Teaching Agile Management

The Fast-Paced, Iterative Project Management Style Used from Amazon to NASA

Welcome – we'll get started soon

- Dial in or use your computer's microphone and speakers.
- Submit questions via the Questions panel on the right.
- This session is being recorded.
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The Fast-Paced, Iterative Project Management Style Used From Amazon to NASA

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APS Webinar, August 21, 2019

WILLIAM & MARY
CHARTERED 1693

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Outline

Why teach students project management techniques?

- Where do physicists find permanent employment?
- What skills are physicists missing?

What is agile project management?

- How does agile management differ from other approaches?
- What are the mechanics of agile project management?

How can you teach agile management?

- Example of one tutorial activity to start team-based projects.
- Example of how to run an entire team-based capstone course.

Objectives

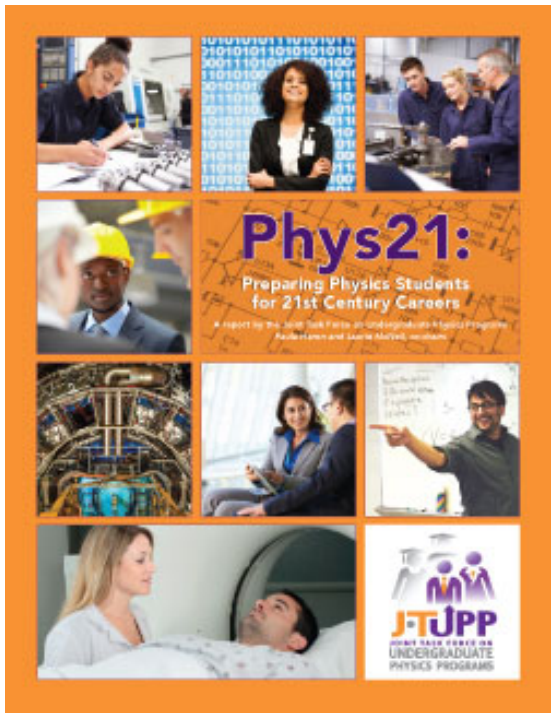
At the end of this webinar, you will be able to...

- explain what agile management is and how it differs from waterfall,
- understand how agile management can be used in student projects,
- implement a 3-4 hour learning activity to introduce agile management.

Joint Task Force on Undergraduate Physics Programs

Findings of Phys21 (compadre.org/JTUPP)

- "The overwhelming majority of physics bachelor's recipients are employed outside academia for all or part of their careers."
- "Since only about one-third of physics Ph.D. recipients end up in academic careers, even students who plan to obtain graduate degrees will benefit from developing skills and knowledge that are valued outside the academic community."



Promote career readiness: four learning goals to focus on!

- Physics-specific knowledge
- Scientific and technical skills
- Communication skills
- Workplace and professional skills

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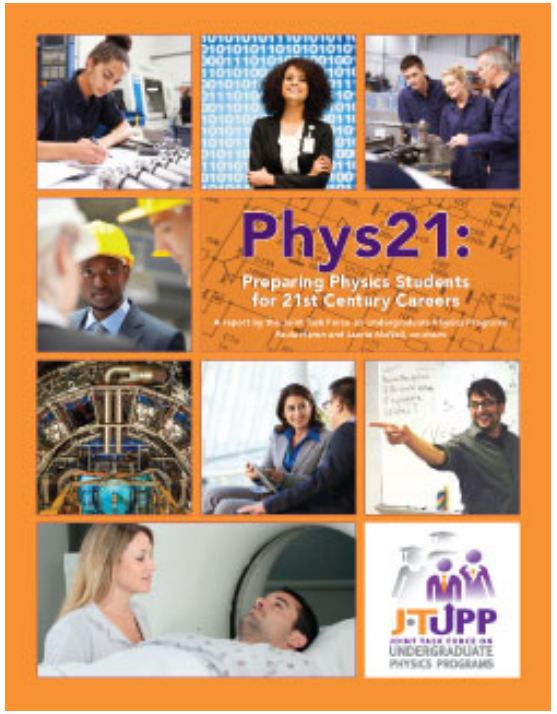

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- Physics-specific knowledge
- Scientific and technical skills
- Communication skills
- Workplace and professional skills

Physicists Find Careers Primarily Outside Academic Research

What skills are physicists missing?[1]

- 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, etc)
- Leadership skills
- Familiarity with basic business concepts (i.e. cost-benefit analysis, funding sources, IP, project management)
- Communication skills (oral and written), esp. how to tailor message to audience
- Real-world experience in companies before graduation
- Awareness of career paths outside of academia

[1] *Sources: ABET Survey of Applied and Engineering Physics Graduates, Kettering University; APS Workshop on National Issues in Industrial Physics, Industrial Physics Lunches.*

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Project Management: Waterfall vs. Agile

Waterfall model

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

Agile management model

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

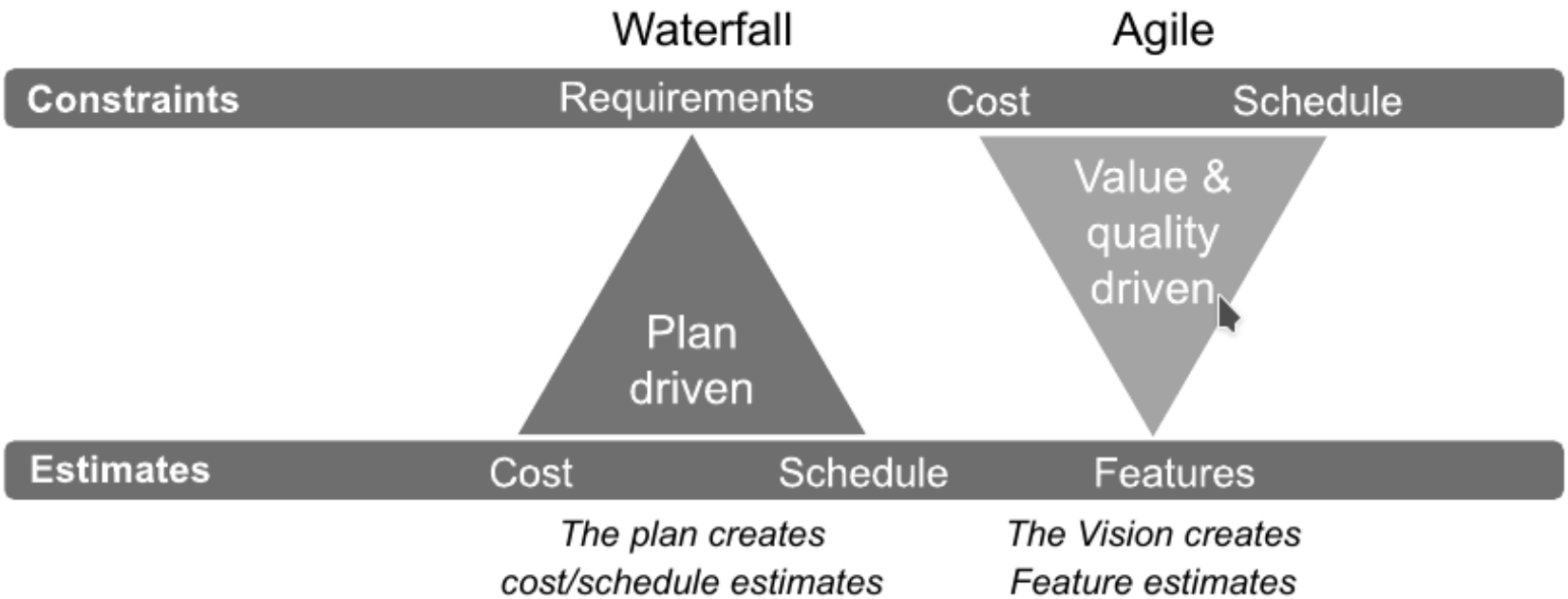

Image credit: Scaled Agile Inc.

