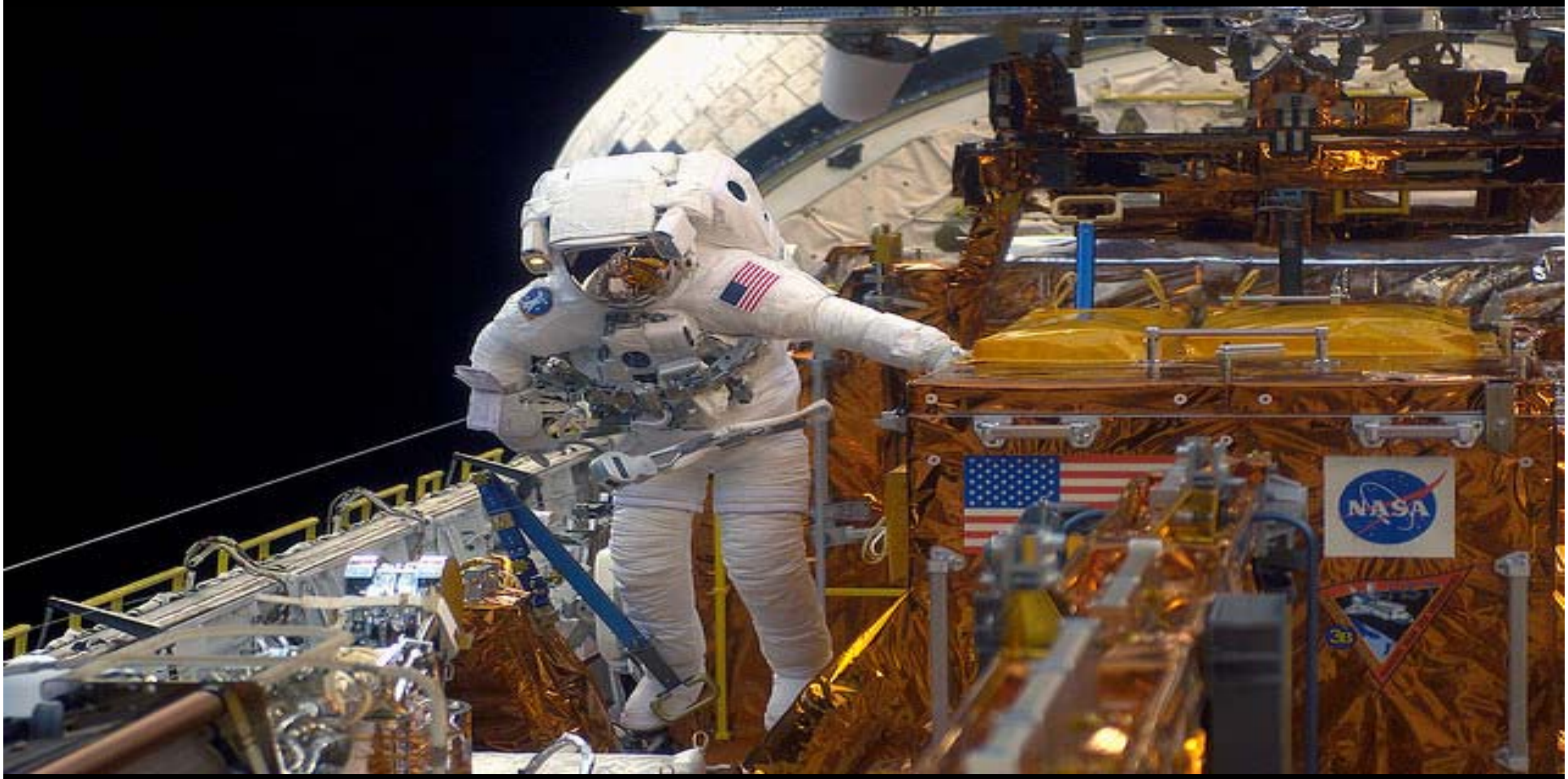


EMU Lessons Learned Database

What can we learn from the Webpage?



