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The dung-beetle's tale

systems-thinking, complexity and the real world

Tom Graves, Tetradian Consulting

Integrated EA Conference, London, March 2014

A question…

Why is it
that the **simple**
don’t stay simple?

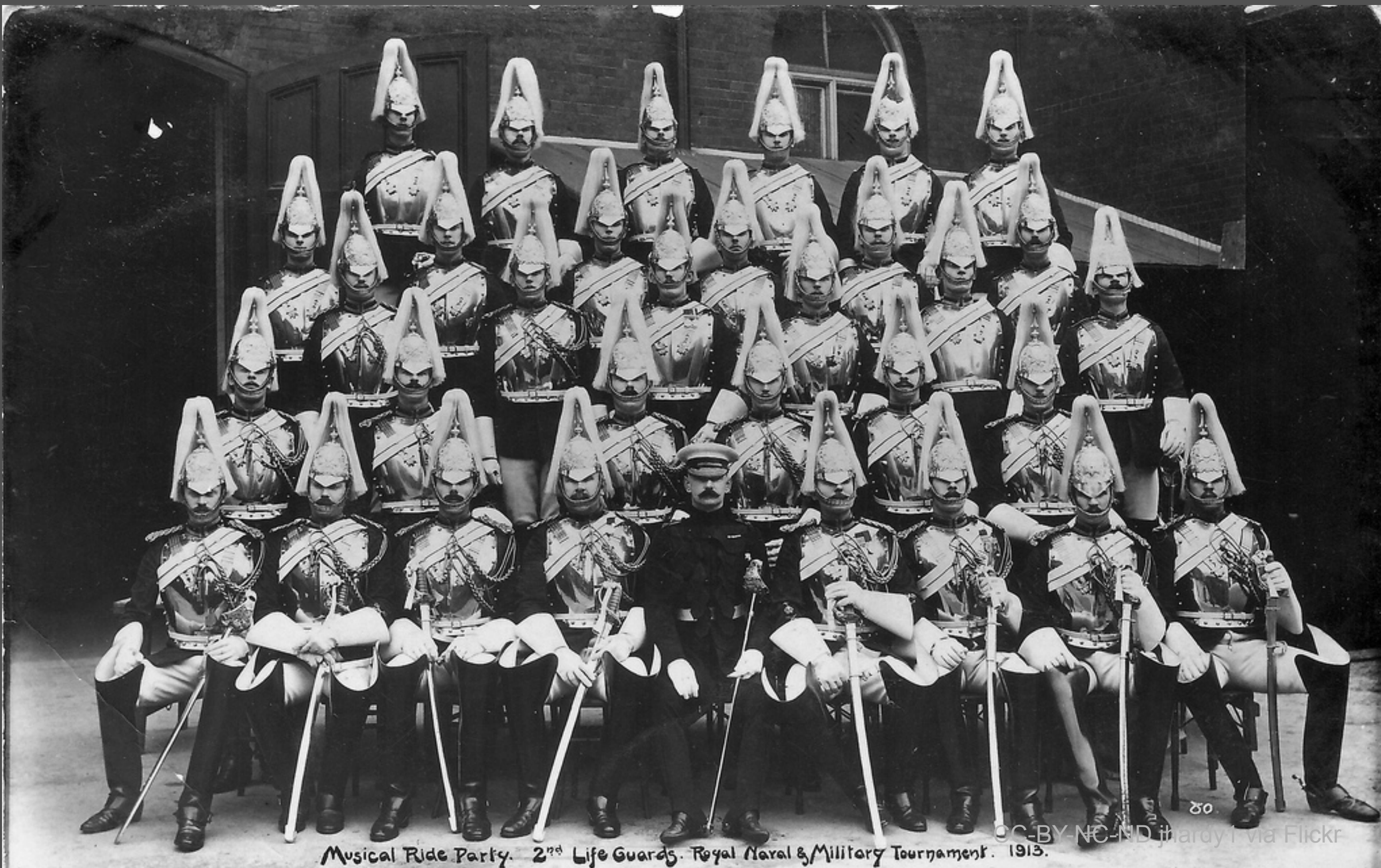
Or, more to the point…

What can we do about it?

Back in the old days,
it had all seemed so simple…

we'd join the armed-forces
for the **comradeship**
the **glamour**
the **glory**…

pride and prestige…



high expectations…

but then the muddy reality…

and kit that didn't work so good…

Tank in der Siegfried-Stellung.
links vor Riencourt vor Gullecourt.

Move forward a century…

We'd join the armed-forces
for the **comradeship**
the **glamour**
the **glory**…

the pride and prestige…

high expectations…

but the
grimy reality…

kit that works in worrying ways…

and mud…

more mud…

and yet more mud…

What happened?

(or didn’t happen, maybe?)

We want it to be **simple**…

…yet it always turns out to be **complex**

– *horribly* complex…

So what ***can*** we do about it?

How can we

***control** it?*

It seems that every attempt to control the complexity makes it more complex.

It *may seem like* every attempt to control the complexity makes it more complex.

Beyond a certain point,
it may seem like every attempt to control the complexity makes it more complex.

Beyond a *not-so-*certain point, it may seem like every attempt to control the complexity makes it more complex.

Subject to certain provisos,
beyond a not-so-certain point
it may seem like every attempt
to control the complexity
makes it more complex.

Subject to certain provisos
and special-cases,
beyond a not-so-certain point
it may seem like every attempt
to control the complexity
makes it more complex.

Sometimes,
subject to certain provisos
and special-cases,
beyond a not-so-certain point
it may seem like every attempt
to control the complexity
makes it more complex.

Sometimes,
subject to certain provisos
and special-cases,
and in unpredictable ways,
beyond a not-so-certain point
it may seem like every attempt
to control the complexity
makes it more complex.

WAAAAHHH!!!

Ahem…

Let’s, uh, start again…

with a **pattern**,

a **map**,

and a **guide**…

It’s a very *pretty* **pattern** in various different forms…

*(it’s called **fractal recursion**,*
but we’ll talk about that later)

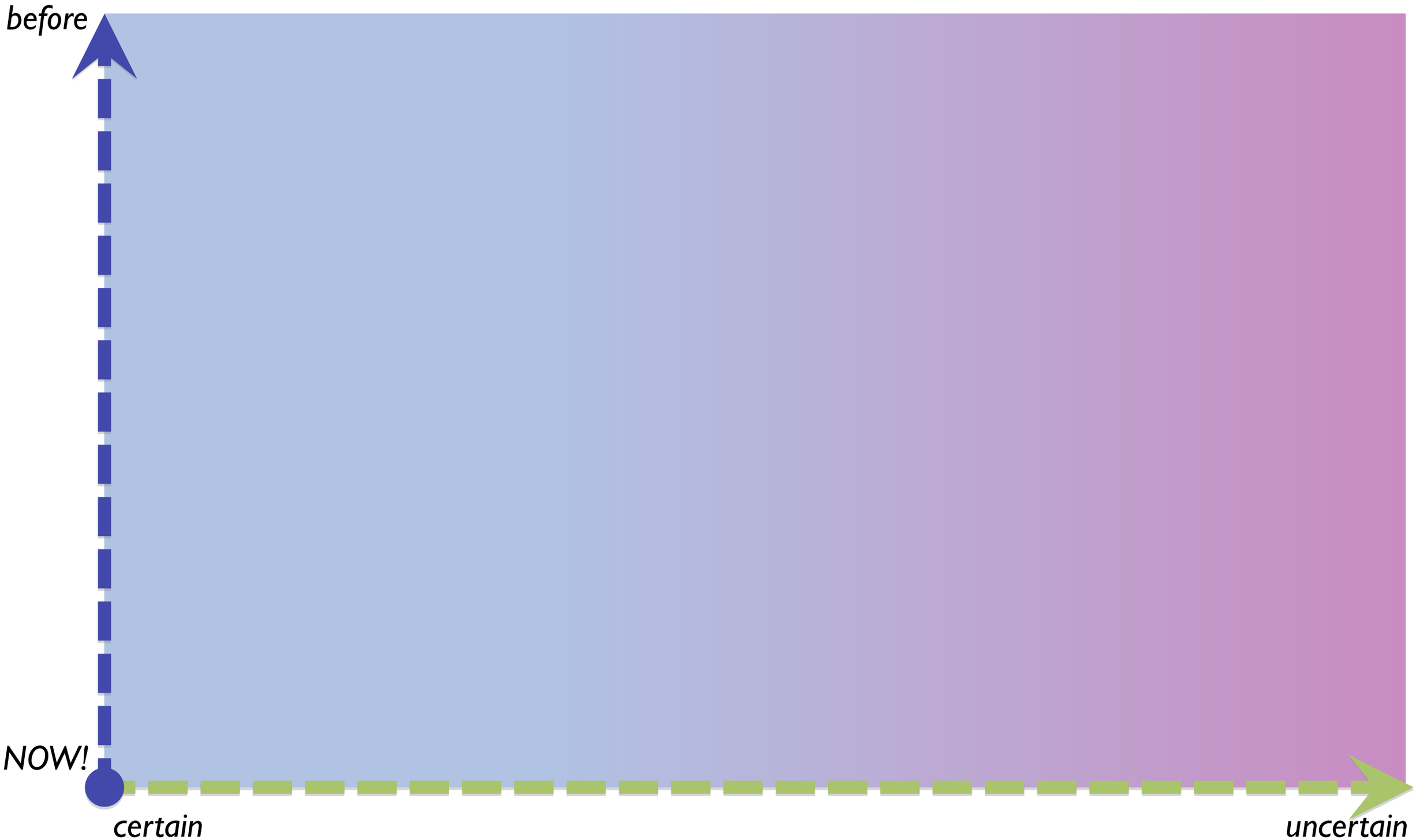
The **map** likewise has a nice *pretty* background…

(pretty background)

with two *axis-lines*

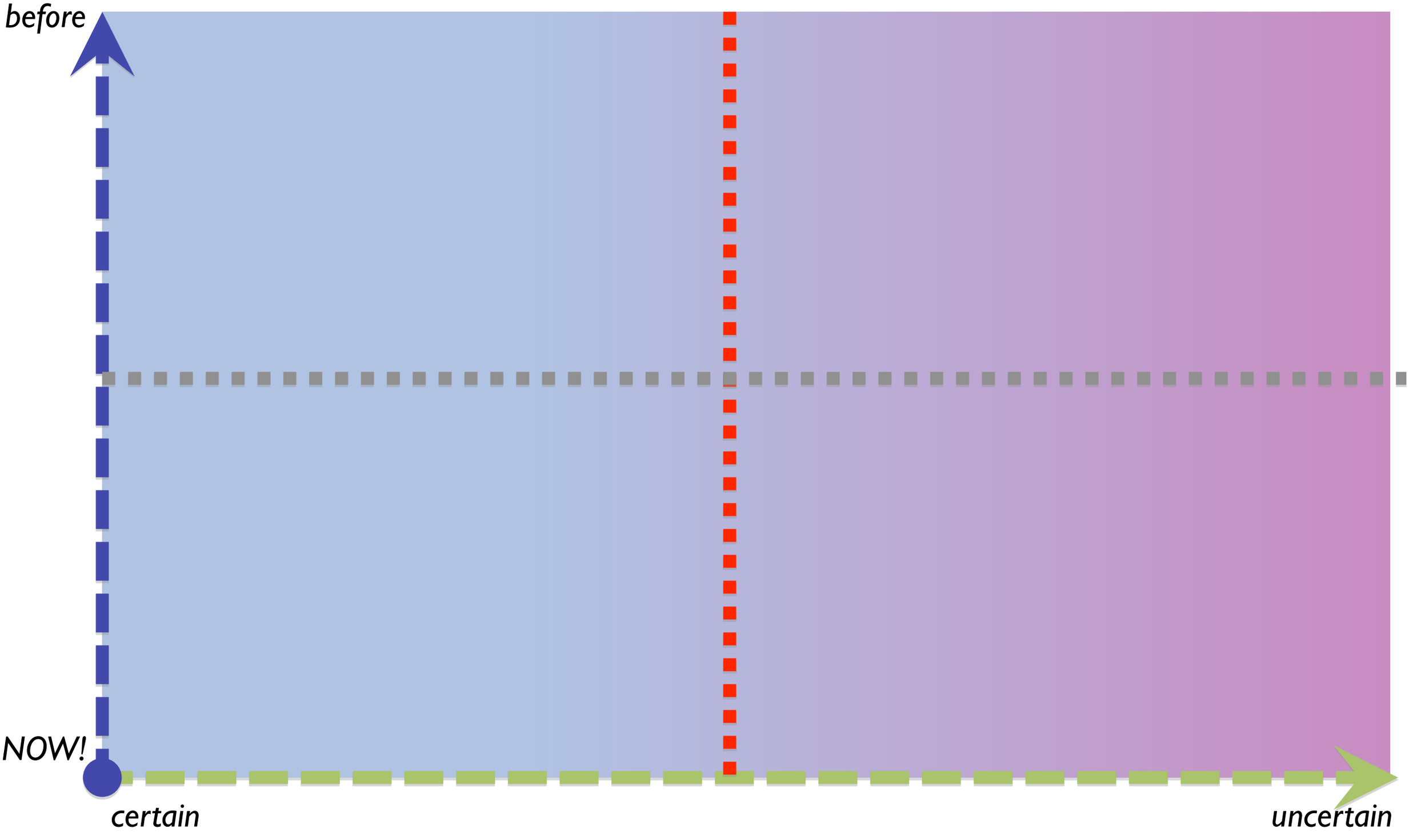
that don’t do very much…

(two axis-lines)



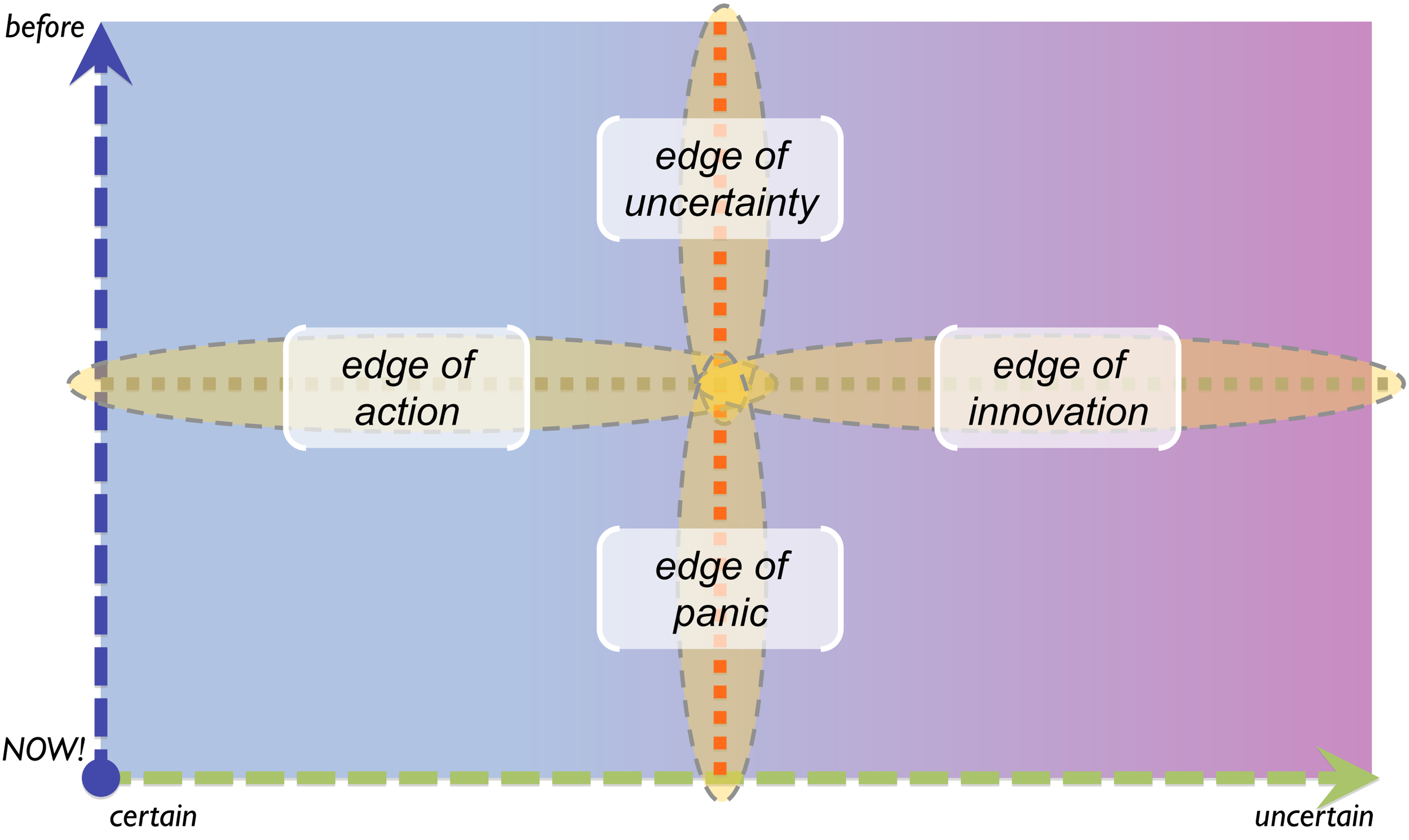
two *boundary-conditions*
that move around a bit…

