The Science of Lean / Agile R&D

Welcome!

Please try to sit with others from your team / department if you're able.

Think about, and be ready to share-

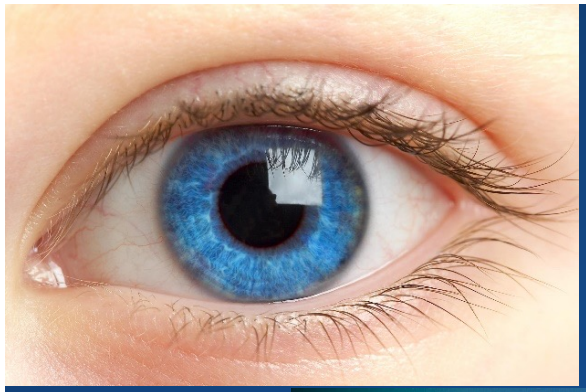
"What does success look like for me today?"

The Science of Lean / Agile R&D

National High Magnetic Field Laboratory Professional Development Day Workshop

Kendra West

Terry Barnhart



Vision
(the "What")

Today's discussions…

- Intro & Kickoff
- Vision - Critical Question mapping
- Thinking - A3 Problem Solving

LUNCH (~12-1:00 PM)

- Organization – Agile Teams & Practices

Thinking
(the "how")

Organization
(the "How")

Introducing you….

What does success look like for me today?

Introducing Kendra West

- Scientist-turned-Agile Coach
- Accelerating scientific insight through empowered people and teams
- Agile R&D Speaker and Author

Education

MAINE

B.S. Biology

Tufts UNIVERSITY

M.S. Engineering Management

Scrum Alliance CSM CERTIFIED

REGISTERED PRODUCT OWNER by scruminc.

REGISTERED SCRUM@SCALE PRACTITIONER by scruminc.

Work Experience

charles river

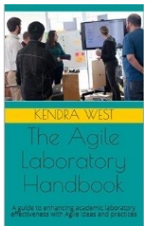
BROAD INSTITUTE

SABETILAB Terra

scruminc. ECSI Consulting

RESILIENCE Waters THE SCIENCE OF WHAT'S POSSIBLE.™

Agile Alliance



Introducing Terry Barnhart

Education

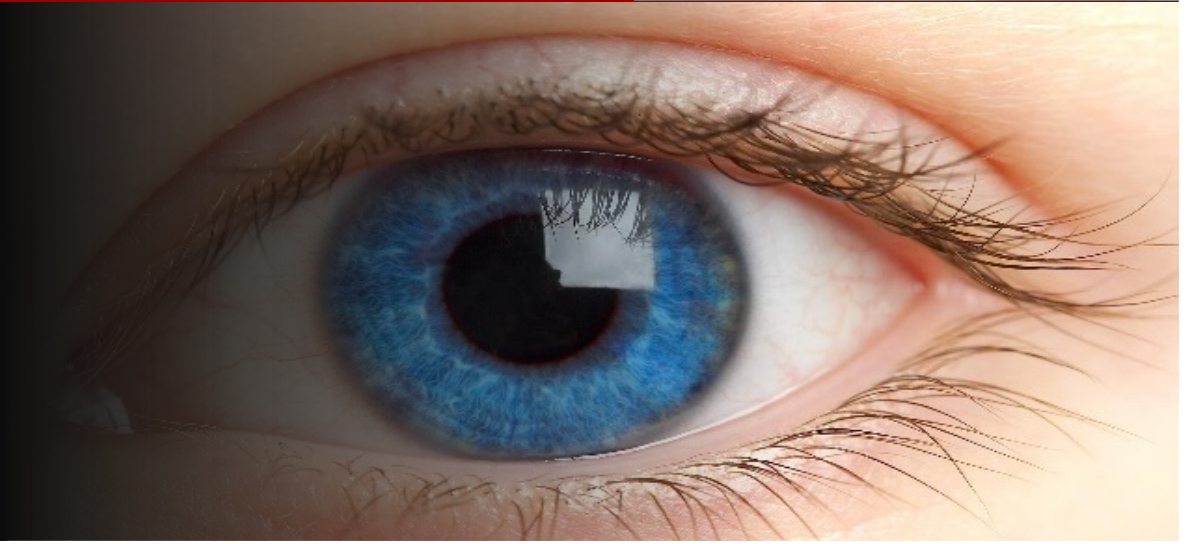
Work Experience

- PhD research chemist
- Strategist
- Project manager
- Leadership & team coach
- Lean R&D developer, practitioner and author
- Speaker

Establishing our Ground Rules

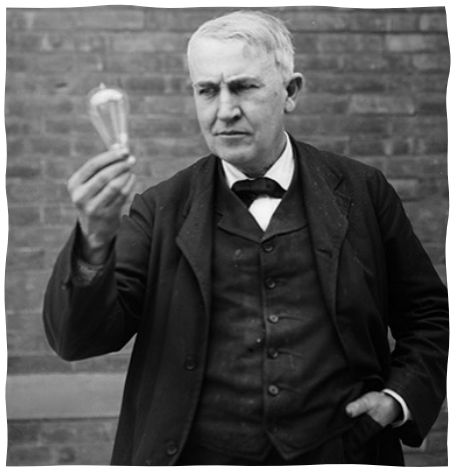
What behaviors/rules will help to support our success?

Introducing Agile R&D



Ford –
Experimented on production methods

Ohno –
Continued that experimentation



Edison –
Experimented with rapid R&D

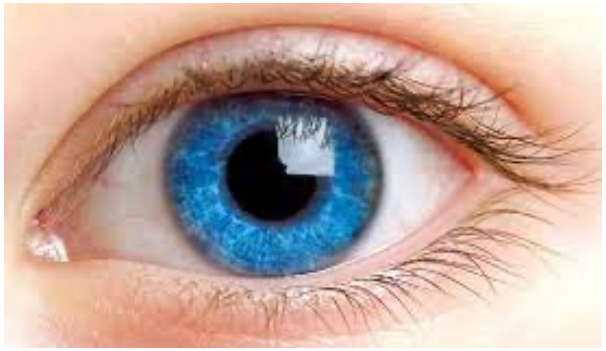
?

Our job? –
Who carries on beyond Edison?

The science of improving production is well established, but what about *innovation* work?

Innovation is *learning work* – to improve learning, we need to cover at least 3 strategic areas

Vision – the "what"



Diverging visions sap energy and time – Can a common vision even be developed?

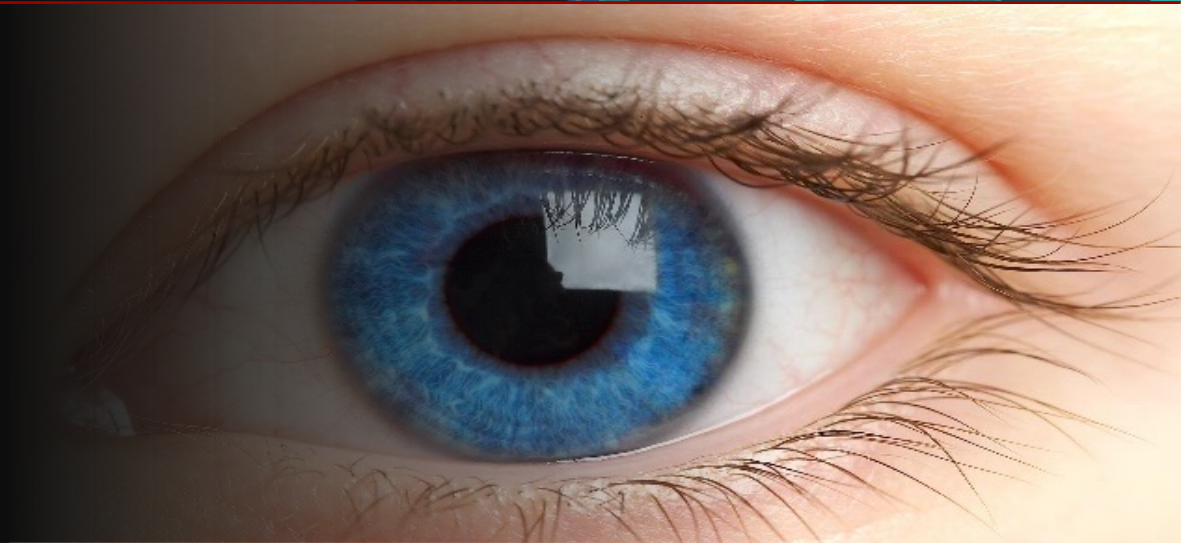
Thinking – the "how"

Wrong experiments give no useful knowledge – How do we improve experimental design?

Organization – the "How"

Individual progress is great, but rapid group progress gives the win – How do we effectively collaborate and improve the way we work?

Creating a shared vision with Critical Question Mapping



Critical Question Mapping Exercise

Process

Prompt	Ideate Individual – 2 minutes	Share Group – 20 minutes
What questions do we need to successfully answer in order to eradicate invasive snakes from the State of Florida?	Write down as many questions as you can think of in 2 minutes Rule 1 – Use a sharpie marker Rule 2 – One question per sticky note Rule 3 – Each sticky needs a ? at the end	Share with each other Ask clarifying questions DO NOT ANSWER questions Create an “affinity” diagram (group stickies by category)

CQM Review

The importance of questions

Proxy for knowledge gaps

- Can capture complexity
- Critical to organizing a program or working a Kanban
- Unfold easily into nested groups (fractal-like)

Psychologically accessible

- Easy to generate
- *Everyone* has valuable questions
- Open up ideas (vs. narrowing them)
- Create respectful alignment vs. divisiveness
- Enable big innovation leaps

Easy to action

- Durable
- Can be answered in almost any order

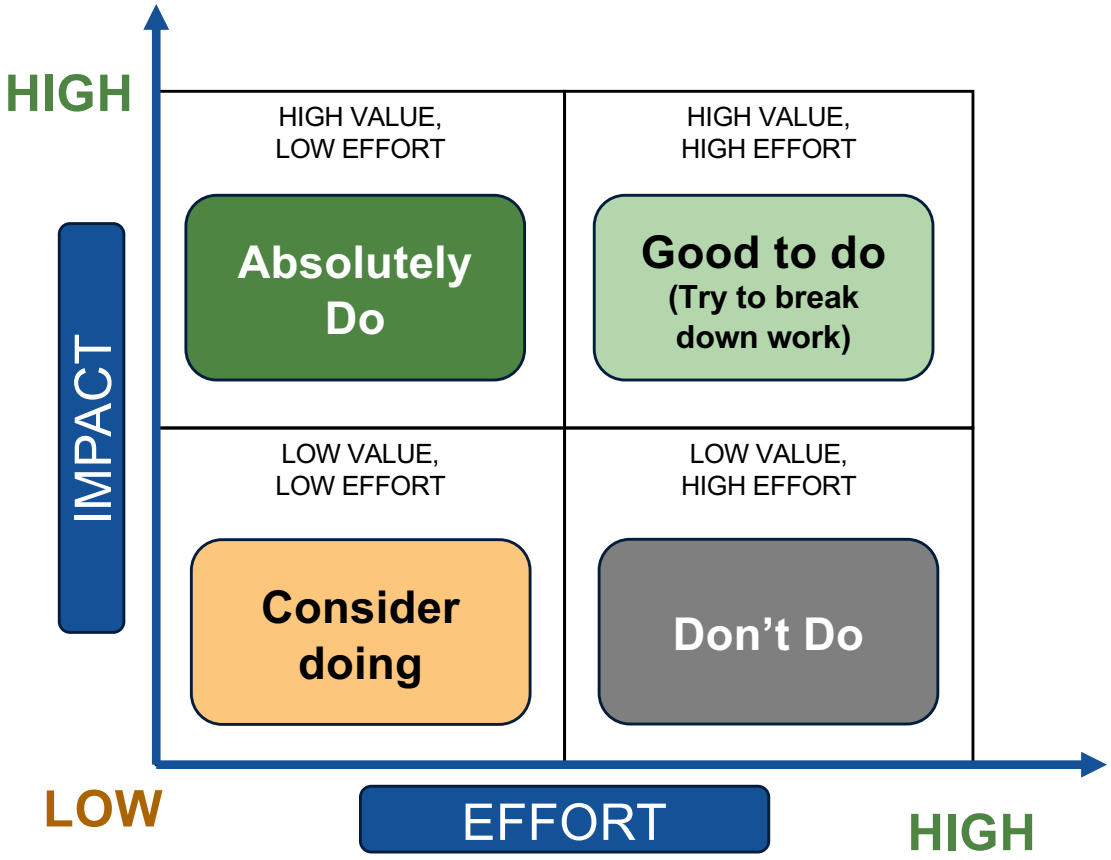
Methodology for Critical Question Mapping

Formulate	Ask	Share, Inquire & Arrange (1 Q at a time)	Agree
A strategic question that you, your team or your organization need to resolve	As many questions as you can think of in 2 minutes 1 per sticky note	• One person shares a critical question • Others ask questions to learn more about that question • When complete, a selected person arranges the Qs in an affinity diagram • Importantly – no one makes a statement	Agree on the most important questions to begin

Remember this for backlogs & Kanban

Ok, so what do we do with this?