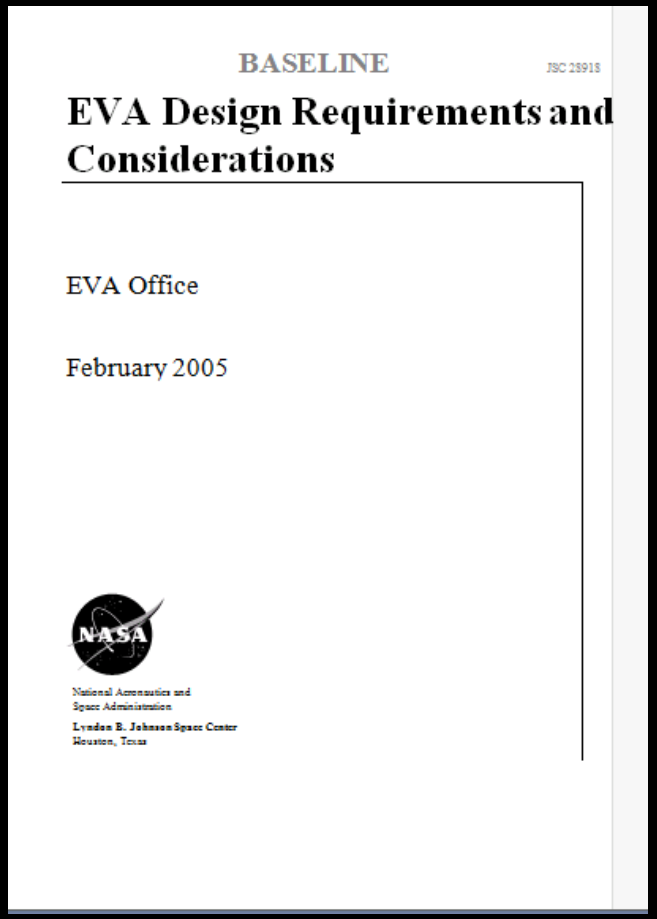
Requirements Document



Requirements Document

Background

- JSC28918 “EVA Design Requirements and Considerations”
- Combination of Requirements Documents
- Intended Users: external hardware providers
- Hardware Design Guidelines
  - EVA Compatibility


BASELINE JSC 28918

EVA Design Requirements and Considerations

EVA Office

February 2005

National Aeronautics and Space Administration

Lyndon B. Johnson Space Center

Houston, Texas

JSC28918 “EVA Design Requirements and Considerations”

NASA Standards for Requirements

- Clear “Shall” Statement
  - *“Product ABC shall XYZ.”*
- Consistent Terminology
- Free of Implementation
  - *“…WHAT is needed, NOT HOW to provide…”*
- Free of Description of Operation

NASA SE Handbook pg 279 appendix C

Requirements Document

Original Format

4.4.4 Glove Palm External Touch-Temperature Compliance

The hardware provider shall demonstrate compliance with EVA glove palm touch-temperature limitations for crew protection from high and low skin touch-temperature limits. These limits do not apply to the backside of the glove and the EMU thermal meteoroid garment (TMG) ortho fabric that have different standards set out in Section 4.4.5. A 30-minute touch-temperature compliance provides a sufficient degree of operational flexibility from a safety perspective. If hardware cannot comply with the 30-minute requirement, the hardware provider shall perform a hazard/safety analysis to evaluate justification and operational impacts. EVA hardware that causes glove or suit TMG compression during normal operation shall also be evaluated via a hazard/safety analysis.