(two boundary-conditions)



and four *edge-conditions*
(sort-of)
(sometimes)
(it’s kinda complex…)

(four edge-transitions)



(we’ll talk about all that later, too)

And our **guide**…

(who *isn't* pretty…)

…is a **scarab**.

not this kind of Scarab…

(sorry…)

source not known

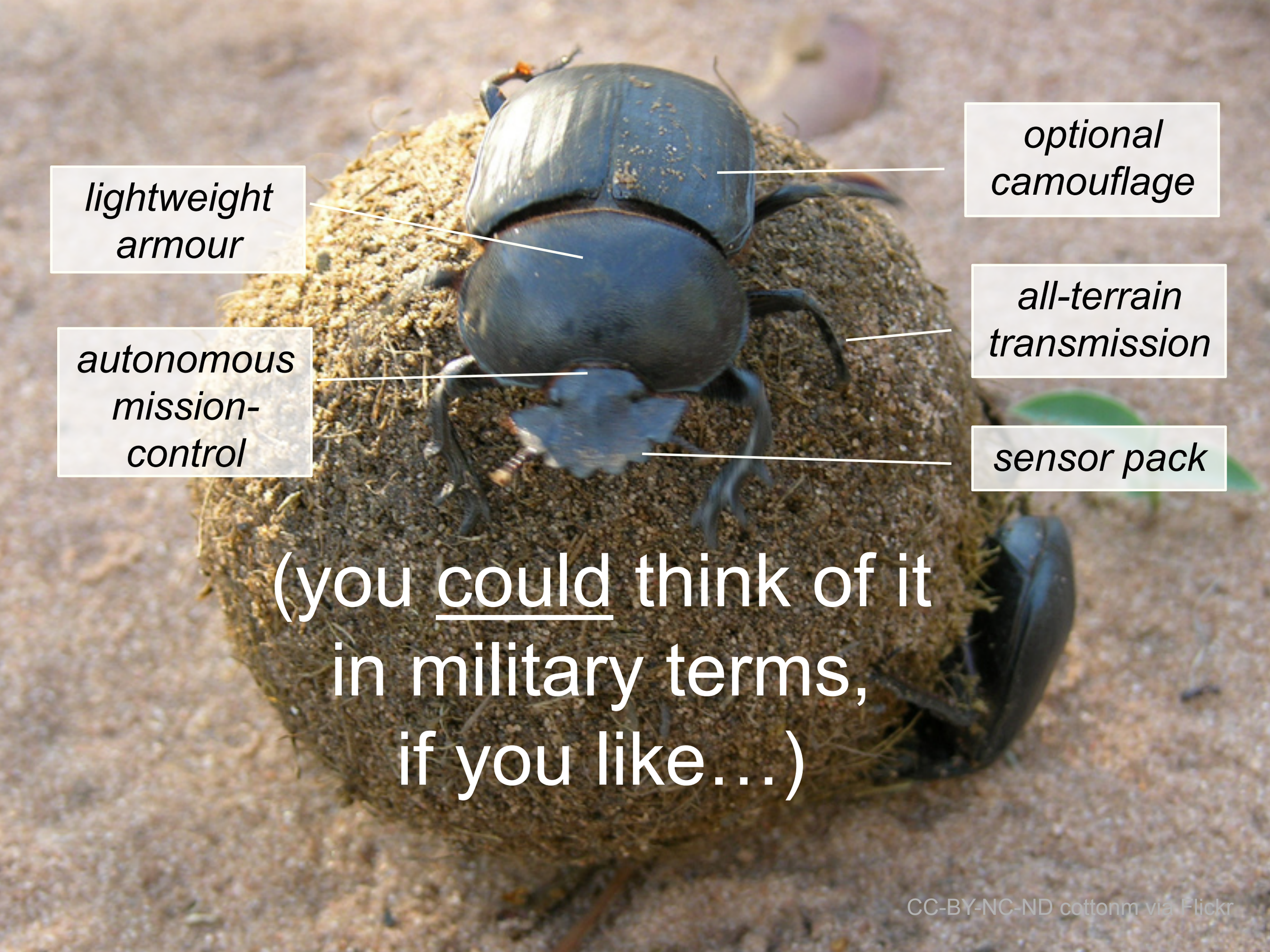
not this kind of Scarab…

(not-quite-so-sorry…?)

it’s this Scarab…

(genus *Scarabaeidae*…)

(*aka* dung-beetle…)

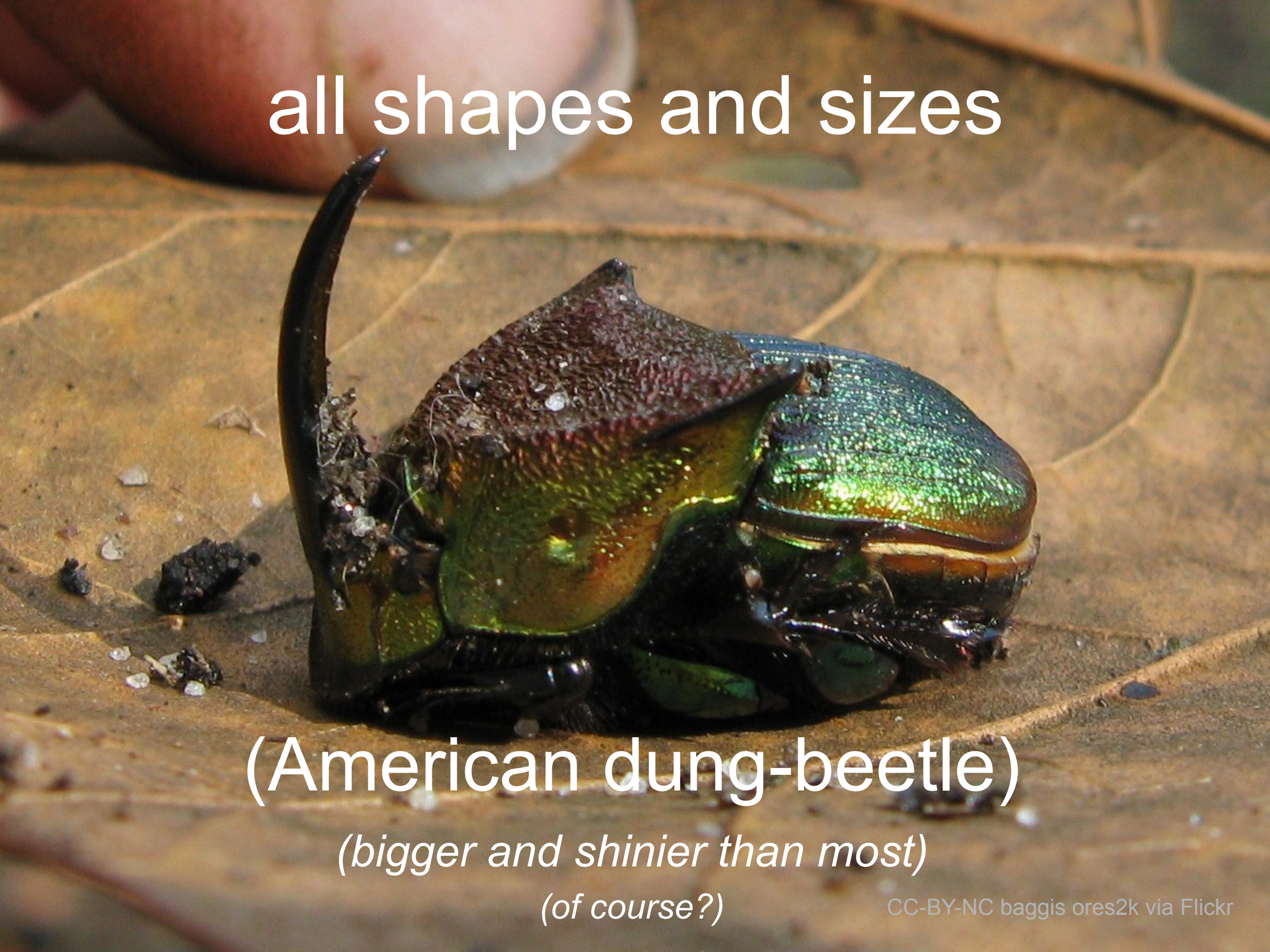


all shapes and sizes…

all shapes and sizes…

(engineers regiment heavy lift unit?)

all shapes and sizes



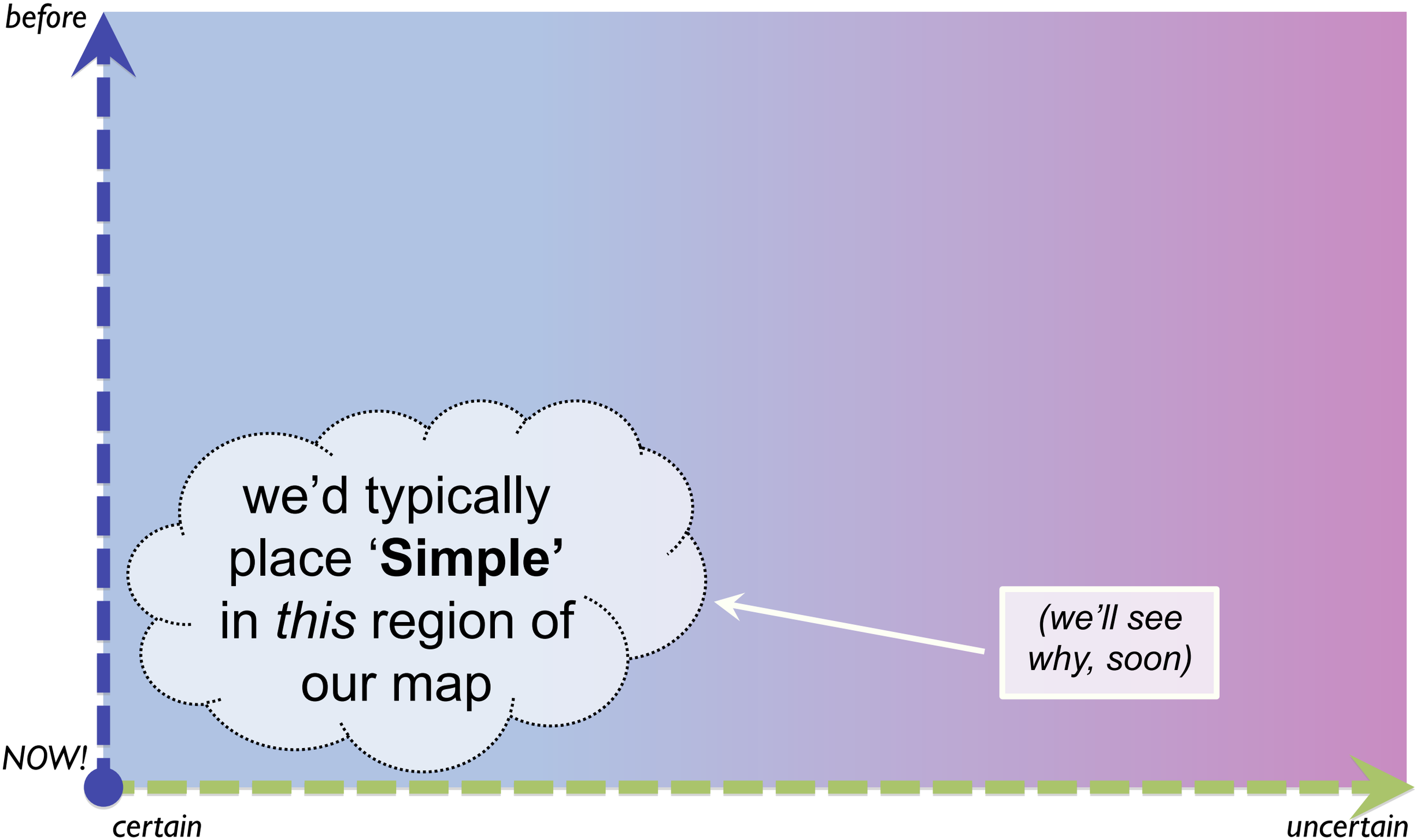
(American dung-beetle)

(bigger and shinier than most)

(of course?)

For most of the time,
life is kinda **simple**
for our tiny scarab…

By the way…


before
we'd typically place '**Simple**' in *this* region of our map
(we'll see why, soon)
NOW!
certain
uncertain

it finds a nice pile of dung…

makes some of it into a ball....

then rolls it home…

and comes back for more…

And then does it all again…

and again…

and again…

and again…

Simple.

"Follow the work-instructions"…

that kind of thing, really…

*(it doesn't need to **think** about it…*

*it just **does** it…*

*…which is <u>why</u> we say this is '**Simple**')*

(though some of that ‘Simple’ is pretty clever, actually…)

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Dung beetles guided by Milky Way

By Jonathan Amos
Science correspondent, BBC News

They may be down in the dirt but it seems dung beetles also have their eyes on the stars.

Scientists have shown how the insects will use the Milky Way to orientate themselves as they roll their balls of muck along the ground.

Humans, birds and seals are all known to navigate by the stars. But this could be the first example of an insect doing so.

The study by Marie Dacke is **reported in the journal Current Biology**.

"The dung beetles are not necessarily rolling with the Milky Way or 90 degrees to it; they can go at any angle to this band of light in the sky. They use it as a reference," the Lund University, Sweden, researcher told BBC News.

Dung beetles like to run in straight lines. When they find a pile of droppings, they shape a small ball and start pushing it away to a safe distance where they can eat it, usually underground.

Getting a good bearing is important because unless the insect rolls a direct course, it risks turning back towards the dung pile where another beetle will almost certainly try to steal its prized ball.

