Agile Project Management for Physics Innovation

Wouter Deconinck
William & Mary

This Activity: Experiencing an Agile Project

Learning objectives of this activity

- Explain what agile management is and how it differs from waterfall
- Understand how agile management can be used in physics student projects
- Explore a 3-4 hour learning activity for you to introduce agile management
- Experience empowerment that students feel when using agile management

This Activity: Experiencing an Agile Project

Introduction (12 min)

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“Chair flying” and retrospective (12 min)

What skills are physicists missing

- Ability to **design** a system, component or process **to meet a specific need**
- Ability to function on multi-disciplinary **teams**
- Ability to recognize value of diverse relationships (customers, supervisors)
- Leadership skills
- Familiarity with basic business concepts (i.e. cost-benefit analysis, funding sources, IP, **project management**)
- Communication skills (oral and written), how to tailor message to audience
- Real-world **experience in companies** before graduation
- Awareness of career paths outside of academia

Sources: ABET Survey of Applied and Engineering Physics Graduates, Kettering University; APS Workshop on National Issues in Industrial Physics, Industrial Physics Lunches. Emphasis mine.

W&M’s Initiatives in Team-Based Design Courses

- Development of **scalable** capstone experiences for increasing enrollment
- Context at W&M:
  - Liberal-arts, no eng/med, subset of depts have graduate programs
  - Physics department is largest STEM graduate research department
  - Regional partners: NASA Langley, Jefferson Lab, Virginia Institute of Marine Science
- 2016: Robo-Ops: Design and development of tele-robotic rover
  - Semester-long class of 15 students (50% physics majors), 3 sub-teams
  - Single project, agile project management (with many lessons learned)
  - Co-supervisor: David North, flight engineer at NASA Langley
  - Outcome: third place on competition at Johnson Space Center
- 2017: Agile Innovation: NASA's Lab77 technology incubator
  - Semester-long class of 15 students (30% physics, 25% compsci, business, neuro, bio, etc)
  - Problem finding, ideation, prototyping into minimum viable product
  - Outcomes: mental health startup and novel drone-borne bacterial sampling system

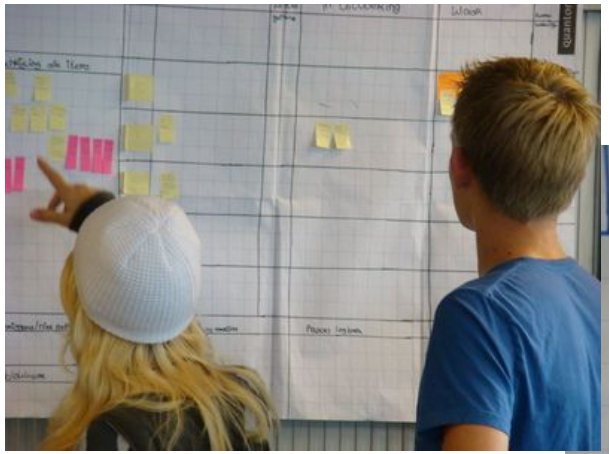
W&M's Initiatives in Team-Based Design Courses

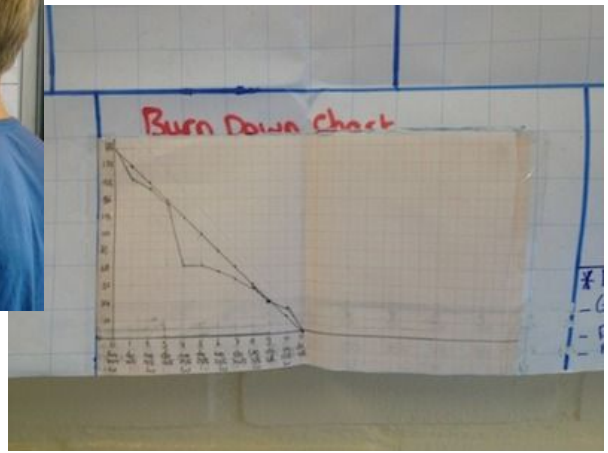
- 2017-2019: Team-based senior research & development projects
  - Year-long senior research projects with 3 graduating physics majors
  - Project inside area of expertise of (and funded by) adviser
  - Outcomes: neutrino physics experiment camera setup, in-vivo fMRI sample holders, cane stabilization for Parkinson's patients
  - Putting a student team on a regular senior research project doesn't work straight away
- 2018-2019: Agile project management senior design course
  - Year-long senior project with 5 graduating physics majors
  - Project entirely outside area of expertise of adviser
  - Co-supervisors: mission engineer at NASA Langley, agile consultant
  - Outcome: MVP of Ejectable Data Recorder (EDR) for NASA mission
  - http://teamagileimpact.com, https://www.youtube.com/watch?v=vWxh9tVRk-E

