



Workmanship Lab Management at Goddard Space Flight Center

Bo Yang, CQE
Terry James, PMP
Alvin Boutte

GSFC Workmanship and ESD Program

SAFETY and MISSION ASSURANCE DIRECTORATE
Code 300

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Acknowledgement

- Malinda Hammond, Code 585 Associate Branch Head
- Gregory Wood, Code 585 LQMS Developer
- Alexander Durkin, Code 585 System Engineer
- Dann Brown, Code 500 Lab Manager
- Becky Pike, Code 373 Branch Head
- Jeannette Plante, Quality Engineering Technical Fellow

Agenda

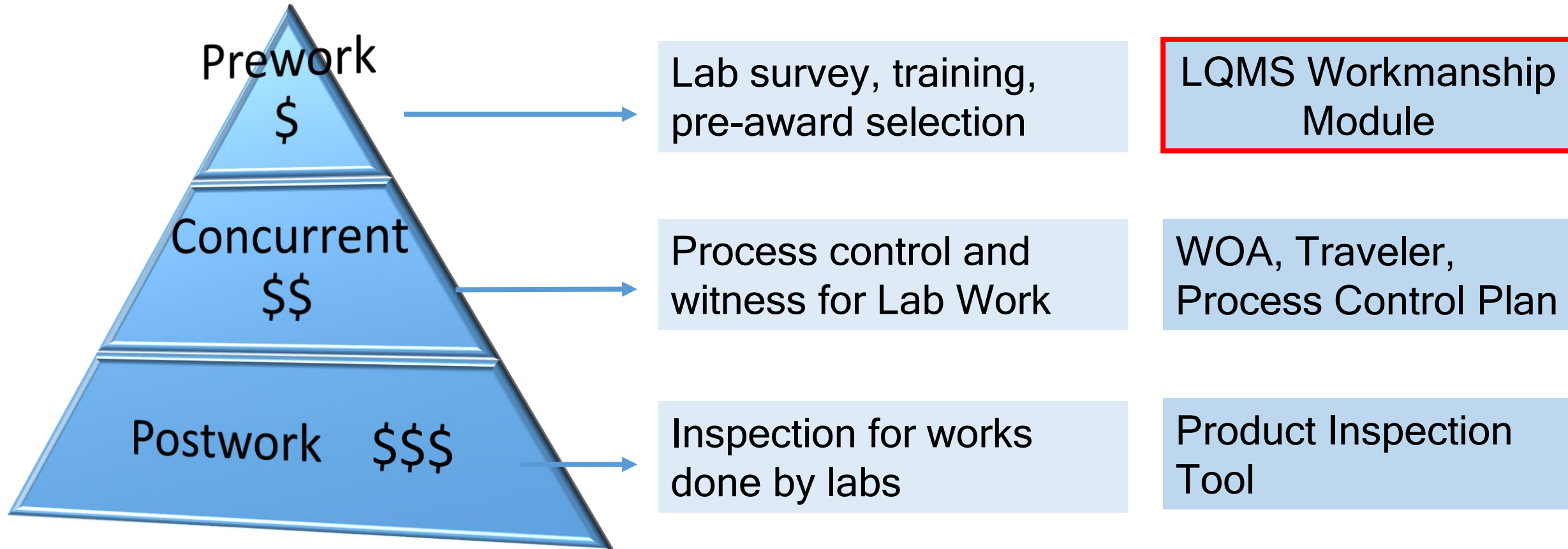
- Overview
- Lab Quality Management System Workmanship Module
- Deployment and Result
- Future Work

Overview:

NPD 8730.5: NASA Quality Assurance Program Policy

- Prework Assurance Measures:
 - Provide increased confidence for meeting prescribed requirements (e.g., pre-award surveys, qualified source selection, training).
- Concurrent Assurance Measures:
 - Ensure that work is being performed in accordance with requirements (e.g., process control, process witnessing).
- Postwork Assurance Measures:
 - Ensure that work was properly performed (e.g., inspections, tests, record review, configuration control).

Cost of Quality



Tools Used for Pre-award Need to Answer:

- How many labs are there at GSFC?
- What do those labs do? (harness? solder? polymeric? etc..)
- Which lab is capable of assembling flight hardware?
- Which lab is capable of performing rework/repair for flight hardware?
- What are the quality of the work from a lab?
-



Lab Self
Assessment \$

Audit \$\$\$

Quality Data
History \$

GSFC Lab Quality Management System (LQMS) Workmanship Module

- No center-wide tool or system exists to this date to aid in the tracking of the workmanship performance of the labs.
- The GSFC Workmanship Program is in need of a system to help the center comply with the requirements of NPD 8730.5, NASA Quality Assurance Program Policy with regards to Workmanship.
- Lab Quality Management System (LQMS) Workmanship Module is our choice.