Dung beetles manage to maintain straight roll paths even on moonless nights

Overall, it's another pattern:

- **sense**
- **make-sense**
- **decide**
- **act**

(rinse-and-repeat, indefinitely,
at every required level)

(yep – another kind of fractal-recursion…)

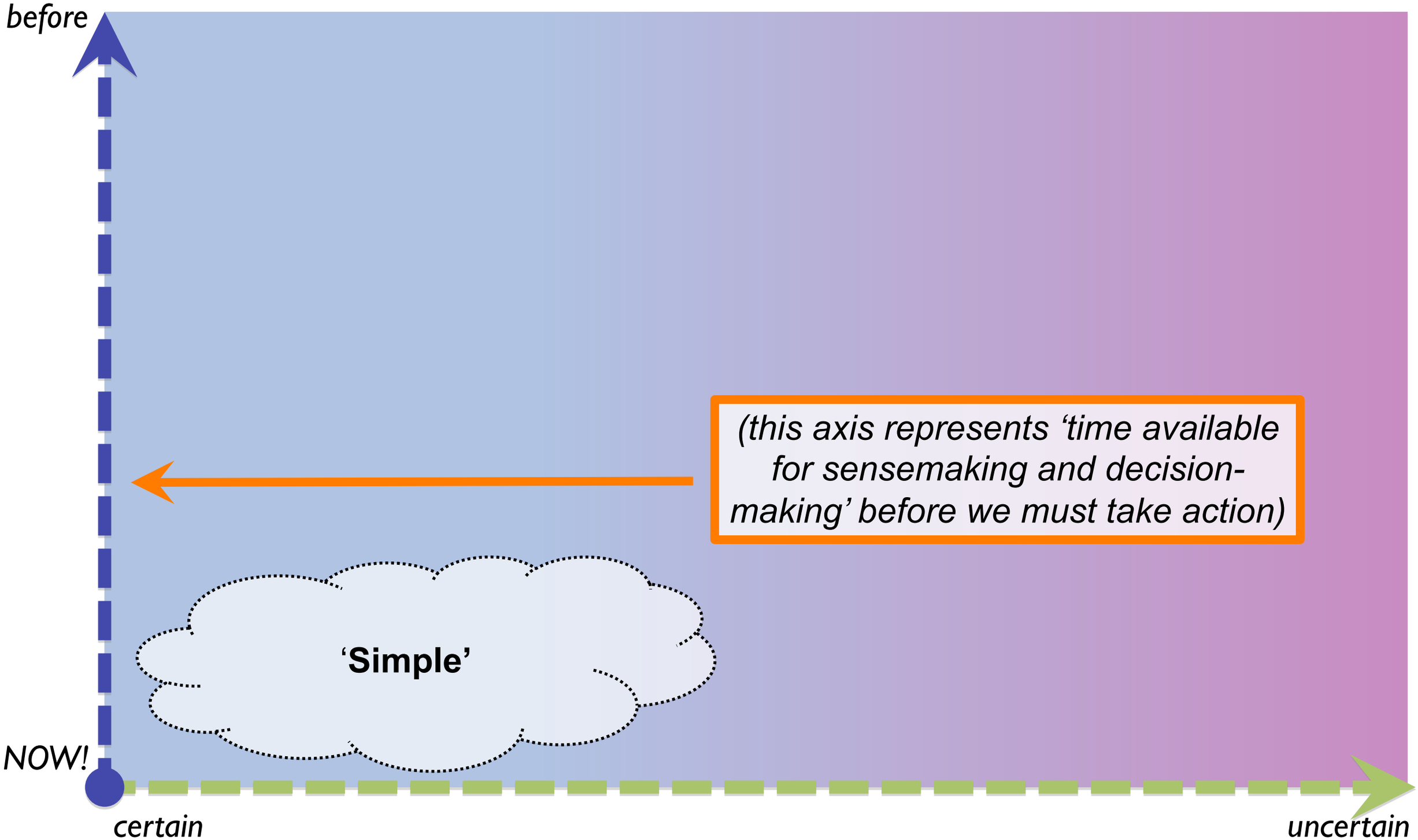
When its Simple doesn't work for some level or context…

our beetle has to stop and think for a bit.

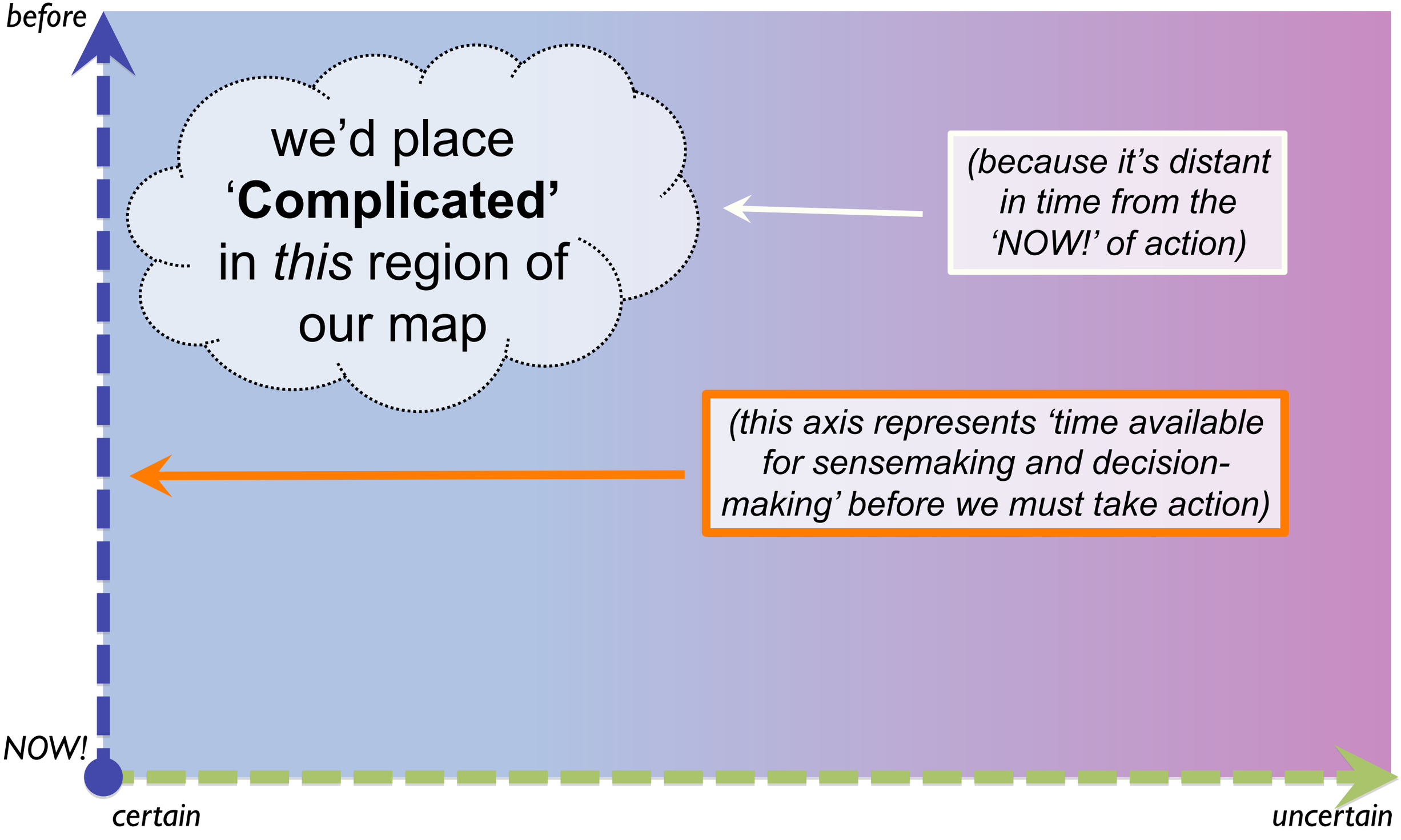
It's kinda **Complicated**…

(for a beetle, anyway…)

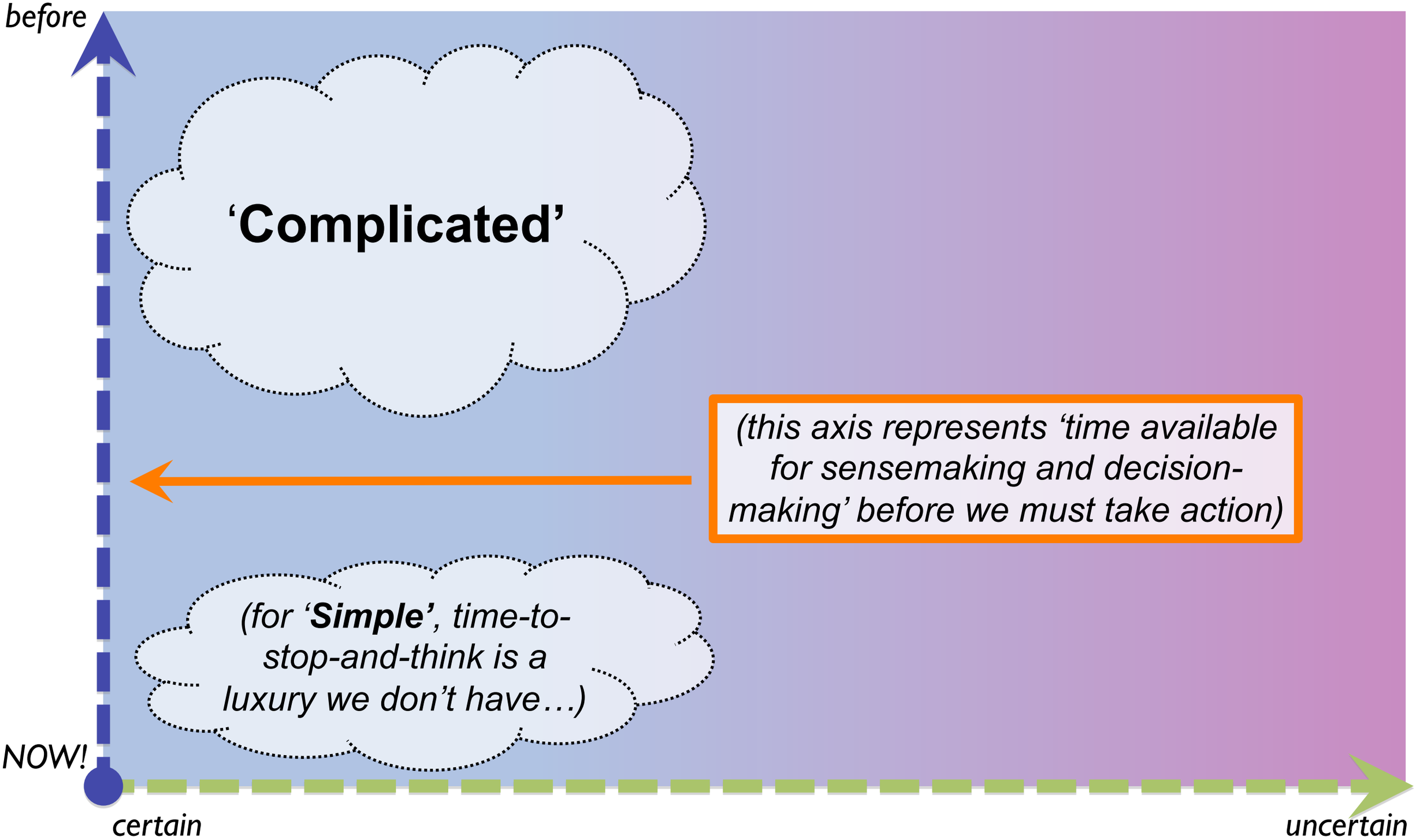
On the map…


before
(this axis represents ‘time available for sensemaking and decision-making’ before we must take action)
‘Simple’
NOW!
certain
uncertain

On the map…


before
we'd place
'Complicated'
in *this* region of
our map
(because it's distant in time from the 'NOW!' of action)
(this axis represents 'time available for sensemaking and decision-making' before we must take action)
NOW!
certain
uncertain

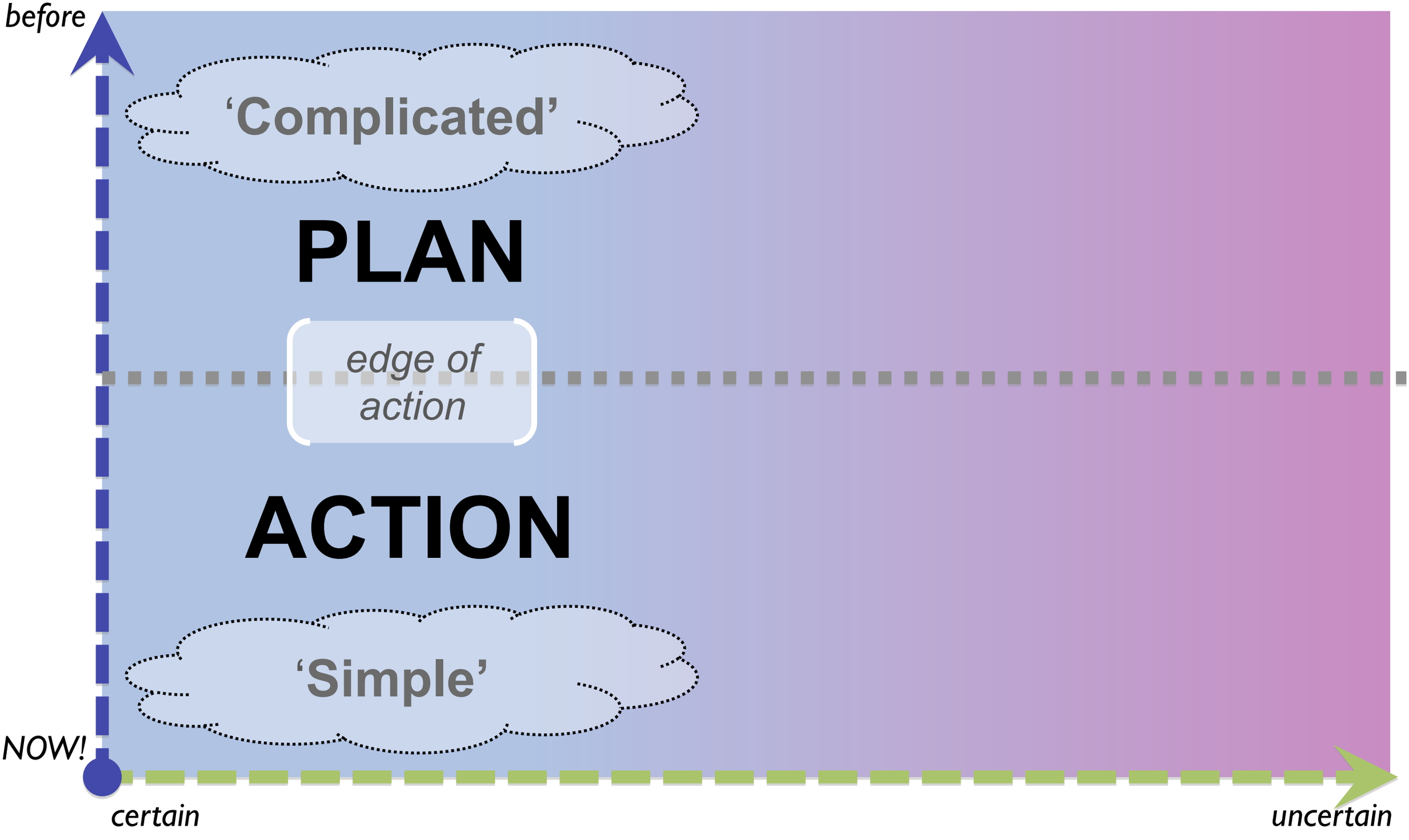
On the map…


before
‘Complicated’
(this axis represents ‘time available for sensemaking and decision-making’ before we must take action)
(for ‘Simple’, time-to-stop-and-think is a luxury we don’t have…)
NOW!
certain
uncertain