Project Management: Waterfall vs. Agile

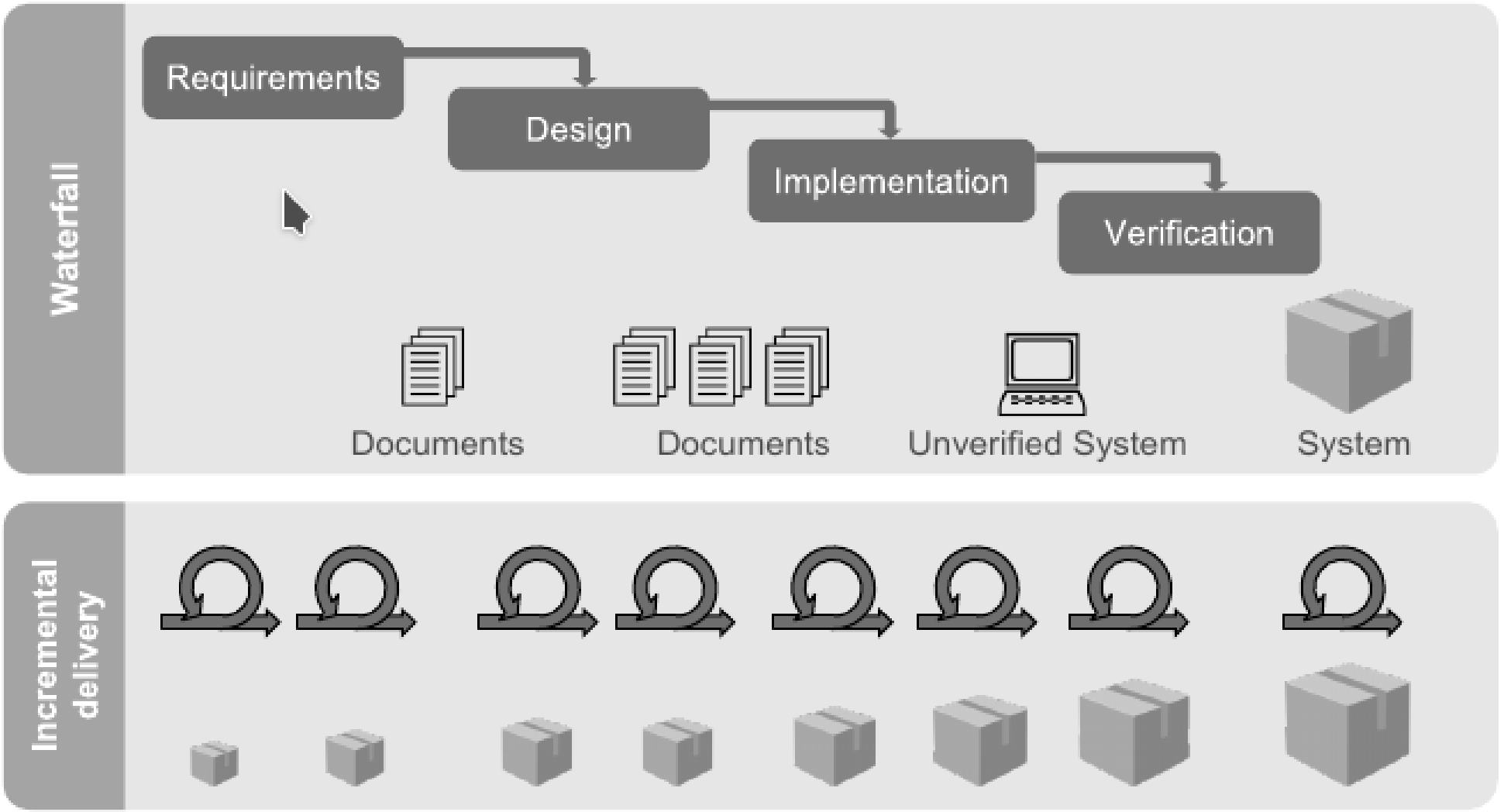

Image credit: Scaled Agile Inc.

A Typical Agile Iteration Cycle

- Plan: user stories/tasks backlog
- PO: product owner/customer
- SM: scrum master/team leader
- Review: demo of latest prototype
- Retro: retrospective of team performance/dynamics

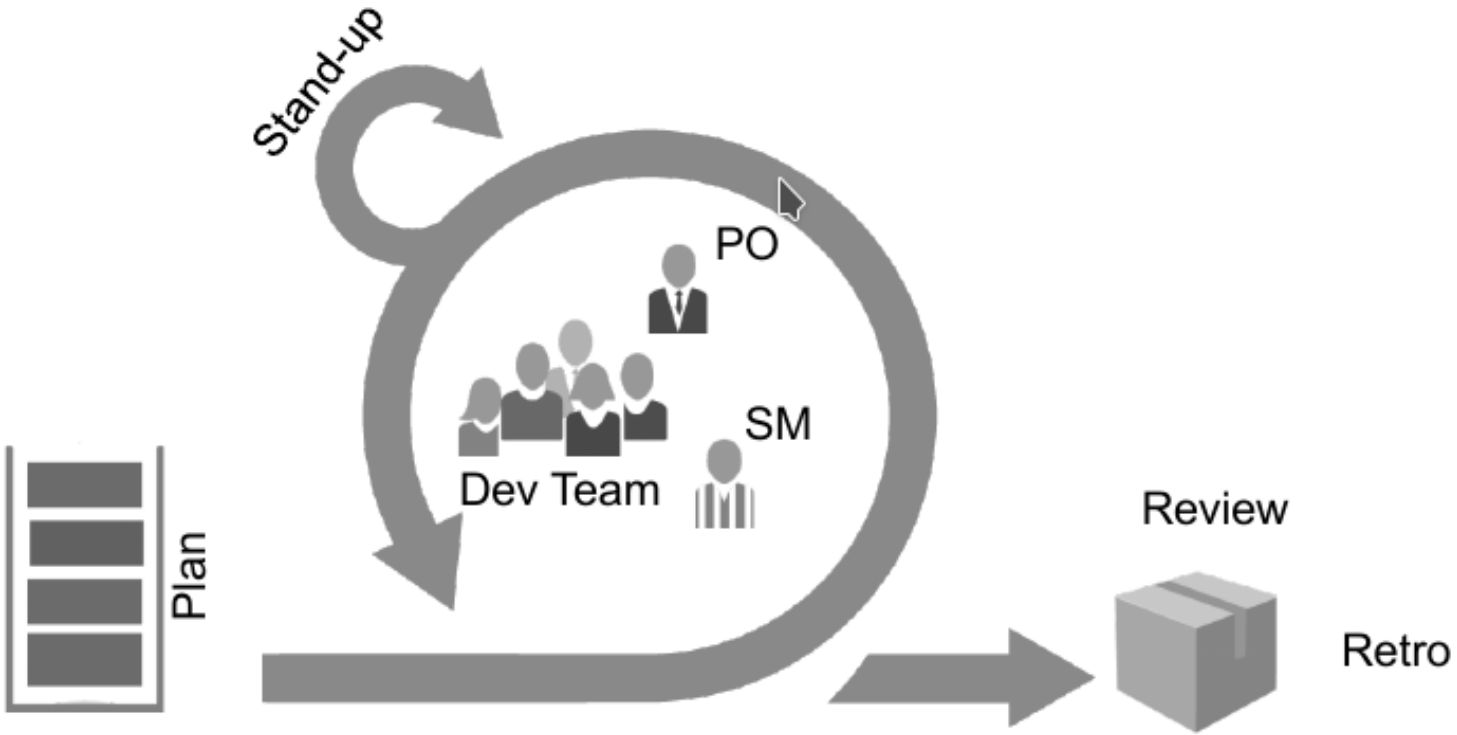

Image credit: Scaled Agile Inc.