Background data: *Touch-temperature compliance might not be achievable in thermal environments that exceed a 150 °F (65 °C) effective EMU radiation sink temperature, because glove thermal radiation exposure becomes a limiting factor. This temperature is derived from an EOL optical property ratio of 0.215 for the exterior EMU surface. Glove exposure to this condition can cause EVA operational constraints, and thermal mittens may be required. However, because these mittens are restrictive to the crewmember's hand dexterity, they are typically not baselined for use.*

4.4.4.1 *Touch-Temperature Compliance by Inspection*

EVA hardware maintained between -80°F to +150°F (-63°C to 65°C) requires no touch-temperature analysis. These limits provide a minimum of 30 minutes continuous glove palm contact at a pressure of 1.0 pounds per square inch. Alternately, Table 4-4 can be used to demonstrate 30-minute touch-temperature compliance of hardware, subject to the following limitations: small, handheld hardware with no more than 50 square inch surface area, and materials predominantly aluminum, stainless steel, titanium, and/or soft goods.

Hot touch-temperature limits can be extended significantly if a shorter contact time is justifiable. For example, temperatures of 170°F (77°C) for up to 10 minutes and 210°F (99°C) for up to 5 minutes may be acceptable with no hardware mass or surface area limitations. The EMU glove performance is documented elsewhere (JSC 39117, "Extravehicular Mobility Unit (EMU) International Space Station (ISS) Extravehicular Activity (EVA) Thermal Environment Requirements for Certification") and can be used for this purpose when applicable. For successive contact durations, glove and skin temperatures may require thermal recovery before the next contact. The hardware provider shall document rationale for an exception allowing touch-temperature durations less than 30 minutes in the Certification and Acceptance Requirements Document (CARD) or alternative safety documentation.

JSC28918 "EVA Design Requirements and Considerations" – 4.4.4 and 4.4.4.1

Requirements Document

Original Format

3.12 Latches 3.3.6.12.6 SSP50021

The hardware provider shall design latches or similar devices to prevent entrapment of EV crewmember appendages and equipment (like tethers).

3.13 Screws and Bolts 3.3.6.12.7,3.2.10.12 SSP50021

The hardware provider shall include protective features on screws or bolts in established worksites (planned and contingency) and translation routes to prevent snagging, and to protect against sharp edges and impact.

3.14 Levers, Cranks, Hooks, and Controls 3.3.6.12.9 SSP50021

The hardware provider shall locate levers, cranks, hooks, and controls where they cannot pinch, snag, cut, abrade, or provide kickback to the EV crewmember appendages or equipment (like tethers).

3.15 Burrs 3.3.6.12.10 SSP50021

The hardware provider shall ensure that exposed surfaces are smooth and free of burrs.

3.16 Hole Size 3.3.6.12.11.2 SSP50021

The hardware provider shall make exposed circular holes other than tether points less than 0.5 in. (12.7 mm) in diameter or greater than 1.4 in. (3.556 cm) in diameter to prevent entrapment of an EMU-gloved finger. Irregularly shaped holes shall be evaluated individually during the safety integration process.

3.17 Protrusions 3.3.6.12.12 SSP50021

The hardware provider shall design or configure equipment, except for translation aids, to not protrude into the 43-in. diameter translation path, reference Figure 4-6.

JSC28918 "EVA Design Requirements and Considerations" – 3.12, 3.13, 3.14, 3.15, 3.16, and 3.17

