



1
00:00:02,266 --> 00:00:05,396
>> Kelly Humphries: We have an expert in liquid flows on space.

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00:00:05,796 --> 00:00:09,646
Dr. Mark Weislogel, from the Portland State University

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00:00:09,646 --> 00:00:11,786
in Oregon is the principal investigator

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00:00:11,786 --> 00:00:14,666
for the CFE experiment.

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00:00:16,116 --> 00:00:18,426
Mark, welcome to Mission Control Houston.

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00:00:19,236 --> 00:00:19,786
>> Mark Weislogel: Greetings.

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00:00:20,266 --> 00:00:21,066
From Portland.

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00:00:21,666 --> 00:00:23,776
>> Kelly Humphries: Hey, thanks for joining us again

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00:00:23,776 --> 00:00:26,986
and let's start off with the basics

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00:00:26,986 --> 00:00:28,776
of what you guys are working

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00:00:28,776 --> 00:00:31,166
on with capillary flow on the space station.

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00:00:32,126 --> 00:00:33,146

>> Mark Weislogel: Well
currently we have a set

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00:00:33,146 --> 00:00:35,166

of these handheld experiments.

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00:00:35,166 --> 00:00:38,826

It's, the acronym is CFE
and they are performed

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00:00:38,826 --> 00:00:40,376

by the astronauts on the,

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00:00:40,456 --> 00:00:43,976

what's a moveable workbench
that's on the space station.

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00:00:44,706 --> 00:00:47,076

And they configured this
container up and set up lighting

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00:00:47,076 --> 00:00:48,886

and cameras and talk
to us on the ground

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00:00:48,886 --> 00:00:52,866

and they deploy a fluid into
a strange container shape

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00:00:53,416 --> 00:00:56,096

where the geometry of
the container interacts

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00:00:56,096 --> 00:00:58,516

with the surface tension and
wetting properties of the fluid

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00:00:58,516 --> 00:01:01,166
to make the liquid go
where we want them to go.

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00:01:01,896 --> 00:01:05,966
And this is an important aspect
of designs for fluid systems

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00:01:05,966 --> 00:01:08,866
on space craft because you can
make the container basically

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00:01:08,866 --> 00:01:11,586
pump the liquid where you want
them to be and what we're trying

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00:01:11,586 --> 00:01:15,956
to do is develop a theoretical
basis to use such forces

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00:01:15,956 --> 00:01:19,746
to replicate fluid behavior in
space just like it would happen

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00:01:19,746 --> 00:01:22,596
on ground, but you're
replacing the impact of gravity

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00:01:22,596 --> 00:01:23,896
with that of surface tension.

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00:01:24,226 --> 00:01:26,676
And so engineers could be much
more familiar with systems

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00:01:26,676 --> 00:01:27,926
and make them more reliable.

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00:01:29,856 --> 00:01:32,376
>> Kelly Humphries: Mark,

you called it "weird shapes"

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00:01:32,376 --> 00:01:34,076
that you were putting
these fluids through,

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00:01:34,076 --> 00:01:35,896
when we talked earlier
this week.

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00:01:35,896 --> 00:01:36,806
Can you tell me a little bit

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00:01:36,806 --> 00:01:38,846
about how these shapes
are designed

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00:01:38,846 --> 00:01:40,726
and what you're trying
to find out there?

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00:01:41,196 --> 00:01:43,276
>> Mark Weislogel: Yes,
the shapes actually arise

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00:01:43,276 --> 00:01:44,866
from mathematical relationships.

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00:01:44,966 --> 00:01:50,426
So we identified these
different families of geometries

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00:01:50,776 --> 00:01:53,196
that make the fluid do different
things at different rates.

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00:01:53,466 --> 00:01:55,716
And so, we, they
have different names.

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00:01:55,716 --> 00:01:57,486

They're "tapered
triangular vessels"

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00:01:57,486 --> 00:02:01,476

or "tapered rectangular
vessels" or "cylinders"

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00:02:01,476 --> 00:02:03,246

with vein structures that taper"

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00:02:03,246 --> 00:02:06,596

or "strange tear drop shaped
sections," these kind of things.

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00:02:07,276 --> 00:02:09,456

And so what you're
used to seeing,

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00:02:09,456 --> 00:02:12,576

you know like cylindrical tubes
or spherical tanks, you know,

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00:02:12,576 --> 00:02:14,866

start to look more
like the innards

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00:02:14,866 --> 00:02:17,626

of a body digestive system.

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00:02:17,626 --> 00:02:20,316

You know, the new shapes
are kind of strange,

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00:02:20,726 --> 00:02:24,756

but it gets these really neat
results of passive manipulation

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00:02:24,756 --> 00:02:27,816

of large amounts
of liquid in space.