A Typical Agile Iteration Cycle

Timeline for sprints of 1-2 weeks

- 1-2 hour sprint planning with product owner
- Daily 10-minute stand-up meetings led by scrum master
- 1-2 hour sprint demonstration with product owner
- 1 hour retrospective after demo without product owner

Roles and responsibilities

- The product owner decides what should be done during a sprint
- The scrum master guides the team in prioritization, resources
- The team collectively decides how long each tasks will take

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"Scrum, but..."

- Students are not full-time employees, have complicated schedules
- Deviations in format while trying to stay true to the spirit

Creating an Agile Workplace Culture

Agile Manifesto (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

"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 introducing these approaches: The Goal (Eliyahu Goldratt), The Phoenix Project (Gene Kim et al.)

Creating an Agile Workplace Culture

Elements of a workplace "culture"

- Beliefs: shared ways of understanding the world
- Artifacts: physical things endowed with meaning
- Rituals: repeated actions or processes with meaning
- Also: values, attitudes, heroes, stories,...

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Agile's cultural elements

- Beliefs: self-organized and empowered teams are more productive[a]
- Artifacts: kanban boards with post-its, physical prototypes,...
- Rituals: moving a task, stand-ups, demos, retrospectives,...
- Values: iteration, collaboration; Heroes: manifesto authors, coaches; Stories: narratives of a synthetic persona interacting with the product

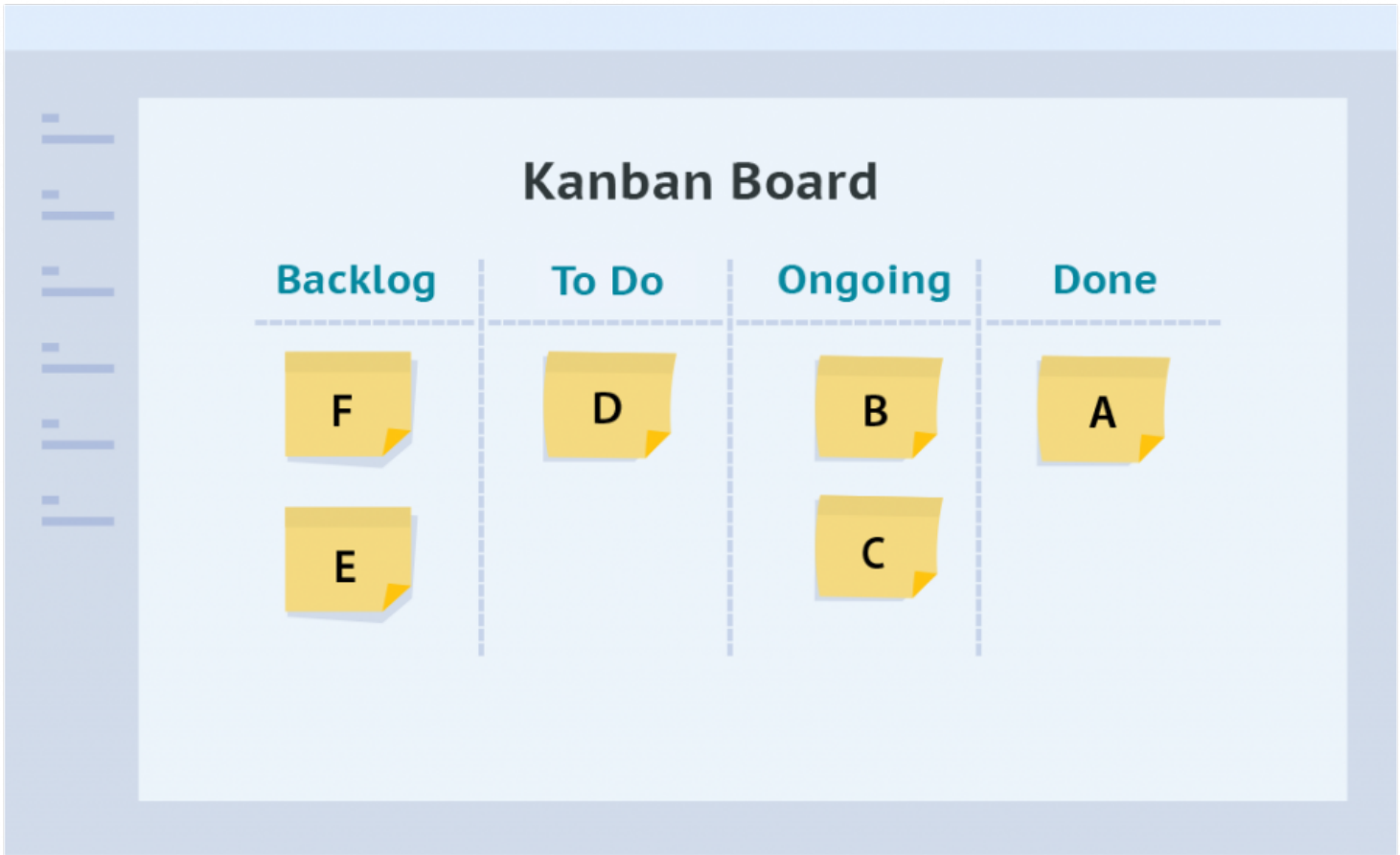
[a] *"Build projects around motivated individuals. Give them environment and support they need. Trust them to get the job done."*

Implementation of An Agile Workplace

Easy visualization of "work in progress" (WIP), artifacts

- Reduce WIP, "batch size of one" in manufacturing, avoid multi-tasking
- Make status of WIP visible, *kanban* boards (todo, ongoing, done)

Core Components of Agile Management



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- Iterative sprints with customer/client/end user
- Retrospections on team performance/group dynamics

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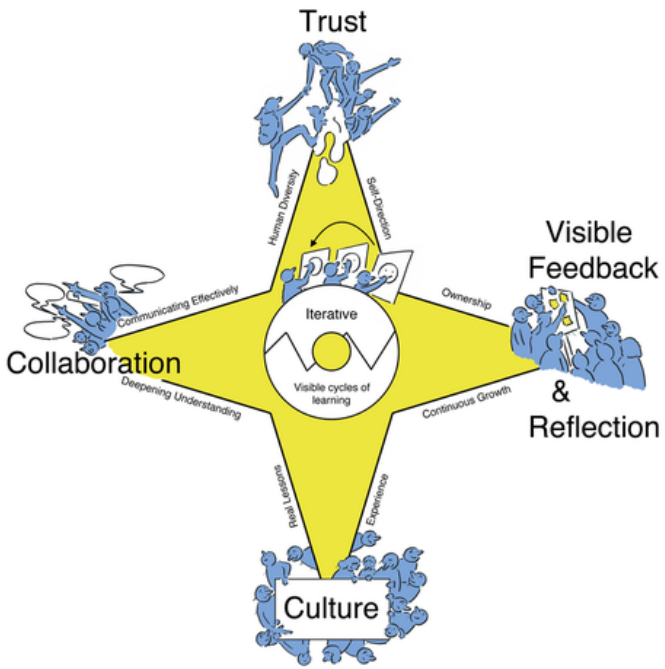
Continuous improvement, beliefs

- Learn by doing, learn by failing: don't expect infallible teams
- Encourage a culture of experimentation among teams
- "Affordable loss principle" instead of focusing on possible gain

Agile in Education

Related movements (K-12 to higher ed)

