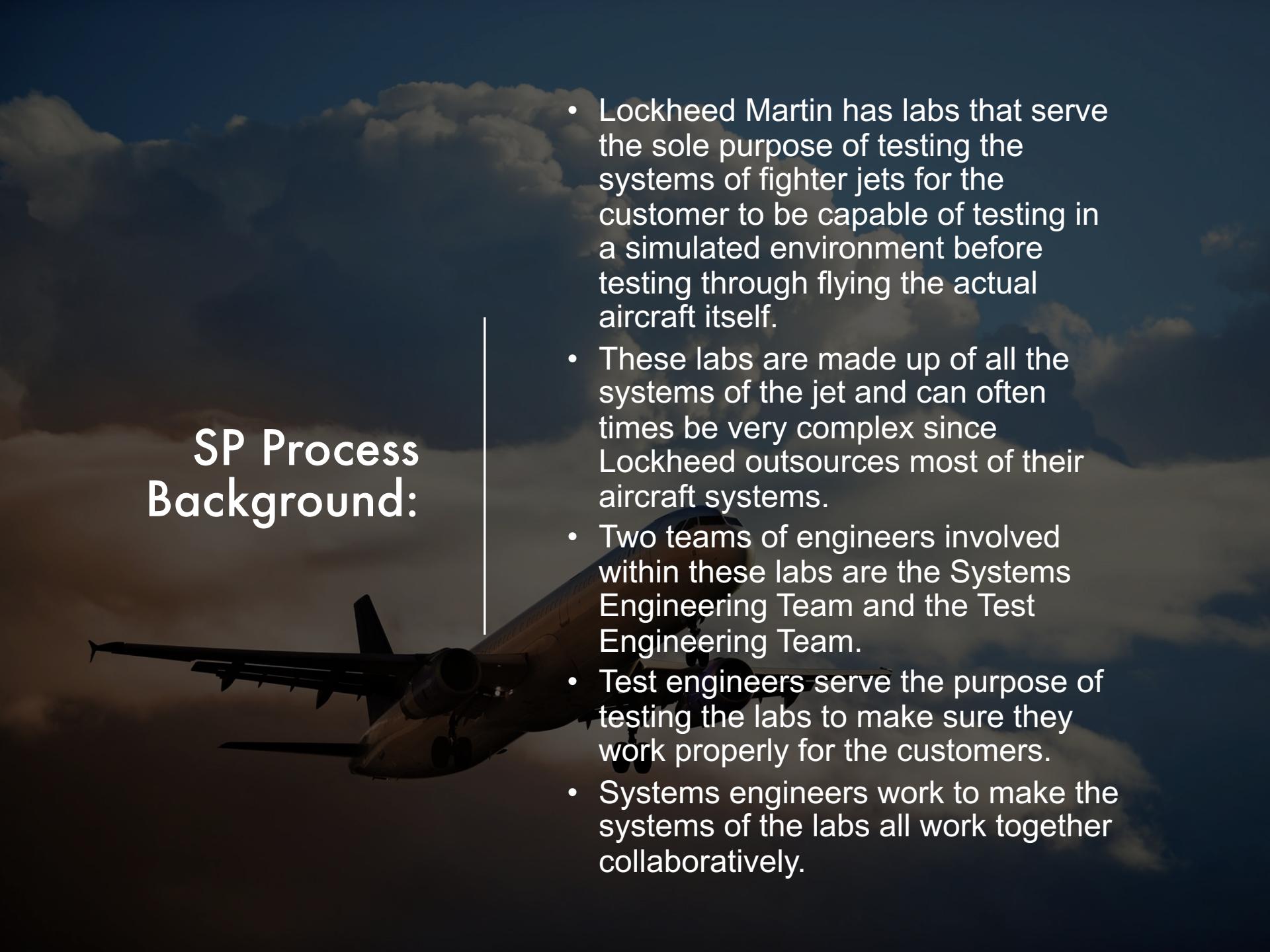


Implementation of Lean Methods in Special Problem Process at Lockheed Martin

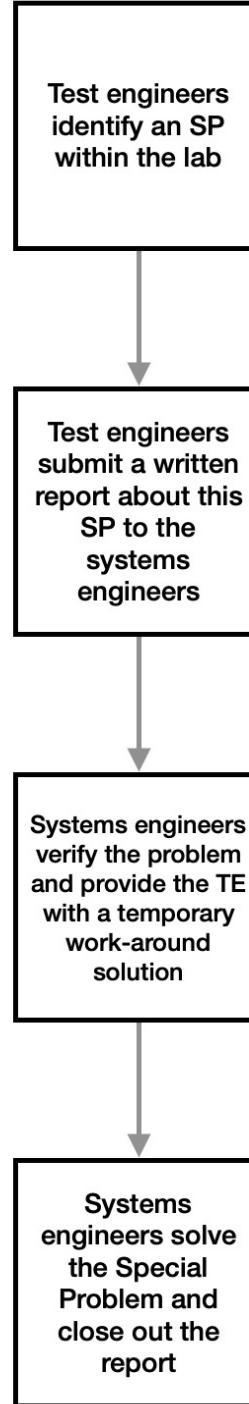


A fighter jet is shown from a low angle, flying towards the viewer through a dramatic, cloudy sky. The clouds are dark and heavy, with bright highlights where the sun is breaking through. The jet's silhouette is visible against the lighter parts of the sky.

SP Process Background:

- Lockheed Martin has labs that serve the sole purpose of testing the systems of fighter jets for the customer to be capable of testing in a simulated environment before testing through flying the actual aircraft itself.
- These labs are made up of all the systems of the jet and can often times be very complex since Lockheed outsources most of their aircraft systems.
- Two teams of engineers involved within these labs are the Systems Engineering Team and the Test Engineering Team.
- Test engineers serve the purpose of testing the labs to make sure they work properly for the customers.
- Systems engineers work to make the systems of the labs all work together collaboratively.

Special Problems (SP) Process Map



Chosen Organizational Method:

Principles of Lean Toyota Production System (TPS)

Best suited methodology and approach to solve problems at LM

Key principles used:

- Level out the workload (Heijunka)
- Standardizing Tasks
- Using visual controls/ Binders to nullify the hidden problems
- Develop people and teams
- Respect the extended network/ outside forces
- Go, and see (Genchi Genbutsu)
- Make decision slowly by consensus
- Become a learning organization through relentless reflection and continuous improvements (Hansei and Kaizen)

Involving people from all levels in the organization

Improved Productivity

Better quality of work

Data Before TPS Implementations

| | Special Problem Daily | | | |
|----------------|-----------------------|----------|--------------------------|------------------------------|
| | Week 1 Statistics | | | |
| | Opened | Closed | Repeated SP Reported < 1 | Non-Repeated SP Reported < 1 |
| 10/11/21 | 3 | 0 | 2 | 1 |
| 10/12/21 | 3 | 0 | 3 | 0 |
| 10/13/21 | 1 | 1 | 1 | 0 |
| 10/14/21 | 1 | 1 | 0 | 1 |
| Totals: | 8 | 2 | 6 | 2 |



We have data before implementing TPS and the number of SPs never seem to go down.



SPs closed weekly is significantly less than the amount open weekly. Average **SP Closed < 4**