Our beetle formulates a plan…

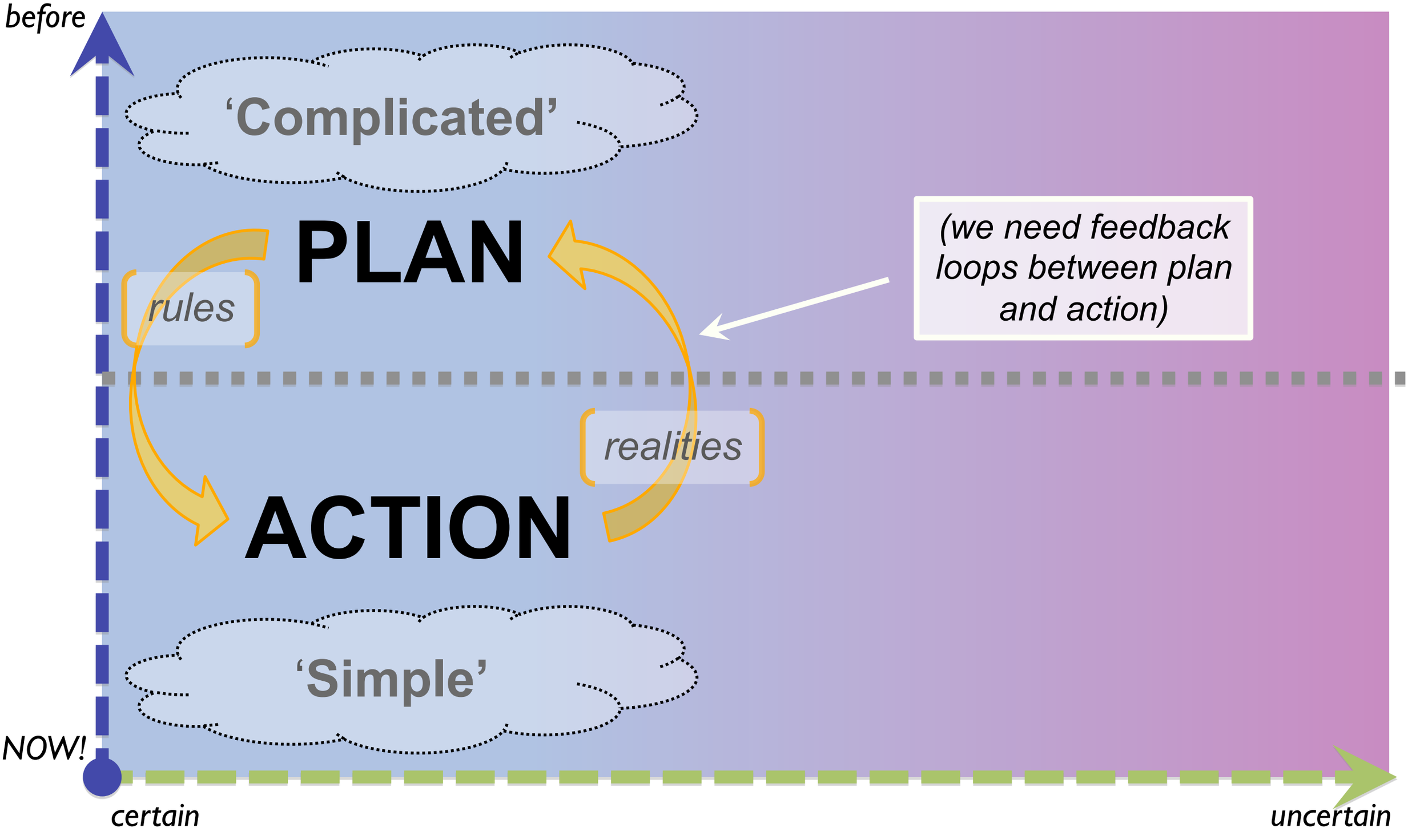
(See beetle. See beetle stop and think…)

Plan versus action

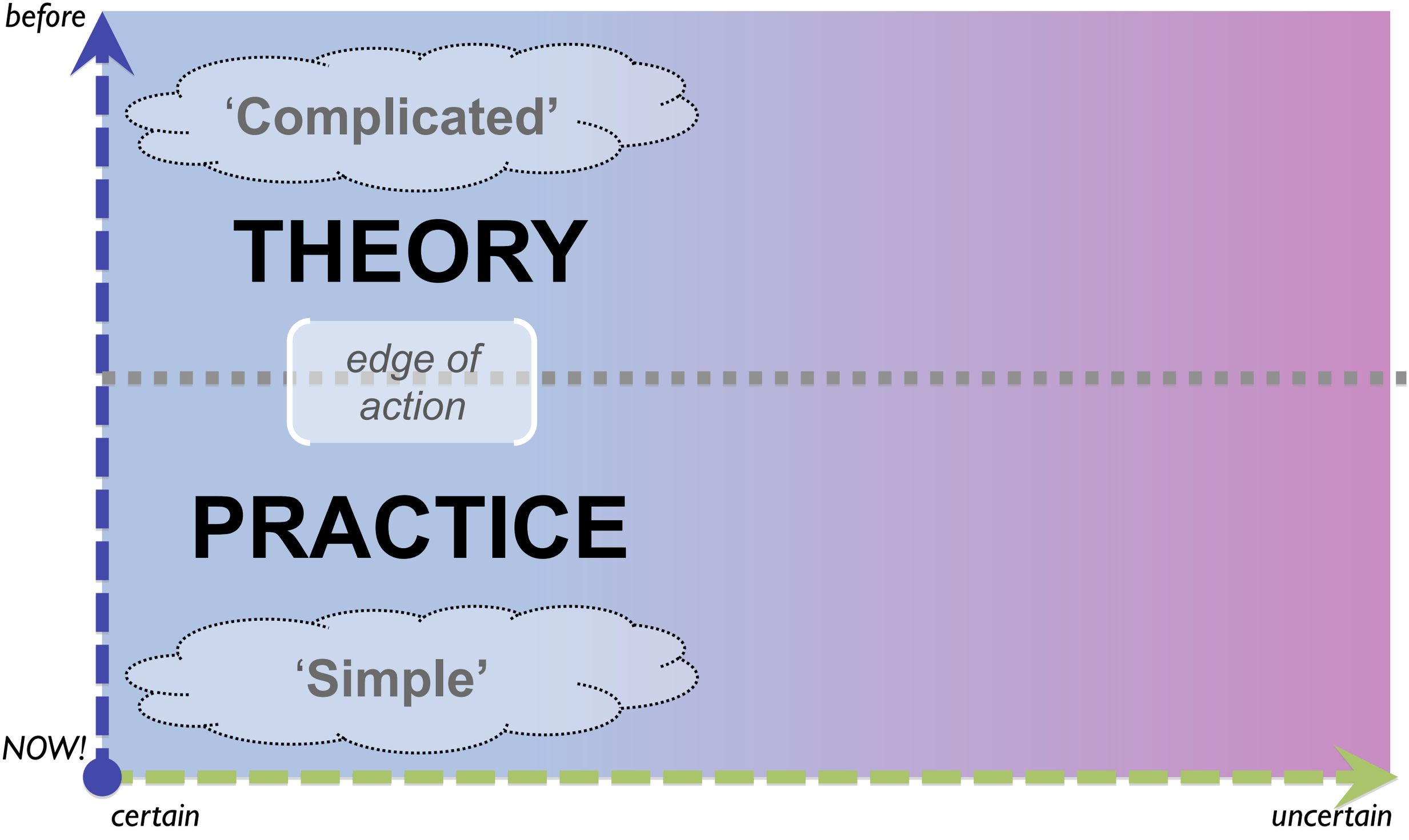


“No plan survives first contact with the enemy”

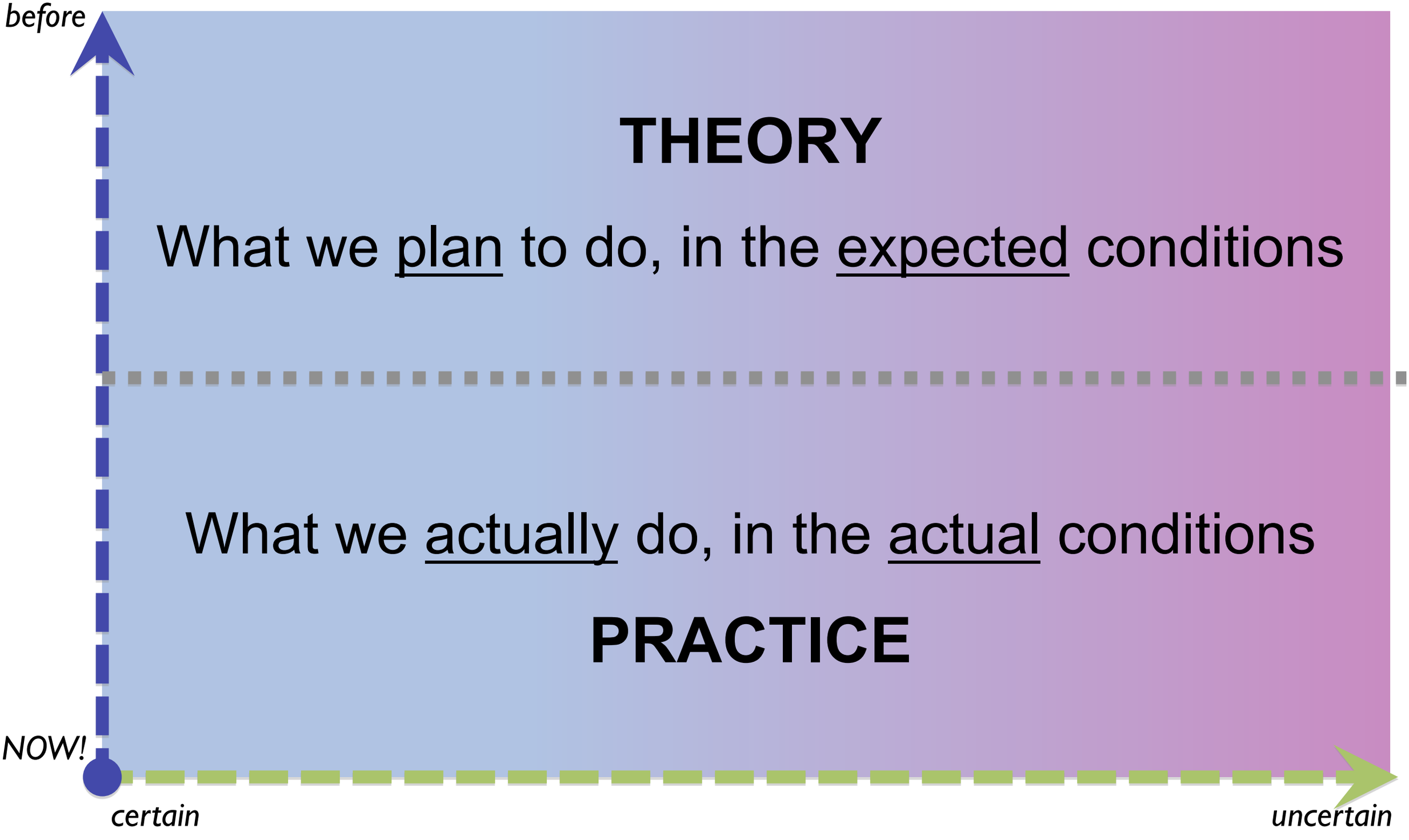
Plan and action



Theory and practice



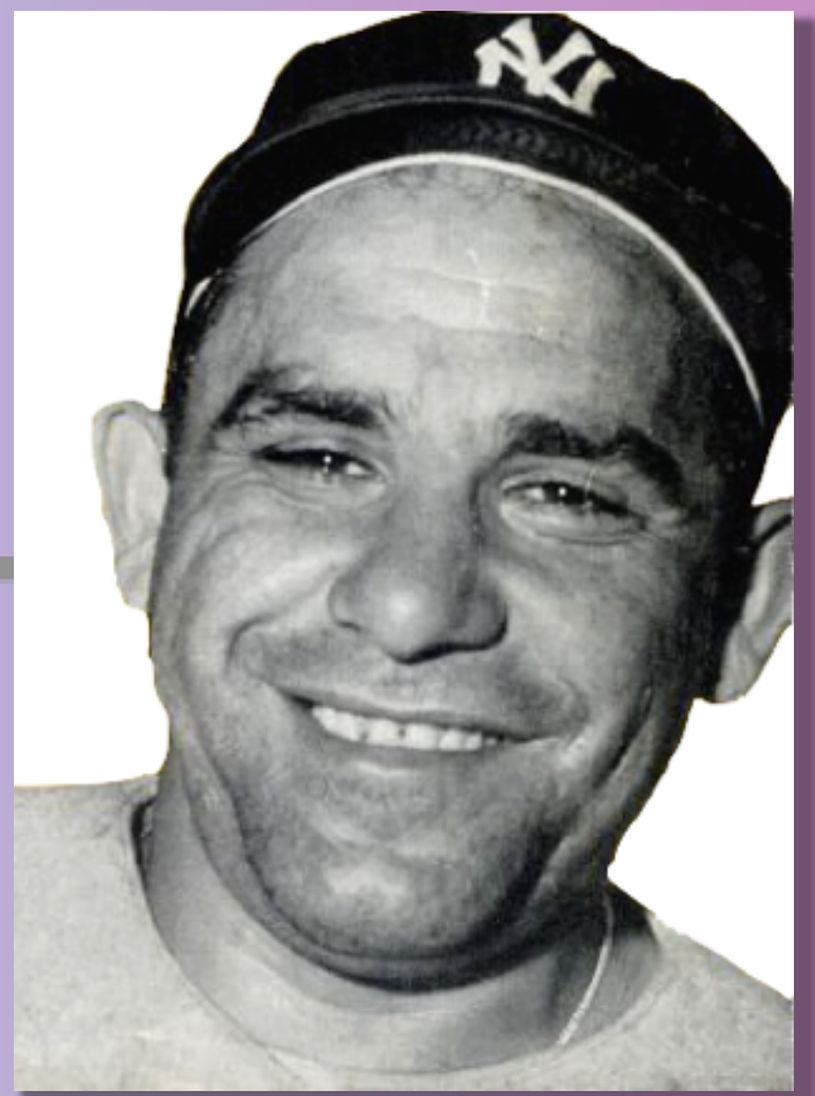
Theory and practice



Theory and practice

before

"In **THEORY**,
there's *no difference*
between *theory*
and *practice*…



…in **PRACTICE**,
there is!"

NOW!

certain

uncertain

Where’s the complexity?

Not much on the surface, it might seem…

(unless IT complicates things?)

ROBOSCARAB

THE NEXT GENERATION PYRAMID EXPLORERS

Years of selective breeding has led to the bravest and brightest Dung Beetles that have ever crawled the earth. Equipped with the latest surveillance technology, next-gen science gear and modern analysis equipment not even the smallest grain of sand goes unnoticed to our brave explorers.

Our state-of-the-art Dung Beetles are certified environmentally friendly and rechargeable.

Equipped with our Mysterious Shaft™ technology, these trained pioneers are ready to get the ball rolling.

For more information on the gamma, see heritage-key.com.

But there’s a catch…

(’cos there’s always a catch…)

…which is where **complexity** does come into the picture.

It’s about dependencies…

Our beetle depends on dung.

(and the right kind of dung, at that…)

It depends on the right animal…

to make that dung.

for
the right
animal…

to make that dung.