Work smarter, not harder: Prioritize what comes first



Other prioritization factors...

- Cost
- Timing / Deadlines
- Dependencies
- Capacity
- Infrastructure

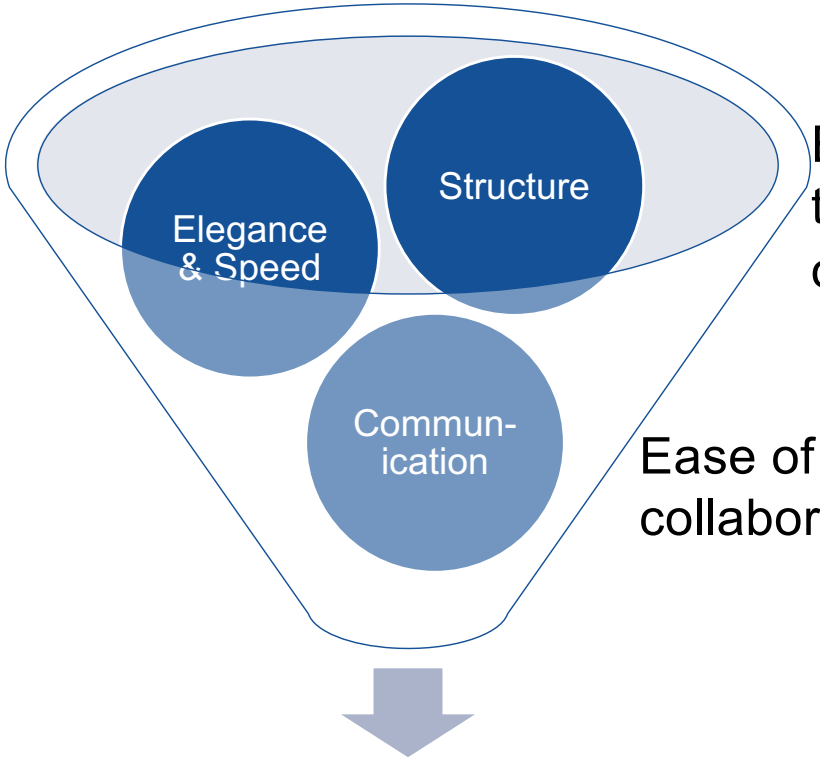
Customize your prioritization method with what factors are important to you.

Improving thinking with A3

(the little “how”)

Experimental improvement every scientist wants

Waste-free, accurate, precise, easily and quickly performed



Experiments that fit together without gaps or overlaps

Ease of sharing and collaborating

Valuable Knowledge

Improving experiments with the A3 (Psst…it's the scientific method on one large sheet)

Problem:	Owner:	Date:

Value when solved:	Goal/Stop condition:
Current State:	Proposed countermeasure — Expected outcome 1. 2. etc.
Analysis:	Learning plan Action — Expected outcome — Start — End 1. 2. 3. 4. Etc.
	Results/next steps

Working with the A3 – Structuring the problem

Problem definition is the hardest and most important part. Ideally, it is a gap, but the easy way is to use a question

Signing accentuates responsibility – 1 person, need not be doing all the work

All knowledge ages. Good to know when to upgrade

Problem: How do we rid Florida of invasive snakes?	Owner:	Date:
Value when solved: Native specie flourishing, safer for small dogs and cats, etc., etc.	Goal/Stop condition: Reduction of invasive snake species to the point where they are no	

If *you* can't define who will benefit and how, then maybe its not the right scientific program

Don't be my thesis advisor. Know when to move on.

Doing your diligence – the left side of the A3

What is known? What has been tried, what is unknown? What analogous (new) knowledge exists? Can you map or diagram it (do so!)?

Current State:

Analysis:

Data runs, library searches, deeper dives into process, scholars to speak with, companies to engage, costs to assess, etc., etc.

Getting creative (in an organized way) – the right side of the A3

These are experiments or solution ideas. Expected outcome is the most important piece – If your thinking is right, outcomes will match, if not, cool learning results

The *Learning plan* is one designed to test your thinking in 2 ways:

1. Outcomes of your actions
2. Your ability to predict work time

This gets you a jump on plan delays, accelerators and countermeasures

Actual results, which allow you to measure against your thinking

Proposed countermeasure	Expected outcome
1.	
2.	
etc.	

Learning plan

Action	Expected outcome	Start	End
1.			
2.			
3.			
4.			
Etc.			

Results/next steps

A few words on creativity: Options

The magic bullet is the belief

- That we can identify ahead of time, the experiment which will prove our hypothesis.
- And we can string several magic bullets into one grand experiment

It turns out this is not true

- The literature method never works in your lab
- The complex, multi-element experiment is invariably impossible to understand when it fails
- The rework associated with it is both endless and far more costly than the opposite assumption:

We cannot know the best approach, but we can *learn* great approaches by trying many things. So, our next challenge is to learn how to identify many things to try…

Elon Musk Claims to be Cursed

Value of Options in Science

Catalysis	**Before multiple options** – BPC catalyst, 6 years of research, Pt catalyst, 6 turnovers **After multiple options** – BPC catalyst, 6 months of research, Ca catalyst, 20,000 turnovers
Structural biology	**Before multiple options** – Best time from idea to protein crystal = 13 months **After multiple options** – Consistently delivered protein crystals in 3 months
Your own examples?	**Before multiple options** – **After multiple options** –

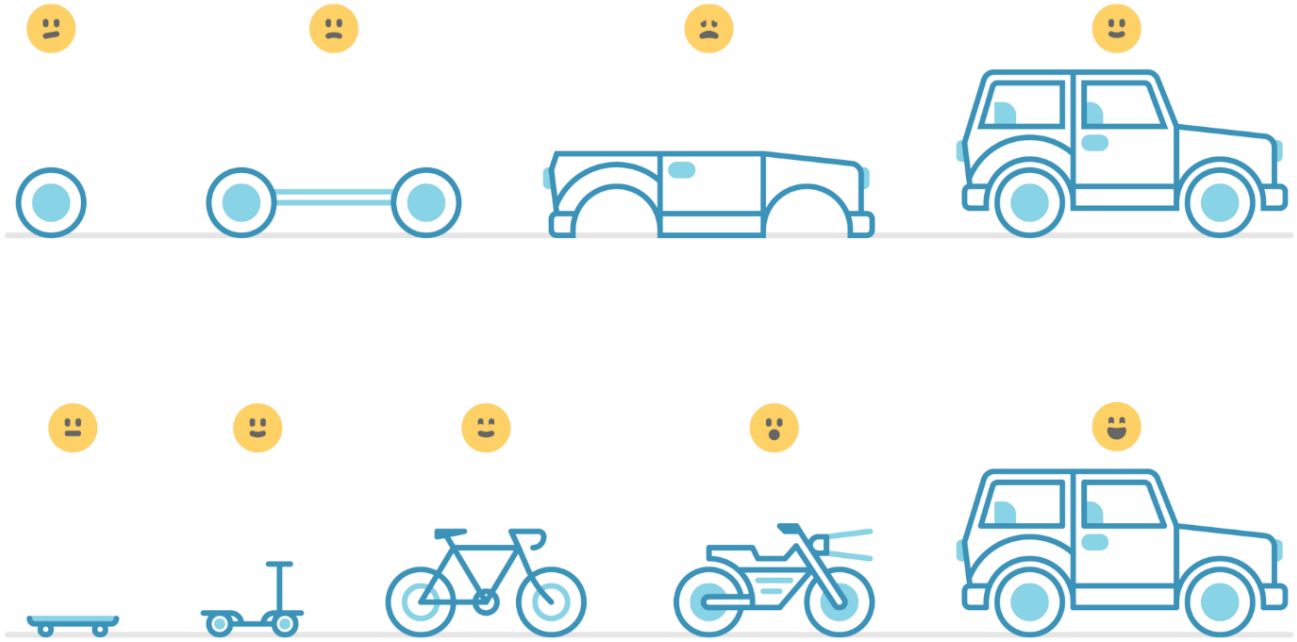
Take away: If you assume your first way will not be the best way, and you identify many options and scale them down for fast testing, you *will* find better answers much faster

Organization: Intro to Agile R&D

What are some of the biggest challenges to effectively getting your work done?

New technology requires a new approach…

Approach work Iteratively



The Agile Manifesto

Individuals & Interactions *over* Processes & Tools

Working Product *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.

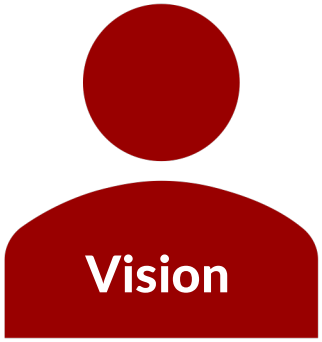
https://agilemanifesto.org/

Characteristics of an Agile team

- Deep connection to a strong & captivating vision
- Continuous, sustainable delivery of evolutionary value
- Cross-functional nature
- Collaborative perspective and transparency into work
- High levels of team autonomy, communication, and collaborative leadership
- Continuous attention to quality, process improvement and team dynamics

Roles & Accountabilities on an Agile team

Product Owner



- Voice of the Customer
- Defines product vision & strategy
- Team priority setter

Development Team Member

- The technical experts
- Cross-functional skill set
- Champions and owners of Quality
- Equal contributors

Scrum Master

- Team Coach & Facilitator
- Impediment Remover
- Champion for continuous improvement

CAUTION: Challenges ahead

Considerations for Cross-Functional Teams:

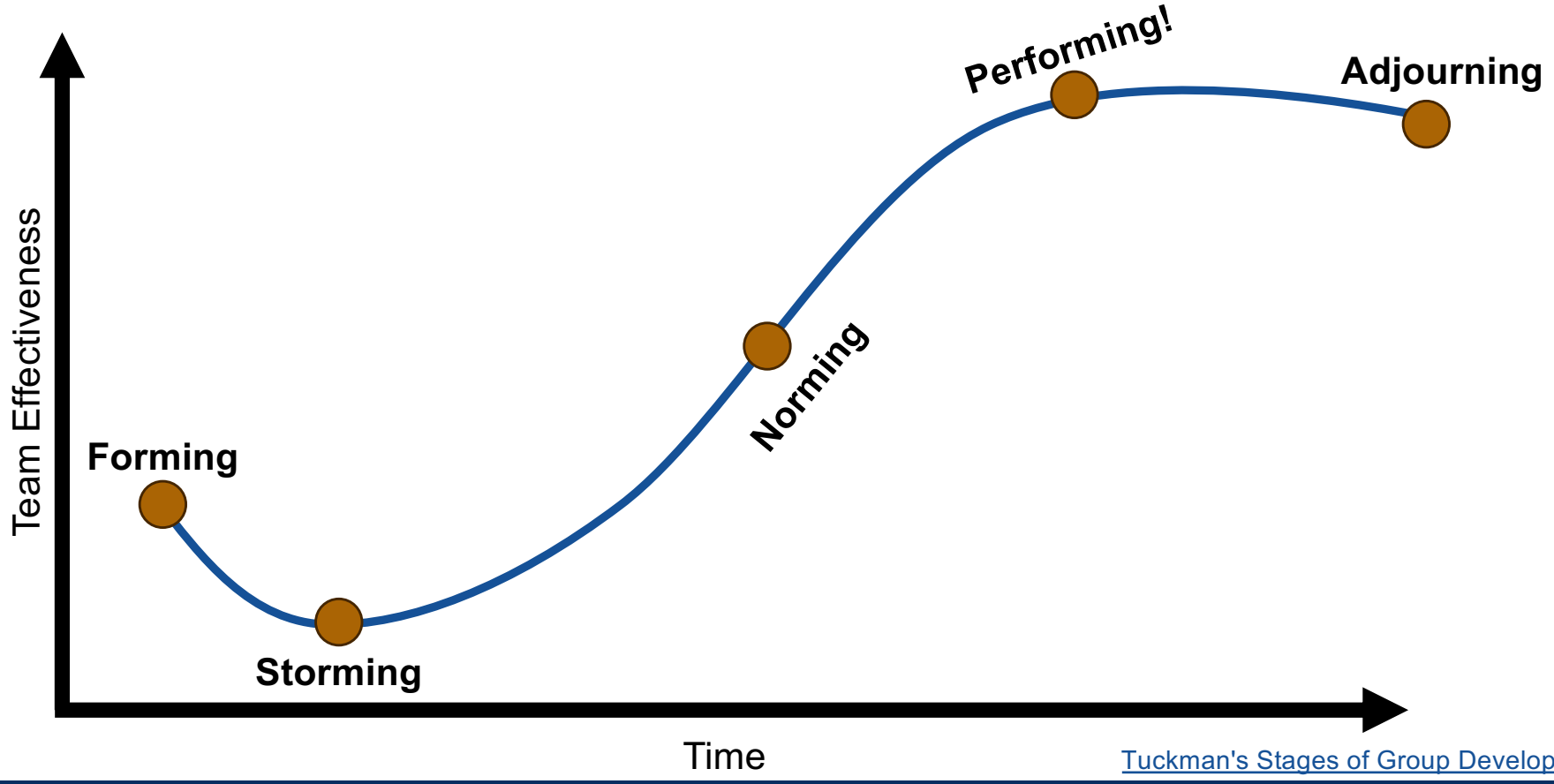
- Communication will be challenging
- Scale smartly
- Focus on the outcome before approach (the Critical Question)
- Assume positive intent
- Purposefully design your way of working with a **Team Working Agreement**