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00:02:27,816 --> 00:02:29,286

>> Kelly Humphries:
And why do we have

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00:02:29,286 --> 00:02:30,266

such a problem with that?

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00:02:31,096 --> 00:02:31,816

>> Mark Weislogel: Well, if...

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00:02:31,886 --> 00:02:35,196

the problem is that you
can have multiple, okay.

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00:02:35,196 --> 00:02:38,256

If you have a container
in low gravity,

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00:02:38,256 --> 00:02:39,466

the liquid could be located

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00:02:39,466 --> 00:02:41,706

in various places
within the container.

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00:02:42,186 --> 00:02:43,766

It would be nice
to design shapes

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00:02:43,766 --> 00:02:46,756

that there's only one possible
place that the fluid could be,

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00:02:47,306 --> 00:02:49,086

and it's where you
want it to be.

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00:02:49,086 --> 00:02:50,696

And that's what we're after.

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00:02:51,216 --> 00:02:54,376

The nature of the mathematics
that governs this stuff is

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00:02:54,376 --> 00:02:56,916

that you have multiple
solutions,

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00:02:56,916 --> 00:02:57,906

many different solutions.

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00:02:57,906 --> 00:03:01,056

So, we're trying to
make that a lot easier.

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00:03:01,746 --> 00:03:02,736

>> Kelly Humphries:
And I would imagine

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00:03:02,736 --> 00:03:06,446

that this would probably help
in the development of systems

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00:03:06,446 --> 00:03:11,206

that could rely on natural
flows instead of hard

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00:03:11,206 --> 00:03:12,806

to maintain pumping systems.

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00:03:13,016 --> 00:03:13,706

>> Mark Weislogel: Exactly.

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00:03:13,906 --> 00:03:17,496

So we would like to get away
from the added complexity

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00:03:17,786 --> 00:03:20,936
of centrifugal, you know,
pumping or separations

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00:03:20,936 --> 00:03:23,336
and that require
orbital maneuvers

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00:03:23,336 --> 00:03:25,856
or even spinning the space
craft, things like that

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00:03:26,326 --> 00:03:29,436
and greatly simplify things so
that the fluid just always goes

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00:03:29,436 --> 00:03:31,816
to where you want it to go
so that the center of gravity

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00:03:31,816 --> 00:03:34,336
of it is known, you know, all
of these things are known.

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00:03:34,406 --> 00:03:35,616
That would be great.

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00:03:36,976 --> 00:03:37,326
>> Kelly Humphries: And...

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00:03:37,326 --> 00:03:38,186
>> Mark Weislogel:
Also, excuse me.

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00:03:38,186 --> 00:03:40,936
Also it would be good, even
if you do use such a thing

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00:03:40,936 --> 00:03:43,696
as a centrifugal method,
if there's ever a failure,

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00:03:43,696 --> 00:03:47,736
you have this back up, passive
means of still being able

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00:03:48,096 --> 00:03:51,426
to hobble along, functioning,
maybe at a reduced level,

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00:03:51,426 --> 00:03:52,456
but you'll still function

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00:03:52,456 --> 00:03:54,366
with no moving parts
in a passive manner.

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00:03:54,366 --> 00:03:57,376
So it's a nice redundant
system as well for systems

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00:03:57,376 --> 00:04:00,066
that already use
something like a centrifuge.

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00:04:01,026 --> 00:04:02,496
>> Kelly Humphries: And
we're already using some

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00:04:02,496 --> 00:04:04,656
of this capillary flow on
the space station, right?

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00:04:05,076 --> 00:04:05,776
>> Mark Weislogel:
Yes, that's true.

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00:04:07,126 --> 00:04:09,036

>> Kelly Humphries: In systems like the cooling system,

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00:04:09,036 --> 00:04:12,296

particularly outside with the ammonia that's used

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00:04:12,296 --> 00:04:13,836

to help get rid of excess heat.

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00:04:14,616 --> 00:04:17,036

>> Mark Weislogel: Yes, but that's designed to be,

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00:04:17,036 --> 00:04:20,786

I believe, is that a single phase?

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00:04:20,786 --> 00:04:24,326

I can't recall what, if that's a single or a two-phase system.

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00:04:24,736 --> 00:04:28,466

I think it's a single phase system so not always do we rely

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00:04:28,466 --> 00:04:31,776

on surface tension, but in some manner, it still winds

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00:04:31,776 --> 00:04:34,136

up rearing it's head and can either bite us

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00:04:34,136 --> 00:04:35,356

or we can exploit it.