And it depends on the right ecosystem…

for the
right feed…

for
the right
animal…

to make that dung.

But if these guys

decide to diversify…

into goat-burgers…

it could be bye-bye
to the ecosystem...

and all too soon, maybe,
bye-bye to anything else…

Which is bad news for
our dung-beetle, because…

the right kind of animal…

...makes the right kind of dung

but the
wrong kind
of animal…

...makes the wrong kind of dung.

No right dung anywhere in range equals no dung-beetle.

Oops…

What **can**
our poor dung-beetle
do?!?

How can it

take control

of all of this?!?

it’s not <u>this</u> kind of Scarab…

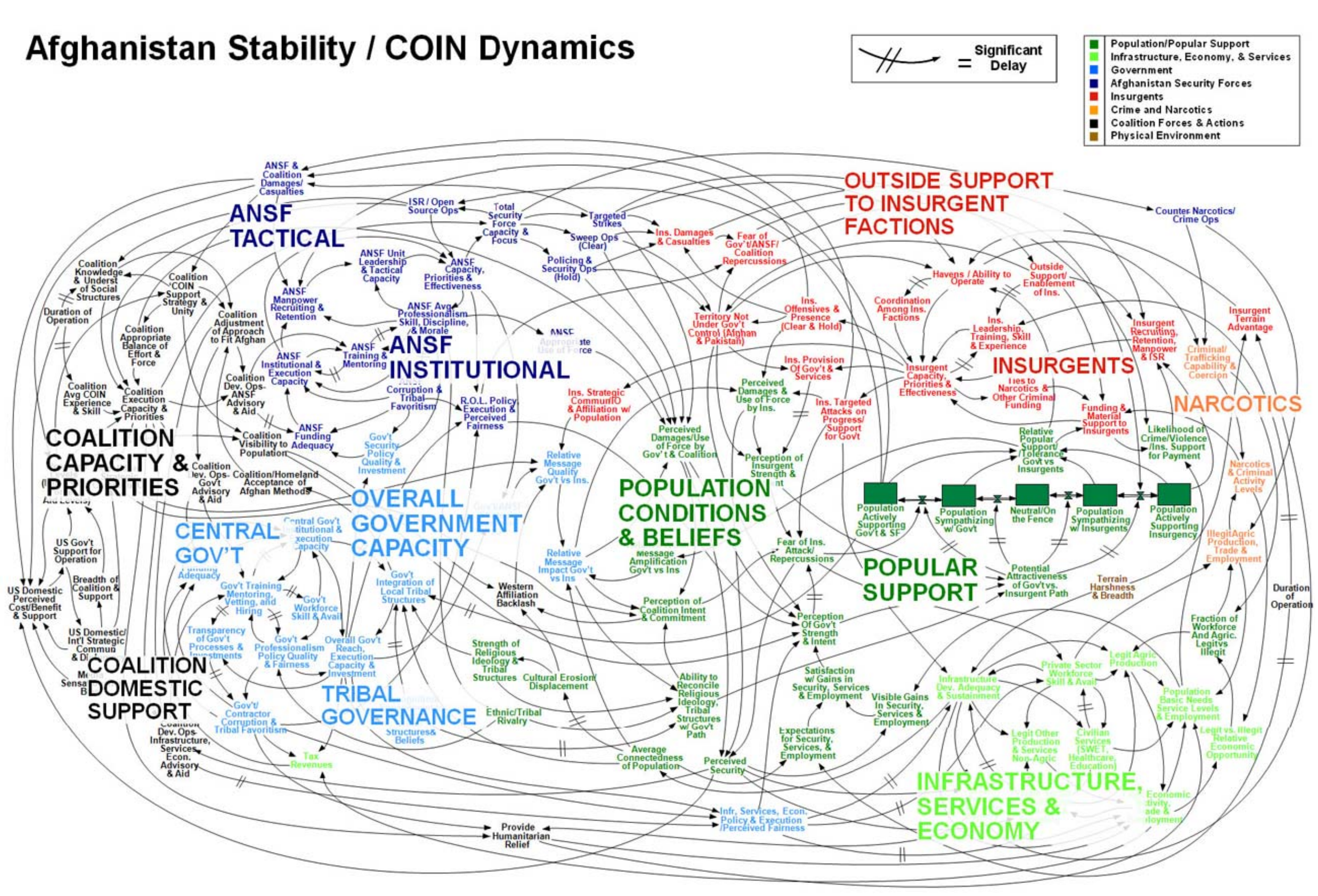
source not known

it’s only this kind of scarab…


so it can’t demolish
McDonalds…
(sorry…)
CC-BY-NC-SA raster via Flickr

If it were *human*,
it might try to plot out
all of the **variables**
and **interdependencies**
in a *systems-map*…

Afghanistan Stability / COIN Dynamics



WORKING DRAFT – V3

…which, yes, does work…

(sort-of…)
(sometimes…)
(it’s kinda complicated…)

But even a dung-beetle
would soon discover

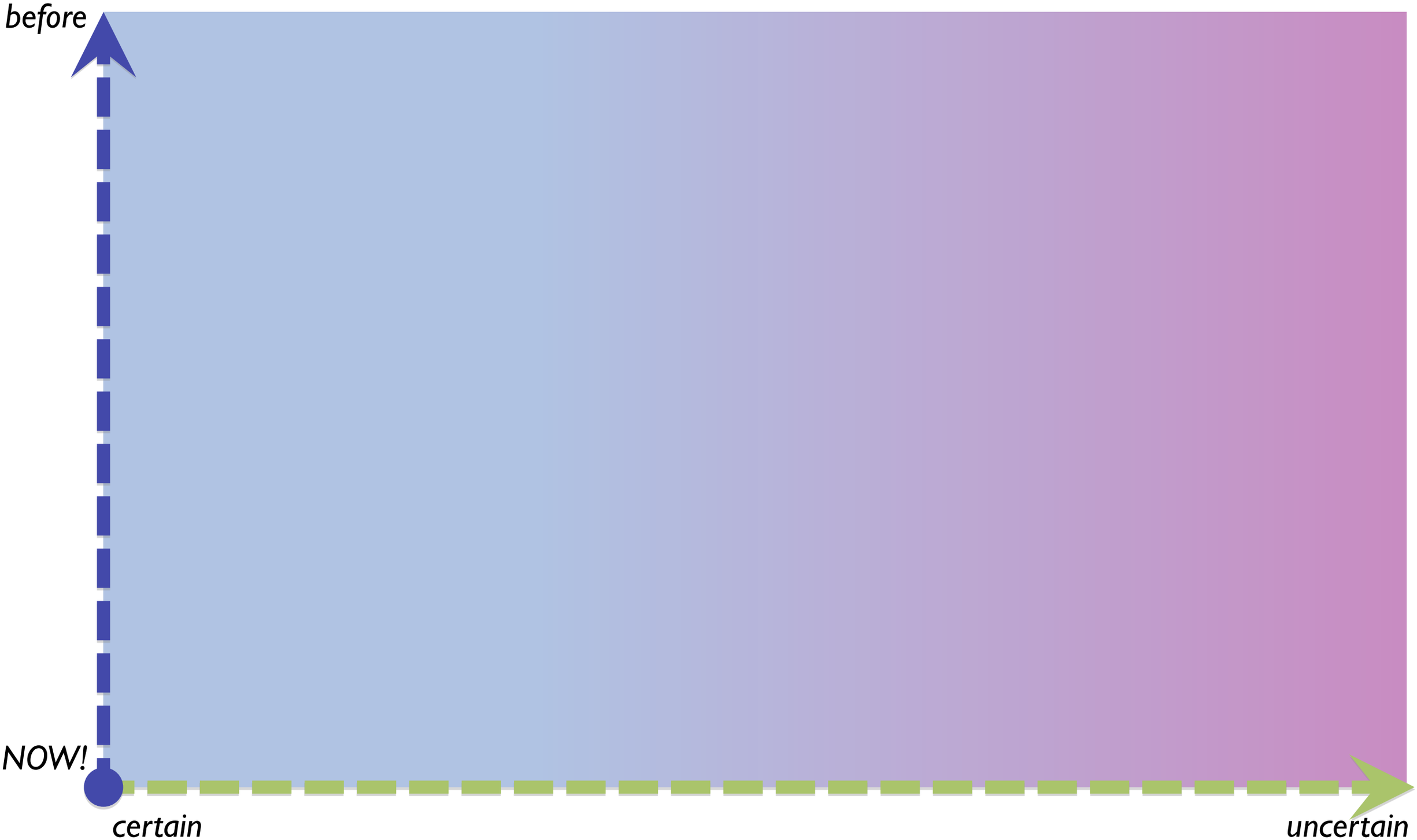
there are *very real limits*

to the usefulness
of that type of Complicated.

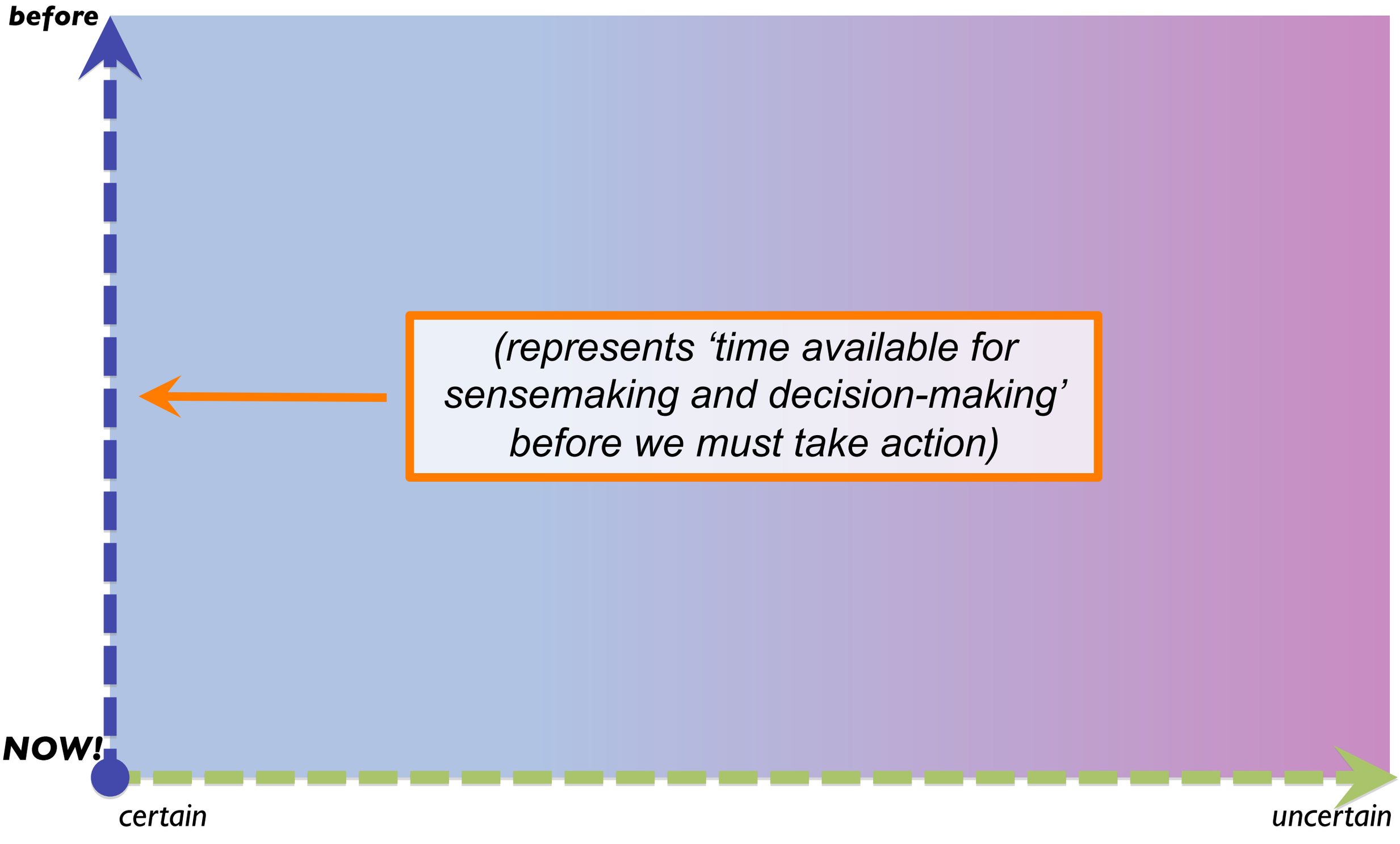
which leaves our poor beetle
kinda lost in the desert…

Where's a good ***map***
when you need one?!?

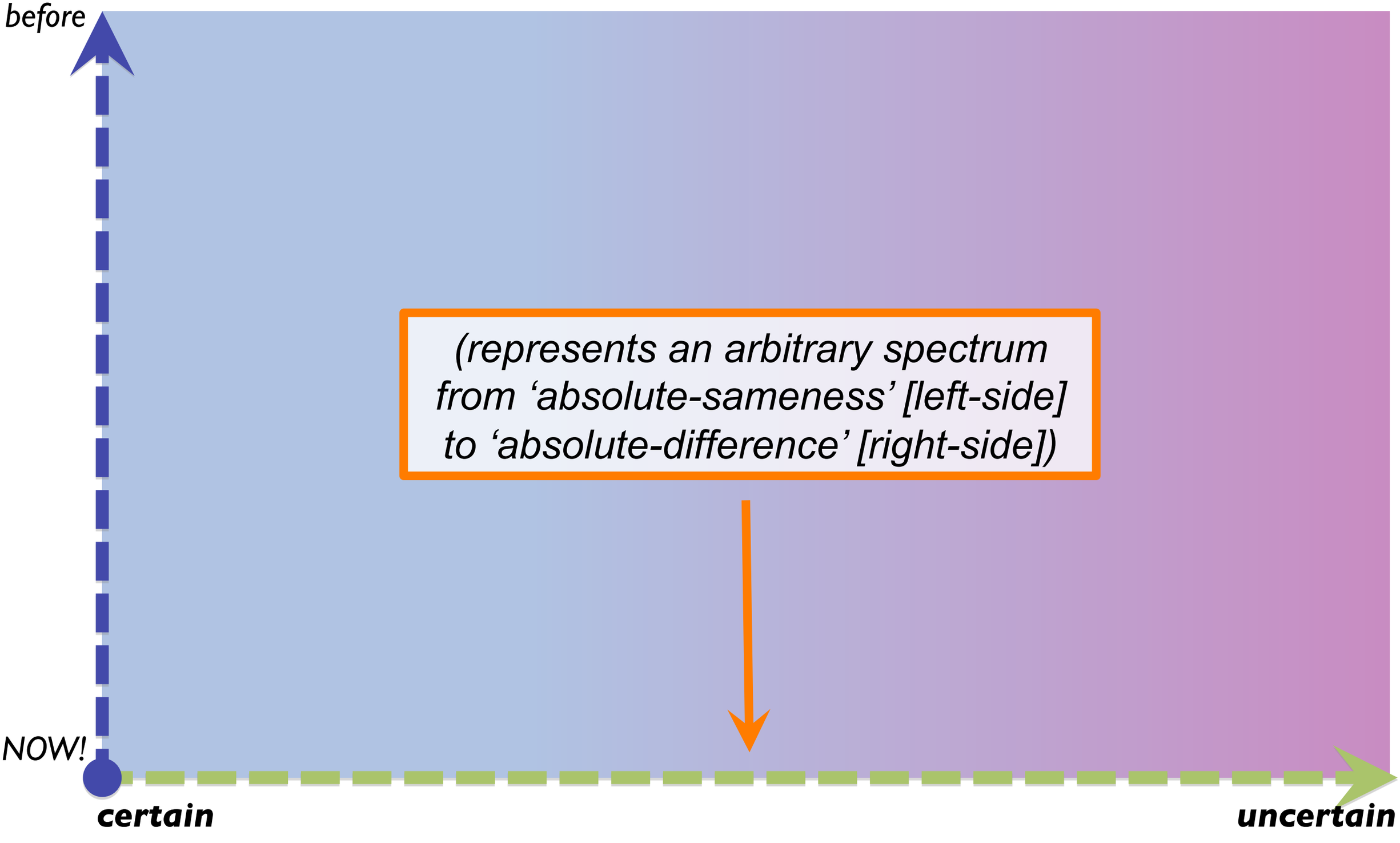
How’s about <u>this</u> map?