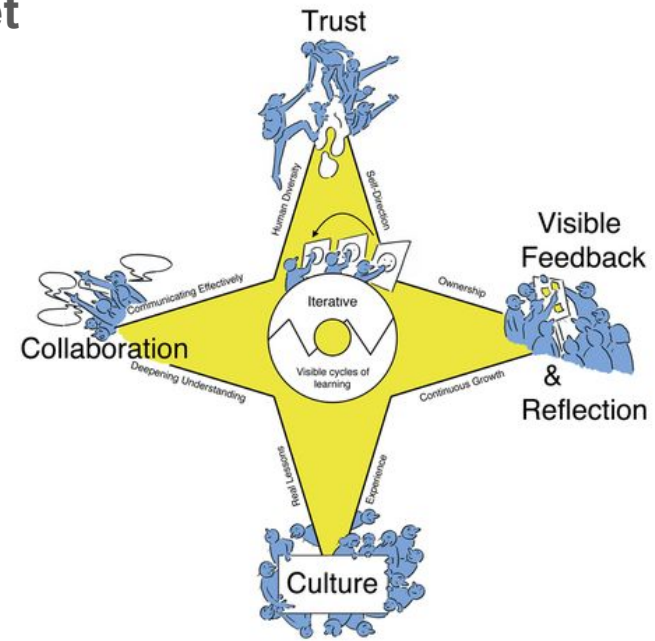
W&M’s Initiatives in Team-Based Design Courses

Related Initiatives in Team-Based Course Design

- Related movements (K-12 to higher ed): *EduScrum*, *Agile in Education*
  - Iterative, reflective, collaborative, and learning based on trust instead of hierarchy
- **Building a growth mindset on top of a skillset**