Establish shared expectations with a Team Working Agreement

- Purpose & Scope
- Roles & Expectations
- Communication Norms
- Meetings & Events
- Documentation & Visibility
- Quality

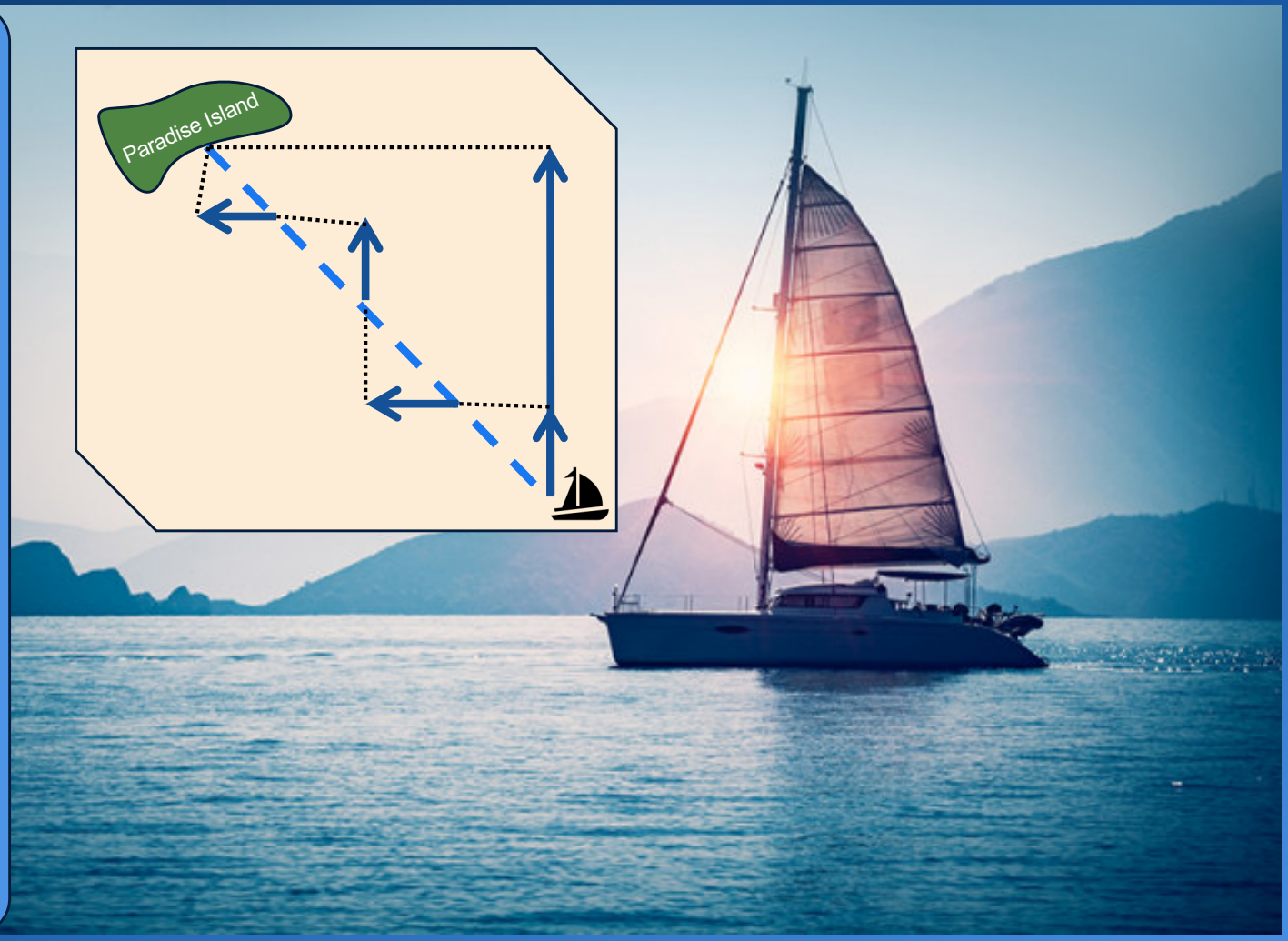
- Authorship & Credit
- Conflicts of Interest
- Learning Goals

Tuckman’s Stages of Group Development

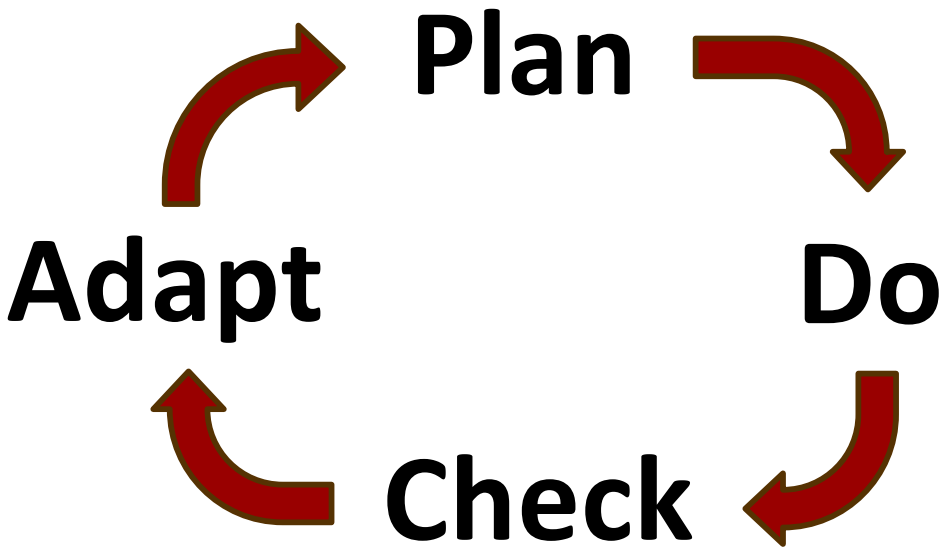


Tuckman's Stages of Group Development

You have two weeks' vacation and you're planning to sail to a beautiful, remote island. The voyage typically takes around **4 days,** but is dependent on the current and weather. How do you maximize your time on the island?

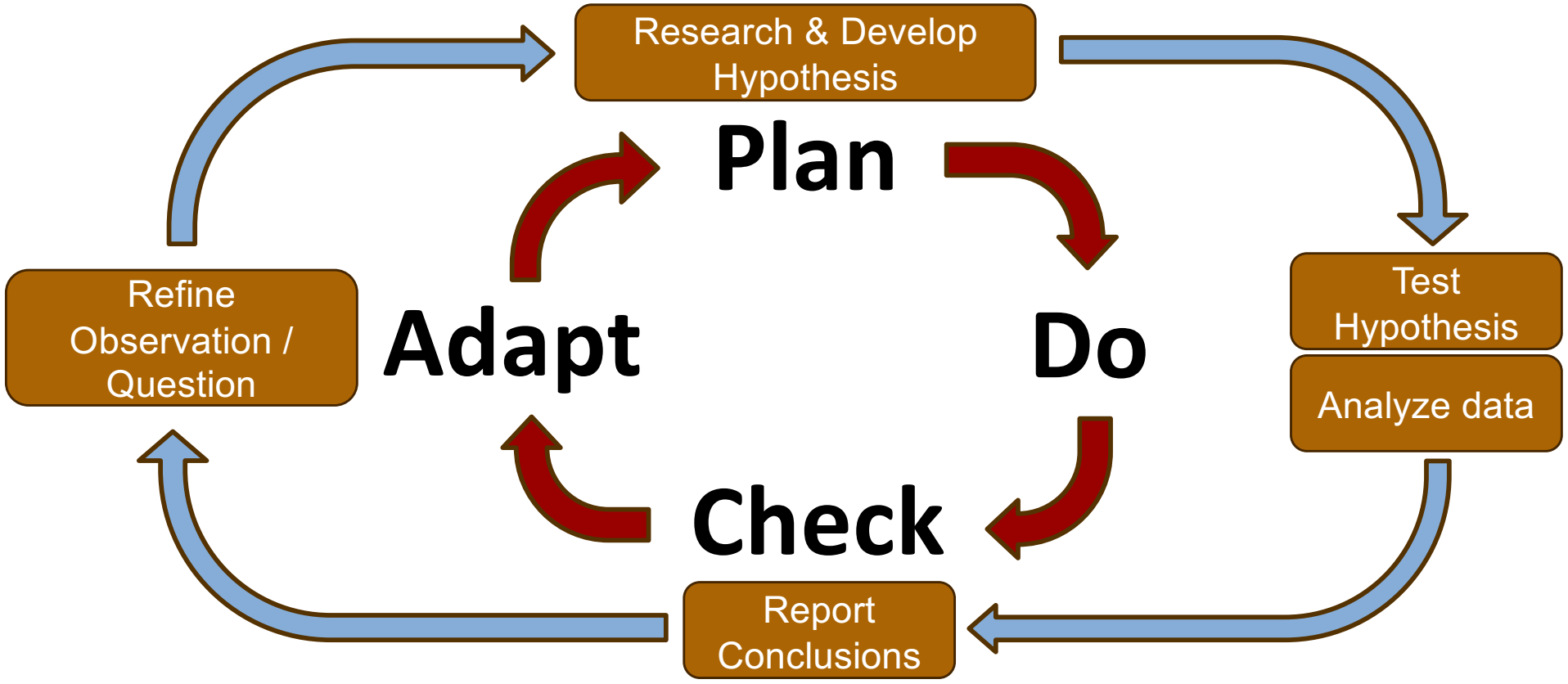


PDCA: The Core Agile Cycle



1. Product
2. Process

PDCA: The Core Agile Cycle



Common Agile Frameworks: Variations on PDCA

Agile frameworks are specific processes and methods that teams apply to work in an Agile way

Scrum
(~1 - 4 week learning cycles)

Kanban
(Daily learning cycles)