Requirements Document

The Beginning

Section #	Section Title	Sub-Section	Subtitle	Requirement	Rationale
3.4	Safety Requirements	Lasers	N/A	The hardware provider shall design lasers to preclude exposing the EV	For health and safety of EV crewmember.
3.5	Safety Requirements	Electrical Safety and Design	N/A	The hardware provider shall design equipment to protect the EV	For health and safety of EV crewmember.
3.5.1	Safety Requirements	Electrical Safety and Design	Shock Protection	The hardware provider shall ensure that any exposed conducting surfaces	For safety of EV crewmember in the event of any contact with
3.5.2	Safety Requirements	Electrical Safety and Design	Mating/Demating of Powered Connections	The hardware provider shall design each powered circuit to have at least	To eliminate potentially hazardous energy levels at the connector
	Safety Requirements	Electrical Safety and Design	Mating/Demating of Powered Connections	The hardware provider shall design connectors to have features that	To eliminate potentially hazardous energy levels at the connector
	Safety Requirements	Electrical Safety and Design	Mating/Demating of Powered Connections	The hardware provider shall design connectors to provide protection of	To eliminate potentially hazardous energy levels at the connector
3.5.3	Safety Requirements	Electrical Safety and Design	Magnetic Field Limit	The hardware provider shall ensure hardware does not generate more	To preclude interference with EMU and EVA tool electrical assemblies.
3.5.4	Safety Requirements	Electrical Safety and Design	Batteries	The hardware provider shall design or use battery materials that are	To ensure that no interference between EMU and batteries occurs.
3.5.5	Safety Requirements	Electrical Safety and Design	Hardware Susceptibility	The hardware provider shall design or use hardware that is compatible with	To ensure hardware can withstand EMI produced from EMU.

Supportive Information	Support References
Reference Document:	
None	
Reference Document:	
Further Design Information:	
Example:	
Example:	
None	
Methods of Verification:	
Reference Document:	

Requirements Document

Then and Now

Section #
Section Title
Sub-section
Subtitle
Requirement
Rationale
Supportive Information
Support References

Why?

Section #
Section Title
Subsection
Subtitle
Subsection
Original Requirement Format
New Requirement Format
Rationale
Supportive Information
Supportive References
Original Documentation
Figures/ Tables Referenced

Requirements Document

New Format

Section #	Section Title	Sub-Section	Subtitle	Sub-Section	Original Requirement Format
4.14.4.1	EVA Design Requirements	Handholds and Handrails	Tether Attachment and Handhold/Handrail Spacing	Crew Safety Tether Attachment	The hardware provider shall incorporate a safety tether
	EVA Design Requirements	Handholds and Handrails	Tether Attachment and Handhold/Handrail Spacing	Crew Safety Tether Attachment	The hardware provider shall design these crew safety tether attachment
	EVA Design Requirements	Handh		her Attachment	The hardware provider shall analyze or

Sectio	Original Re	Figures/Tables Referenced (All figures inserted from left to right in the order mentioned in the "Support References"	ment Format
4.14.4.1	The hardware p	Table 4-7.png	nt point shall be
	incorporate a s	Table 4-7.png	port structure, for
	The hardware p	Table 4-7.png	iment points shall have
	these crew safe		N) in any direction per
	The hardware p	Table 4-7.png	all be anaylzed or tested
4.14.4.2	test this loadin	None	and not combined with
	The hardware p		dholds/handrails and
	that the spacing betwee		her attach points shall not

3.6.4.	
3.6.4.4 - GDRD	None

Requirements Document

Forward Work

- Combine with CxP 70130 “Constellation Program Extravehicular Activity Design and Construction Specification” to make one requirements doc
- Make into a web database
- Include in another web database