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00:04:35,356 --> 00:04:42,786

So we still, we must understand this to make systems reliable

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00:04:42,836 --> 00:04:44,956

that we can count on
their performance.

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00:04:45,706 --> 00:04:46,956

>> Kelly Humphries:
And as I recall,

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00:04:46,956 --> 00:04:48,996

you have a student
team that's involved

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00:04:48,996 --> 00:04:50,426

in doing this work too, right?

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00:04:50,806 --> 00:04:51,166

>> Mark Weislogel: Yes.

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00:04:51,946 --> 00:04:53,166

>> Kelly Humphries: Could
you tell us a little bit more

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00:04:53,166 --> 00:04:55,906

about how many students
you have working with you

113

00:04:56,146 --> 00:04:58,166

and the learning
experience this provides?

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00:04:58,476 --> 00:04:58,846

>> Mark Weislogel: Yes.

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00:04:58,846 --> 00:05:02,986

This is probably the greatest
part of this work is yes,

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00:05:02,986 --> 00:05:07,016

we have, I have three
students currently now working

117
00:05:07,216 --> 00:05:09,636
on this particular project.

118
00:05:10,016 --> 00:05:12,486
And these students have been
involved in training astronauts

119
00:05:12,486 --> 00:05:15,416
and helping develop the crew
procedures to actually talking

120
00:05:15,416 --> 00:05:17,466
with the astronauts
during the operations.

121
00:05:17,646 --> 00:05:20,556
One of those students, who's now
a PhD student at Portland State,

122
00:05:20,706 --> 00:05:23,686
Will Blackmore, has
completed over 10 sessions,

123
00:05:23,746 --> 00:05:28,136
discussing with the astronauts,
during the experiments,

124
00:05:28,136 --> 00:05:31,506
this is through a control
station that NASA allowed us

125
00:05:31,506 --> 00:05:32,726
to set up at our campus.

126
00:05:33,206 --> 00:05:35,496
This experience is
really something.

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00:05:36,076 --> 00:05:39,056

He's very good too, and I
rely on him a lot to take some

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00:05:39,056 --> 00:05:43,326

of the pressure off me because
it's intimidating if you ask me,

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00:05:43,326 --> 00:05:45,336

especially when you're
excited about the experiment

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00:05:45,336 --> 00:05:47,366

and the things that can go
wrong and the possibility

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00:05:47,366 --> 00:05:48,986

of getting the data
in just moments.

132

00:05:48,986 --> 00:05:50,076

Oh, it's very exciting.

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00:05:51,006 --> 00:05:53,516

>> Kelly Humphries: And you
told me earlier this week

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00:05:53,516 --> 00:05:57,656

that you all have been on
a different sleep schedule

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00:05:57,656 --> 00:06:00,026

because the space
station operates generally

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00:06:00,026 --> 00:06:01,856

on Greenwich Mean Time
which means that they get

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00:06:01,856 --> 00:06:04,436

up at midnight Central
Time here in Houston,

138

00:06:04,436 --> 00:06:06,696

and you're two hours earlier
out there in Portland.

139

00:06:06,986 --> 00:06:08,116

How's that been working
out for you?

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00:06:08,626 --> 00:06:10,816

>> Mark Weislogel: It works out
and we've gotten used to it,

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00:06:10,816 --> 00:06:12,666

but when we bring new
people onto the team,

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00:06:12,666 --> 00:06:14,726

they can experience
difficulties.

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00:06:14,726 --> 00:06:16,966

I think we've had 10 all
nighters, you know, already,

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00:06:16,966 --> 00:06:20,516

just in the last few months
and so, it's something to try

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00:06:20,516 --> 00:06:22,836

and live a normal day, working
pretty hard and then all

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00:06:22,836 --> 00:06:24,786

of a sudden you know,
here goes an all nighter,

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00:06:24,786 --> 00:06:28,856

but a little caffeine and the
enthusiasm keeps us going.

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00:06:29,256 --> 00:06:30,626

>> Kelly Humphries:
Have you seen anything

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00:06:30,626 --> 00:06:33,576

that surprised you
on CFE-3 so far?

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00:06:34,066 --> 00:06:34,536

>> Mark Weislogel: Oh yes.

151

00:06:34,866 --> 00:06:41,486

We do not anticipate this,
so, but we're growing

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00:06:41,486 --> 00:06:44,906

to expect you know,
some very, some,

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00:06:44,906 --> 00:06:49,116

you could call them
discoveries, some new things

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00:06:49,116 --> 00:06:50,026

that we didn't imagine.