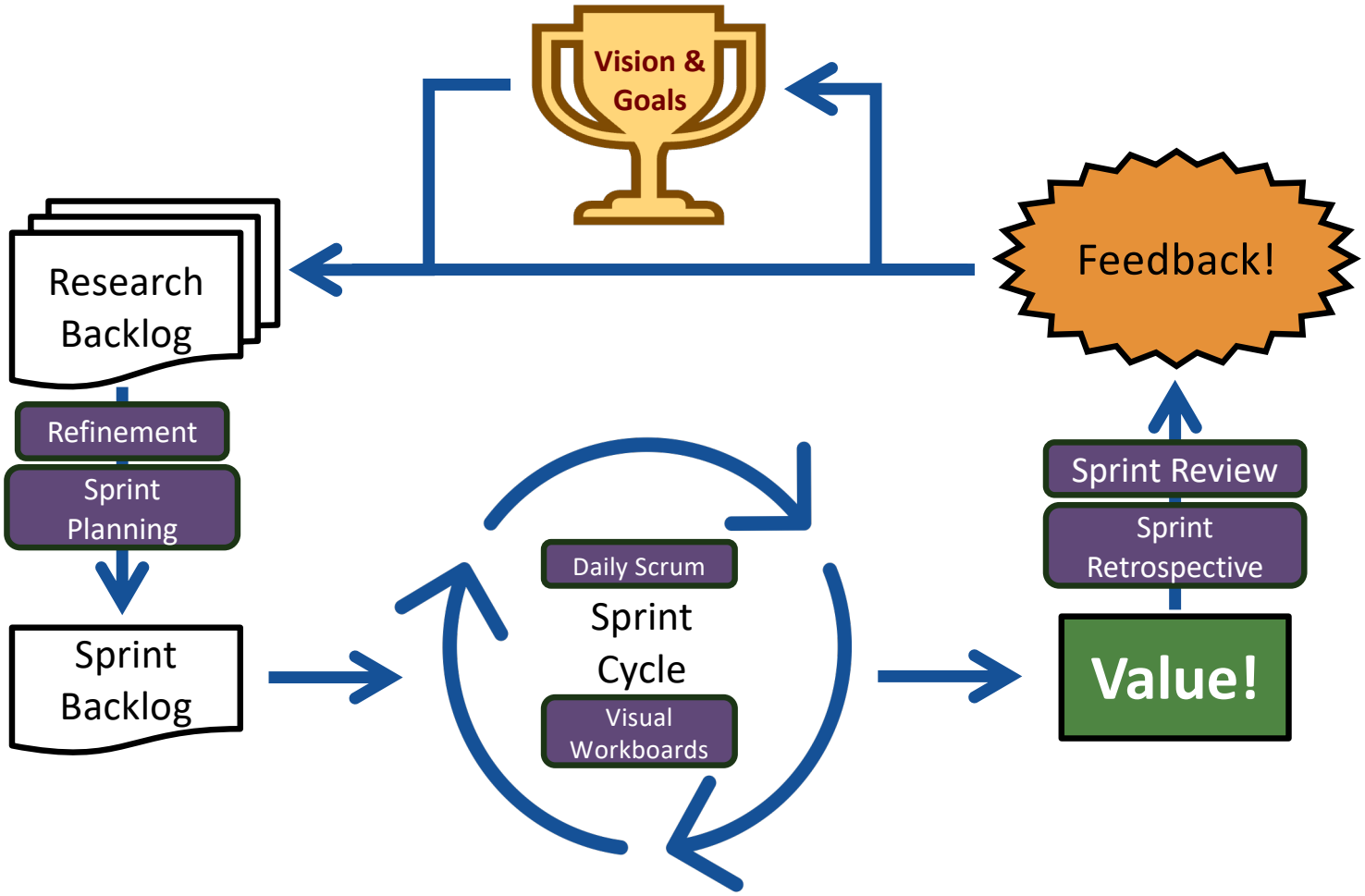
Now, variations are emerging for R&D

Team Science

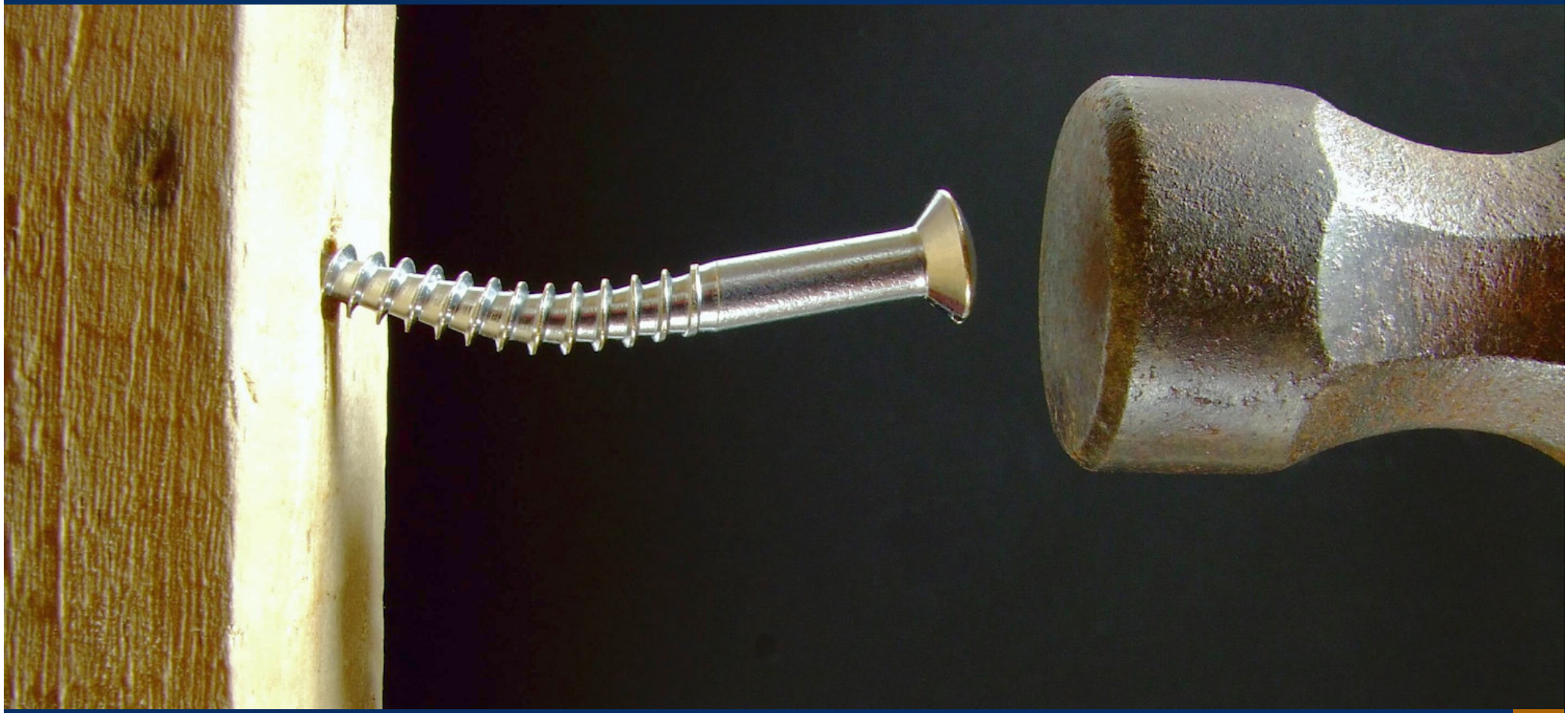
LabScrum

Ranger

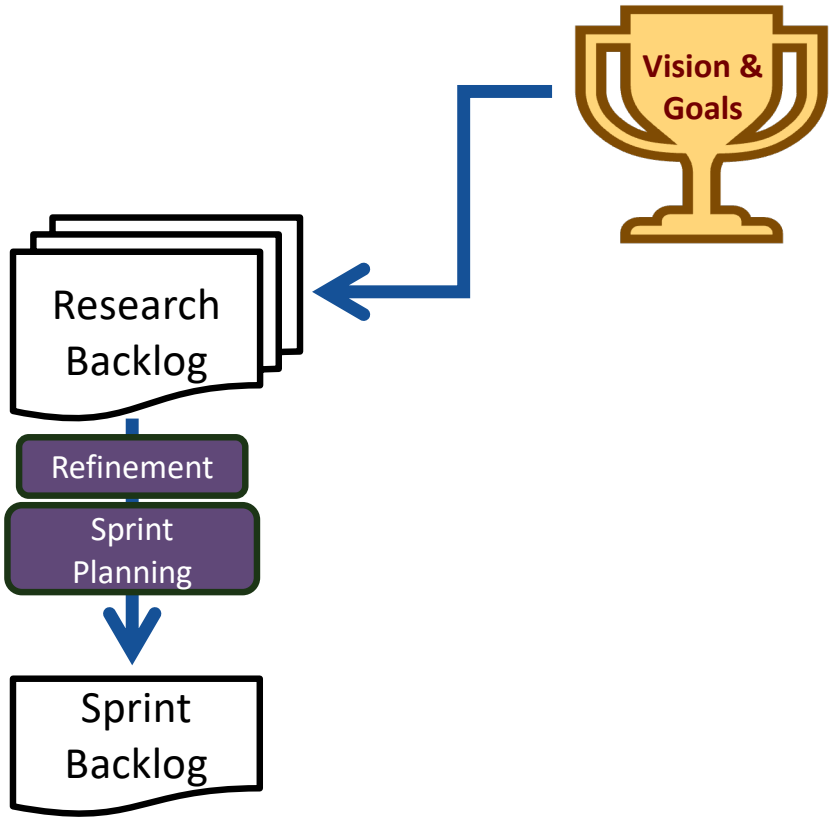
The Scrum Framework



“Individuals and interactions, over processes and tools…”



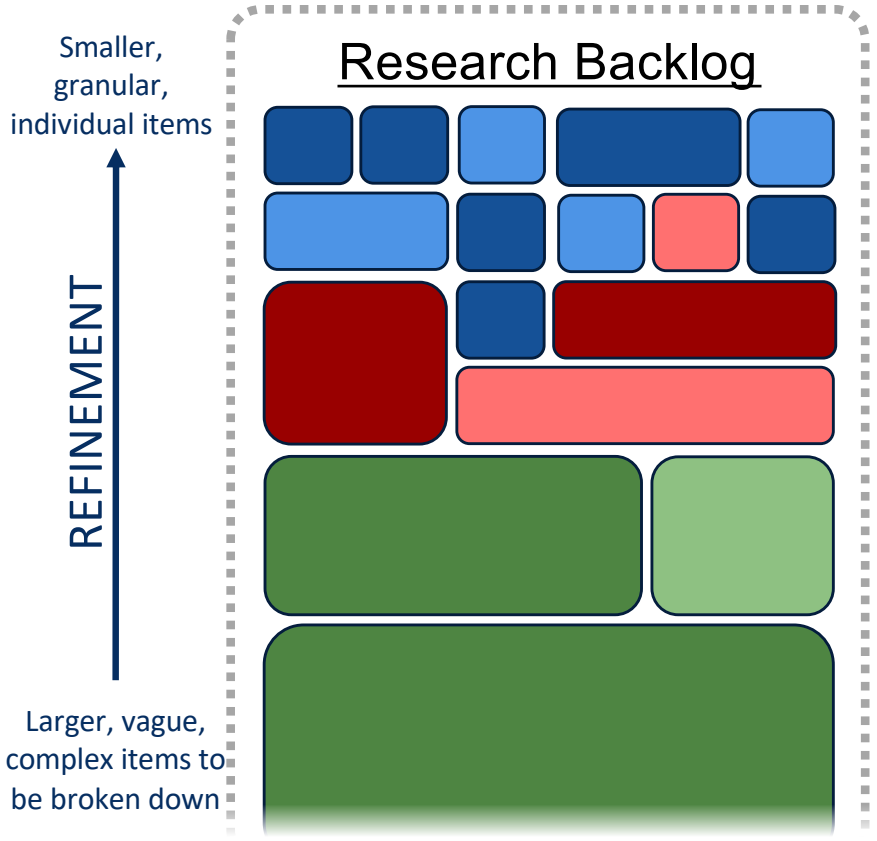
Refinement & Sprint Planning



Backlog Refinement

The process of breaking down a large deliverable into smaller, individually workable units of value. Work is considered “refined” when the team is clear on:

1. **What** the team needs to learn, **Who** the work is for, and **Why** the work is important
2. The specific outcomes that need to be met for the work to be considered ”Done”. (**Acceptance Criteria**).
3. Any risks, dependencies, or open questions to be resolved before the work is started (Meets **Definition of Ready**)



Backlog Refinement

Sprint Planning

The team's Planning event for the Sprint where they…

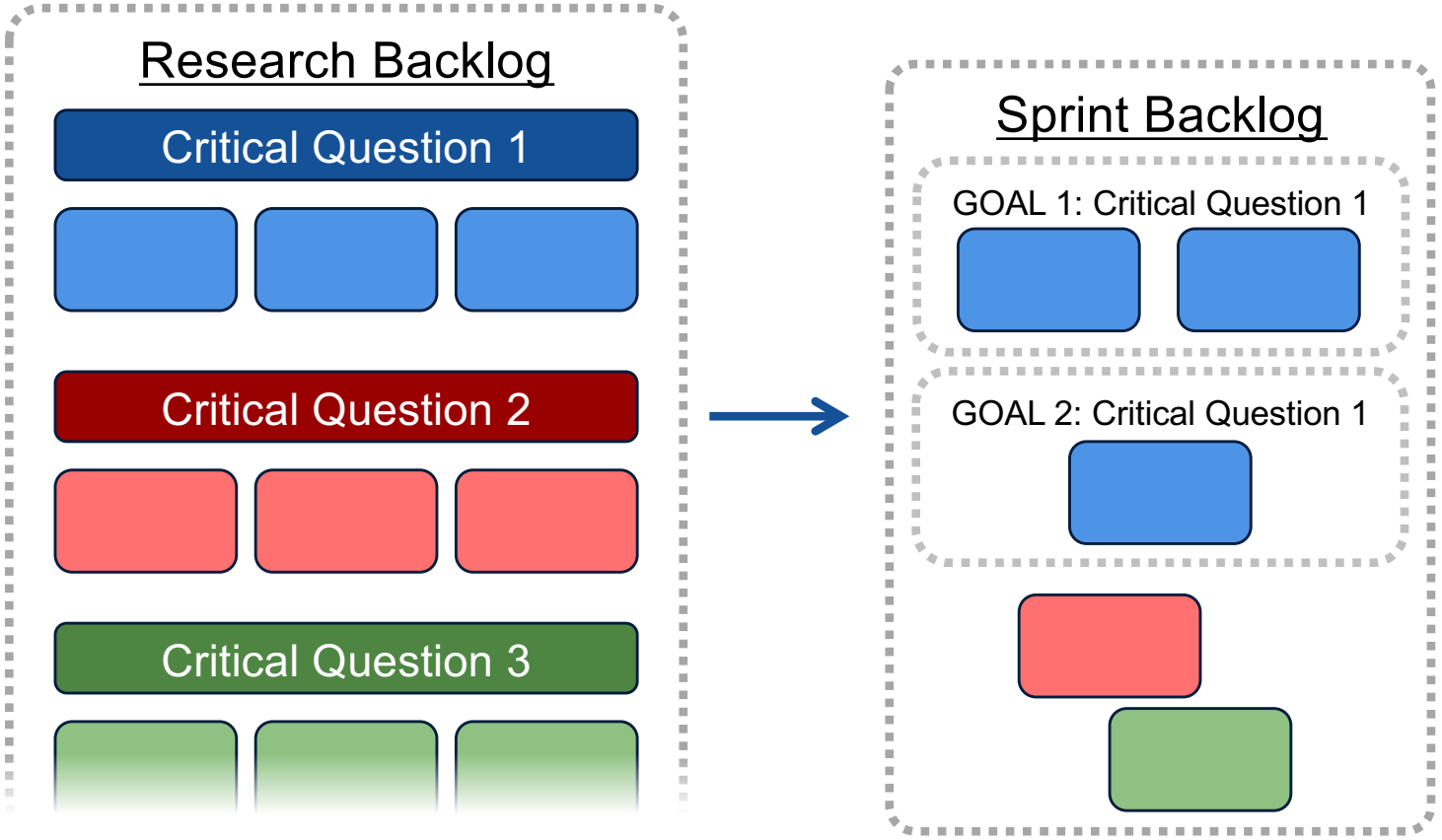
1. **Define Focus:** Align on ~1-3 outcome-based **Sprint Goal(s)**

"What is the minimum work we can do that will help us learn the most?"
"What aspects of our vision are most important to get feedback on first?"