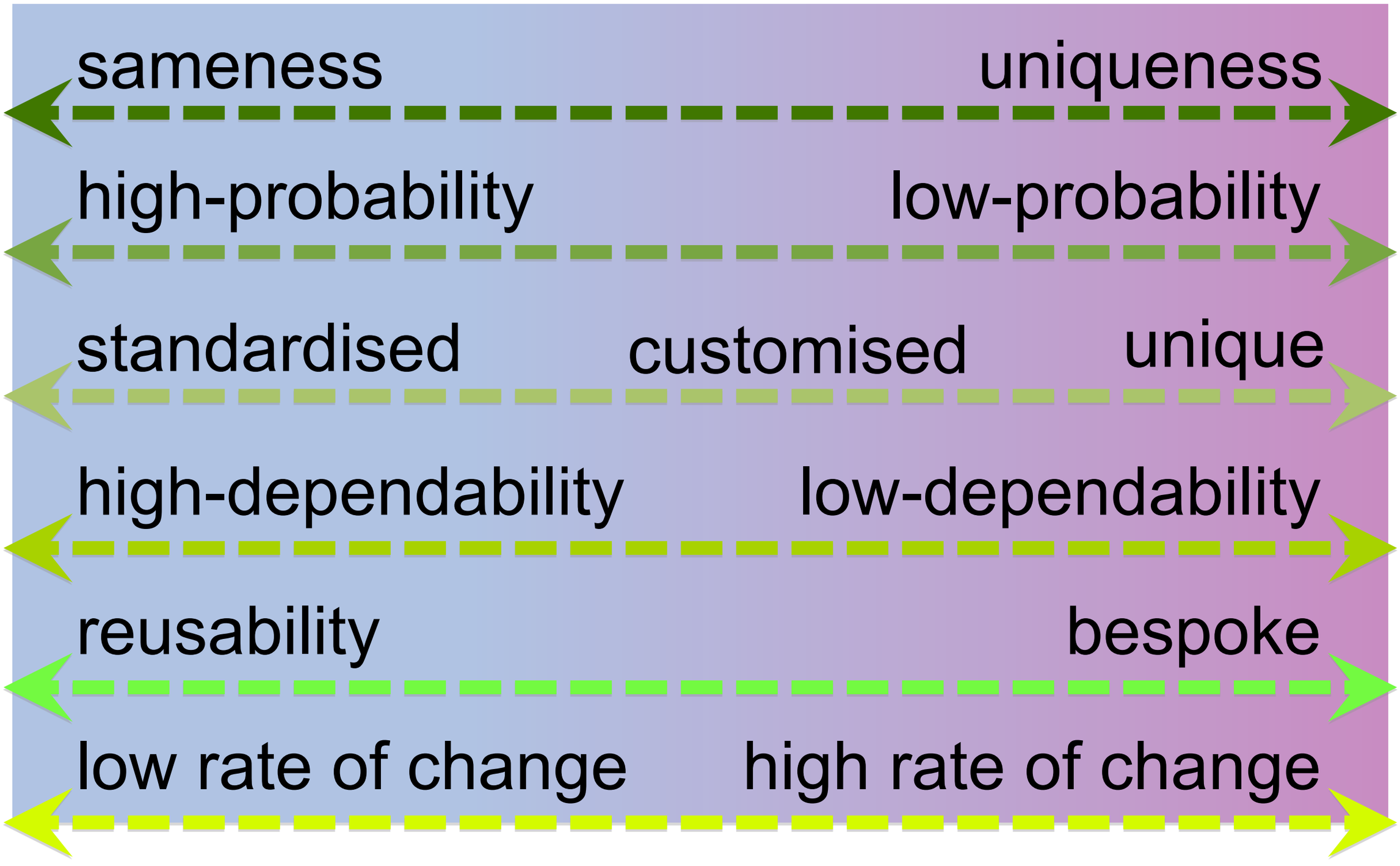
We've noted its vertical-axis…



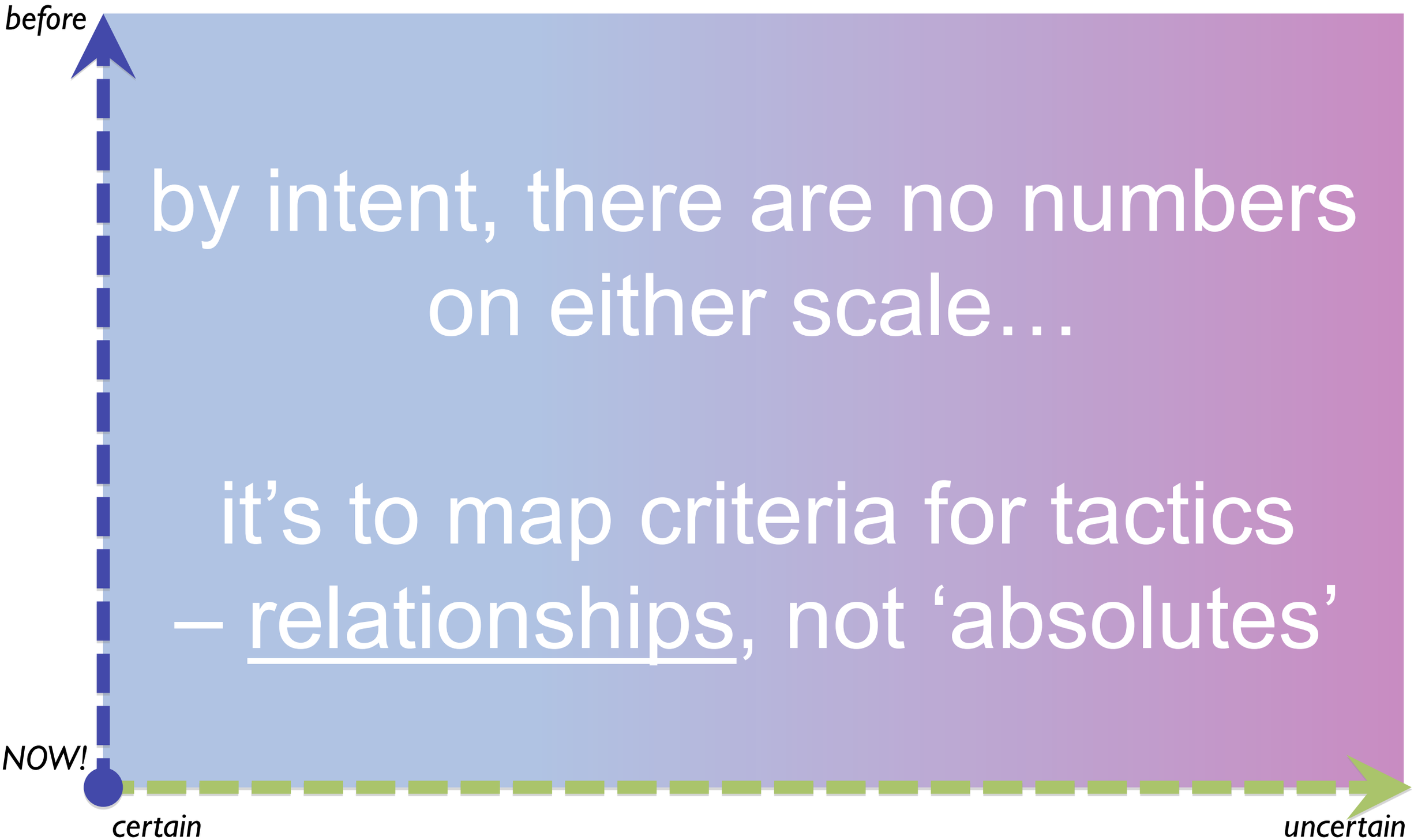
…let's look at its horizontal-axis



A bunch of similar scales…



What, no numbers?



We don’t need no steenkin’ numbers!

(but we do need options for varying tactics…)

The Simple
(or Complicated)
would prefer to try
to ‘**take control**’
of everything…

but…

…‘control’ won’t work on everything…

Take control! Impose order!

"Insanity
is doing
the same thing
and expecting
different results"

(Albert Einstein)

ORDER

(IT-type rules <u>do</u> work here)

Order and unorder

“Insanity
is doing
the same thing
and expecting
different results”

(Albert Einstein)

ORDER

(IT-type rules <u>do</u> work here)

edge of uncertainty

“Insanity
is doing
the same thing
and expecting
the <u>same</u> results”

(not Albert Einstein)

UNORDER

(IT-type rules <u>don’t</u> work here)

certain → *uncertain*

Same and different

A quest for certainty: **analysis**, algorithms, identicality, efficiency, business-rule engines, executable models, Six Sigma...

SAMENESS

(IT-systems do work well here)

An acceptance of uncertainty: **experiment**, patterns, probabilities, 'design-thinking', unstructured process...

UNIQUENESS

(IT-systems don't work well here)

certain — *uncertain*

Why skills are needed…

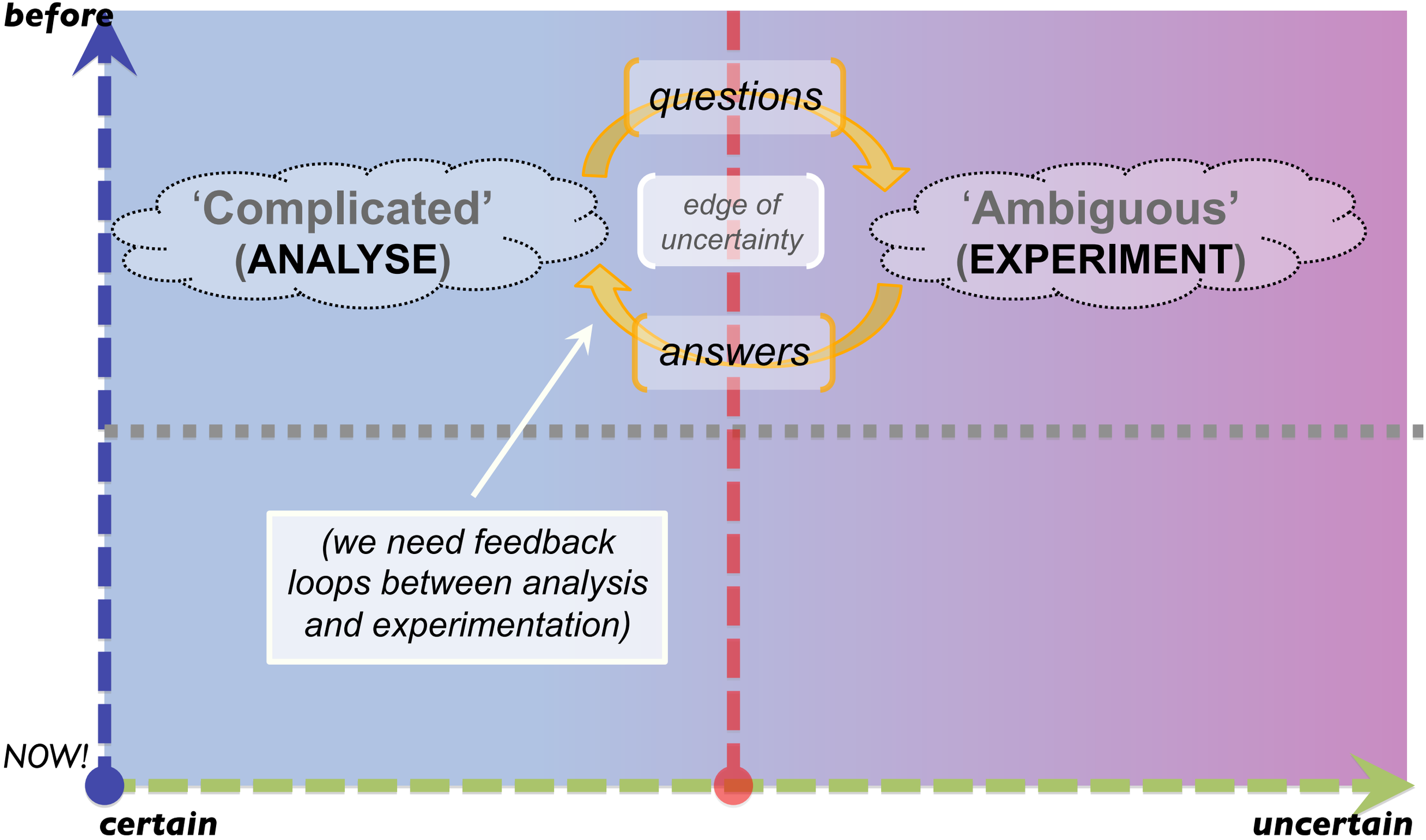
What is always going to be
uncertain or **unique**?

What will always be ‘**messy**’?

(‘Messy’ – politics, management, wicked-problems, ‘should’ vs ‘is’, etc.)

Wherever these occur,
we’re going to need human skill…

Certain and uncertain



Complexity
includes themes such as
wicked-problems

Tame- and wicked-problems

- definable formulation
- static ‘solution’
- clear end-point
- solution is true/false
- each essentially same
- finite dependency

‘TAME’

(‘control’ <u>can</u> work here)

- no defined formulation
- dynamic ‘re-solution’
- no clear end-point
- solution is good/bad
- essentially unique
- infinite dependency

‘WICKED’

(‘control’ <u>can’t</u> work here)

certain — *uncertain*

Terms such as
‘**complexity science**’
may unintentionally mislead:

physical-sciences apply
mostly in the ‘tame’-space…

most ‘*complexity-science*’
applies in the ‘wicked’-space.