- EduScrum, Agile in Education
- Iterative, reflective, collaborative, and learning based on trust instead of hierarchy and assessment



Building a growth mindset on top of a skill set

Agile Team-Based Physics Design Courses at W&M I

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

Robo-Ops: Design and development of tele-robotic rover (2016)

- Semester-long class of 15 students (50% physics majors), 3 sub-teams
- Single project, agile project management (with many lessons learned)
- Co-supervisor: aerospace engineer at NASA Langley
- Outcome: third place on competition at Johnson Space Center

Agile Team-Based Physics Design Courses at W&M II

Agile Innovation: NASA's Lab77 technology incubator (2017)

- Semester-long class of 15 students (30% physics majors)
- Problem finding, ideation, prototyping into minimum viable product
- Co-supervisor: incubator head at NASA Langley
- Outcomes: mental health startup and novel drone-borne bacterial sampling system

Agile Senior Research Capstone Course (2018-19)

- Year-long senior project with 5 graduating physics majors
- Project entirely outside area of expertise of adviser (scalable)
- Co-supervisors: mission engineer at NASA Langley, agile consultant
- Outcome: MVP of ejectable data recorder for NASA mission
  NASA put project out for bids (waterfall) and didn't get any...

Agile Senior Research Capstone Course

Implementation

- Assigned roles: SM, scribe, archivist, ambassador, devil's advocate (only to get started and to give students initial responsibility)
- "Scrum, but" students are part-time researchers so slower paced
- Stand-up meeting (15 mins) led by SM every 2 days, at university
- Sprint demonstration (1 hour) with PO every 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
- Results at teamagileimpact.com

Agile Senior Research Capstone Course

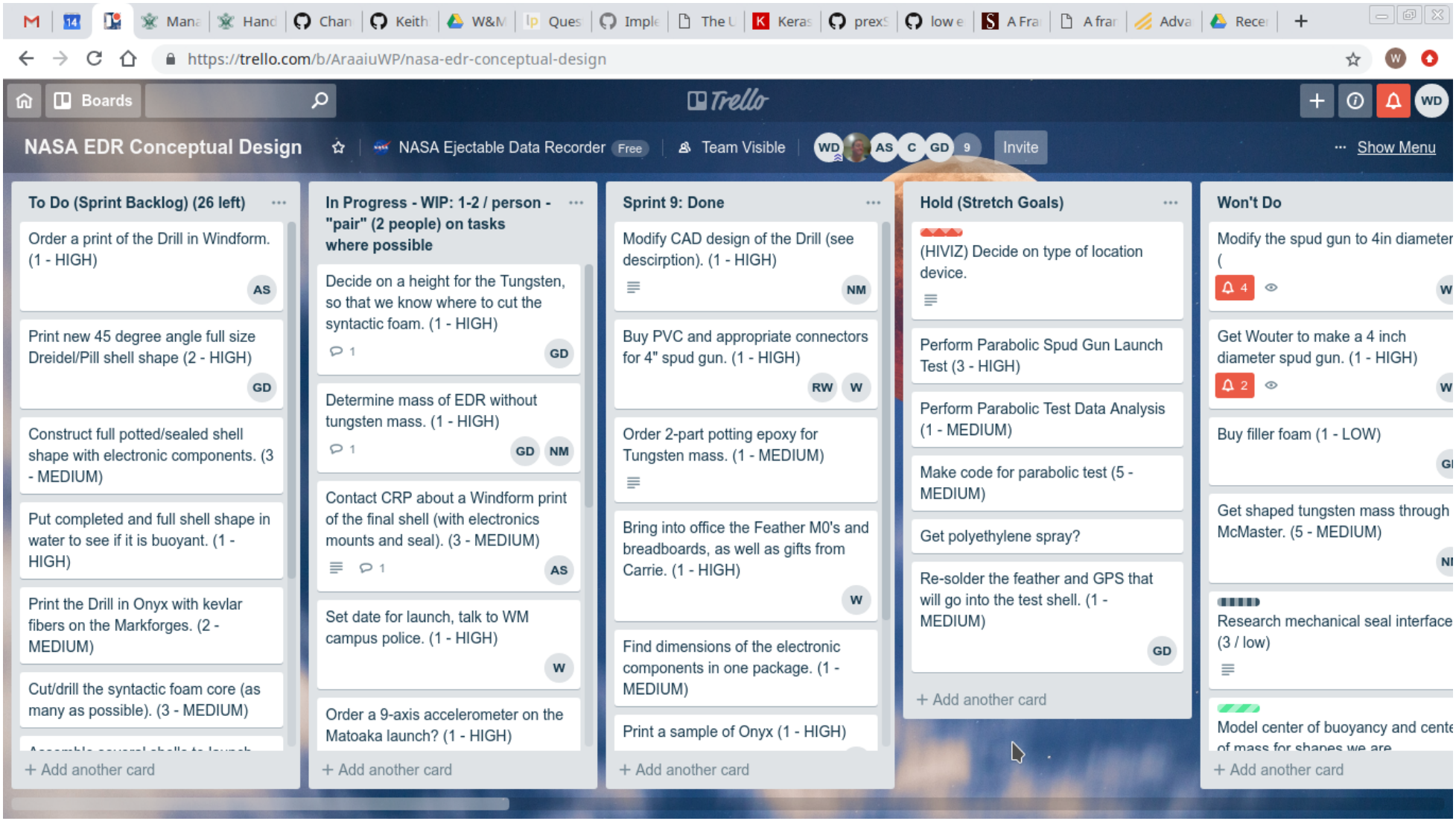
From Goals to Tasks

- Start with overall goals: "At the next demo, we would like to see functionality X" (driven by product owner)
- 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

- User stories: "As a <role>, I want <activity> so that <value>"
  - e.g. "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 weight: 1, 2, 3, 5, 8 (roughly equates to hours), longer must be split up in smaller parts to remain manageable
- Multiple team members should be able to complete any card's task

Agile Senior Research Capstone Course



CubeSat Scrum: An Agile Tutorial Activity

Problem

- Year-long team-based projects are not possible for everyone
- Needed introductory activity to familiarize students with agile
- Available agile tutorials are mainly focused on software development

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- Needed introductory activity to familiarize students with agile
- Available agile tutorials are mainly focused on software development

Solution

- Short activity with cheap materials that introduces students to the core components of agile management of hardware project
- Subject similar to an experimental scientific design project
- Sufficient degrees of design freedom, not intended as a lab activity

The CubeSat Challenge at cubesatscrum.com (CC BY-NC-SA)
(by BEC, Berkana Enterprise Consulting, our agile consultant)

CubeSat Scrum: An Agile Tutorial Activity

The PIPELINE Network

American Physical Society [US] | aps.org/programs/education/innovation/pipeline/index.cfm

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- Industrial Physics

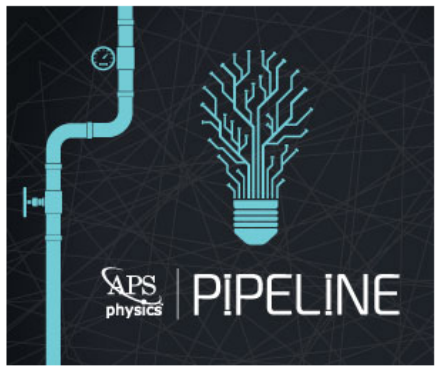
Home | Programs | Education | Physics Innovation and Entrepreneurship Education | **The PIPELINE Network**

The PIPELINE Network

The PIPELINE Network is a three year project bringing together the efforts of seven institutions to create and document new approaches to teaching innovation and entrepreneurship in physics.

The project is charged with developing research instruments to investigate the link between physics innovation and entrepreneurship (PIE) education experiences and corresponding student and faculty attitudes. These deliverables will be made available via web, email, and meetings.