Work **smarter**, not harder.

2. **Assemble the plan:** Populate a Sprint Backlog and refine the team's commitment for the Sprint.
3. **Do a Gut Check:** Check for confidence that the team feels they can get the work done.

Defining the Sprint Backlog



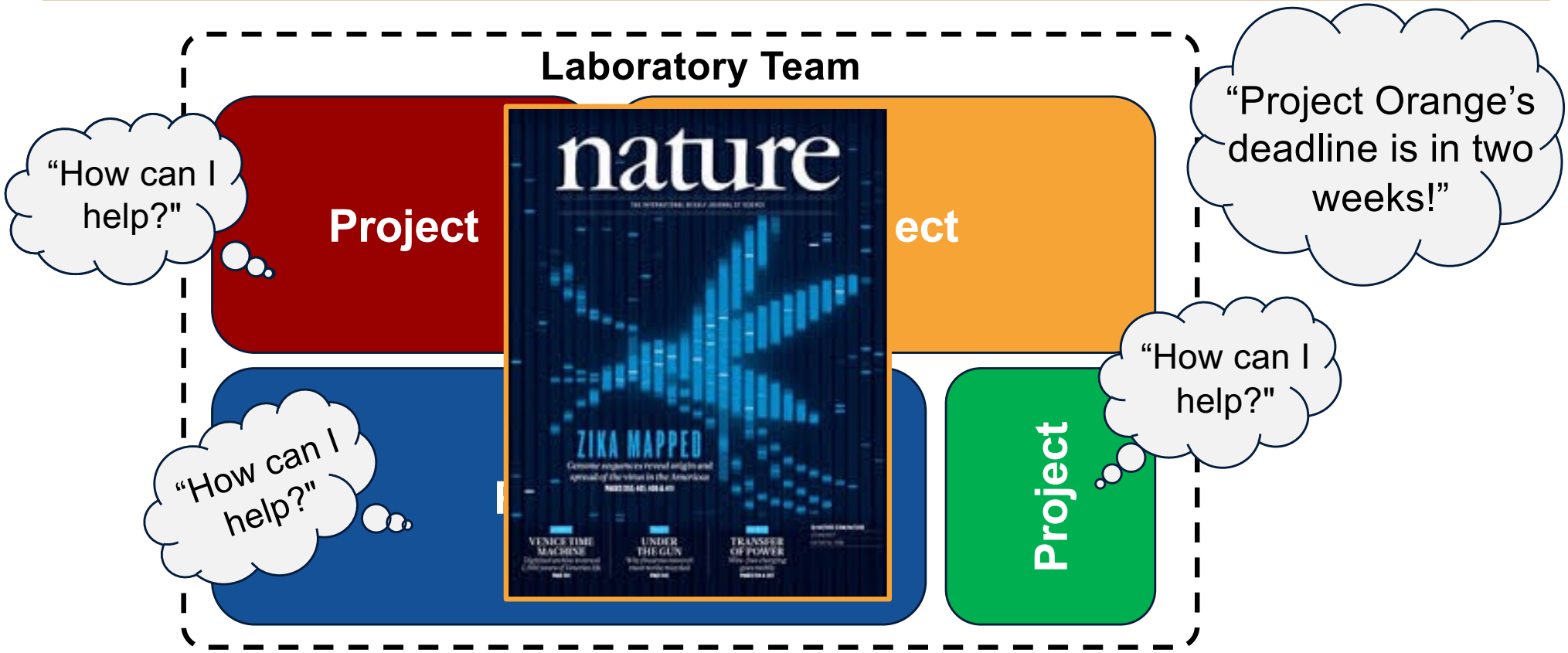
Exercise: Plan your first Sprint!

With your team, take a look at your A3 and Critical Question map, and define your first sprint!

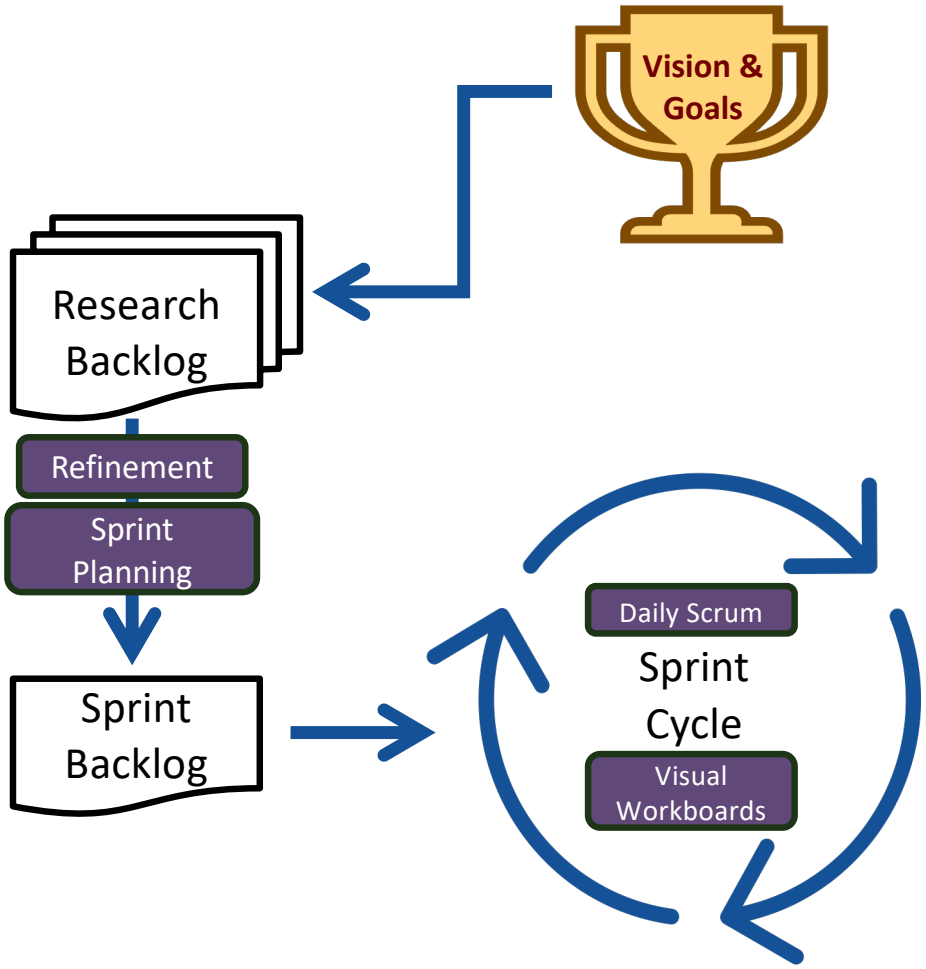
0. Decide on your Sprint Length
1. Define 1-3 Sprint Goal(s)
2. Populate the Sprint Backlog
3. Do a Gut Check: Check for confidence that the team feels they can get the work done.

How did that go?
What could have helped your team plan more effectively?

Sprint Goals in action



The Daily Scrum & Visual Workboards



The Daily Scrum

A quick, 15-minute sync to collaboratively **inspect and accelerate progress** towards the Sprint Goal. Daily Scrums are a space to…

- Identify blockers and problems (not necessarily to solve them!)
- Coordinate on work or handoffs across the team
- Adapt the Sprint Plan
- Escalate actions when needed

Daily Scrums focus on the flow of work:

“What did I learn about our Sprint Goals yesterday?”

“What do I hope to learn about our Sprint Goals today?”

“Is there anything slowing me down?”

“Has anyone seen results like this before?”

“Are there other approaches that we should consider?”

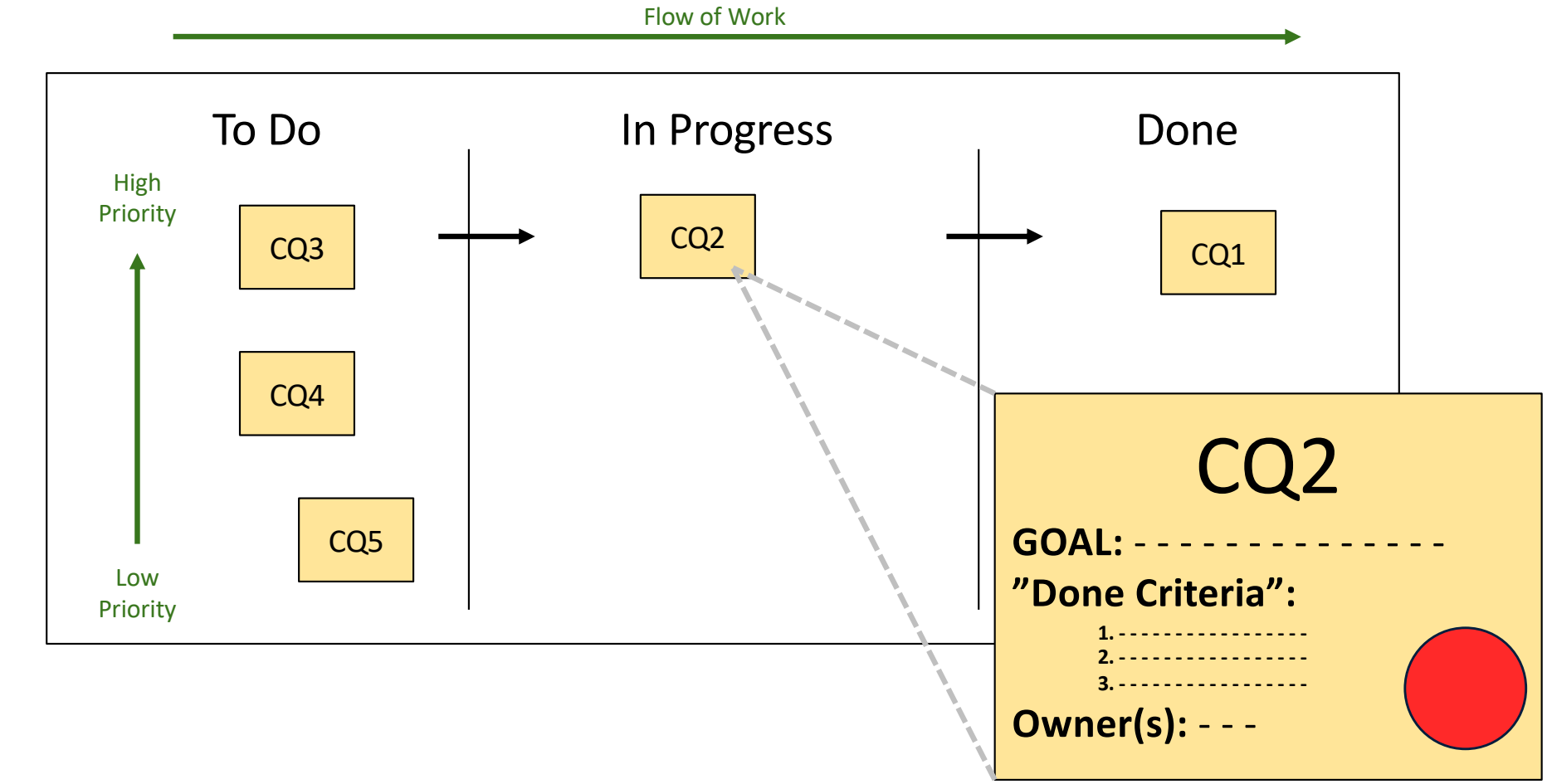
“What time do you need my data to be able to run that analysis today?”