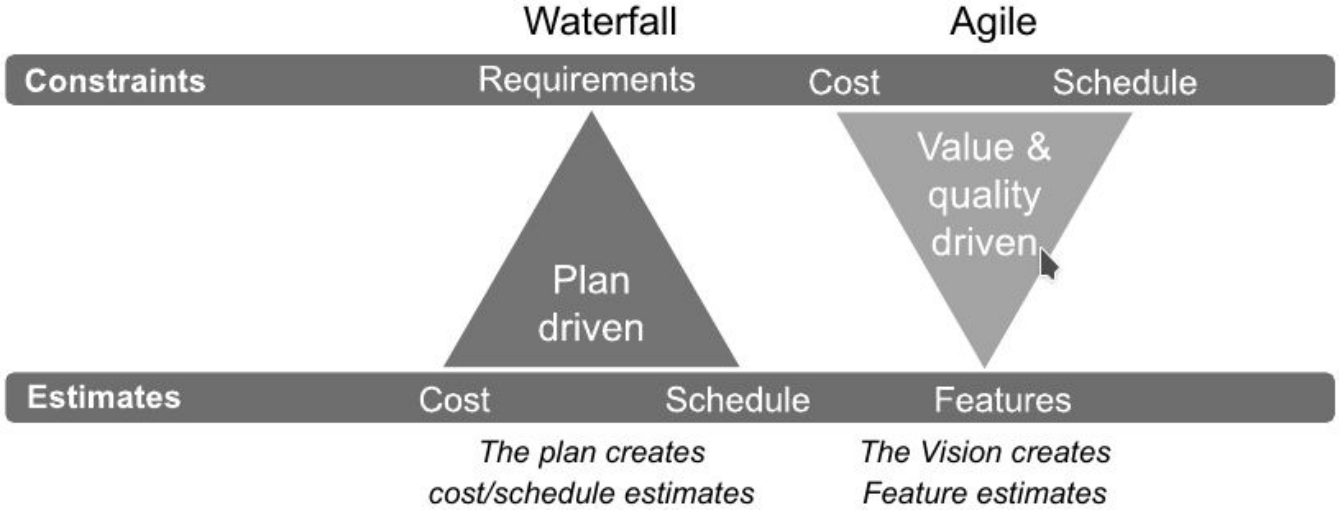
Project Management: Waterfall vs. Agile

Waterfall

- DOE/DOD/NASA: WBSes, gantt charts
- Large projects, extensive planning
- Reqts drive cost and schedule

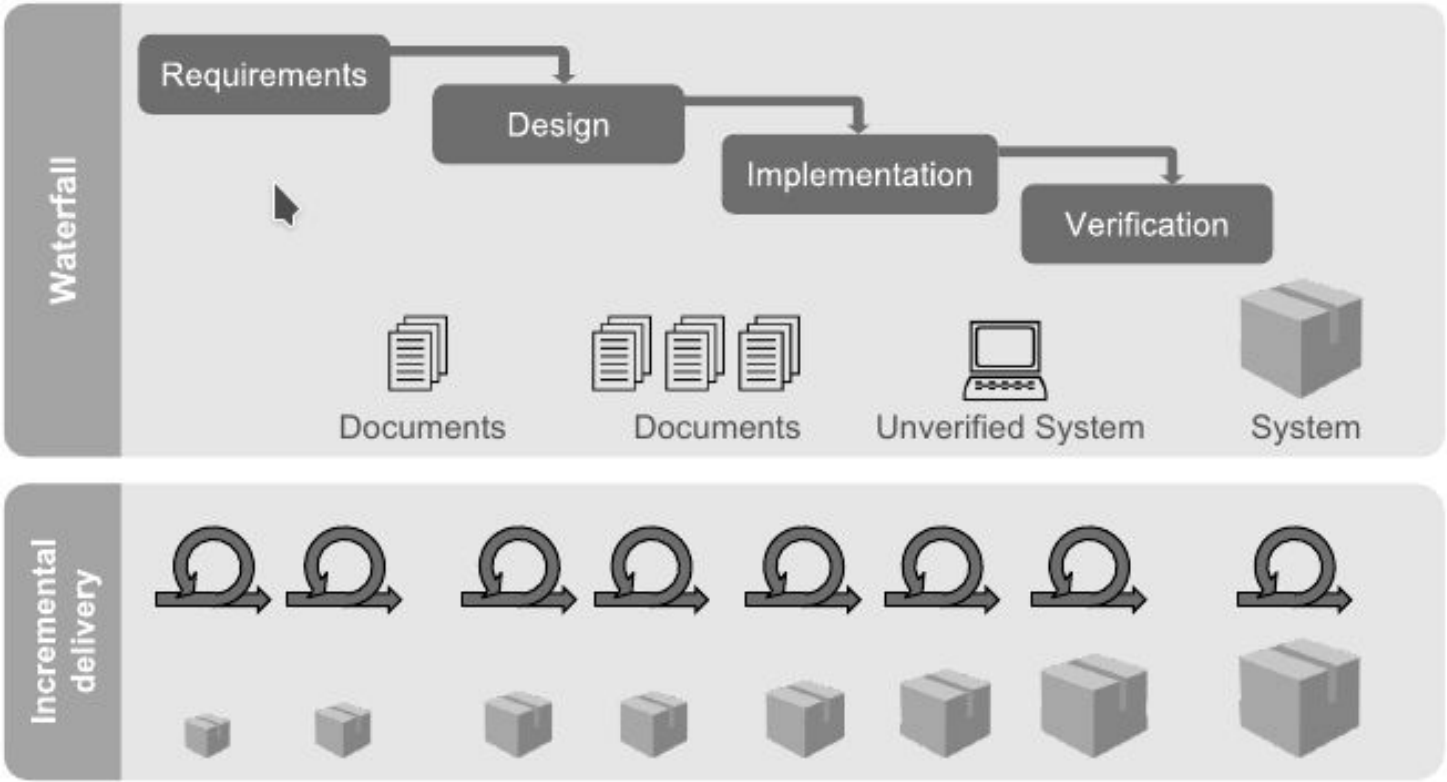
Agile

- Start-ups and collections of small teams, changing reqts
- Current cost and schedule drive features/priority iteratively



Source: Scaled Agile Inc.