LQMS Workmanship Module Objective

- Allow labs to self check against the workmanship requirement, as well as benchmark and improve flow down of standards.
- Allow workmanship group and branch to effective tracking of lab performance regarding workmanship.
- Allow workmanship group and branch to identify lab capabilities (e.g. hand soldering, SMT assembly, cable and harness manufacturing).

GSFC Lab Quality Management System (LQMS)

The screenshot shows the homepage of the GSFC Lab Quality Management System (LQMS). At the top left is the NASA logo. To its right, the text reads "National Aeronautics and Space Administration" and "Lab Quality Management System - Home". On the top right, there is a search bar with "Search NASA.gov" and a "Go" button. Below the search bar, the user's identity is displayed: "AUID: byang7" and "Access: Workmanship Program Manager".

A navigation menu is located below the header, with links for "ESD", "FOM", "MGSE", "LDE", "LMN", "SAVE", "PVS", and "Workmanship". Under the "Workmanship" link, there is a sub-menu with "Labs", "Capabilities", "Help", and "Admin".

The main content area is titled "Welcome to the Workmanship Home Page". It contains the following text:

The GSFC Workmanship Program is responsible for implementing the Agency mandated compliance with the workmanship standards in soldering, polymeric application, cable crimping & harnessing, and fiber optics activities, that are performed onsite in the Greenbelt campus.

This LQMS Workmanship Module is intended to provide a tool for the lab owners/managers to self-evaluate the level of standards flow downs in their responsible area. These self-evaluation results are not shared with other lab owners/managers, engineering team, management team, and are only accessible to the lab owners/managers of that lab, and the workmanship manager. The goal is to provide a method for the lab owners/managers to quarterly check against the workmanship requirement, benchmark and improve their standards flow-downs.

While the labs that make flight hardware or critical GSEs are mandatory to answer the questionnaire quarterly, we welcome the non-flight hardware labs and R&D labs to use this module for self-evaluation as well.

If you have any GSFC workmanship program questions, concerns, suggestions, please feel free to contact Teresa A. James (301.614.5928 or teresa.a.james@nasa.gov)

Curator: Bo Yang (301.286.6129 or bo.yang@nasa.gov)

Useful links:

- GSFC Workmanship & ESD Control Wiki - This Wiki Page provides lessons learned and best practices related to printed circuit boards, soldering; bonding, staking and conformal coating; cable and harness production; fiber optic cable production; and ESD Control.
- NASA Technical Standards System – This website provides various NASA Directives including the workmanship standard NASA-STD-8739.4, NASA-STD-8739.5, NASA-STD-8739.6. By entering the document number in the search block, the system can also redirect you to the **IHS Document Search**, where the external standards such as IPC-J-STD-001, IPC-WHMA-A-620 can be located.

At the bottom of the page, there is a footer with the NASA logo on the left, the "Goddard SPACE FLIGHT CENTER" logo in the middle, and contact information on the right:

- Help Desk: GSFC-585-Helpdesk@mail.nasa.gov / (301-286-6034)
Goddard Space Flight Center
Computing Environments and Collaborative Technologies Branch / Code 585
- Official: Teresa A. James
• Curator: Gregory Wood
Visit NASA.gov
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One Page for Each Lab

Workmanship Overview

Lab Name Cryogenics Facility
Status Submitted and Valid
Next Due 04/23/2019
Site Greenbelt
Building / Room 007/055A
Lab Owner Silk, Eric
Lab Manager Hait, Tom
Alt. Lab Manager

Lab Capabilities

ESD Class:		Soldering:		Harness/Connector Assembly:	
ESD Class:	Yes	Machine Soldering	No	Crimping	No
Polymeric Applications:		Hand Soldering	Yes	Electrical Test	Yes
Conformal Coating	No	Surface Mount	No	Fiber/Optics	No
Bonding	No	Printed Wiring Assemblies	No	Connector Assembly	No
Encapsulation/Potting	No	Tinning	Yes	Splicing	No
Staking	No	Rework	No	Soldering	Yes
Rework	No	Repair	No	Rework	No
Repair	No			Repair	No

[+ Add Note](#) 

2018 Workmanship capabilities changed.

UVWX

Questionnaire History

Creation Date 	Due Date	Submit Date	Updated by	Status	+ Add Questionnaire 
10/25/2018	11/24/2018	10/25/2018	UVWX	Submitted and Valid	

Questionnaire Tailored to Each Lab

Question MasterSheet

Question	Phrase	Machine Solde ring	Hand Solde ring	PWA	SMT	Tinn ing	Stak ing	Con for mal Coa ting	Bon ding	Enc aps ulation	Splici ng	Crimp ing	Conn ector Asse mbly	Electri cal Testin g	Fiber Optic s	ESD	
1a-Training 1	8739.1B Polymerics						1	1	1	1							Edit
1a-Training 2	8739.4A Crimp Cable and Harness										1	1	1	1			Edit
1a-Training 3	IPC/WHMA-A-620CS Crimp Cable and Harness										1	1	1	1			Edit
1a-Training 4	8739.5A Fiber Optics														1		Edit