The project is advised by an industry team and by three institutions with strong innovation and entrepreneurship focused physics programs: Carthage College, Case Western Reserve University, and Kettering University.



PIPELINE Curricular Materials

Material	Developed By	Level	Duration	Phys21 Area(s)
User Innovation Module	Loyola University MD	Advanced (Junior/Senior)	300 - 375 Minutes class time, plus extra curricular activities	Physics Specific Knowledge, Workplace Relevant

CubeSat Scrum: An Agile Tutorial Activity

CubeSat Materials

CubeSat Materials

Activity Description:	Link to Resources:
Competitive team-based workshop	Github account for cubesat-scrum

Level: Any

Relevant Phys21 Area(s):
Communication Skills, Professional and Workplace Skills

Learning Objectives:
Learn how team-based projects can be effectively managed with agile methodology

Duration:
Ideally 4 hours, at least 3 hours

Target Audience:
Undergraduate or graduate students

CubeSat Scrum: An Agile Tutorial Activity

cubesat-scrum

CubeSat Scrum objectives, lesson plan, and instructor notes

View the Project on GitHub
aps-pipeline/cubesat-scrum

This project is maintained by aps-pipeline

Hosted on GitHub Pages — Theme by orderedlist

CubeSat Scrum (by APS PIPELINE)

This repository contains CubeSat Scrum objectives, lesson plan, and instructor notes. These materials were developed with support of the APS PIPELINE project

Learning objectives

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

Required materials

The paper templates are available in this repository. For each team print a copy of these templates on card stock (65 lbs weight works well, heavier becomes difficult to fold, user story cards on p45 through end can be 2-up). You will also need to get some easily obtained crafts materials.

Additional teaching materials for the CubeSat Scrum workshop, including K-12 lesson plans developed by students at Old Dominion University, are available at https://cubesatscrum.com/ or directly on DropBox.

Schedule and roles

This activity will take up to 4 hours to complete. A suggested schedule is available. You may also want to consider the different roles that all participants in the activity will be asked to play. You will need at least

CubeSat Scrum: An Agile Tutorial Activity

Starting point: cubesat mission design

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

Agile management condensed

- Sped up agile project with 3 sprints of 3 'working days' of 10 minutes
- Maintain all rituals: sprint planning, stand-up, demo, retrospective

CubeSat Scrum: An Agile Tutorial Activity

IceCap CubeSat Mission Objective

- Satellite used for measuring ice melt and solar reflection has been re tasked.
- There is a urgent need to fill this gap in coverage in support of the United Nations work on global warming.
- The IceCap CubeSat mission will fill this need with a polar orbit optical imaging and solar sensors.
- The mission must launch within 4 months to meet the desired window of coverage.

http://cubesatscrum.com/

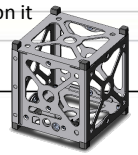
CubeSat Scrum: An Agile Tutorial Activity

1. CubeSat Frame

As a mission commander I want a frame to house and protect my CubeSat components so that my mission can be launched and executed.

Acceptance Criteria:

- All the open areas of the cubesat must be cut out due to weight
- Any mission payload that uses cameras or sensor must have sufficient room in the frame to operate.
- There must be 4 rails that surround the sides of the cube sat that fit in the P-POD rail system
- The CubeSat must be able to open to inspect the internal components.
- The external frame must have the name and logo place on it
- There must be remove before flight Pin Cubesat



http://cubesatscrum.com/

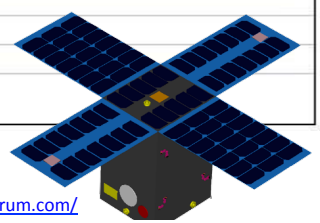
2. Solar Array / Power Storage

As a CubeSat in orbit
I want solar power for all my components at all times
So that my mission will be a success.

Acceptance Criteria:

- Solar Cells with sufficient power to run and charge the batteries
- Batteries that can run the components while behind the earth
- Solar Array will fold to conform with P-POD launcher
- Calculate the power produced

Documentation: Complete the Orbital Mission Power Management Worksheet



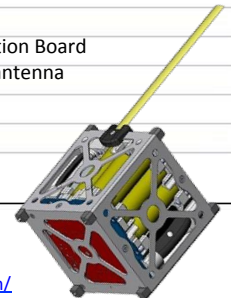
http://cubesatscrum.com/

3. Communication

As a CubeSat
I want to have a communication system, Transmitter and Receiver, Send and Receive
So that I can communicate Housekeeping data, commands, and to relay payload data.

Acceptance Criteria:

- Assemble Cellular / Radio modem communication Board
- Connect to At least 2 arms of a tape measure antenna
- Power Amplifier to boots signal
- Antenna will auto deploy after exit from P-Pod
- Antenna will not interfere with the solar array



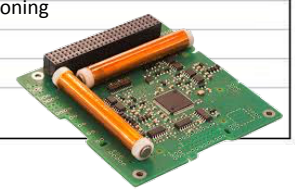
http://cubesatscrum.com/

4. Stabilization

As a CubeSat Mission
I need to have Stabilization
So that my payload camera can be oriented on my mission objectives.

Acceptance Criteria:

- Assemble Magnetic Rod Stabilization component
- Integrated to Attitude Sensing Component
- Must run continuously for Solar and camera pointing.
- Integrate with Attitude Cameras for positioning



http://cubesatscrum.com/

CubeSat Scrum: An Agile Tutorial Activity

5. Navigation GPS

As a CubeSat Mission
I need to have GPS Navigation
So that I can track my mission, manage commutation, take pictures, move from Sun to dark power modes.

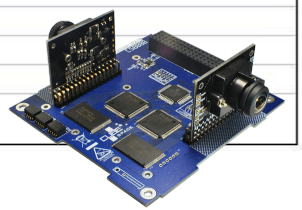
Acceptance Criteria:
- Assemble GPS component assembly
- GPS is next to the CPU in the stack
- Must run continuously for Solar and camera pointing.

http://cubesatscrum.com/

6. Payload

As a mission product owner
I want my payload to have optical sensors
So that I can capture images to transmit them to the ground station.

Acceptance Criteria:
- The CubeSat will have a payload camera
- The frame will accommodate the objective lenses of the camera
- The cubesat payload camera will be able to operate at all times.



http://cubesatscrum.com/

7. Remove Before Flight

As a mission product owner
I want to incorporate my remove before flight tag
So that my cubesat will go live when it is removed.

Acceptance Criteria:
- The CubeSat will have a remove before flight tag
- The remove before flight tag will be connected to On off Switch
- Placement of on off switch location as needed

http://cubesatscrum.com/

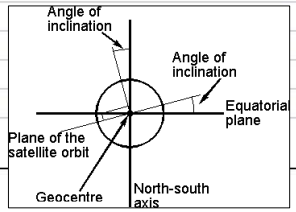
CubeSat Scrum: An Agile Tutorial Activity

8. Launch Vehicle Selection

As a mission product owner
I want to have a launch vehicle
So that I can fly my mission

Acceptance Criteria:

- Select from the list of options the right launch vehicle.
- Ensure that cost is kept to a minimum.
- Ensure that orbit is polar.
- Ensure that size is appropriate.

