[Morse code beeps]
[Whoosh]
[Helicopter rotor]
Hi everyone.
My name is Nick Rober.
I am a Fellow with the AeroAstro Comm Lab.
And today we're going to be talking about
managing a research project.
So the lesson goals for today
are first to identify
ways that we can both define
and scope a research topic.
We'll talk about
how we can learn strategies for,
breaking projects into manageable bits.
And then we'll also practice,
tracking our progress for a given research
topic,
and adapting your plan as things change.
So first I want to jump into why
actually managing a research
topic is important.
So if you haven't figured this out by now,
research can be very messy.
So things don't usually go
according to plan.
Things change as you,
as you go through, researching a topic,
and what we call a scope
creep can be very normal.
And what scope creep is, is
just the gradual
changing of your scope of your research.
So as you go through a project, maybe
you add things, maybe you remove things.
The scope of what you're actually
researching changes as you go, and this is
super super common.
And so
what we see is that if you're,
if you have poor project management,
there can be a lot of wasted
time, a lot of frustration, a lot of,
you know, difficult meetings
with your advisor.
But if you have very clear,
and efficient management,
you can make progress a lot faster,
and your impact is usually pretty,
is usually higher.

So the thing to keep in mind
is that even from very early stage,
stage planning of your research topic,
this is something
that you should keep in mind.
You want to be able to identify
what you're going to be doing next,
how that might change,
and then avoiding getting stuck
in kind of cycles of reading and,
and going back to the drawing board.
And then also you,
with good project management,
you can notice quickly
when a direction isn't really working or
probably won't pan out.
So what are the common research challenges
that make this difficult?
People will often try
and address a topic
that is either too broad or too vague.
This usually leads to kind of
just reading without much focus
and and trying to get as much information,
but you don't necessarily
know what information
you're trying to get.
And then if you have difficulty
explaining your project
in 1 or 2 sentences,
that can be an indication that you're
working on something a little bit vague.
Trying to solve a lot of stuff at once.
So we'll talk about this
a little bit later,
but if you're doing a lot of things
it makes it a challenge
to actually get anything done because,
the amount of stuff that you're doing
is really difficult.
So what this often manifests as
is feeling busy
but not actually getting much done.
Another thing that is important
to keep in mind is, is your project
progress trackable?
Is, the, are the things that you're
doing, measurable in some way?
And another important
challenge that we'll talk about

is communication with your advisor.
So if you're meeting,
if your meetings feel unproductive,
or if you're getting
a lot of contradictory feedback
that seems different
from one meeting to the next,
it may be an indication that you're,
you're not moving with enough focus.
So the important thing
to kind of begin with is
you want to start
with a very clear question.
So keep in mind
that research is ultimately a practice
of asking and answering questions
and you shouldn't be trying
to accomplish everything in one go.
So whenever you're starting
or working on a research project,
a very key question that you should ask
yourself is what gap am I addressing.
So this could be through the form of
you know what.
So what doesn't work,
what isn't understood,
or what is missing in current approaches?
You may ask why, why does a gap matter?
Why does this thing happen?
Or how?
So how can this be addressed with, you
know, a given set of tools that may exist?
Or how can we develop
new tools to address this problem?
And the thing to keep in mind
is that you want to keep it narrow enough
that it's something that is achievable,
but not too narrow, that it becomes
uninteresting or trivial.
So one way to do this is,
with what I call the scope matrix.
So there's three axes to the scope
matrix.
One axis is the problem.
So how big or small, easy or hard
is the problem?
One axis is the method.
So, is your method that you're going
to try to apply super, super new
never been done before, or is it something

that's maybe a little bit more standard?
And then the third axis is the domain.
So you know, how broad or narrow
is the set of problems that you're trying
to to address.
And ultimately what this boils down to
is that increasing along one axis
will usually require a decrease
in the other to remain feasible.
So for example, consider
we have some problem,
and we want to,
we want to solve that problem.
If I want to take a standard method
and update it
so that I have some new method,
maybe the problem can stay the same,
but the domain of types of,
things that it applies to is reduced.
So that is represented
by this diagram here.
An overambitious
example for this scope matrix.
So you could imagine if we have
our problem is safety
performance and stability,
so three properties of a system,
maybe what we're trying to do
is develop a unified control
and verification framework.
So that does a lot of stuff.
And then the domain is for all autonomous
aerospace vehicles.
These are all three different things
that have kind of maxed out one of the
axes of the scope matrix, and solving
this problem would be super, super hard.
So you kind of need to reduce one
or more of the axes to actually,
you know,
think about actually solving this problem.
So with that in mind, we will launch
into our first activity of the day.
So open the Apply the Scoping Matrix file,
and take about five
minutes to complete that.
[Alien
spaceship beeps]
Okay, so once we've kind of thought
about our project and scoped it out