Questionnaire Detail

Lab Name	Cryogenics Facility
Status	Submitted and Valid
Creation Date	10/25/2018
Due Date	11/24/2018
Last Update	UVWX
By	
Submit Date	10/25/2018
Last Update	10/25/2018
Date	
Lab Type	Flight Work (Flight Hardware, Critical GSE) Non-Flight Work

Lab Capabilities

ESD Class:	No	Soldering:		Harness/Connector Assembly:	
Polymeric Applications:		Machine Soldering	No	Crimping	No
Conformal Coating	No	Hand Soldering	Yes	Electrical Test	Yes
Bonding	No	Surface Mount	No	Fiber/Optics	No
Encapsulation/Potting	No	Printed Wiring Assemblies	No	Connector Assembly	No
Staking	No	Tinning	Yes	Splicing	No
Rework	No	Rework	No	Soldering	Yes
Repair	No	Repair	No	Rework	No
				Repair	No

The questionnaire form has been completed and submitted. Thank you!

- [0-Background](#)
- [1-Training](#)
- [2-Environment](#)
- [3-Procedures](#)
- [4-Tools](#)
- [5-Handling](#)
- [6-Fabrication](#)
- [6a-Fabrication-Cable Harness](#)
- [6b-Fabrication-Fiber Optics](#)
- [6c-Fabrication-Polymeric](#)
- [6d-Fabrication-Soldering](#)
- [7-Inspection](#)
- [8-Rework/Repair](#)
- [9d-Workload](#)
- [9g-Equipment Capacity](#)
- [9-Records](#)
- [top](#)

0 - Background [100% Completion, 11 out of 11 Questions]

The following standard apply to your area (select all that apply):

8739.6A Workmanship Standard	Yes
J-STD-001FS WAM1	Yes
GSFC-STD-8001 Water Soluble Flux	No
GSFC-STD-6001 CCGA	No
300-PG-8730.6.1A ESD	Yes
Solder pot is used for tinning in your area.	No
Tinning or gold removal is performed by soldering iron only. No solder pot is used.	Yes
All personnel in the lab are contractors.	No
Assembly includes heat sensitive parts	No
Razor blade is used to removing cable outer jacket.	No
Assembly includes moisture sensitive parts	No

1 - Training [100% Completion, 9 out of 9 Questions]

Employees are trained to the following (select all that apply):

9d - Workload [100% Completion, 12 out of 12 Questions]

Workload for the past 6 months has been:

increasing	No
decreasing	Yes
steady	No
flucating	Yes

The 6 months forecast of the workload is:

increasing	Yes
decreasing	No
steady	No
fluctuating	Yes

There has been continuous work over the past:

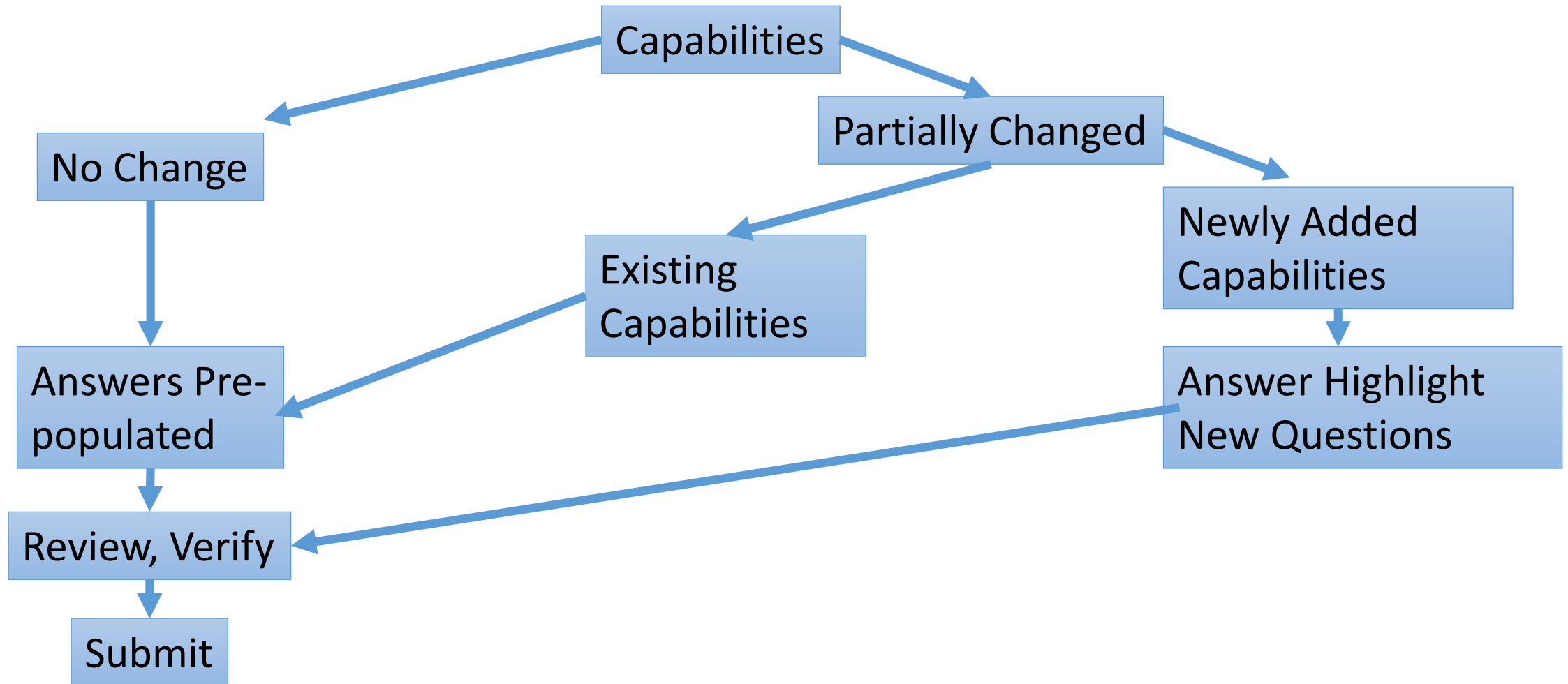
3 months	Yes
6 months	Yes
12 months	Yes
18 months or more	Yes