Visual Workboards

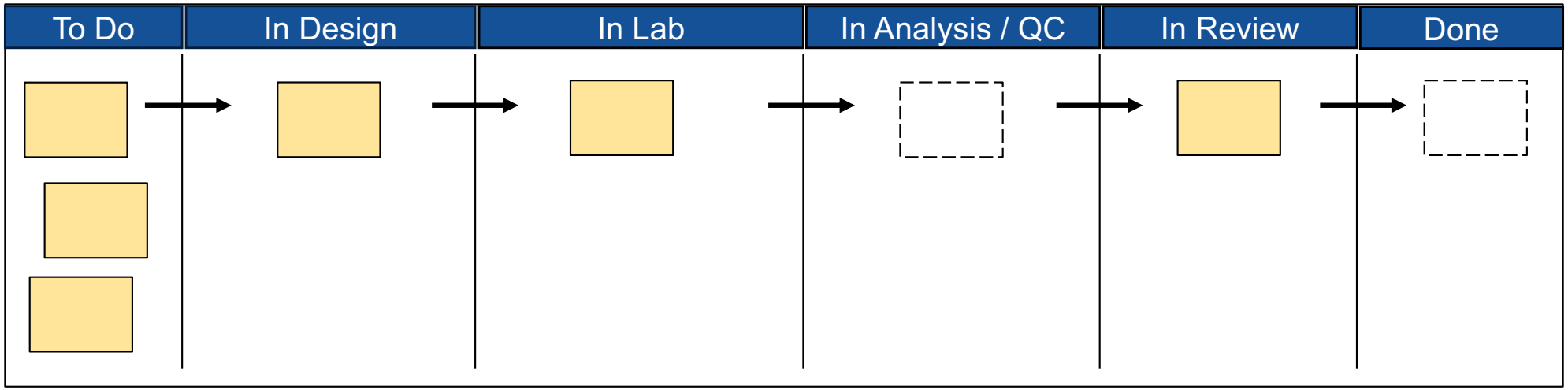
A visual workboard is an **information radiator** for which projects and/or tasks are in flight, who is working on them, and how things are going.

Visualizing work helps ensure a team stays on the same page.

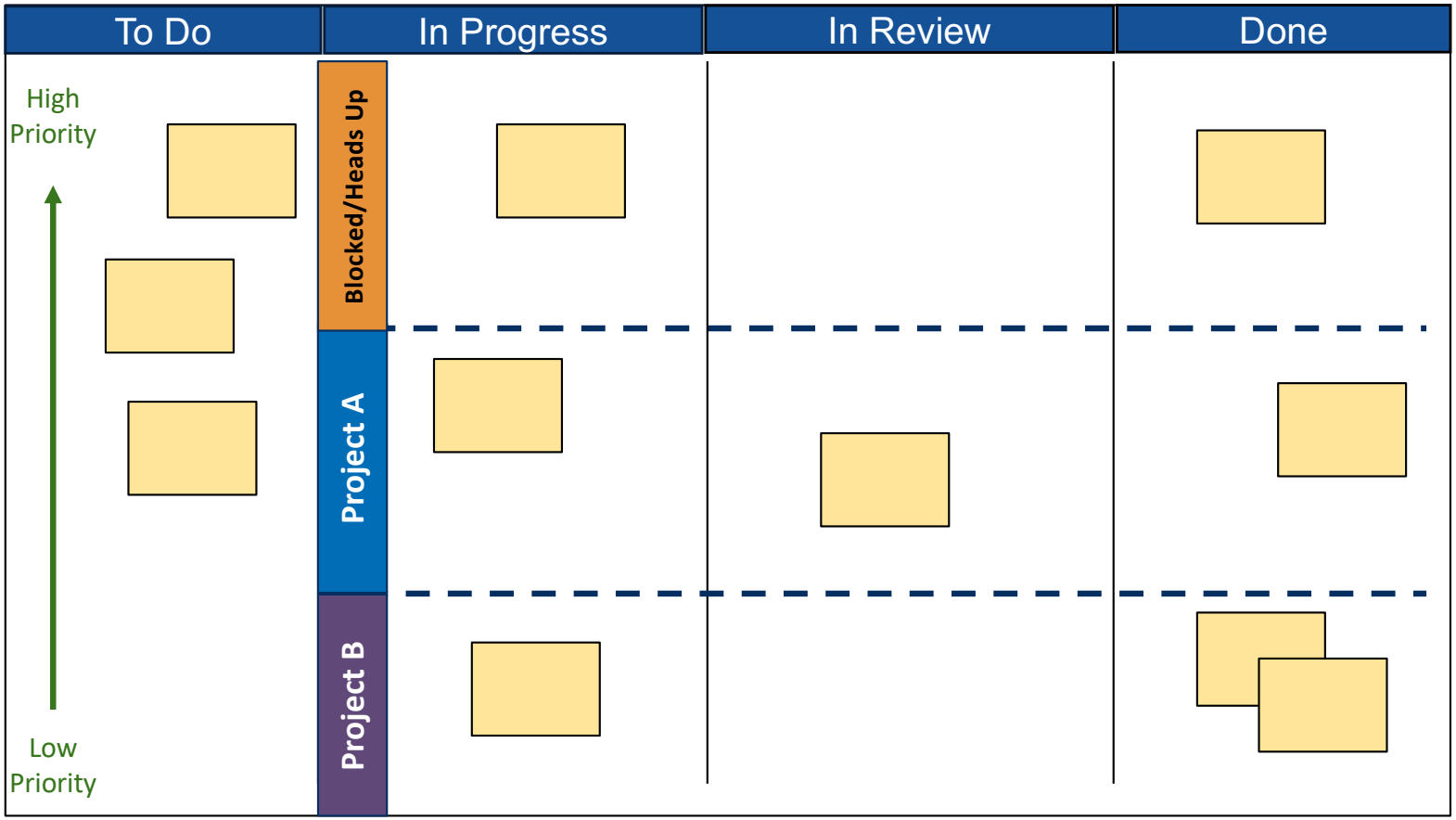
Basic kanban board:



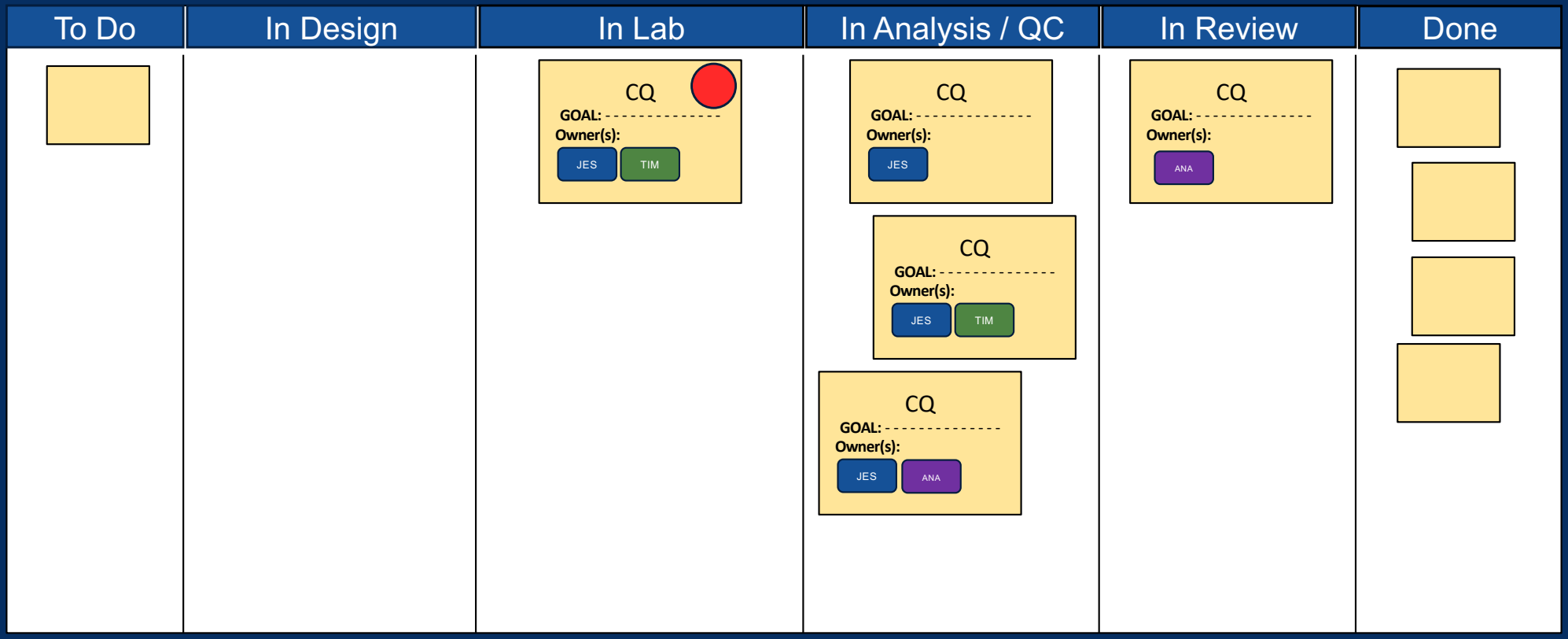
Customize to your own workflows

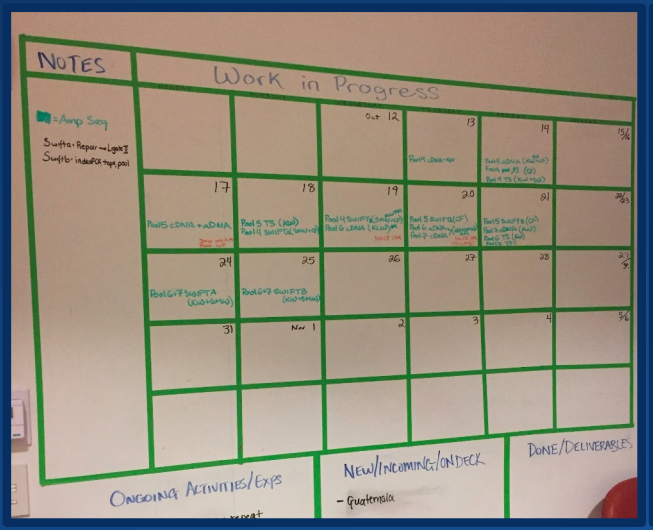


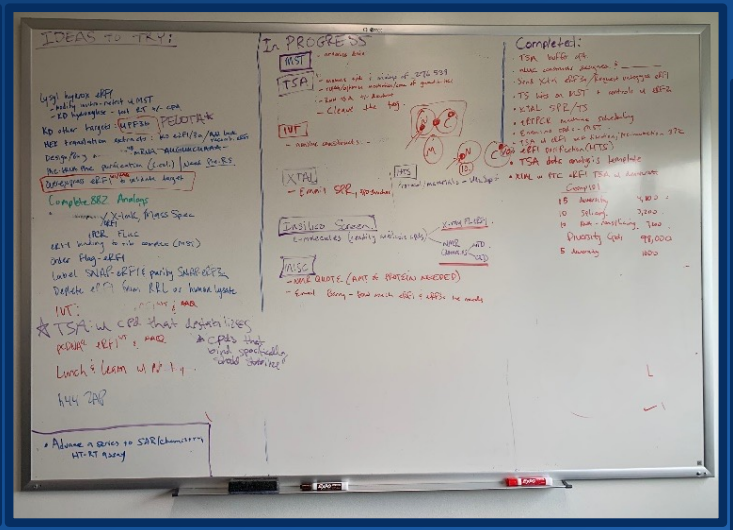
Customize to your own workflows



What questions come to mind when you're looking at this Kanban board?