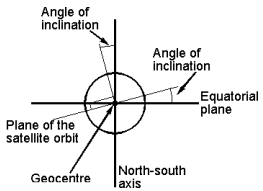


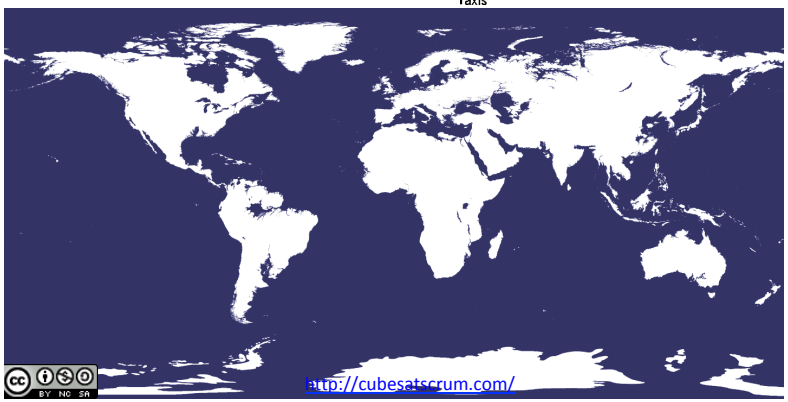
http://cubesatscrum.com/

Select Your Launch Option

Vehicle	Orbit	Launch Date	Size Available	Cost
Delta II	High Polar Elliptical North South Axis 5 Deg	3 Months	1 U	$50,000
Atlas 5	Retrograde Equatorial Axis 10 Deg	3 Months	1 U	$40,000
SOAR	Polar North South Axis 7 Deg	1 Month	2 U	$75,000
Delta II	Polar North South Axis 7 Deg	1 Month	3 U	$110,000
Minotaur 1	Posigrade Equatorial Axis 10 Deg	5 Months	1 U	$30,000
Delta IV	Polar North South Axis 5 Deg	6 Months	1 U	$40,000
Lynx Mark III	Polar North South Axis 0 Deg	3 Months	2 U	$60,000
Pegasus XL	Polar North South Axis 15 Deg	1 Year	3 U	$100,000
Falcon 9	Retrograde Equatorial Axis 10 Deg	5 Months	1 U	$40,000
Delta IV	Polar North South Axis 7 Deg	4 Months	1 U	$35,000
Delta II	Posigrade Equatorial Axis 45Deg	2 Months	2 U	$50,000
Go Launcher 2	Polar North South Axis 5 Deg	5 Months	3 U	$90,000
Super Strypi	Retrograde Equatorial Axis 10 Deg	6 Months	1 U	$50,000
Pegasus XL	Polar North South Axis 0 Deg	3 Months	1 U	$25,000
Minotaur 1	Polar North South Axis 7 Deg	1 Year	2 U	$10,000
Delta IV	Retrograde Equatorial Axis 10 Deg	5 Months	3 U	$80,000
Pegasus XL	Posigrade Equatorial Axis 45Deg	4 Months	1 U	$45,000
Delta IV	Polar North South Axis 7 Deg	2 Months	1 U	$60,000
Delta II	Retrograde Equatorial Axis 10 Deg	1 Year	2 U	$75,000
Atlas 5	Polar North South Axis 4 Deg	4 Months	2 U	$50,000

Orbital Path Map
Sketch your selected Orbital based on launch option here.





http://cubesatscrum.com/

CubeSat Scrum: An Agile Tutorial Activity

9. Mission control Pre Launch Checklist

As a mission commander
I want my cubesat to pass the prelaunch checklist
So that I can be cleared for launch and fly my mission.

Acceptance Criteria:

- The CubeSat will conform to the mission checklist
- All components required will be present
- Weight conforms to size 1.33 KG per 1U
- Mission will be chair flown. Instructor will be mission command.

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Mission Control Pre Launch Checklist

Component	Power Required	Cost Estimate	Weight
Frame / Structure			
Communication			
Antenna / Active or Passive			
Power /Generation /Storage			
Solar Array			
Attitude Determination			
Attitude Control			
Propulsion			
Computer			
Payload			
Remove Before Flight			

http://cubesatscrum.com/

Orbital Mission Power Management

	DAY					Night				
	10	20	30	40	50	60	70	80	90	100
CPU										
Stabilization										
Communication										
Payload										
Attitude										
Solar Cells										
Flight Comp										
Battery										

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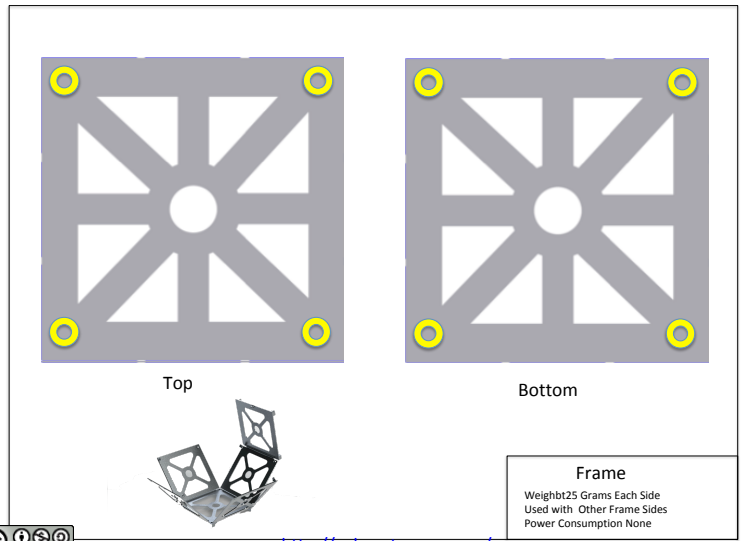
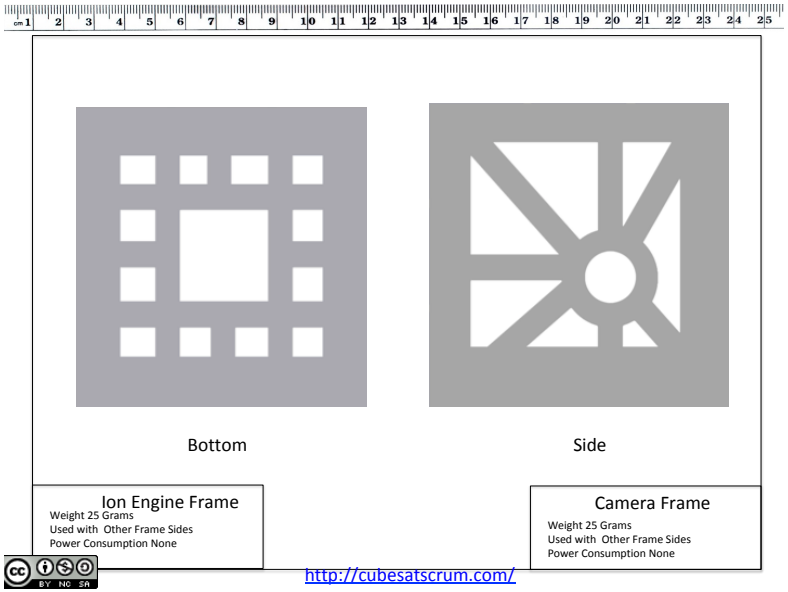
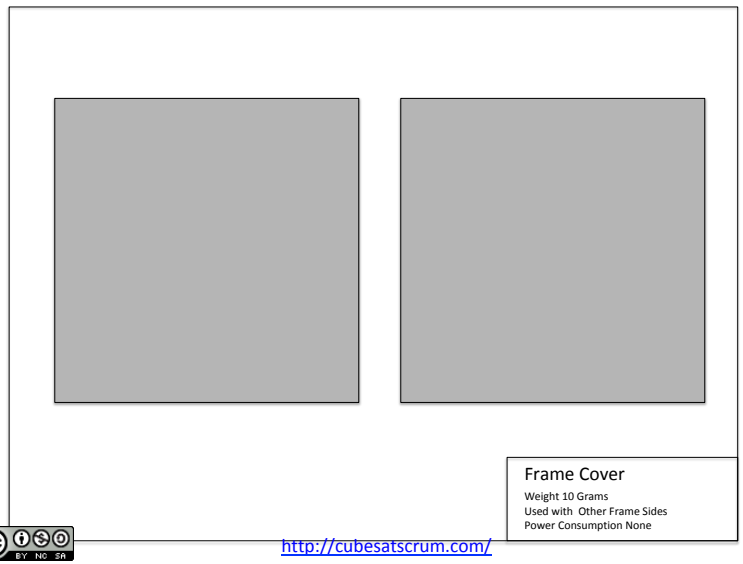
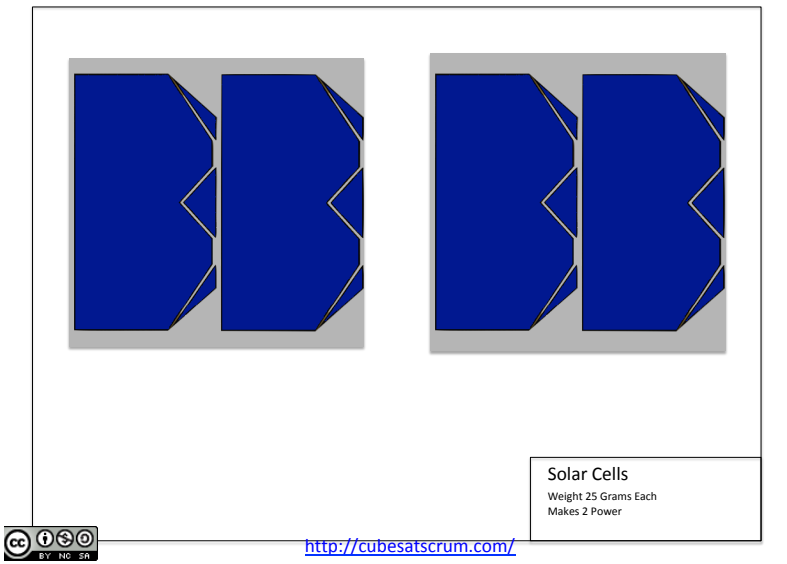
CubeSat Scrum: An Agile Tutorial Activity