9g - Equipment Capacity [100% Completion, 15 out of 15 Questions]

There has been new equipment added to the lab in the past:

3 months	No
4-6 months	No
7-12 months	Yes
13-18 months	Yes
No new equipment has been added in the past 1.5 years or more	No

Bring Down the Cost



Self-Assessment Data Analysis

Lab Name	Date (yymmdd)	ng	ng	A	T	ni	ki	til	di	ic	ci	ng	bl	t	s	E	A	M	1	1	0	in	ng	tc	y	pa	lie	1	m	m	m	ni	de	pa	rs	
Cryogenics Facility	2018-10-25 14:39:25	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	1	0	1	0	0									0	0
Cryogenics Facility	2018-10-25 14:29:47	0	1	0	0	1	0	0	1	0	0	0	1	1	0	0	1	1	0	0	1	0	1	0	0		1	0	1	0	1	1	1	0	0	
Cryogenics Facility	2018-10-25 14:17:54	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	1	1	0	0	1	0	1	0	0									0	0	
Cryogenics Facility	2018-10-25 14:10:47	0	1	0	0	1	0	0	0	0	0	0	0	1	0	1	1	1	0	0	1	0	1	0	1									0	1	
Cryogenics Facility	2018-10-24 17:54:29	0	1	0	0	1	1	0	1	1	0	0	1	1	0	0	1	1	0	0	0	0	1	0	1		1	0	1	0	1	1	1	0	0	
Cryogenics Facility	2018-10-24 17:22:05	0	1	0	0	1	1	0	1	1	0	0	0	1	0	0	1	1	0	0	0	0	1	0	1		1	0	1	0	1	0	1	0	0	
Cryogenics Facility	2018-10-25 10:55:02	0	1	1	0	1	1	0	1	1	1	0	1	1	0	1	1	1	0	0	0	1	1	0	1		1	0	1	0	1	1	1	1	1	
Telecommunicatio	2018-08-23 15:58:45	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0									0	0	
Communication St	2018-07-12 19:48:54	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	1			0	0									0	0	
Code 564 Develop	2018-08-22 15:08:34	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	1	0	1	0	1		0	0	1	0	1	1	1	0	0	

LQMS Workmanship Module Objective

- Allow labs to self check against the workmanship requirement, as well as benchmark and improve flow down of standards.



Area of Risk and Improvement Focus for Each Lab: Gap Heat Map

$\frac{\text{\# of Clauses not Flowed Down}}{\text{\# of Total Clauses Asked}}$

		Training	Environment	Procedures	Tools	Handling	Fabrication	Fabrication Crimping	Fabrication Polymers	Fabrication Soldering	Fabrication Fiber Optics	Inspection	Rework/Repair	Record
0	Machine Soldering	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	Hand soldering	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	PWA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	SMT	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	Tinning	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	Staking	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	conformal coating	0%	0%	2%	0%	0%	0%	3%	0%	0%	7%	3%	0%	0%
1	Bonding	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	Encapsulation/Potting	0%	0%	6%	0%	0%	6%	8%	0%	0%	7%	7%	0%	0%
0	splicing	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	crimping	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	connector assembly	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	Electrical Test	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	Fiber/Optics	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	ESD	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