Skills Acquired

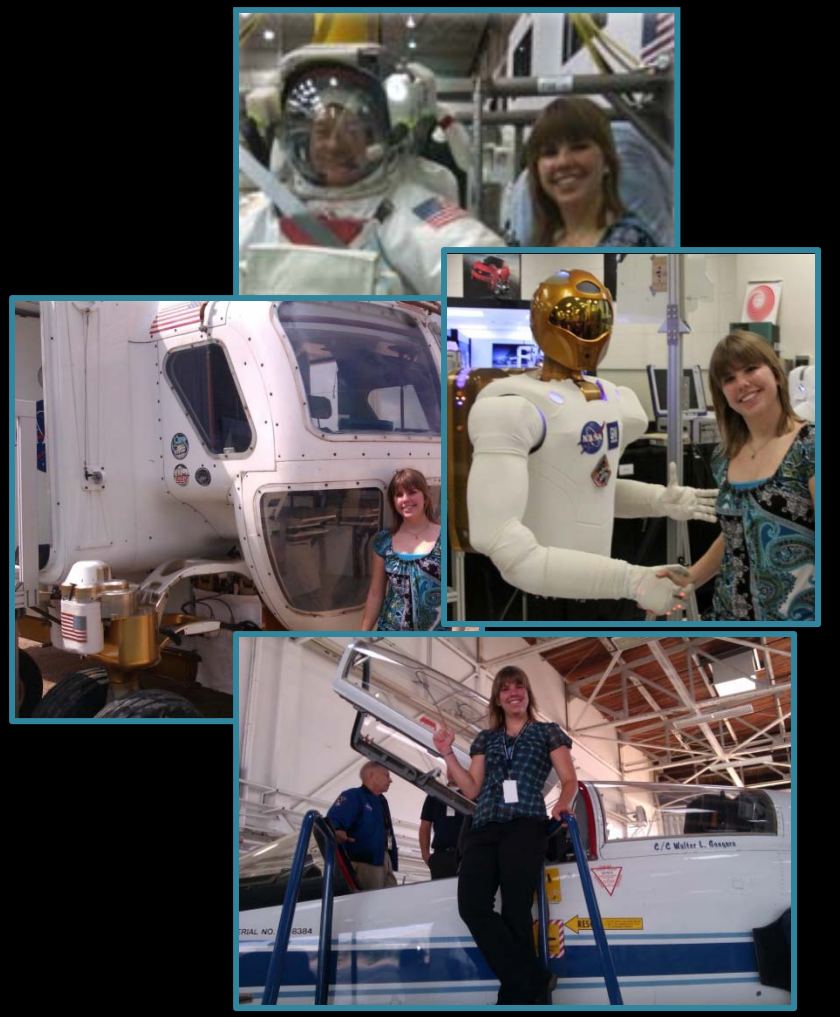
- Knowledge of the EMU
  - EVA Tools and hardware
- Knowledge of the Requirements for an EVA
- NASA Engineering Analysis Process
- Professional Experience
  - Scheduling
  - Organizing

JSC Experience

- Classes
  - EVA PGT/TM 31001
  - Small Tools
  - Large Tools
  - ISS JNT AL INTRO 21105
  - ISS EMU 21105
  - ISS ECWS INTRO 21014
  - ISS JNT AL HDW 31105
  - ISS ECWS MALS 21014
  - SS ECWS MALS 21014
  - EVA SKILLS TRAINING
  - And CBT courses