There is a handful of SPs that are repeated SPs that have already been reported. Average **SP Repeated > 5**



Repeated SPs waste the time of the systems engineers are doing double the work on these repeats



There was no specific method to assigning out SP. Therefore, we looked how we could apply Principle 4

Principle 4: Level Out the Workload

- Communicated with the team lead to understand how SP are delegated to the engineers
- Worked with the team lead to assess reassigning SP to each engineer per level
- Analyzed all teammate strengths and weaknesses and assessed who would be able to close out a specific SP at a faster pace, based on their knowledge base and skillset



Principle 6: Standardize Tasks

Standardizing tasks helps keep all the engineers stay on the same page

A template created for an email sending every other morning for the test engineers to know what SP are already open

Creating a word document with step-by-step details of the SP process.

The checklist also keeps the experienced engineers in check to make sure no steps were missed.

With the number of steps, we have in the SP process, it is easy to miss a couple.

Principle 7: Visual Controls Part 1

Working inside a classified area brings up new challenges.

We came up with the idea of using colored index cards inside the lab

Each Index card has a small description of what SP are already open.

Each color is tied to a certain subsystem or specific part of the lab.

Each index card is then placed in front of where that subsystem is located. Providing the test engineer with a brief visual cue

Radar

Special Problems Reported

- Unidentifiable object not detected
- Radar disconnect from EW
- Distance not accurate to object
- Wrong version loaded

Sensors

Special Problems Reported

- Sensors turning off mid test
- Camera sensor gives error message
- Height sensor displays wrong data

Principle 7: Visual Controls Part 2

We used a binder in which we keep in the lab that goes into further detail regarding the SP already open and the specific work-around to be implemented for every SP.

Once they verify if the SP, they ran into is already open then they can refer to the binder the find the specific work around.

If the SP they found is not listed on the index card related to their specific system, then they know this particular SP has not been reported and they can create a report themselves.