		Training	Environment	Procedures	Tools	Handling	Fabrication	Fabrication Crimping	Fabrication Polymers	Fabrication Soldering	Fabrication Fiber Optics	Inspection	Rework/Repair	Record
0	Machine Soldering	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	Hand soldering	14%	25%	14%	23%	18%	6%	13%	13%	17%	11%	17%	14%	11%
0	PWA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	SMT	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	Tinning	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	Staking	0%	20%	12%	20%	21%	6%	12%	19%	13%	18%	18%	11%	0%
0	conformal coating	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	Bonding	0%	20%	13%	20%	21%	6%	12%	20%	13%	18%	18%	12%	0%
1	Encapsulation/Potting	0%	20%	14%	20%	21%	6%	11%	21%	13%	18%	21%	13%	0%
0	splicing	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	crimping	0%	20%	3%	8%	11%	6%	3%	10%	8%	11%	13%	3%	0%
0	connector assembly	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	Electrical Test	0%	25%	5%	13%	14%	6%	8%	10%	9%	13%	20%	7%	0%
0	Fiber/Optics	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	ESD	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Area of Risk and Improvement Focus for Each Lab: Gap Heat Map

$$\text{Gap Heat Map \%} = \frac{\text{\# of Clauses not Flowed Down}}{\text{\# of Total Clauses Asked}}$$

		Training	Environment	Procedures	Tools	Handling	Fabrication	Fabrication Crimping	Fabrication Polymers	Fabrication Soldering	Fabrication Fiber Optics	Inspection	Rework/Repair	Record
0	Machine Soldering	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	Hand soldering	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	PWA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	SMT	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	Tinning	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	Staking	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	conformal coating	0%	0%	2%	0%	0%	0%	3%	0%	0%	7%	3%	0%	0%
1	Bonding	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	Encapsulation/Potting	0%	0%	6%	0%	0%	0%	6%	8%	0%	7%	7%	0%	0%
0	splicing	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	crimping	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	connector assembly	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	Electrical Test	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	Fiber/Optics	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	ESD	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Gap Heat Map: # of Clauses not Flowed Down

	Training	Environment	Procedures	Tools	Handling	Fabrication	Fabrication Crimping	Fabrication Polymers	Fabrication Soldering	Fabrication Fiber Optics	Inspection	Rework/Repair	Record
Machine Soldering	0	0	0	0	0	0	0	0	0	0	0	0	0
Hand soldering	0	0	0	0	0	0	0	0	0	0	0	0	0
PWA	0	0	0	0	0	0	0	0	0	0	0	0	0
SMT	0	0	0	0	0	0	0	0	0	0	0	0	0
Tinning	0	0	0	0	0	0	0	0	0	0	0	0	0
Staking	0	0	0	0	0	0	0	0	0	0	0	0	0
conformal coating	0	0	1	0	0	0	0	1	0	0	1	1	0
Bonding	0	0	0	0	0	0	0	0	0	0	0	0	0
Encapsulation/Potting	0	0	2	0	0	0	1	2	0	0	1	2	0
splicing	0	0	0	0	0	0	0	0	0	0	0	0	0
crimping	0	0	0	0	0	0	0	0	0	0	0	0	0
connector assembly	0	0	0	0	0	0	0	0	0	0	0	0	0
Electrical Test	0	0	0	0	0	0	0	0	0	0	0	0	0
Fiber/Optics	0	0	0	0	0	0	0	0	0	0	0	0	0
ESD	0	0	0	0	0	0	0	0	0	0	0	0	0