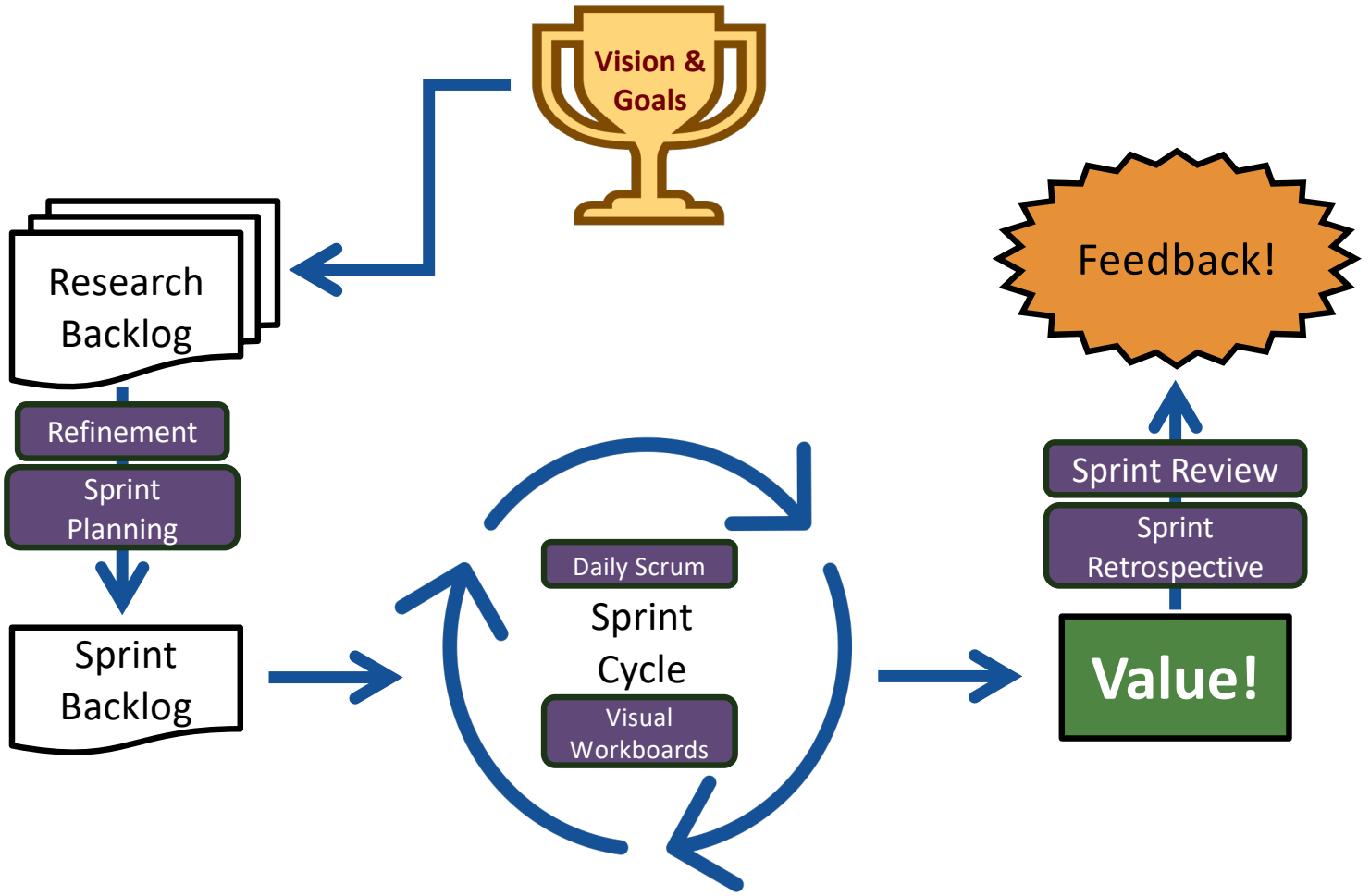

NOTES
Work in Progress
ONGOING ACTIVITIES/EXPS
NEW/INCOMING/ON DECK
DONE/DELIVERABLES


IDEAS TO TRY:
IN PROGRESS
Completed:


Auto Test Office Hours:
Tues + Fri
11:30-2
GOAL 20 Test Runs Passing!
SWAT-onation
TO DO
IN PROGRESS
DONE
DEMO?


Data Generation
Software
Analysis

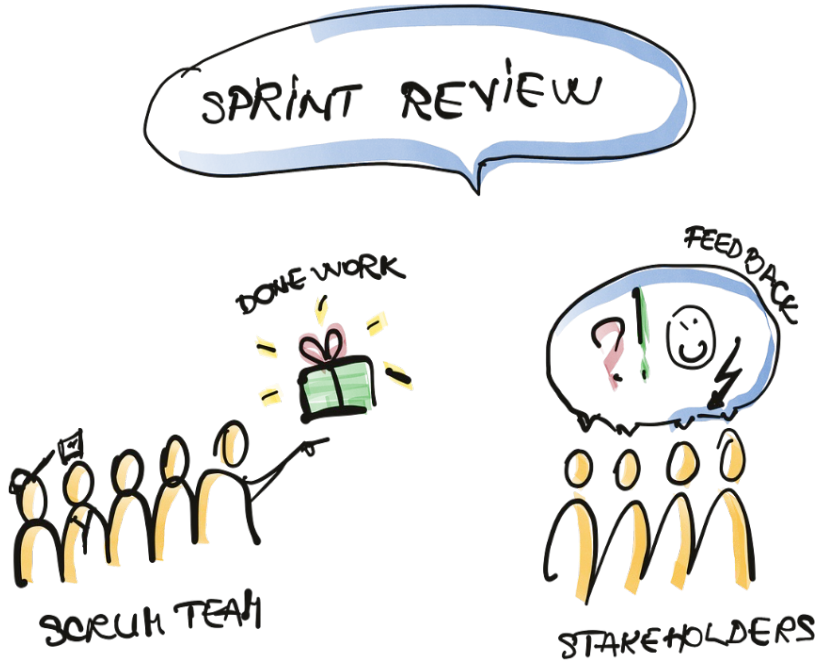
Sprint Review & Retrospective



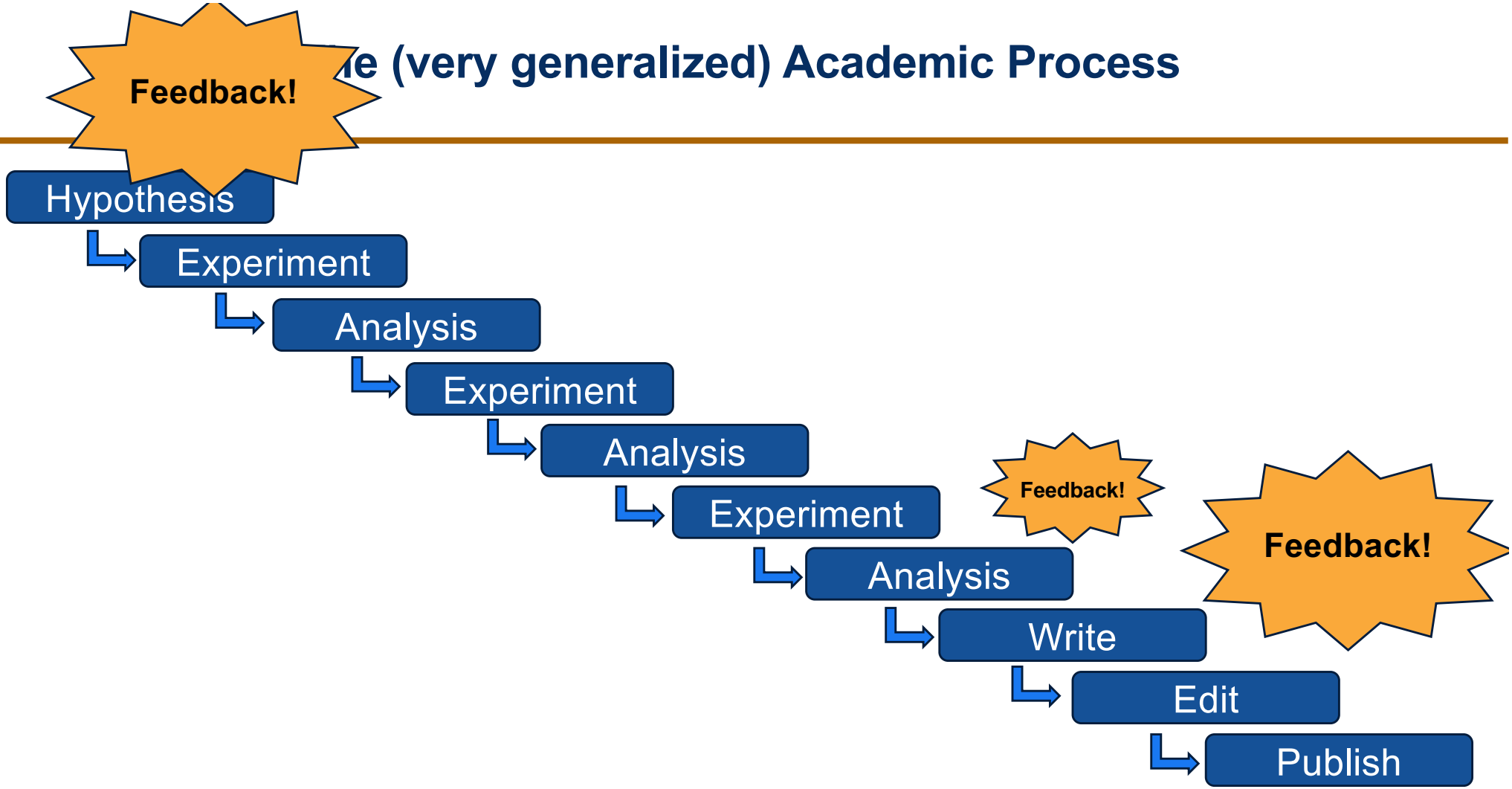
The Sprint Review

The closing event to the Sprint which demonstrates value and insights gained for early feedback and direction with Customers and Stakeholders.

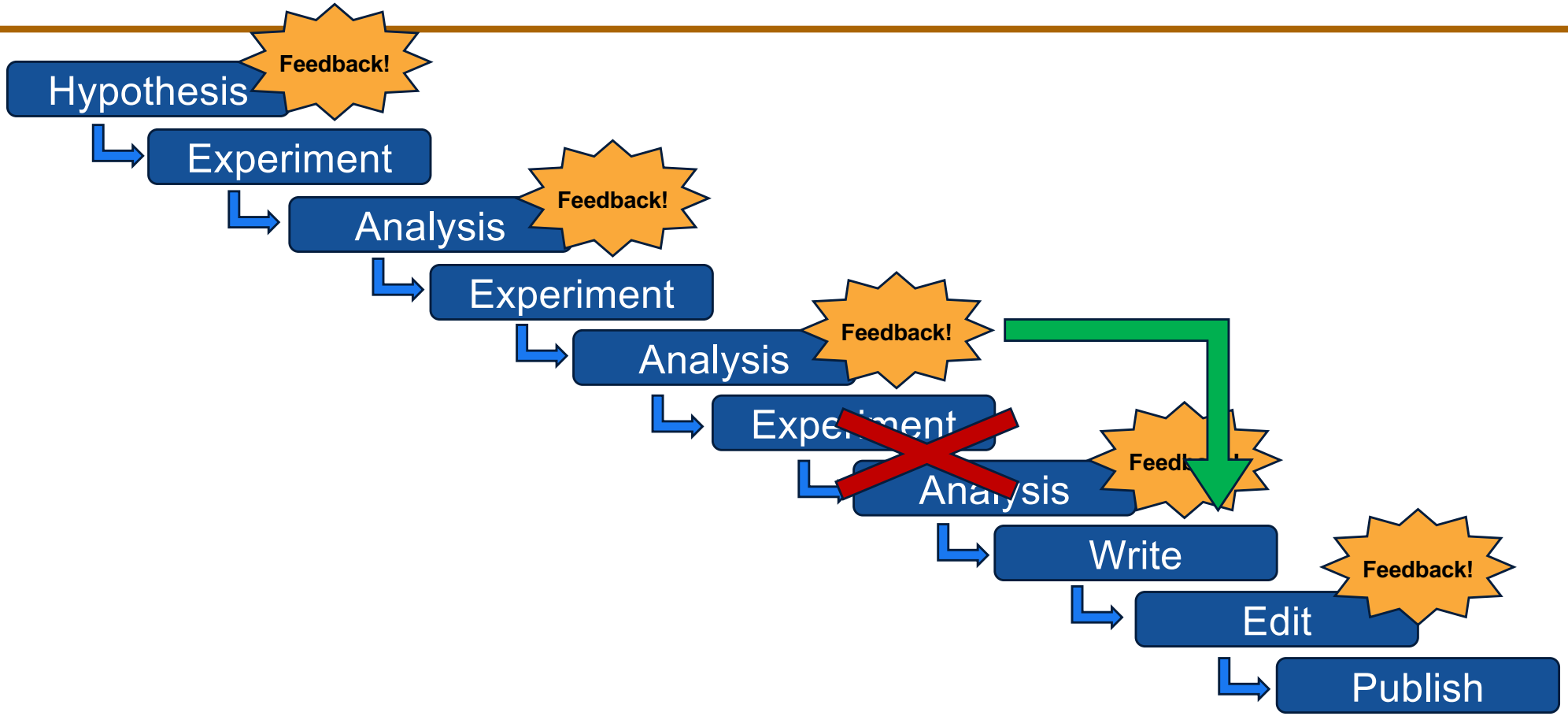
- Value demonstrated does **not** need to be finalized or polished
- A good Sprint Review feels like a discussion
- Highlight upcoming Sprint Goals for feedback before they're started
- Incorporate feedback into strategy
- Consider what kinds of feedback are valuable to your work



