Flying the F-16 into the Future with SAFe®
Evolving the Falcon Factory

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F-16 History and Background
F-16 History and Legacy

• F-16 Fighting Falcon – the world’s most successful, combat-proven multirole fighter

• Over 4,600 aircraft built since production was approved in 1976

• Approximately 3,000 operational F-16s in service today in 25 countries

• F-16 Block 70/72
  – Newest and most advanced F-16 production configuration
  – Combining numerous capability and structural upgrades

• New production F-16 can operate to 2070 and beyond with structural and capability upgrades
The Business Environment for Change

• In 2013 fierce competition for 4th Gen fighters

• Affordability while adding new capabilities was key

• F-16 production line in danger of ending

• Leadership realized – What Got Us Here, Won’t Get Us to the Next Level

• Started experimenting with some Scrum teams for Software in 2013/2014
Our Initial SAFe Implementation
The Beginnings of SAFe

In 2015
VP of PD said “Let There be Scaled Agile for All and it Shall be Governed by 5”

How did we get here?

- Started Scaled Agile Aug’15
- First PI Planning with 1 Program Jan’16
- Added Programs Jan’17
- Plateau
- Rapid Spontaneous Progress

Today?
F-16 SAFe Value Stream

- The F-16 Product Development Value Stream comprises of 6 Agile Release Trains
- The F-16 Value Stream has about 200 people mostly at the Aeronautics headquarters in Fort Worth
SAFe for the F-16
Our SAFe Journey – A Retrospective
What We Did Right Starting Out

• Trained our Change Agents as SPCs
• Our SPCs provided comprehensive training for the entire Value Stream
  – Leading SAFe® for Leadership
  – ART launches with SAFe® For Teams
• Synchronized the entire F-16 Value Stream
  – Cadence of 13 week Program Increments
  – Six 2 week iterations + 1 week for planning
• VersionOne as our Agile Project Management tool
• Agile team rooms with pairing stations for all our Agile Software teams
• Established pair programming as the norm
Sprint Reviews and Demos

• Wildly successful Sprint Reviews and Demos
• Heartbeat of our Value Stream
• Lot of participation from across the Value Stream – Other Agile teams, System Design, System Test, PVI, Pilots, Leadership all the way up to VPs
• Lot of feedback received and acted upon in subsequent iterations
• Contributes immensely to increased engagement, motivation and knowledge transfer especially for early career employees
Our Biggest Challenges Starting Out

• Changing the way we execute without impacting current programs – DON’T BREAK F-16!
• CULTURE CHANGE!
• Cross-functional teams or even cross-functional ARTs!
• Getting buy-in from non-software teams
• Funding continuous improvement activities
• Limited availability of test labs and resources
• Prioritizing our work across 20+ active programs
• Limiting Work in Progress
• Measuring Earned Value in an Agile environment
• Lack of Foreign Military Sales customer interaction
• Our performance review process
Could We Get Waterfall Out of Our Process?
Agile Development – 101

SAFe Agile Methodology

• Breaks Large Capabilities into Smaller Features
• Iterative Cycle to Develop Requirements, Design, Software and Integration Testing Smaller Features
• Early Integration Testing Reduces Risk Incrementally and Delivers Value Sooner

* - Includes integration of all airborne software in a simulated environment. Also with ground software and hardware when available. System Test develops their tests in this phase.
+ - This is when we go to the System Test lab.
How Does That Break Down Into PIs?

Program Increment (PI) X

PI N
- Detailed Design and SW Code Phase III
- Requirements & Design Ph III
- System Integration & Test

PI N+1
- Detailed Design and SW Code Phase III
- Requirements & Design Ph III
- System Integration & Test

PI N+2
- Detailed Design and SW Code Phase III
- Requirements & Design Ph III
- System Integration & Test

Minimum Viable Product

Transition Flight Test
Let’s Waterfall the Capabilities into PIs!

It takes us 9 months to deliver any value even to Flight Test! This is due to the hand offs between the functional ARTs at PI boundaries.
Step in the Right Direction

• 9 months to deliver a capability to Flight Test still a big improvement on our normal delivery and feedback cycle of 3-4 years for an average size program

• The problem is that we stayed on Step 1 for 3 years!

• In retrospect, maybe baby steps wasn’t such a good idea

• At this point, we have several successful cross-functional product centric teams

• Still no general purpose cross-functional teams due to Domain specific knowledge needed
Constraints of Our Unique Environment
The Case Against Cross-Functional Teams

• The biggest criticism of cross-functional teams in our environment is that we would
  – Lose design and component integrity
  – Lose sight of the big picture
  – Lose domain knowledge

• The Design Guild and Component teams need to be co-located and work together constantly
to be able to mentor early career employees into becoming Subject Matter Experts

• Had success with experienced System Design Engineers as Product Owners of Software
teams, but don’t have enough Design SMEs to be able to do that
Our Solution – Epic Teams

• Lack of cross-functional teams is overcome by Epic teams

• For each major Epic during initial development, we form a team with Epic leads from each ART – System Design, Core Software, Mission Planning, Vehicle Systems, Lab and Tech Services, and System Test

• Epic teams meet during PI Planning in an Epic Bullpen
  – Plan their work for the PI
  – Coordinate all their dependencies

• Epic teams continue to meet weekly during the PI in an Epic Scrum
  – make any adjustments needed to their plan
  – elevate any impediments that they need help with
Prioritizing Work Across All Programs

• In any given PI, we generally have the same teams supporting upwards of 20 programs