Similar to the index cards, the binder is color coded by system and specifies the needed details in regard to all the existing SP.

| SP Reported | | | |
|----------------|---|--------|---|
| System | Title | Status | Work-Around |
| Radar | Unidentified object not detected. | Open | Initiate ACM mode in order to identify the unidentified object. |
| Radar | Radar disconnects from EW. | Open | Power cycle Radar. |
| Radar | Distance not accurate to object. | Open | RESIM simulation in order to get accurate distance. |
| Radar | Wrong version loaded. | Open | Power cycle Radar. |
| Sensors | Sensor turning off mid-test. | Open | Power cycle Sensors. |
| Sensors | Camera sensor gives error message when start-up. | Open | Hold the error message for three seconds then resync the sensors. |
| Sensors | Height sensor displays wrong data. | Open | RESIM simulation in order to get accurate height data. |
| Core Processor | Processor heats up after thirty minutes. | Open | Power off simulation and let it sit untouched for ten minutes |
| Core Processor | Processor runs slower than expected. | Open | Power cycle Core Processor. |
| Core Processor | Processor communication with Radar lost. | Open | RESIM simulation in order to boot communication again. |
| Software | Wrong message display on screen dealing with a certain version. | Open | Disconnect all participants from SDS and re-load simulation. |
| Software | Software GPS shows negative altitude. | Open | Initiate SDS to re-sync all participants. |

Principle 10: Develop Exceptional People & Teams

- Identified and classified the teams involved in overall process as Systems Engineer, Testing Engineers and supporting staff.
- Conveyed the importance of working in teams and how teams are interdependent.
- Made immediate changes in process after taking feedbacks from teams
- Considering the feedbacks and listening to teams created sense of respect and responsibility which resulted in improving overall process and achieving better results.



Principle 11:

Respect Your Network

- This principle encourages having respect for your partners and suppliers and treat them as an extension of your business.
- Partners - Test Engineers
- How?
 - Through work collaboration to improve communication
 - Support and challenge
 - Extending knowledge of SPs
- Tools?
 - SP binder
 - Index cards

Principle 12: Go and See

*Go and see for yourself to thoroughly understand the situation
(Genchi Genbutsu)*

At LM the report process was one of the major problems as we kept having repeated SPs reported.

- Problem of unclosed SPs
- Increase in lead-time for problem resolution

Solutions?

- Observation – Systems Engineer need to understand the process
- Leveling the workload
- Assigning difficult SPs to more experienced Systems Engineers

Tools?

- 5 Whys?

Principles 13 & 14:

Make decisions slowly by consensus & act rapidly

- Twice-a-week meetings
- Involved all stakeholders
- Established effective communication tools

Relentless improvement and reflection

- Twice-a-week meetings
- Feedback surveys
- Addressed concerns

Data After TPS Implemented:

| | Special Problem Daily | | | |
|----------------|-----------------------|----------|--------------------------|------------------------------|
| | Week 6 Statistics | | | |
| | Opened | Closed | Repeated SP Reported < 1 | Non-Repeated SP Reported < 1 |
| 11/15/21 | 2 | 2 | 0 | 2 |
| 11/16/21 | 3 | 2 | 1 | 2 |
| 11/17/21 | 2 | 2 | 0 | 2 |
| 11/18/21 | 1 | 3 | 0 | 1 |
| Totals: | 8 | 9 | 1 | 7 |

On the first week, we hit a new record of SPs closed in comparison to the previous three weeks. Average **SP Closed < 9**

We also hit a new low when it came to repeated SPs reported. Average **SP Repeated < 1**

After implementing Principle 4 by spreading the workload, had more balanced numbers of SPs per employee