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00:06:50,026 --> 00:06:52,506

Like when the astronauts
will manipulate the test cell

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00:06:52,506 --> 00:06:54,546

in ways that, oh,
we learn on the spot

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00:06:54,546 --> 00:06:57,076

that we can do something
different and get new data,

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00:06:57,076 --> 00:06:59,736

better data, more data,
and in some cases,

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00:06:59,736 --> 00:07:01,916

we see fluid doing things
that we don't expect,

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00:07:01,916 --> 00:07:03,616

at rates we didn't anticipate

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00:07:03,616 --> 00:07:05,796

and those are the ones
we scratch our heads

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00:07:05,796 --> 00:07:08,286

and sometimes we say, "Oh, we
should have thought of that,"

163

00:07:08,286 --> 00:07:10,586

but sometimes we
say, "Oh, that's new."

164

00:07:10,916 --> 00:07:11,766

Let's go after that."

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00:07:11,766 --> 00:07:15,446

So what we discover can
change what we discover.

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00:07:16,326 --> 00:07:19,356

And fortunately for
us, in our cases,

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00:07:19,356 --> 00:07:20,986

it's always been expansive.

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00:07:21,066 --> 00:07:25,096

So everything that we've
observed improves our science

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00:07:25,136 --> 00:07:25,736

to a high degree.

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00:07:25,736 --> 00:07:26,276

It's been great.

171

00:07:27,256 --> 00:07:29,326

>> Kelly Humphries: And
tell us a little bit

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00:07:29,326 --> 00:07:30,546

about yourself, Mark.

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00:07:30,546 --> 00:07:33,216

I know it's all about the math,
but give us a little background

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00:07:33,216 --> 00:07:35,106

of your education and
where you're from so

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00:07:35,106 --> 00:07:39,586

that we can help folks identify
with the real people involved

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00:07:39,586 --> 00:07:40,706

in the experiment in space.

177

00:07:41,066 --> 00:07:41,516

>> Mark Weislogel: Okay.

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00:07:41,516 --> 00:07:45,056

Well, I was pretty much
a snoozer in high school,

179

00:07:45,056 --> 00:07:48,006

but got turned on in
college to fluid mechanics

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00:07:48,006 --> 00:07:49,676

at Washington State University,

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00:07:49,676 --> 00:07:51,776

where I got both undergraduate
and Master's degrees.

182

00:07:52,266 --> 00:07:55,086

And that's when I first saw
microgravity fluid mechanics

183

00:07:55,086 --> 00:07:58,026

and that really changed
things for me.

184

00:07:58,436 --> 00:08:01,666

I wound up getting a PhD
at Northwestern University

185

00:08:01,666 --> 00:08:04,516

and working at NASA Glenn
Research Center for 10 years

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00:08:04,516 --> 00:08:07,816

and that, that's
where I got fascinated

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00:08:07,816 --> 00:08:09,356

with microgravity work.

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00:08:10,016 --> 00:08:12,796

Since then, have come to
Portland State University

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00:08:12,796 --> 00:08:15,296

where we've just recently
built a drop tower in support

190
00:08:15,296 --> 00:08:20,546
of the microgravity work and it
has really been just a series

191
00:08:20,546 --> 00:08:24,616
of discoveries and novelties and
developing the science and now,

192
00:08:24,616 --> 00:08:27,466
now we're into this application
mode where we're applying things

193
00:08:27,466 --> 00:08:30,126
to systems on the ground, you
know, microfluidic systems.

194
00:08:30,576 --> 00:08:33,876
From something as simple as
candle flame wicks, you know,

195
00:08:33,876 --> 00:08:37,316
structures to actual
processing of blood samples,

196
00:08:37,636 --> 00:08:40,666
things like that, as
well as applying our work

197
00:08:40,666 --> 00:08:43,226
to developing better
systems for space craft too.

198
00:08:43,226 --> 00:08:46,376
So we are, I mean, we're
really enjoying this.

199
00:08:47,726 --> 00:08:49,126

>> Kelly Humphries:
Well, Mark Weislogel,

200
00:08:49,126 --> 00:08:51,666
from Portland State University,
I want to thank you again

201
00:08:51,666 --> 00:08:52,806
for being with us here today,

202
00:08:52,806 --> 00:08:57,026
to talk about capillary flow
experiment 3 and we look forward

203
00:08:57,026 --> 00:09:00,596
to seeing the benefits of your
work in the everyday things

204
00:09:00,596 --> 00:09:01,636
that we use here on earth.

205
00:09:01,986 --> 00:09:04,146
>> Mark Weislogel: That
would be great wouldn't it?

206
00:09:04,146 --> 00:09:04,406
[Laughter]