• The challenge is to set relative priorities for work across all the Programs

• We compute Business Value for each Feature using our own custom WSJF calculation in a spreadsheet
  – Validated and blessed by Program Management each PI
  – Primary input that the teams use to plan their work
  – The key to our success since we are able to visualize all our work in one place
Our Biggest Challenges Report Card

✓ Changing the way we execute without impacting current programs – DON’T BREAK F-16!
✓ CULTURE CHANGE!
✓ Cross-functional teams or even cross-functional ARTs!
✓ Getting buy-in from non-software teams
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✓ Limited availability of test labs and resources
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✓ Our performance review process
What We Would Do Differently

• Start out with cross-functional product-centric teams
• NO functional ARTs!
• Focus on value delivery
• Have our major suppliers participate in PI Planning
• Modify our contracts with suppliers to require intermediate deliveries
• Bring all F-16 functions into our Value Stream
• Define a strategic Roadmap and Vision for the Value Stream
• Practice decentralized decision making and empower the teams
• Celebrate our successes as a team!
How Has SAFe Helped Us Improve?
Our SAFe Report Card

• What’s Gone Well
  – Now looking at the entire body of work across ALL programs
  – Good at planning and executing 13 weeks of work ~95% success rate
  – Successful at meeting program milestones
  – Greatly improved collaboration and cross-training
  – Ability to attract, energize and retain new talent

• Challenges Still Ahead
  – Defects detected sooner, but no significant decrease
  – Affordability challenges remain
  – Portfolio management lacking
  – Not very cross-functional
How Do We Measure Our Success?

• We have a lot of metrics – maybe too many!

• Are we measuring the right things?

• Some of the better ones
  – Percentage of features completed in a PI as a measure of our predictability
  – Feature out metrics trends along with the underlying reason so we can troubleshoot our problem areas
How Do We Measure Our Success?

• Better measure is the feedback we get from our customers which has been increasingly positive
• Best measure of our success is all the new business we have generated!
• Lockheed has started a new F-16 production facility in Greenville, South Carolina

“We see a bright future as we continue to look at global security and the growth of the F-16 around the world. We understand that this aircraft remains a critical tool for military cooperation with many of our allies and as we know it has helped maintain peace and stability in some of the most difficult regions of the world. I still marvel at what this aircraft has done but even more so at what it will do in the future: protect the United States armed forces as well as the men and women in uniform of trusted allies.”
– Michele Evans

“We were able to quickly respond to flight test issues and roll it into the next tape. I think Tape X was actually a good example of how to use agile. The feedback loop was responsive and we actually made much more headway in Tape X than I feel we did in any other tape.”
– F-16 Flight Test Pilot
Culture Change

• Culture change beginning to happen
• Agility comes from the people doing the work
• Employees are our most valuable resource
• Teams measuring their Happiness Metric
• Leadership beginning to embody Servant Leadership
• Daily Scrums go all the way up to the Executive Action Team to remove impediments every day
• Very successful Culture of Accountability initiative underway
• Seeking and acting upon feedback has become the norm
• Retrospectives are driving improvements every day
**Culture Change Feedback from the F-16 Team**

“Cross-training resulting from the close team collaboration is a big motivator for early career employees.”

“I don’t want to ever put my headphones on anymore because I may miss a learning opportunity via discussions in my Agile team room.”

“Teamwork divides the task and multiplies the success.”

“Benefits of on-going design discussions involving whole team, i.e. true collaboration rather than just a review, can not be overstated.”

“I feel the Just In Case team is a great example of building an engaged, high performing team and shattering silos. The team is comprised mostly of early career employees focused on innovating and automating our simulated testing environment.”

“We felt the makeup of our Agile team engages everyone, and performs at a high level because it is truly cross-functional and above all, shares a common vision. True collaboration while minimizing the constraints helps us achieve our goals and produce phenomenal results.”
Where Do We Go From Here
Our Capability “Factory” – Current and Future

• Today Our Factory
  – Reliably Produces Work in 13 Week Increments
  – Produces for All F-16 Programs
  – Meets Our Program Commitments

• But Our Factory
  – Isn’t Operating Any More Efficiently
  – Has Not Improved the Quality of Our Products
  – Production Capacity is Limited and May Not Meet the Future Needs

• Our Future Factory Delivers Value
  – Speed to Delivery
  – Roadmap / Vision
  – Joyous Workforce
  – Customer Satisfaction

• Being Successful at Delivering This Value Will Achieve:
  – Affordability
    • Focused Effective Cross-Functional Teams
    • Increased Efficiencies Through Automation
    • Roadmap / Vision to Pursue Affordability
  – Effectiveness
    • Deliver Valuable Products to Our Users Often
    • Meets / Exceeds Their Needs – Combat Ready
Agile Journey – Path Forward and Up

• Transformation Workshop in January to evaluate our progress and decide on a path forward

• Identified several initiatives that will help us move forward with agility that we are actively working
  – Implement Lean Portfolio Management
  – Generate an F-16 Roadmap that aligns our operations with our strategy
  – Implement a Continuous Integration/Continuous Delivery DEVOPS Pipeline
  – Utilize automated daily builds for System Test
  – Implement a Continuous Planning model where we deliver value every 2 to 3 months
  – Leverage automated testing in a simulated environment to off-load our system test labs
In Summary
Summary

• We have made significant advances since we started our F-16 SAFe journey in 2015
• The challenges have been numerous but we have overcome a lot
• Can’t stop at good enough though!
• Lockheed Martin is in the midst of an Agile and DevSecOps revolution
• Shifting our Agile Transformation into a higher gear leveraging SAFe Principles to get F-16 to the next level of affordability and effectiveness