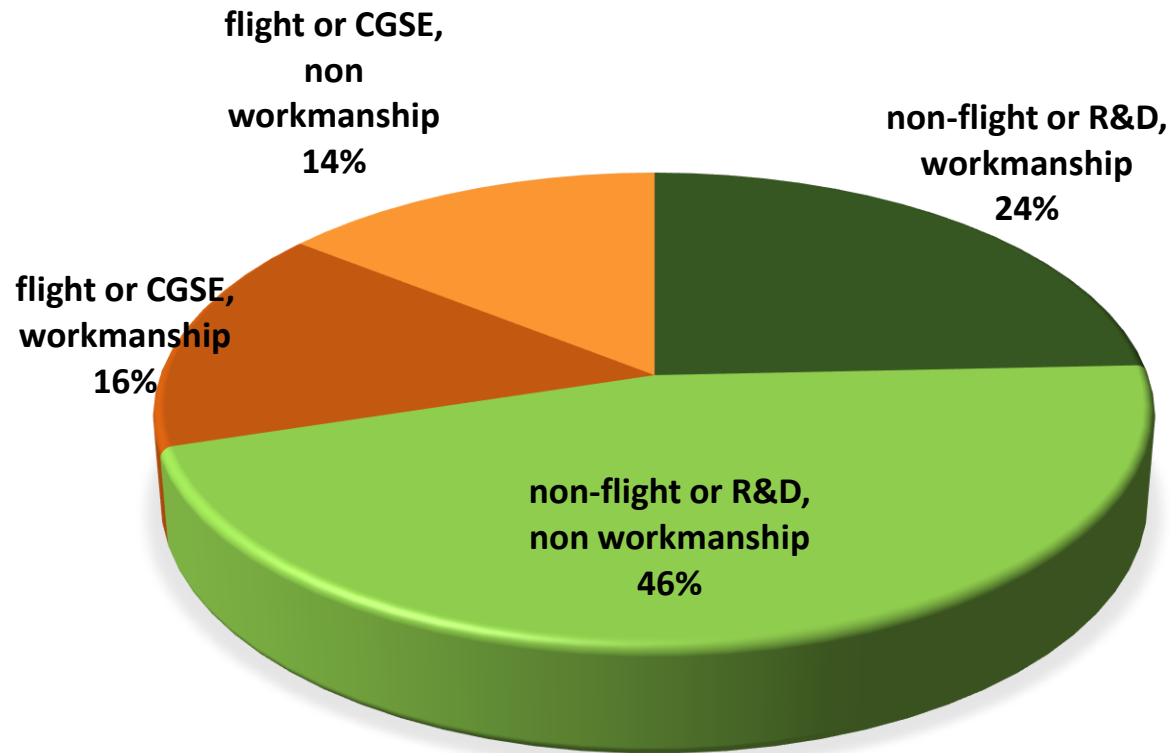
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- Allow labs to self check against the workmanship requirement, as well as benchmark and improve flow down of standards.
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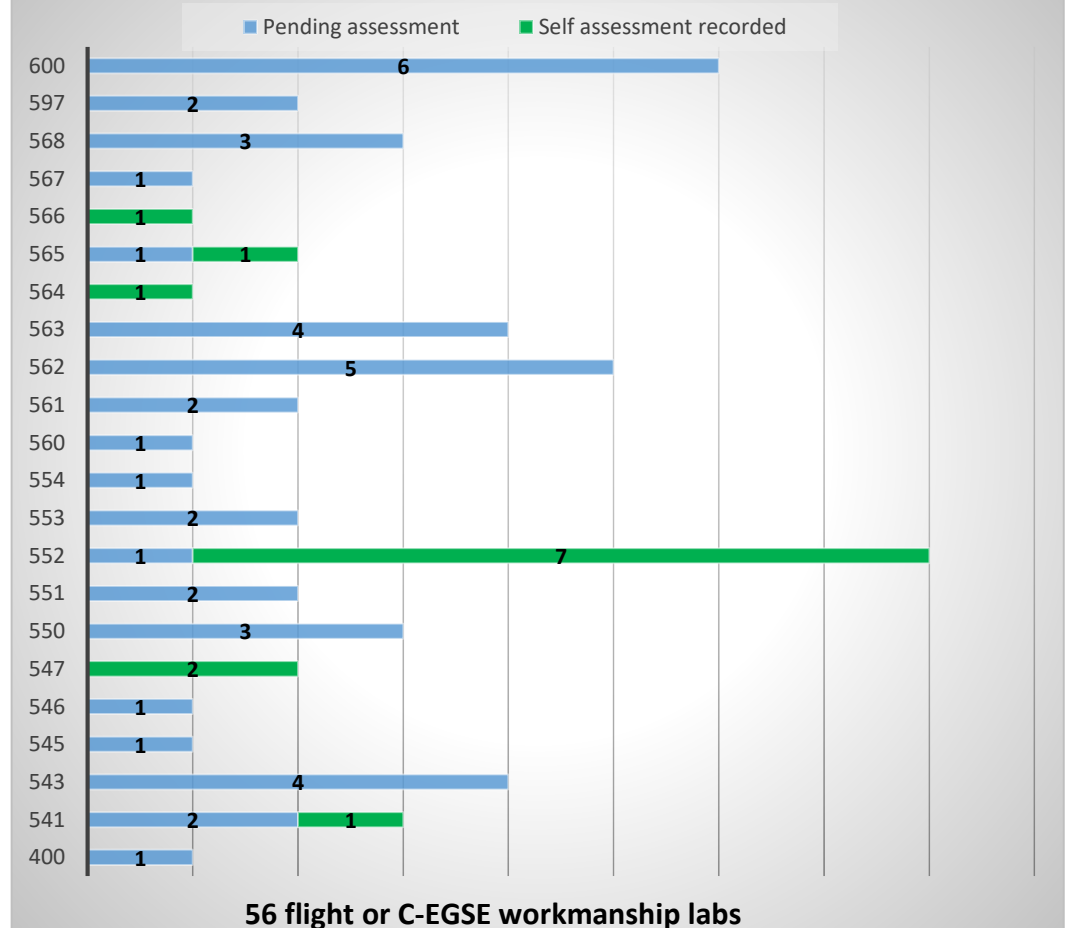
Know the Big Picture of the Lab

LABS AT GSFC



Total lab count as of Feb 2019: 362
labs within code 400,500,600, flight non-flight defined.