Complexity
also includes
unintended-consequences

(a classic driver for wicked-problems…)

INTENDED CONSEQUENCE

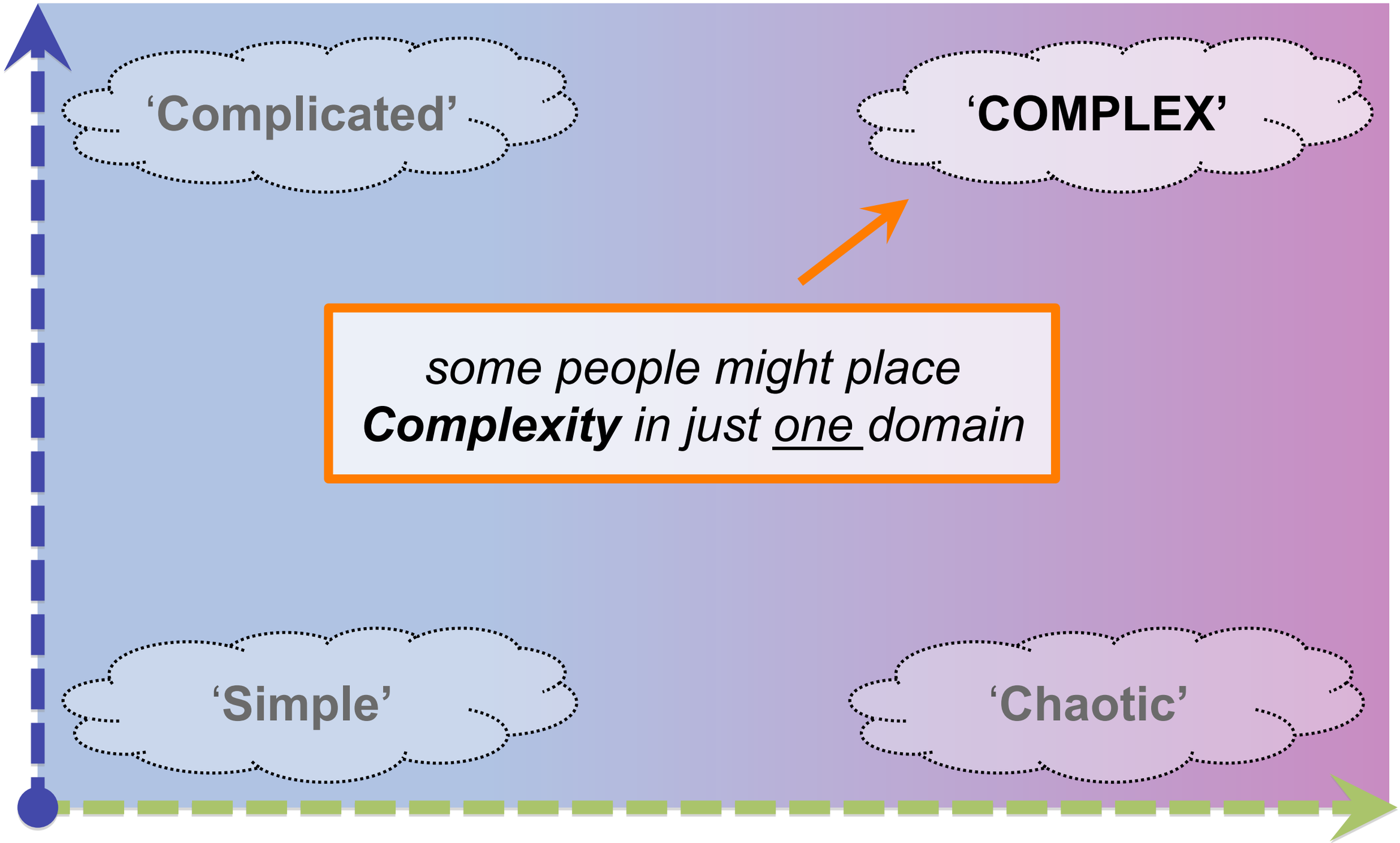
“engage hearts and minds…”

“how to get kids killed…”

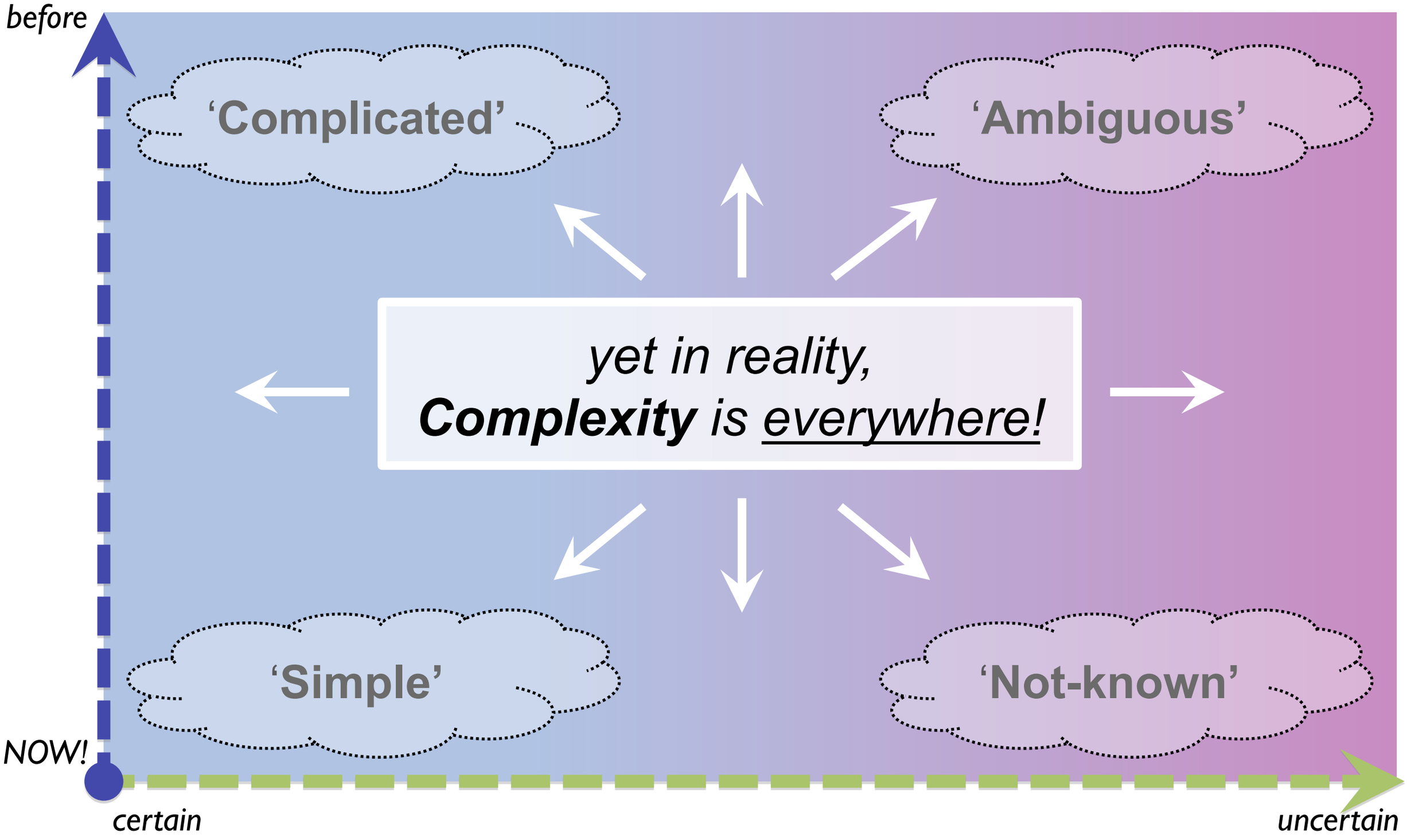
Think **VUCA**:

- **V**olatile
- **U**ncertain
- **C**omplex
- **A**mbiguous

Where to map complexity?



Where to map complexity?



Many meanings of
‘Complexity’…

(and of ‘Chaos’ or ‘Chaotic’, too)

– we need to embrace them all

(not make the Simplistic assertion
that only one kind is ‘the real complexity’…)

Complexity: they're <u>both</u> right…

Roger Sessions:

"eliminate complexity!"

(Simple Iterative Partitions; Snowman)

SAMENESS

(most IT-type models <u>do</u> work well for this)

John Seddon:

"embrace complexity!"

(Vanguard Method; 'failure-demand')

UNIQUENESS

(most IT-type models <u>don't</u> work well for this)

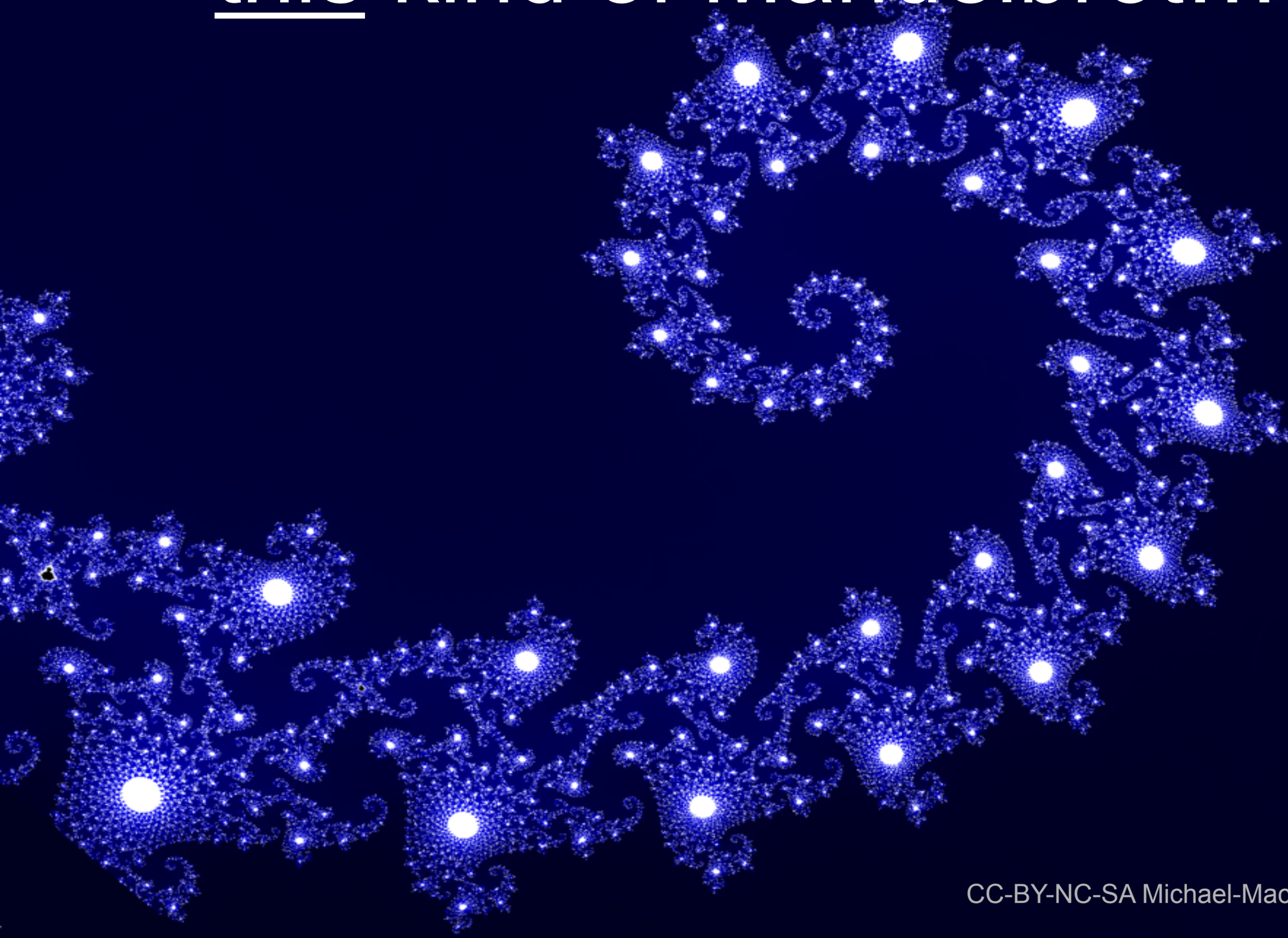
certain ***uncertain***

They're both right, because of **fractal recursion**…

- a point we can illustrate via Mandelbrot…

not this kind of Mandel Brot…

this kind of Mandelbrot…



fractal recursion…

self-similarity at every scale…

self-similarity at every scale…

always similar, yet always different…

Fractal recursion means that <u>every</u> point includes its own:

- **S**imple
- **C**omplicated
- **A**mbiguous (‘Complex’)
- **N**ot-known (‘Chaotic’)

NOTE:

'self-similar' is <u>not</u> the same as *'the same'*…

'high-probability' does <u>not</u> mean *'will always happen'*…

'low-probability' does <u>not</u> mean *'will never happen'*…

Use the right tactics
for each domain…

don’t mix them up!

But the beetle says…

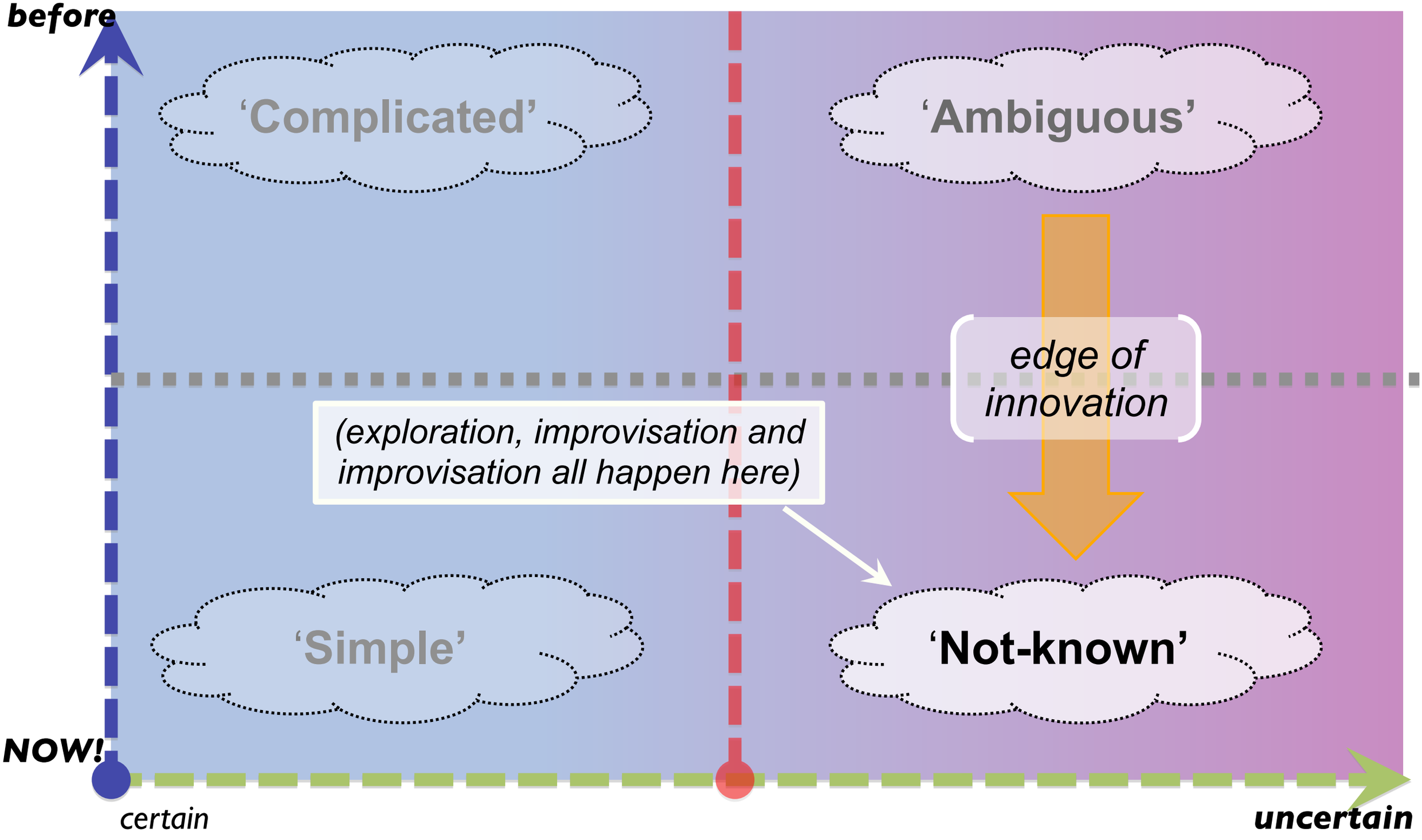
“it’s too easy to hide in theory here…”

At some point
we need to **stop theorising**
(or hypothesising – to be pedantic)
and get back in touch with
the **real-world**, in **real-time**…