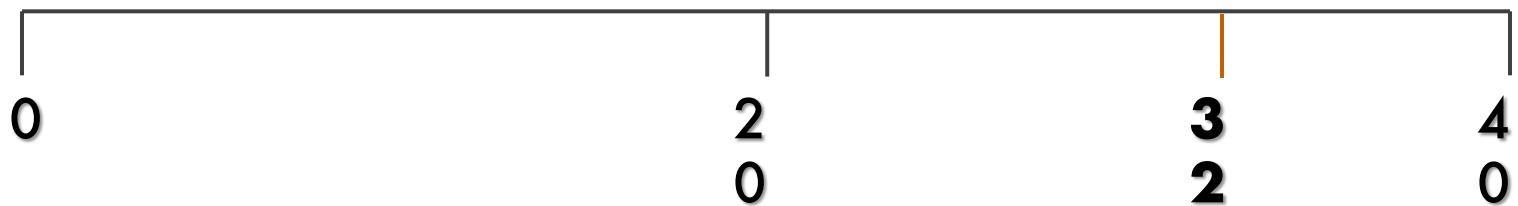
Feedback Survey Results

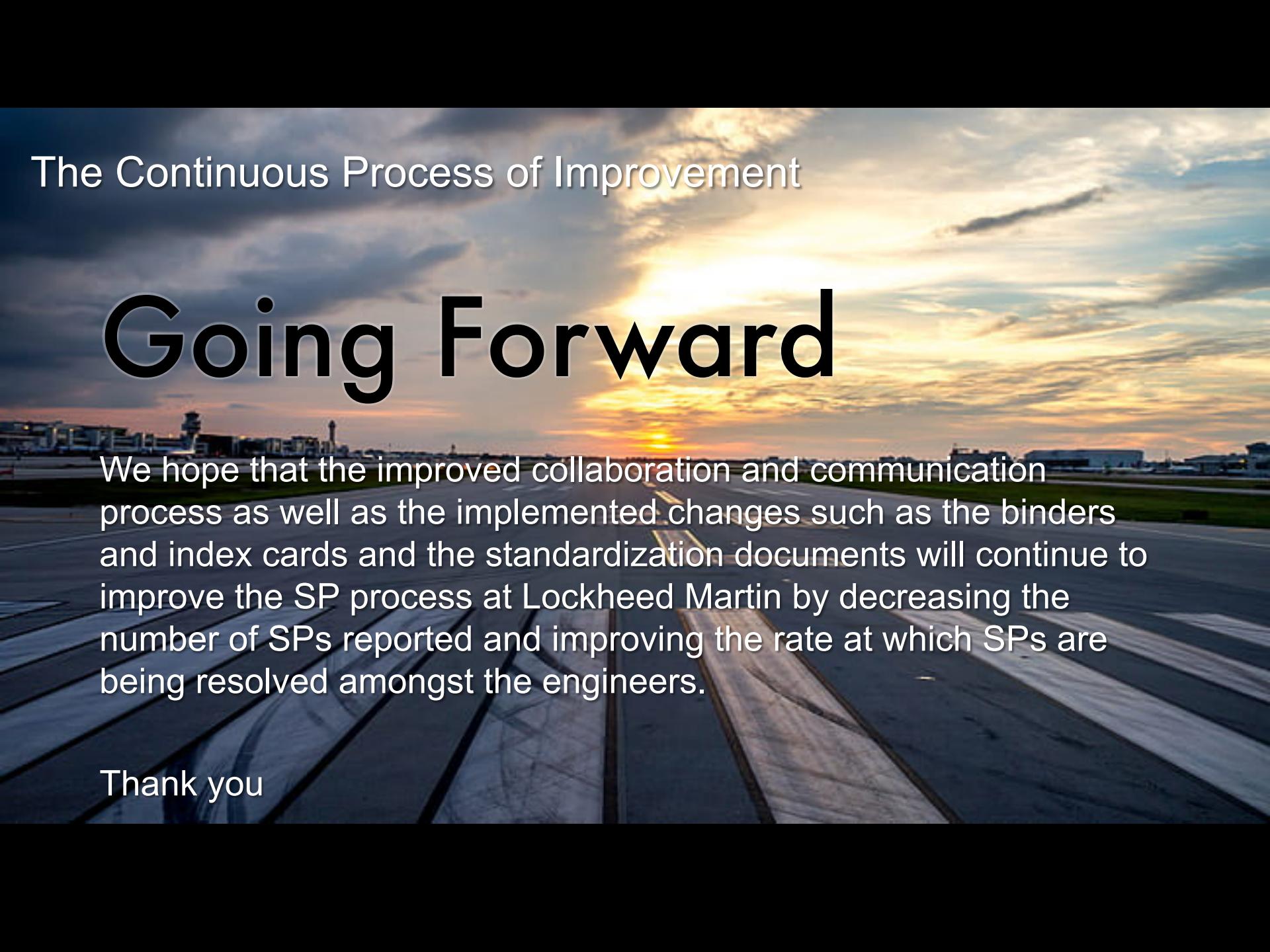
- Have you found the SP reporting system to be more convenient and effective?
- What has been the most helpful change for you?
- Have you noticed a change in the number of newly reported SPs?
- Have you felt that the SP resolution process has gotten faster?
- Was communication effective in introducing and implementing the changes to the SP reporting system?

Total Score Range:

Min.

Max.





The Continuous Process of Improvement

Going Forward

We hope that the improved collaboration and communication process as well as the implemented changes such as the binders and index cards and the standardization documents will continue to improve the SP process at Lockheed Martin by decreasing the number of SPs reported and improving the rate at which SPs are being resolved amongst the engineers.

Thank you