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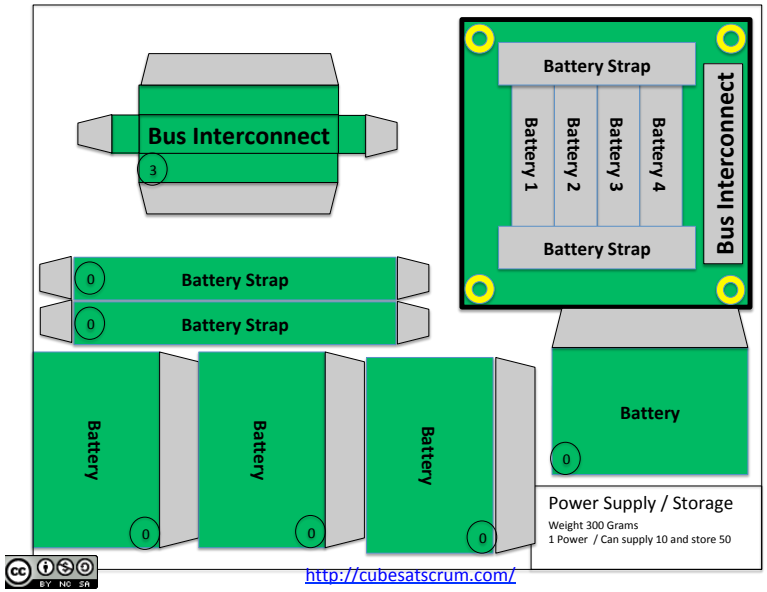
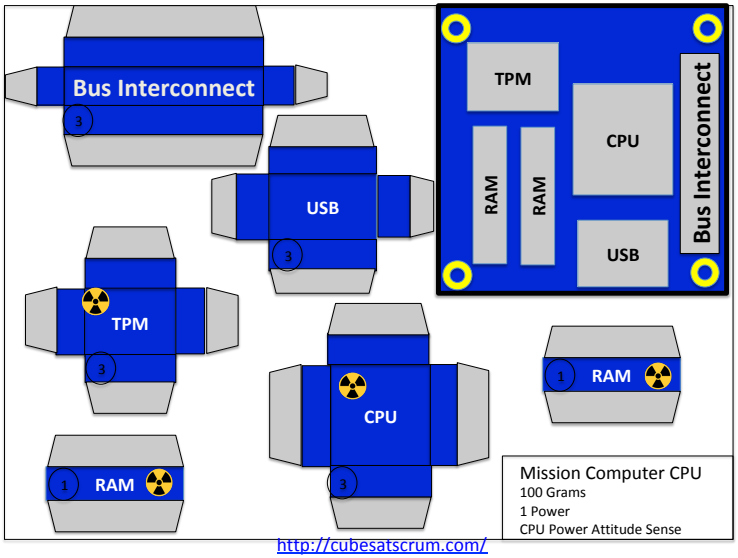
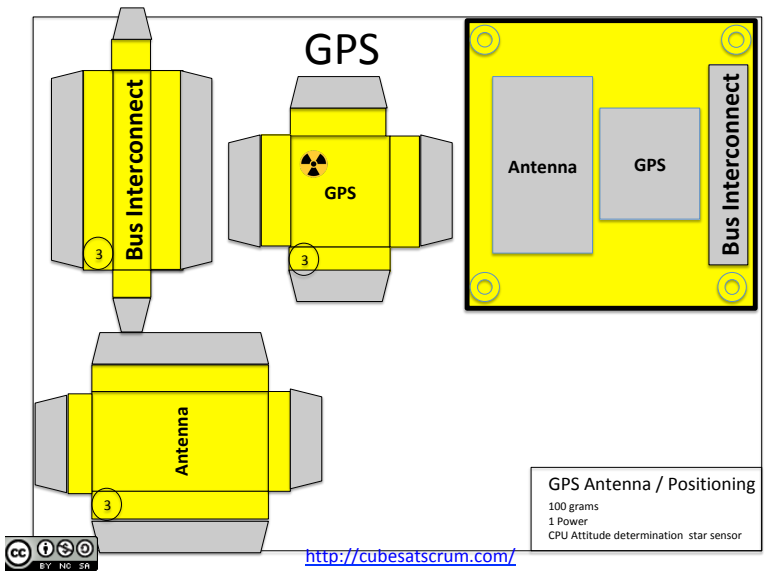
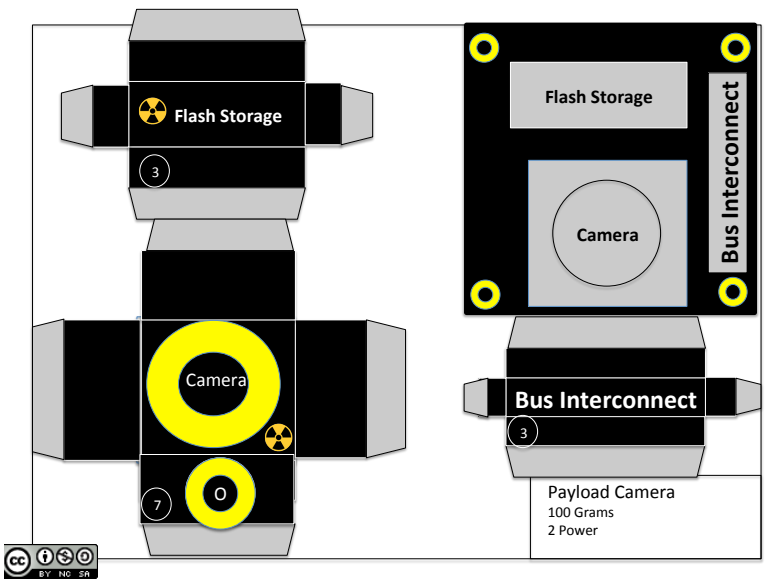








CubeSat Scrum: An Agile Tutorial Activity

Activity roles

- NASA directorate (i.e. instructor):
  - keeps everyone on a strict time schedule,
  - ensures that tasks are written on post-its and moved on the kanban,
  - ensures not work is done during the non-work times.
- Scrum master (SM) per team (i.e. a regular team member):
  - leads the sprint planning, stand-ups, demonstration, and retrospective,
  - does not act as a boss, but instead enables team productivity.
- Product owner (PO) per team (i.e. not a regular team member):
  - acts as mission director for the project,
  - participates in sprint planning and demonstration,
  - expresses priorities and goals.
- Team members (everyone else), from 5 to 10 members per team:
  - write cards of tasks as they become apparent,
  - move their cards through the kanban columns,
  - stay focused on the tasks of the current sprint.