Project Management: Waterfall vs. Agile



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Project Management: Waterfall vs. Agile

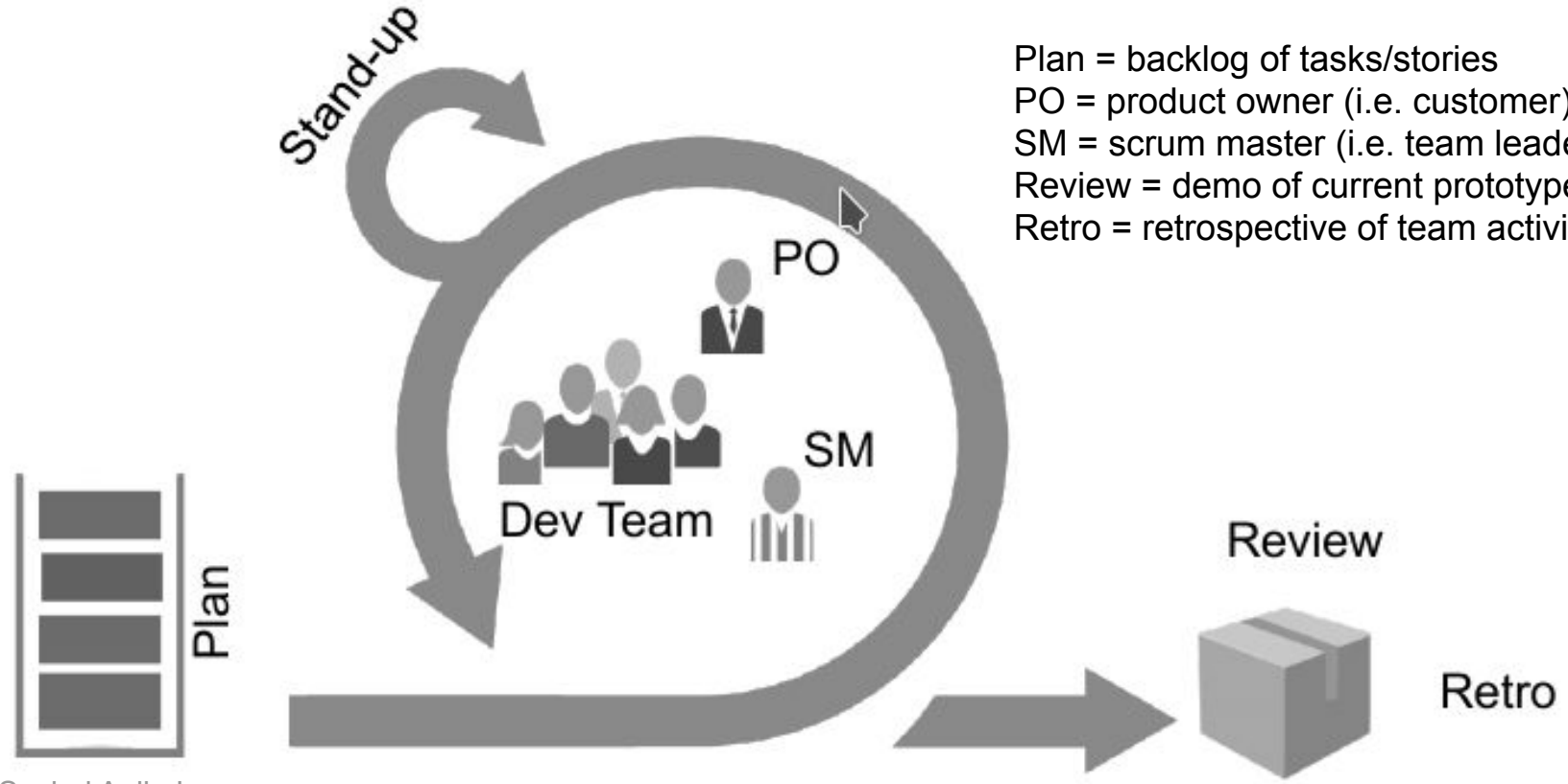
Agile Manifesto (2001, http://agilemanifesto.org/)