Assessment Snapshot Example






Deployment Status

- LQMS Workmanship module developed and available in the production server.
- Survey focused on code 500 labs.
- Developed GPR for center-wide adoption.
- In process of developing a PG.

LQMS Workmanship Module Objective

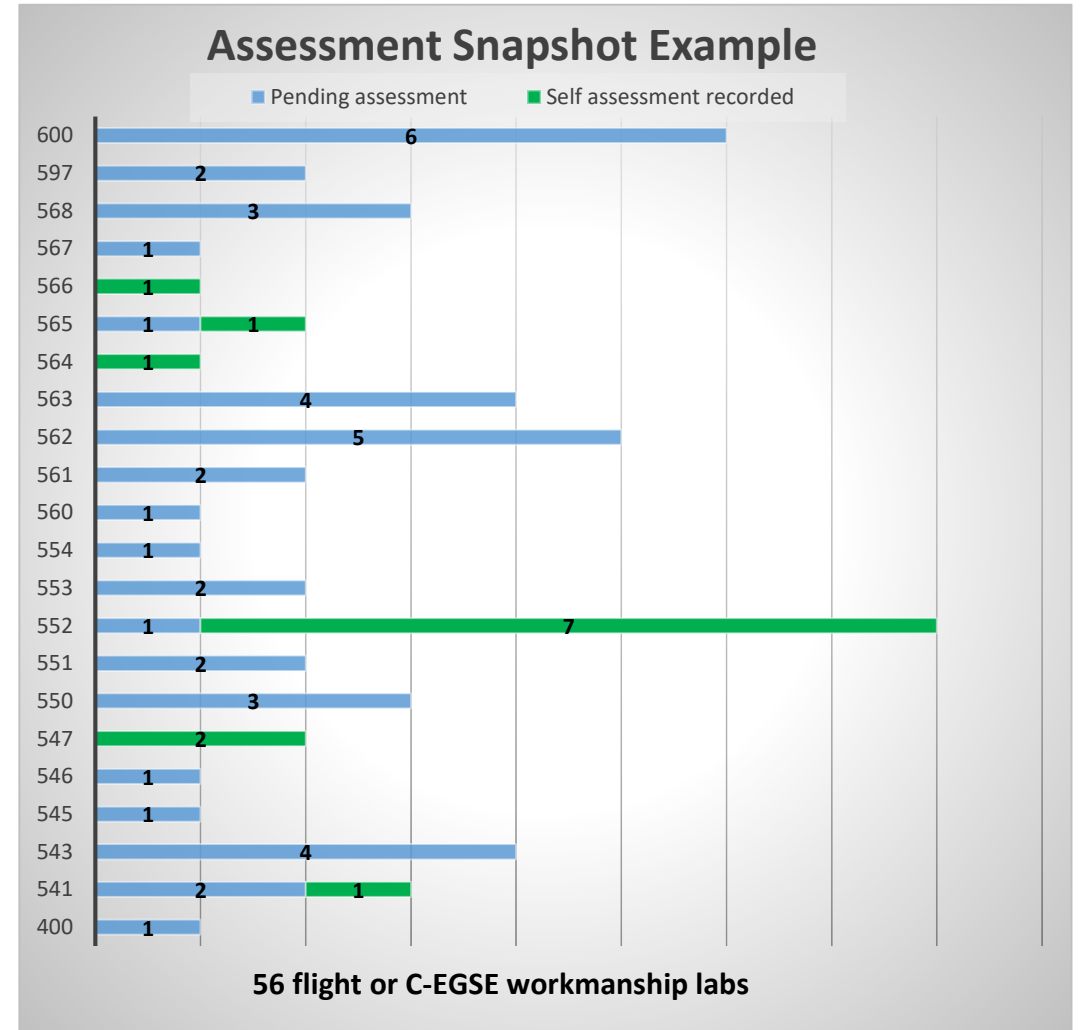
- Allow labs to self check against the workmanship requirement, as well as benchmark and improve the standards flow down. 
- Allow workmanship group and branch to effectively track lab performance regarding workmanship. 