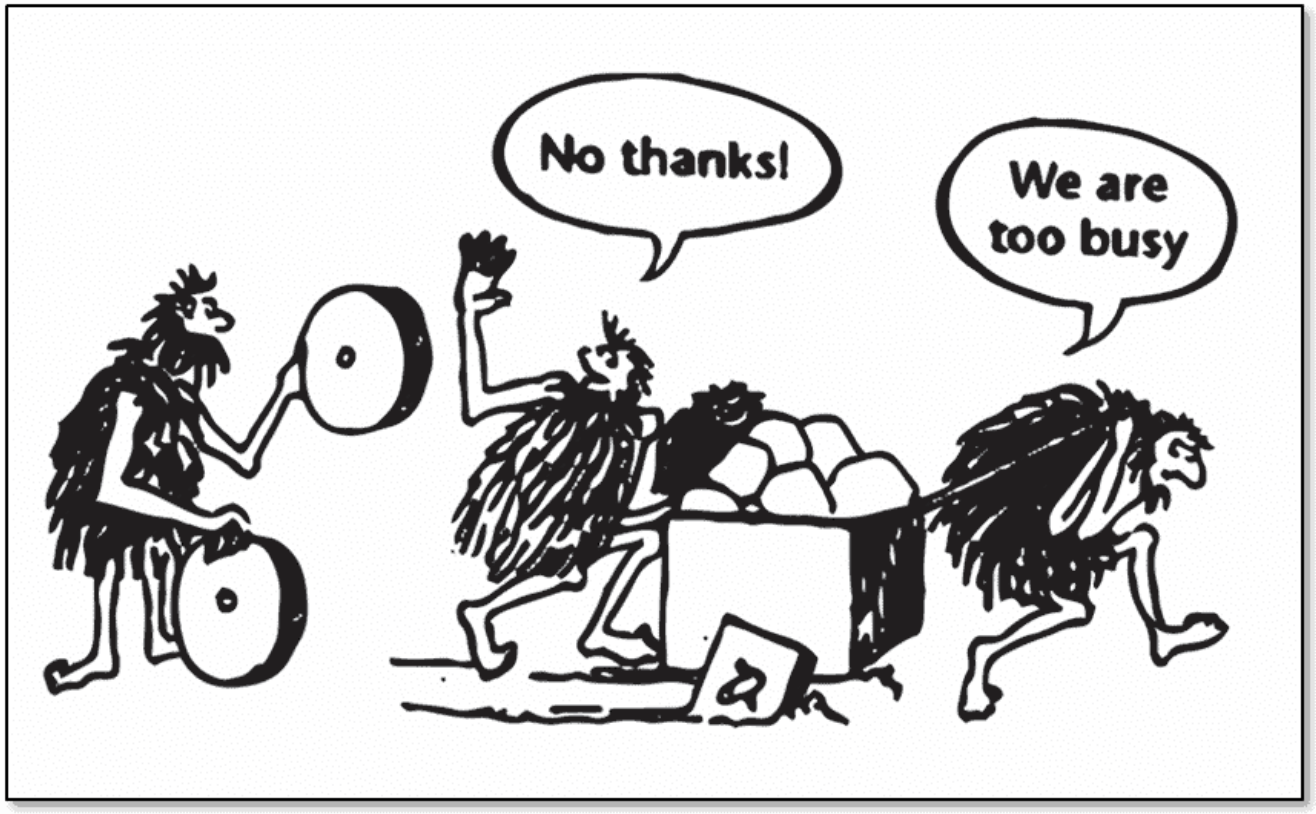
ne (very generalized) Academic Process



The (very generalized) Academic Process



The Sprint Retrospective:



The Sprint Retrospective:

A Retrospective meeting is a recurring event focused on continuous team and process improvement. Retros end in definition of actions and experiments to help the team become more effective.

- At times, a team may benefit from a more targeted Retro discussion
- Share Continuous Improvements across teams to accelerate group learning

Retro discussions are typically framed around two conceptual questions:

“What is going well, and why?”

“What do we want to change, and how?”

“Who’s going to own this action, and when are we following up?"

The Prime Directive of an Agile Retrospective

"Regardless of what we discover, we understand and truly believe that everyone did the best job they could, given what was known at the time, their skills and abilities, the resources available, and the situation at hand."

Quick tips for Constructive Feedback

1. Be tough on process, not on people.
2. Bring questions, not judgements.
3. Focus on the action’s impact on the team.
4. Acknowledge your part in the situation.
5. Establish a common goal to work towards together.
6. Follow up.

Quick tips for Constructive Feedback

Negative feedback harms trust and decreases performance for a time.

Positive feedback builds trust and increases performance for a time.

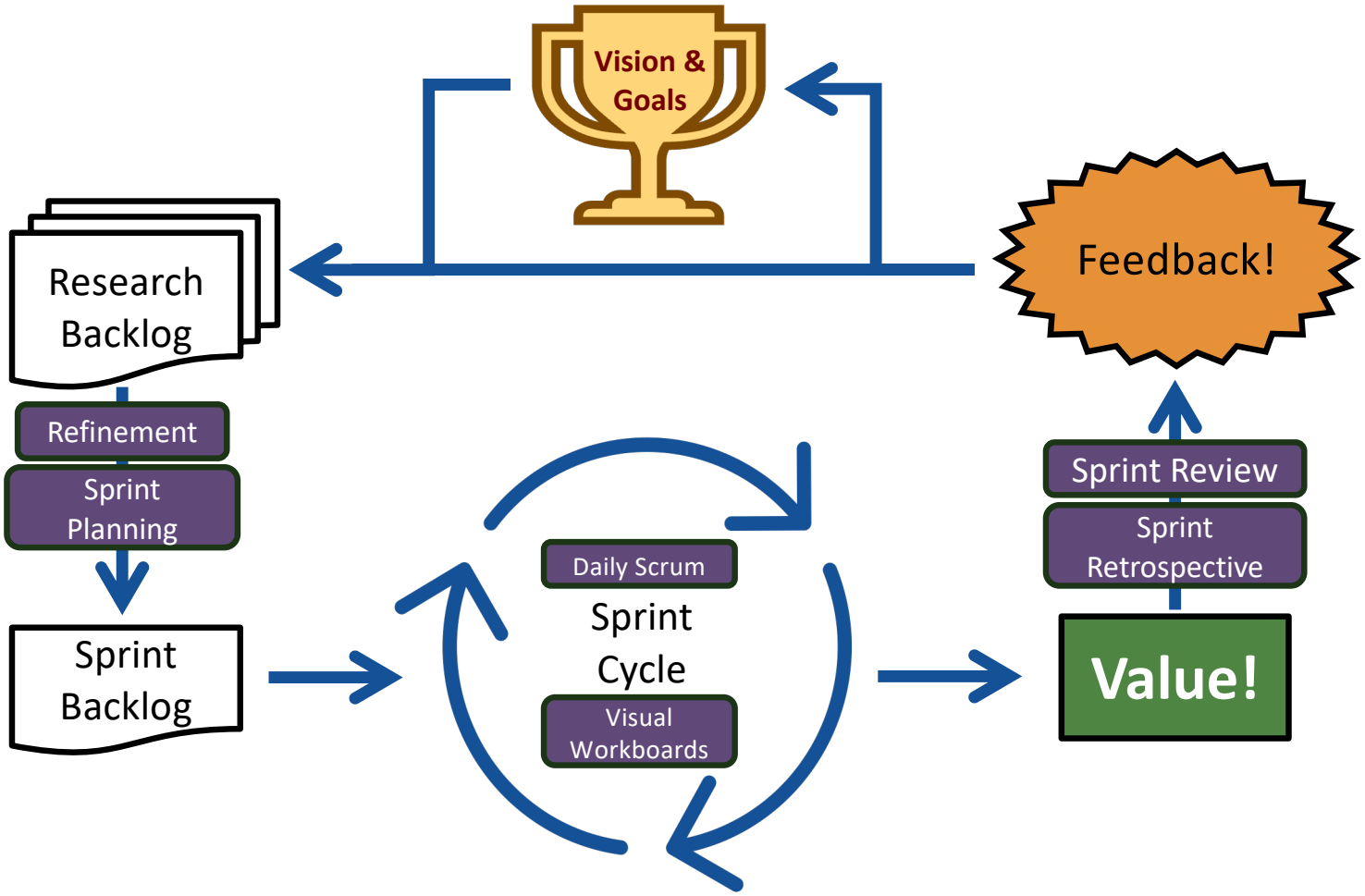
Practicing Constructive Feedback

Things have been going well for your research project, but lately one team member, Mike, has been showing up late to meetings or missing them entirely. When he does join late, the group will often need to repeat themselves and re-open topics that were already discussed. Mike apologizes profusely when he is late, but there's no question that his absence and tardiness is slowing down the team.

With a partner at your table, practice your feedback conversation with Mike.

Retrospectives on multiple scales

Inspect, and adapt.



Agile R&D Coaching Scenarios

The following are situations that one might encounter working on an R&D project. With your table, put on your “Agile Coaching Hat” and discuss how you would help each team navigate through the challenge with the Agile principles in mind.

Agile R&D Scenario: The Siloed Scientist

Marie is the PI of a small lab in the Geochemistry department. She coordinates a team of eight people at varying experience levels and technical backgrounds. Lately, the lab has been working on an important project using a new analysis protocol developed by Cameron, a Post-Doc within the group. Cameron insists on running the analysis himself, but has not been able to keep up with the influx of results to analyze and it's starting to put the project behind schedule. When other lab members try to help Cameron, he quickly loses patience and takes back over saying "We don't have time to mess this up."

What's the "root cause" for the challenge the group is facing?

How would you coach the team?

What's the first action you would take?

Agile R&D Scenario: Conflicting Priorities

The management team of the MagLab is at their bi-weekly planning meeting, and tensions are high. Lan, the manager for the Lab Operations team, is complaining that her team members keep getting pulled from their processing work into support for Tim's Process R&D group. Lan says she needs her team to focus on their work so that the team can sustain operations for their existing projects. Tim says without the help, the group will not meet the deadline for their project, which involves a promising new technology to offer to the MagLab research community. Lan's team members are confused at which project they should be focusing on, and feel frustrated at being caught in the middle.

What's the "root cause" for the challenge the group is facing?

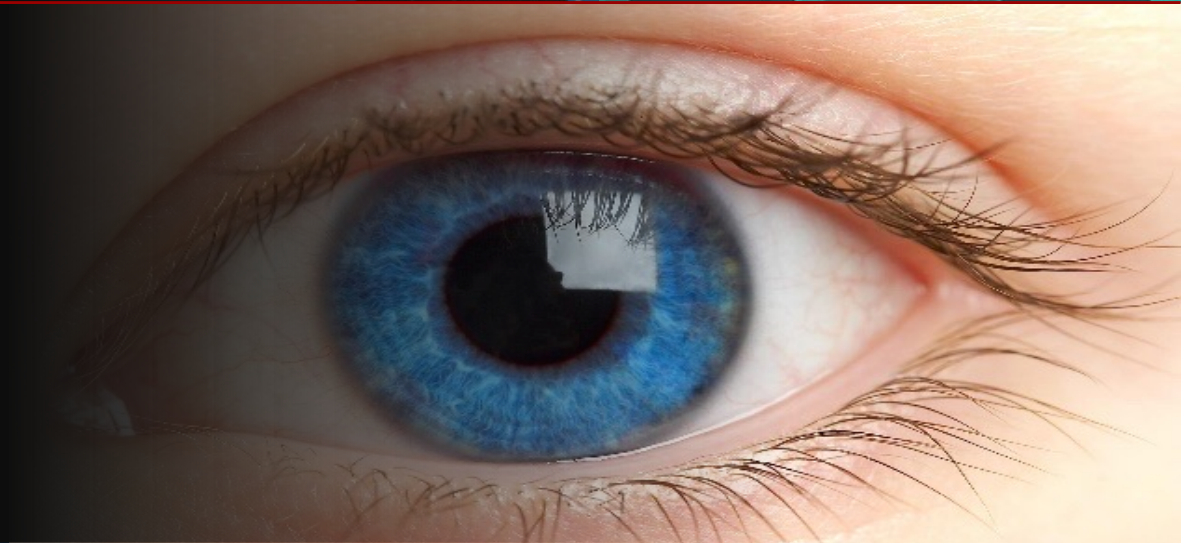
How would you coach the team?

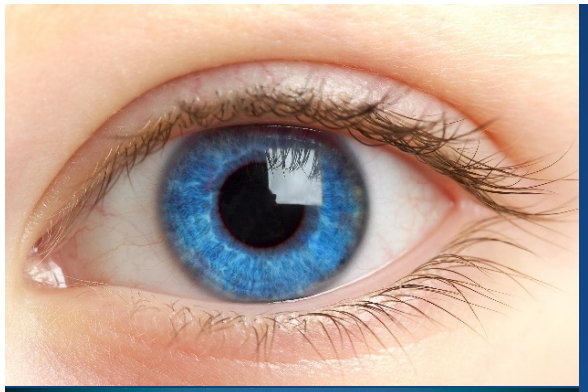
What's the first action you would take?

Open Q&A

What challenges are <u>you</u> experiencing in your lab?

Review





Vision
(the "What")

→ Create Questions.
Structure the unstructurable.

Thinking
(the "how")

→ Craft your science.
Work smarter, not harder.

Organization
(the "How")

→ Work dynamically.
Small, fast learning cycles.

Resources for further learning

Lean R&D Learning

- "Creating a Lean R&D System: Lean Principles and Approaches for Pharmaceutical and Research-Based Organizations" - Terry Barnhart
- "Lean Product and Process Development" - by Allen C. Ward & Durward K. Sobek II
- "Managing to Learn" – John Shook
- "Toyota Production System" - Taiichi Ohno

Agile Framework Guides

- The Scrum Guide
- Kanban Guide
- Collaboration in Team Science Field Guide
- Scrum@Scale Guide

Agile Laboratory Learning

- The Agile Laboratory Handbook
- Experience Report: Agile in the Academic Laboratory
- Video: Enhancing Laboratory Effectiveness with Agile Ideas & Practices
- Using Dynamic Work Design to Help Cure Cancer (and other diseases)

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