and have some idea of what we're doing
that's reasonable and achievable,
the next piece of managing a research
project is to break your project
into units.
So I have what I like to call
the minimum research unit.
So this is just a small
and meaningful result
that can be, achieved by you
know, 1 or 2 actions.
But basically what you want to do is
you want to start with 1 or 2
small questions,
that can be answered through
one experiment and it produces
maybe a tangible figure, or graph,
or a result that you can kind of point to
and say,
you know, “I answered this question,
with this result.”
These minimum research units help
to decide what to work on next.
They help to recognize you know, progress
when you're making it.
So once you get this figure, you say,
you know, this is progress.
And then it helps to avoid getting stuck
in these loops where you kind of
have this vague idea of your direction
you're moving, but not actually,
getting any progress in that direction.
So some examples of a minimum research
unit could be,
implementing a turbulence model
and comparing it to baseline CFD.
You might study the flow separation for
one angle of attack of, of a wing,
or you might evaluate
the aerodynamic performance,
for some airfoil modification.
So let's, go into the next activity.
So find the file.
Break Down Your Project
and take roughly five minutes to complete
that.
[Alien spaceship beeps]
So the next piece of managing a research
project is, is very important,
this is, milestones and tracking.

So there's a couple of different types
of milestones.
We have short term milestones.
So these are usually on the order of days
to weeks, maybe a month, Where.
you have a focus on doing
and accomplishing something.
Maybe you're learning something.
Maybe there's something
you need to understand better.
But it's often
tied to one of these single
kind of minimum research units
that we talked about previously.
So these short term milestones
ultimately, what they help you do is,
make progress in a visible way
that, helps you,
you know, track whether or not
you're moving in the right direction.
And it also helps
you avoid getting overwhelmed.
So by breaking things into smaller pieces,
they feel more manageable
and you can move more consistently
in the right direction.
Long term milestones, on the
other hand, are usually more
on the order of a month to a year.
They're really good for kind
of motivating your research direction.
They can be used to, kind of choose
what short term goals you have.
But ultimately they're, they're focused
on kind of high level outcomes.
So it could be something like,
I want to finish my thesis,
I want to get this journal paper done,
something like that.
And that is what you can use to kind of
build your short term milestones,
to build up to that.
And what long term milestones do is
they will give you direction
and motivation for your research.
They'll kind of teach you or show you what
you need to prioritize in your short
term work.
And then they'll also anchor
your project's overall purpose

into something real and achievable.
And throughout all of these milestones,
you want to be tracking your progress
in some way.
So there should be some amount of,
you know, here's this output
that I got from this milestone.
And then that can be applied, you.
know, iteratively through your long term
horizon so that you're able to keep track
of the fact that you're actually
doing things, tangibly.
And then the final piece of,
managing a research project is adapting
and refining your, your approach.
Because, like I said at the beginning,
rarely does
a research project
go fully to plan without any changes.
So you should always expect that,
you know, as you go through researching
a specific topic your ideas about that
topic and your approaches might change.
This can happen for a bunch of reasons.
Maybe, you learn that
the problem you're working on is actually
either much easier
or much harder than you expected.
So you'll need to change to accommodate
that.
Maybe something you thought would work
actually didn't,
so you need to find either a new method
or a new problem.
You might discover prior work
that you didn't
really previously know about,
and that's something that
you'll have to go back and say, okay, does
this, does this compete with my method,
is this complimentary to my method,
how can we deal with that?
Additionally, as you're,
as you're working on a project, you know
constraints or issues with,
the approach might become more clear.
So you might have,
you know better ideas or different ideas
from what you previously had.
And then ultimately,

your interest can also evolve.
So you may find that you know, as you're
researching something,
maybe you become interested
in something else
and that's something
that you want to look at in the future.
So these are all different ways that,
you know as you're going through research
the things that you're working on
might tend to change.
So the thing to keep in mind
is that, you know, just because,
something is changing,
does not mean it's failure.
It's it's
all part of the research process.
These are just things that happen,
and it's it's very, very natural
for the trajectory of research projects
to change as you become more informed.
But what you want to keep in mind
is that you should always
be kind of checking in with yourself.
Asking yourself, is the scope
still manageable?
So has this project become so big
and so broad that, you know,
I can't reasonably actually
achieve it anymore?
Or is it still something
that is achievable,
just maybe different than before?
Are the methods still feasible?
So is is the approach that you had given,
you know, maybe you've learned some
new things, is this still a good approach
or the best approach?
And then as you go,
you should also be checking in
with the milestones that you'd previously
set and asking if they're realistic.
There may be things that you know
took longer than expected
or were faster than expected,
and you should be updating kind of your,
your plan as you go through
your research project.
So with that,
you should now be able to

deliberately manage scope,
by making trade offs between,
you know, the problem, the method,
and the domain of the research
that you're pursuing.
You should be able to break your work
into small, trackable units.
And you should be able to plan
your project communicate
with your advisor,
and adapt your research over time.
So thank you.
[Morse code beeps]