LQMS Workmanship Module Objective

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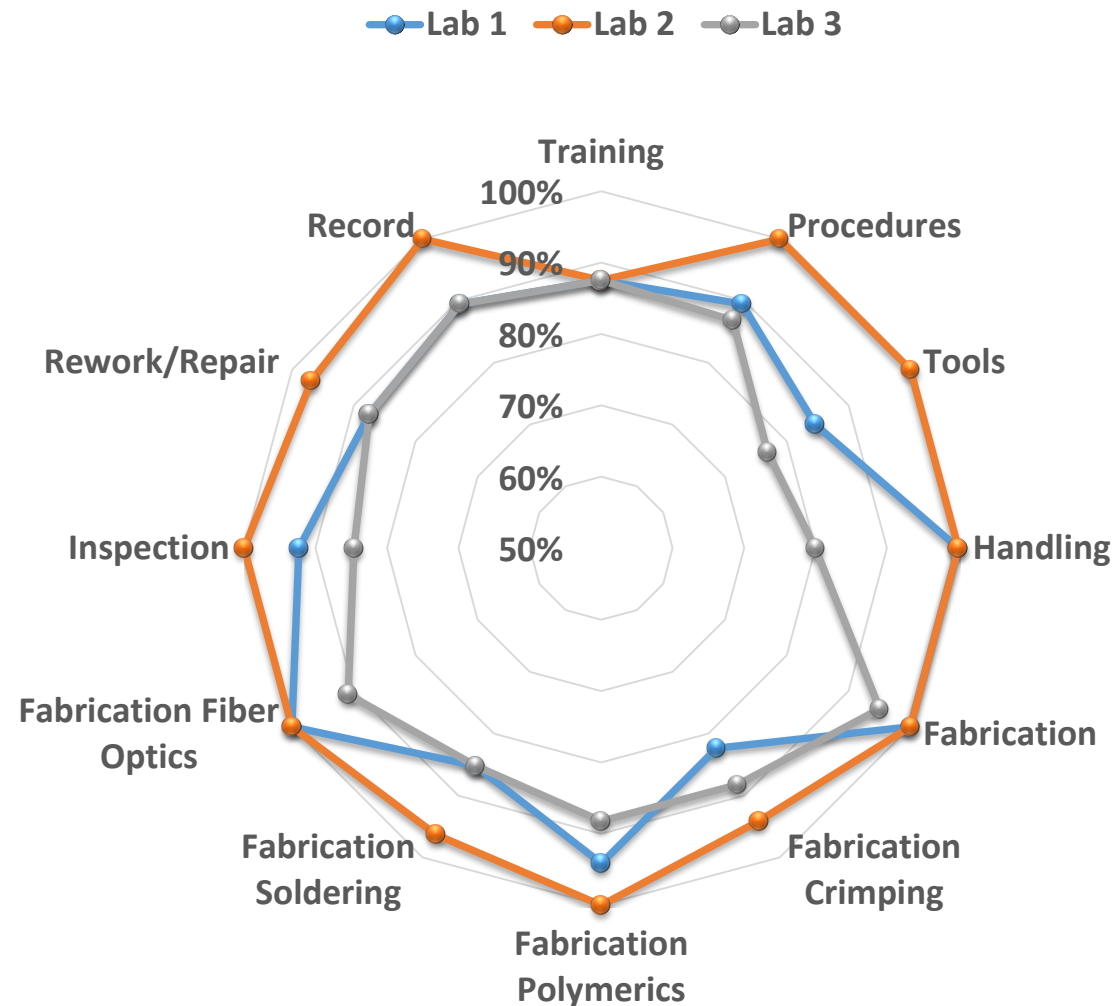
GSFC Flight & CGSE Lab Workmanship Availability

Workmanship Types	Lab Counts
Bonding	26
Conformal Coating	5
Crimp Connections	21
Electrical Test	28
Encapsulation/Potting	13
Fiber Optics/Cables	9
Hand Soldering	33
Machine Soldering	1
PWA (Printed Wiring Assemblies)	23
Repair (Does not result in 100% product conformity)	18
Rework (Results in 100% product conformity)	21
Soldering	26
Staking	24
Tinning	30
Connector Assembly	3
Splicing	2
Surface Mount NEW	22
Grand Total	305






Lateral Compare of 3 Labs on Hand Soldering Activity

Hand Soldering Gap Analysis Self Evaluation



- Some common standard, such as NASA-STD-8739.6 impacts all manufacturing activities, not limited to hand soldering.
- Lab 2 has the highest conformance to applicable standards.
- Lab 3 shows some improvement opportunities in nearly all key areas in the assembly process. Some detail look is needed, especially in tools.

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Future Work

- Collaborate with different branches to support the workmanship module deployment, guided by GPR-8730.9.
- Create a dashboard to show analysis on each lab and lateral comparison.
- Analyze lab self-evaluation data and product inspection data to help determine which labs need to be audited or improved.
- Work with the lab on the area needs to be improved.
- Analyze if any clause in existing standards needs to be revised.