Agile: From Software to Mission System

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MOS & GDS

- Mission Operations System (MOS)
  - People, Team(s), Products, Processes

- Ground Data System (GDS)
  - Software, hardware, facilities

- Mission System = MOS + GDS
Waterfall to Agile for Software

- We began the journey to agile design and development with software
In the Beginning (Software)

- Delivery every 6 months
- The 6 month delivery cycle created too much time for customer expectations to diverge from what we were building
  - Customers needed to see the product more frequently
- Progress difficult to measure
- Long and formal design specs
  - Too much time talking, not enough time doing

Subsystem1  Subsystem2  Subsystem3  Subsystem4

6 Months  6 Months  6 Months  6 Months
Time for Changes

• Fix the problems iteratively, without a broad proclamation of methodology, i.e. “we are going to be agile” or “we are going to be “lean”
Agile Sprint

• Agile Tailored for our team

• Deliver to customer every 3 weeks

• Nightly build

• Release every 3 months

• Emphasis on constant interaction and use

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Key attributes of our tailored agile process for software

- The measure of progress is working code
- Rank issues, always focus on the highest priorities
- Demonstrations, not presentations
- Customer interaction over extensive requirements meetings (some meetings still required)
- Visible progress - nightly or continuous builds
- Ship on time, features that are not ready go into the next sprint or release
- Verification using both QA and customer use in context
Agile for MOS

- NASA “standard” process definition is waterfall
  - It’s proven, it works
- Why change a proven process?
  - Potential gains in effectiveness, efficiency
  - Team engagement, culture of doing
  - Cost reductions
Tailored Agile

• For MOS
  • Simulation for Design
  • Assessment of capability through demonstration
  • Early and frequent builds and tests
  • Risk reduction through targeted experiments
  • Maturation of tools and processes through frequent use

• For Software
  • The measure of progress is working code
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Agile Applied: Resource Prospector MOS

- The Mission
  - Lunar Rover
  - Search for volatiles at a polar region
  - Launch 2021?
- For now, using agile methods on
  - New design
  - Where it increases effectiveness
Resource Prospector Ops

- Lunar surface operations, round trip light time + comm latency = 6 - 30 seconds
- Short duration surface mission 5 - 7 days
- Fully distributed operations, including core teams, everyone operates from home institution
- Lighting, power constraints
- Operation in shadowed regions, no light for a billion years, rover is solar powered
- Continuous comm requirement
- Class D Mission
Agile Applied on RP

- 2015 Distributed Operations Test (DOT)
- Traditional design approach
  - Write a document (s)
  - Present, discuss, review
  - Train the team and test the design in simulations, late in the mission development flow
- Agile approach
  - Write a simple document
  - Conduct a series of simulations, for design, not training (though the team was trained in processes and procedures), early in the flow
  - Test and iteratively improve the concept of operations by trying it
Distributed Operations Test

- Simulation for Design
- Assessment of capability through demonstration
- Maturation of tools and processes through use
- Early and frequent builds and tests
• Test/Validate
  • Distributed decision making
  • Distributed command and data flow
  • Integrated situational awareness tools/integration into flight and ground system processes
  • Integrated ground/flight system test procedures
  • Team composition and roles
  • Waypoint driving

• What we did
  • Multiple simulations culminating in the Distributed Operations Test (DOT)
    • Three day DOT
    • Iterative refinement to procedures and processes
    • Mission operations teams using prototype tools
    • Distributed teams
      • Mission Team, science, rover drivers in California, rover hardware, rover systems in Texas, payload in Florida, drill in Southern California
What was Agile about DOT?

- Simulation for Design
- Assessment of capability through demonstration
- Early and frequent builds and tests
- Risk reduction through targeted experiments
- Maturation of tools and processes through frequent use

- How we used the information
- GDS architecture improvements for robustness and reliability
- Updates to team composition and roles
- Updated requirements
- Update software designs
Agile Example: Procedures

• “Say it then sim it”

• We wrote procedures, conducted a brief review then tried them

• Develop procedures by trying them out

• User paper simulations to fill in what’s not there yet
Procedures Sim/Walk Through

- Procedure Sim
- Google Hangouts to connect NASA centers
- Mix of paper and prototype software
An Agile MOS requires an Agile GDS

- DevOps
  - Medium to high fidelity simulations require parts of the GDS
  - Updating GDS across multiple locations
  - Prototype system for near-continuous integration, testing and deployment
    - Kickstart, Ansible, Docker
  - Rapid deployments, containers
Challenges

- Are low fidelity simulations beneficial?
- High fidelity simulations may be complex and labor intensive to set up
  - Focus on flight forward work, don’t put extensive effort into simulation work that is not flight forward
- Difficult to sim frequently
Conclusions

• Ideal - fly early and often

• If we can’t fly as often as we want

  • Focus on doing

  • Say it, then sim it

• After an issue is articulated in a meeting, instead of ongoing meetings, say it, then sim it
Conclusion

- Team culture can be shifted from a culture of meetings and documents to a culture of doing