JSC Experience

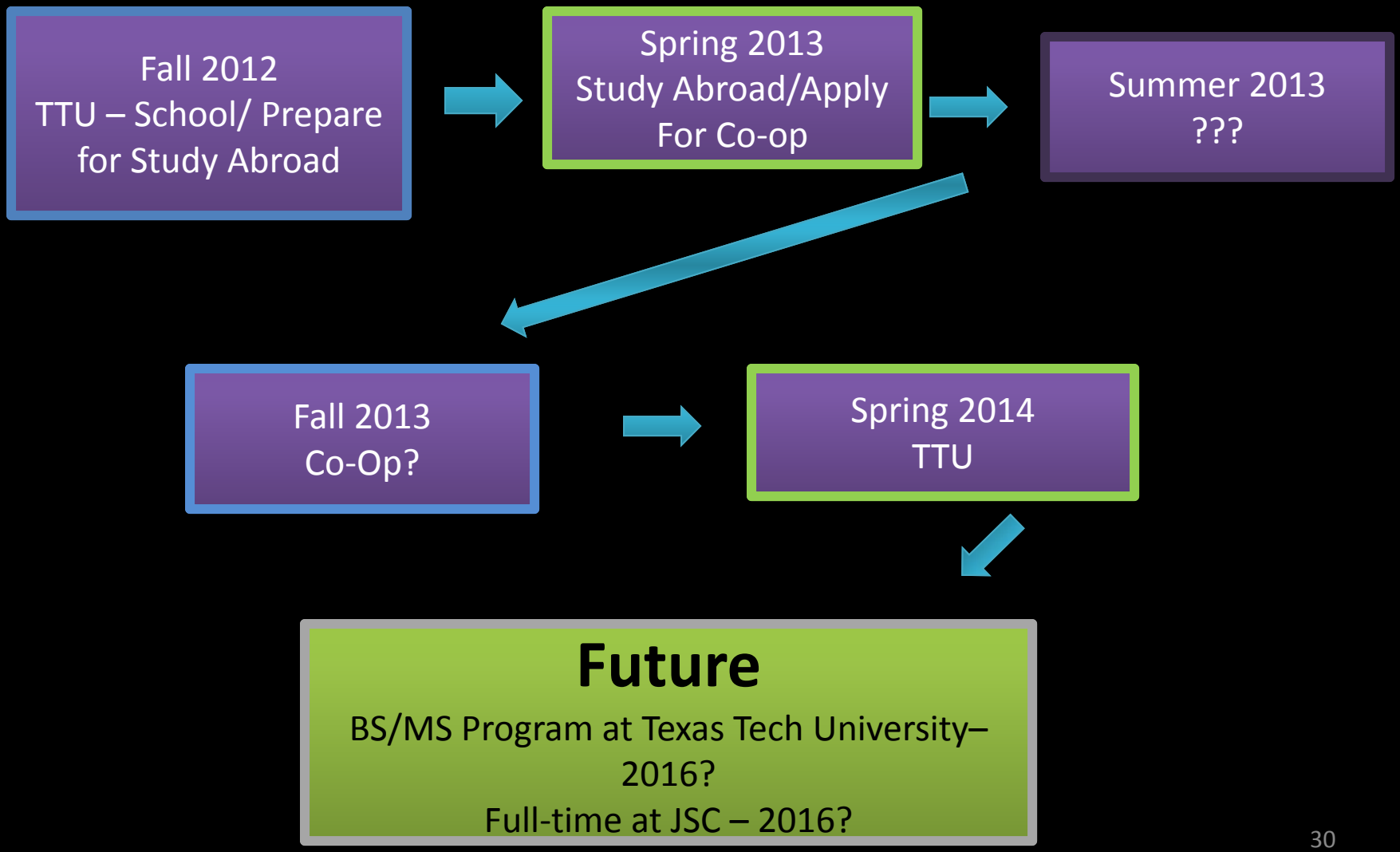
- Tours
  - NBL
  - Robonaut
  - SEV
  - Building 9: Mock ups, ARGOS, and SAFER
  - Building 30: MER, IMC, MCC
  - Suit Lab
  - Lunar Lab
  - Pyrotechnics Lab
  - EV Facilities



JSC Experience

- Lectures
  - Ginger Kerrick
  - Chris Cassidy
  - Sy Liebergot
  - Dr. Everett Gibson
  - Mike Finch
  - Gene Krantz
- Other
  - Observed Russian EVA from IMC
  - Expedition 28 Crew Welcome Home Awards Ceremony
  - CAS Mentor
- Outside JSC
  - Houston Livestock show and Rodeo
  - Beauty and the Beast
  - Ecuador Medical Mission Gala
  - Quidditch Tournament in College Station
  - Sherwood Forest Faire in Austin

Future Plans



Acknowledgements

Mentor – Lori Crocker

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NASA Experiences – Larry Gana, Tamra George, and JSC Co-Ops

USRP Internship Coordinator – Diego Rodriguez

Former XA Interns – Jake Baker, Peter Schulte, Sean Miller, Samantha McCue, Eric Lang, Kevin Matthews

All of XA

Previous support: Bert Magh, David Fitts, Camille Alleyne

References

- JSC 28918
- Google Images
- Texas Tech Quidditch and IQA website

Questions?

Thank You!

- http://www.youtube.com/watch?v=dI9Cxq7MIrY