CubeSat Scrum: An Agile Tutorial Activity I

Introduction (15 min)

Sprints (3 x 45 min)

Close-out

- "Chair flying" (15 min)
- Activity retrospective (15 min)

CubeSat Scrum: An Agile Tutorial Activity II

Sprint 1 (45 min)

- Planning (5 min)
- Day 1: (10 min)
  - Stand-up (2 min)
  - Work (8 min)
- Day 2: (10 min)
  - Stand-up (2 min)
  - Work (8 min)
- Day 3: (10 min)
  - Stand-up (2 min)
  - Work (8 min)
- Demo (5 min)
- Retro (5 min)

Sprint 2 (45 min)

- Planning (5 min)
- Day 1: (10 min)
  - Stand-up (2 min)
  - Work (8 min)
- Day 2: (10 min)
  - Stand-up (2 min)
  - Work (8 min)
- Day 3: (10 min)
  - Stand-up (2 min)
  - Work (8 min)
- Demo (5 min)
- Retro (5 min)

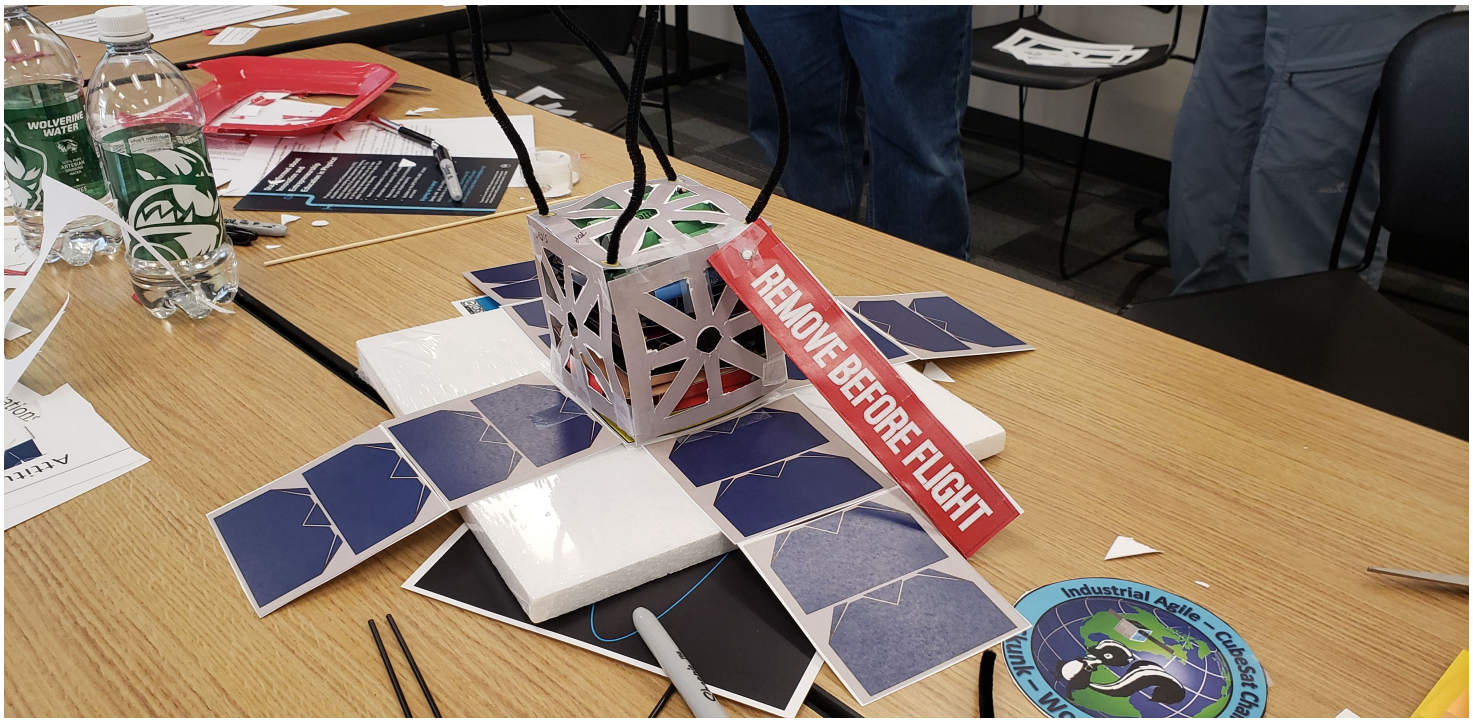
Sprint 3 (45 min)

- Planning (5 min)
- Day 1: (10 min)
  - Stand-up (2 min)
  - Work (8 min)
- Day 2: (10 min)
  - Stand-up (2 min)
  - Work (8 min)
- Day 3: (10 min)
  - Stand-up (2 min)
  - Work (8 min)
- Demo (5 min)
- Retro (5 min)

CubeSat Scrum: An Agile Tutorial Activity I

CubeSat Scrum: An Agile Tutorial Activity II

CubeSat Scrum: An Agile Tutorial Activity III



Outline

Why teach students project management techniques?

- Where do physicists find permanent employment?
- What skills are physicists missing?

What is agile project management?

- How does agile management differ from other approaches?
- What are the mechanics of agile project management?

How can you teach agile management?

- Example of one tutorial activity to start team-based projects.
- Example of how to run an entire team-based capstone course.

Teaching Agile Management

The Fast-Paced, Iterative Project Management Style Used From Amazon to NASA

Wouter Deconinck, William & Mary
(now at University of Manitoba)
wouter.deconinck@umanitoba.ca

APS Webinar, August 21, 2019

WILLIAM & MARY
CHARTERED 1693

Supported by the NSF under Grant No. DUE-1625872, APS PIPELINE project. Opinions are not necessarily the views of the NSF.

Teaching Agile Management

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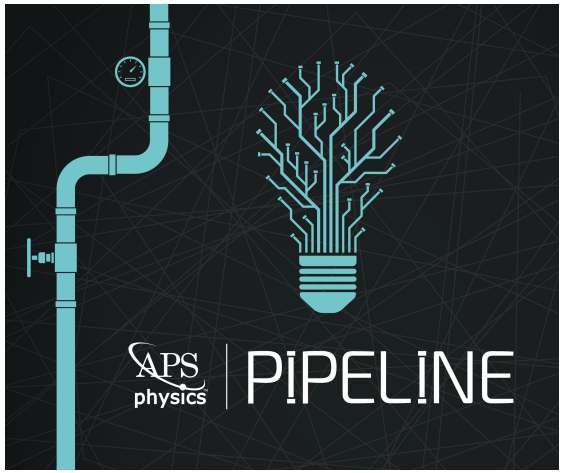

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