- **Individuals and interactions** over processes and tools
- **Working products** over comprehensive documentation
- **Customer collaboration** over contract negotiation
- **Responding to change** over following a plan

That is, while there is value in the items on the right, we value the items on the left more.

Related initiatives: User-Centered Design, Lean, Toyota Production System, DevOps,... Even novels have been written about these approaches:
The Goal (Eliyahu Goldratt), *The Phoenix Project* (Gene Kim et al.)

Project Management: Waterfall vs. Agile



Plan = backlog of tasks/stories
PO = product owner (i.e. customer)
SM = scrum master (i.e. team leader)
Review = demo of current prototype
Retro = retrospective of team activity

Source: Scaled Agile Inc.

Core components of agile frameworks

- Easy visualization of work in progress
  - Reduce work in process, “batch size of one” in manufacturing, avoid multi-tasking
  - Make status of work visible, kanban boards (ready, doing, done)
- Frequent feedback on project progress and people performance
  - Daily or near-daily short stand-up meetings
  - Iterative sprints with customer
  - Retrospections on team performance
- Continuous improvement
  - Learn by doing, learn by failing
  - Encourage experimentation
  - Affordable loss principle instead of focusing on possible gain

These are desirable aspects in education as well as project management.

Agile Senior Design Capstone: Organization

- Assigned roles: SM, scribe, archivist, ambassador, devil's advocate
- Scrum, but students are part-time researchers so slower paced
- Stand-up meeting (15 mins) led by SM every 1-2 days, at university
- Sprint demonstration (1 hour) with PO every 1-3 weeks, on location
- Followed by retrospective (30 mins) and next sprint planning (1 hour)
- Physical support tools: shared office/workspace, whiteboards, post-its
- Online support tools: Trello (kanban board), Slack (virtual space), Zoom

Agile Senior Design Capstone: Implementation

From Goals to Tasks

- Start with overall goals: “At the next demo, we would like to see functionality X” (largely driven by PO)
- Develop list of tasks that can be completed by single person in a single setting (by entire team)
- Three C's: Card, Conversation, Confirmation (or Criteria)

Tasks based on Card Template

- “As a <role>, I want <activity> so that <value>”
  - “As a NASA LOFTID mission planner, I want to recover the payload after reentry so that stored data can be analyzed.”
- All cards assigned a Fibonacci score: 1, 2, 3, 5, 8 (a.u., equates roughly to hours), longer must be split up in parts

Agile Senior Design Capstone: Implementation

Participation of External Partners

- Strong motivator for students (even if not with name recognition and job prospects of NASA)

Consultants and Mentorship

- Benefited from industry partner (Adam Beck, Berkana Enterprise Consulting)
  - Agile coach, called in during half of the stand-ups, attended nearly all demos and team retrospectives (often virtually)
  - Provided optional parallel agile scrum master training for the teams (one current team member interviewed for agile project manager jobs based on this experience)
  - Opportunities for mentorship exist at many companies where you are

Today’s activity: Experiencing an agile project

Starting point

- Ambitious but vague design project somewhat outside of area of expertise (similar to how a student feels about a large senior design project)

Agile condensed

- Sped up agile project with 2 sprints of 3 ‘working days’ of 10 minutes each
- Maintain all ceremonies: sprint planning, stand-up, demo, retrospective

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Let’s get started!

- Split in teams of 5-10 people
- Determine a scrum master (i.e. master of ceremonies, who will keep stand-ups on topic)
- Explore your materials

At first, expect to feel:

- overwhelmed
- unfamiliar with
- frustrated at first

Agile management will help with this:

- by providing a structure to follow
- by having frequent points for adjustment
- by putting your team in charge of the progress in the project