*- down into the '**Not-known**'…*

or, colloquially…

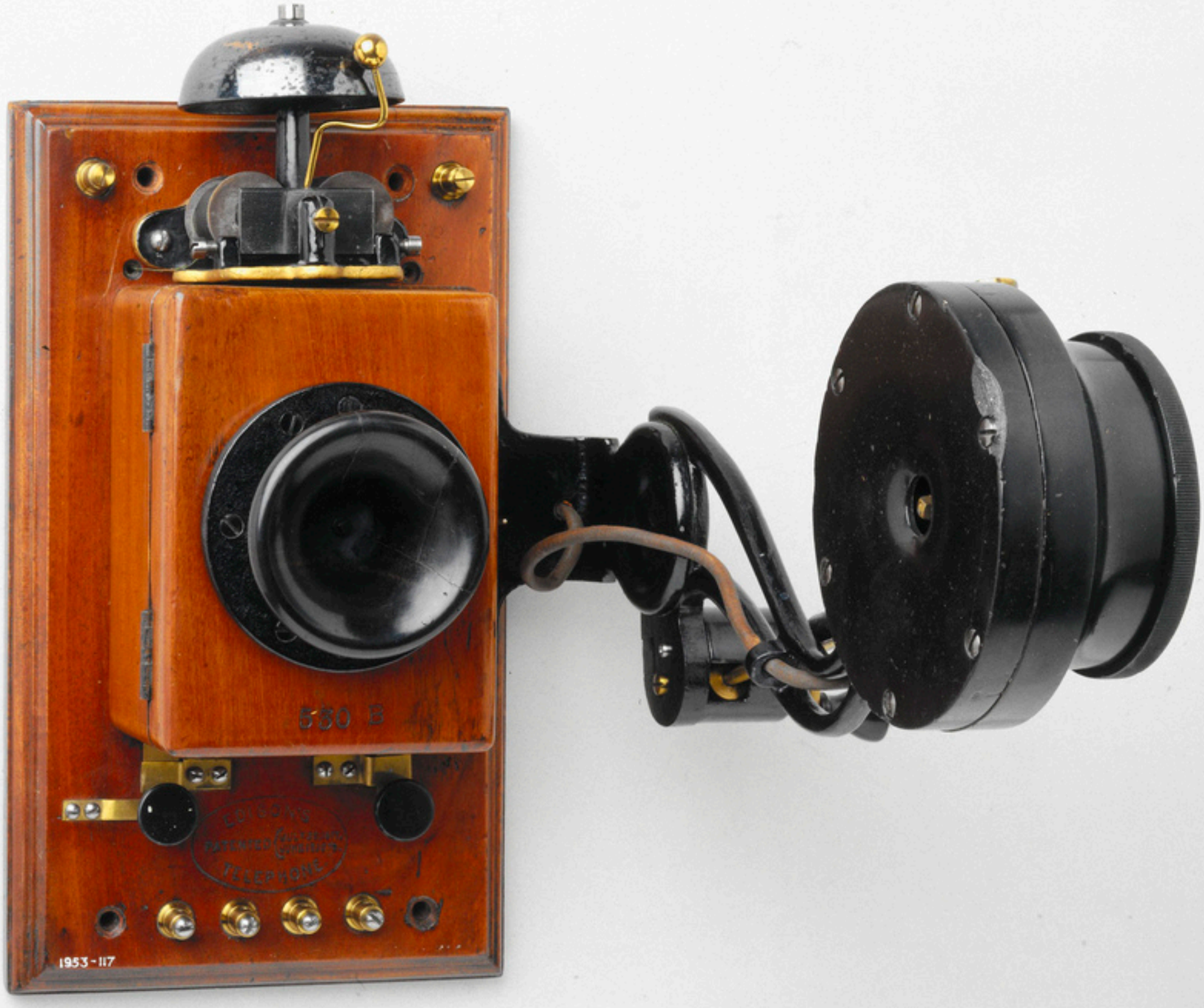
Back to the real-world again…

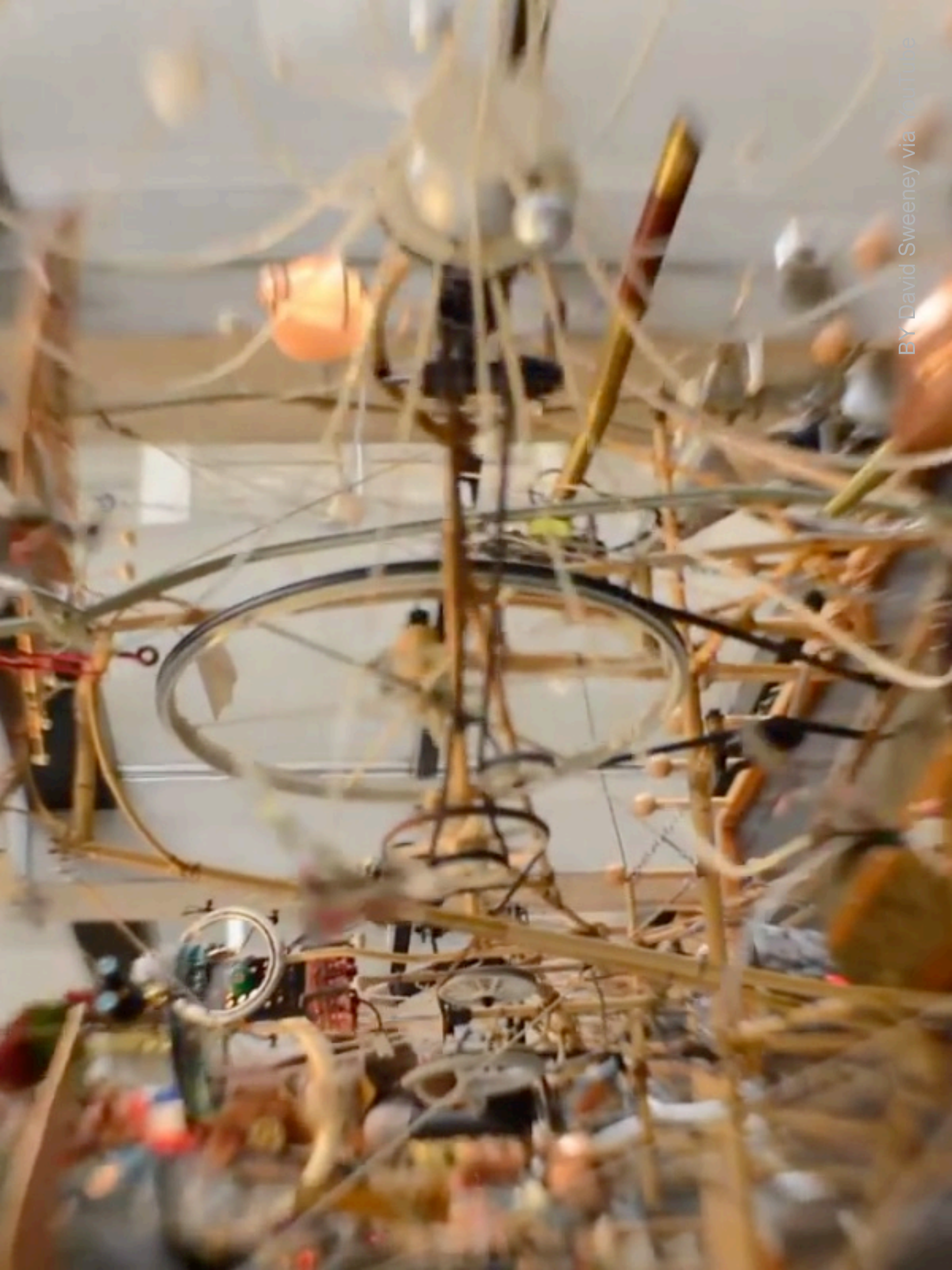


Here, even a dung-beetle…

can learn how to fly!

All invention
– everything ‘new’ –
at first appears *here*,
in the Not-known…




BY David Sweeney via YouTube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Scroll Saw
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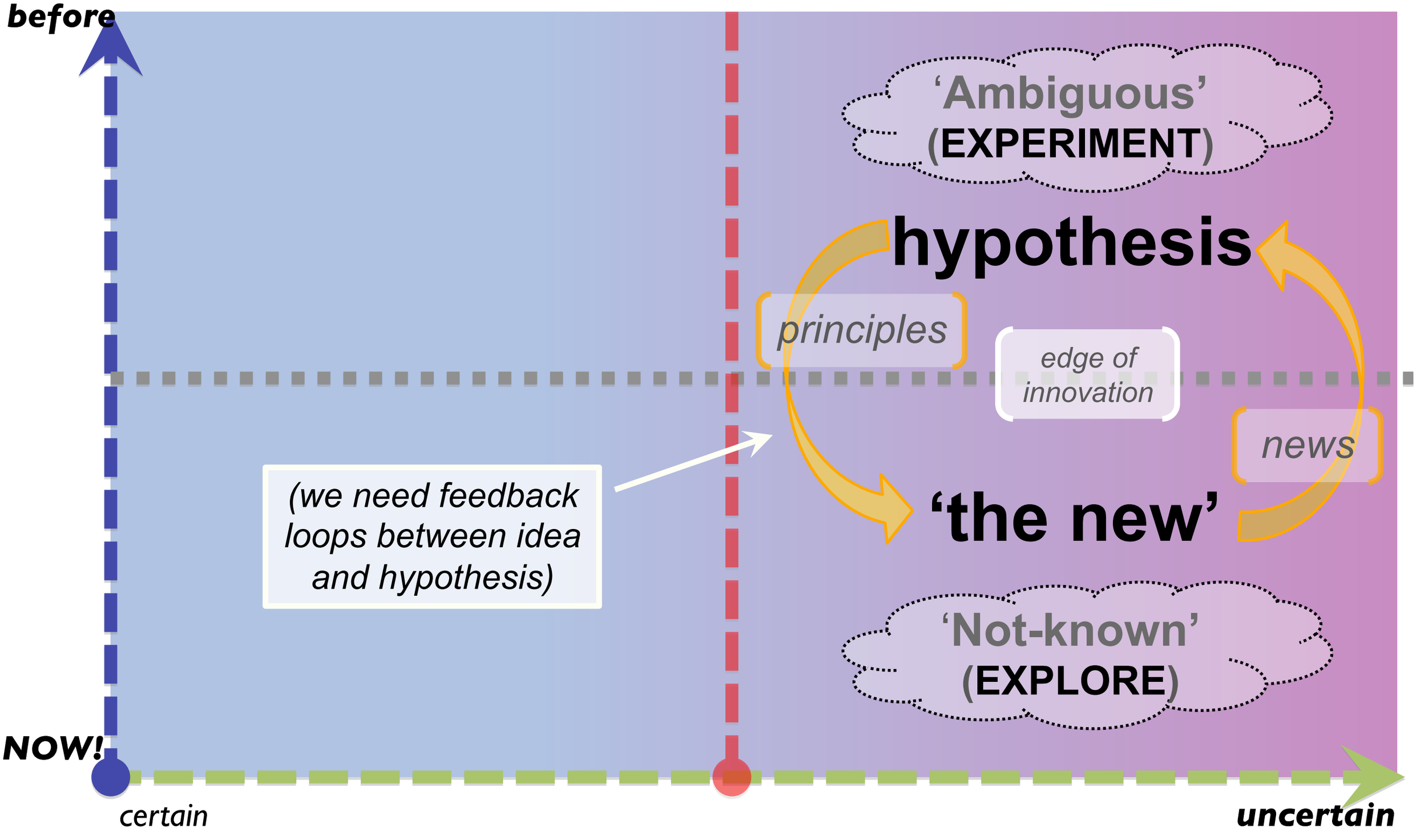
Idea and hypothesis



Where do new ideas come from?

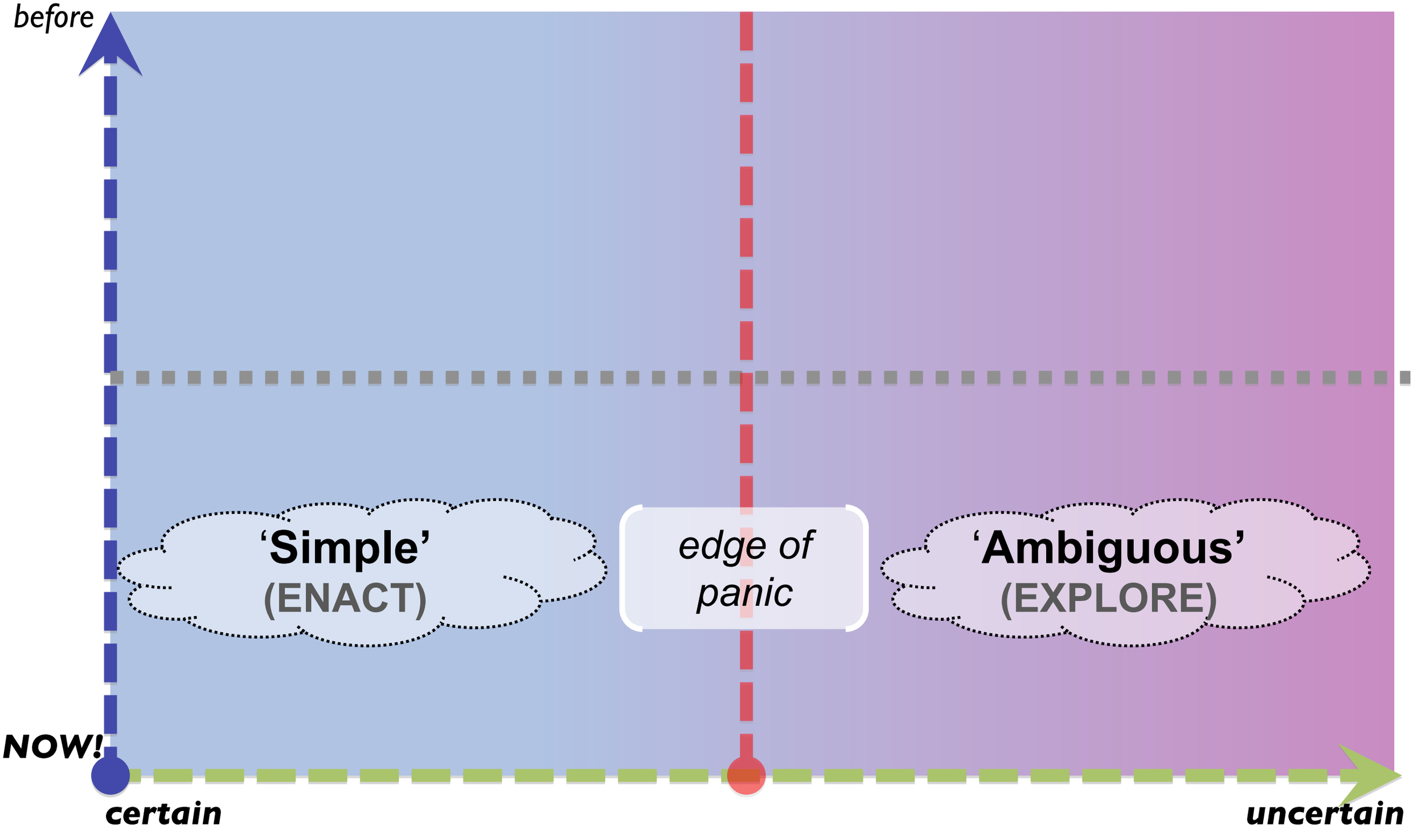
“Accept the burden of uncertainty… be comfortable with being uncomfortable.”

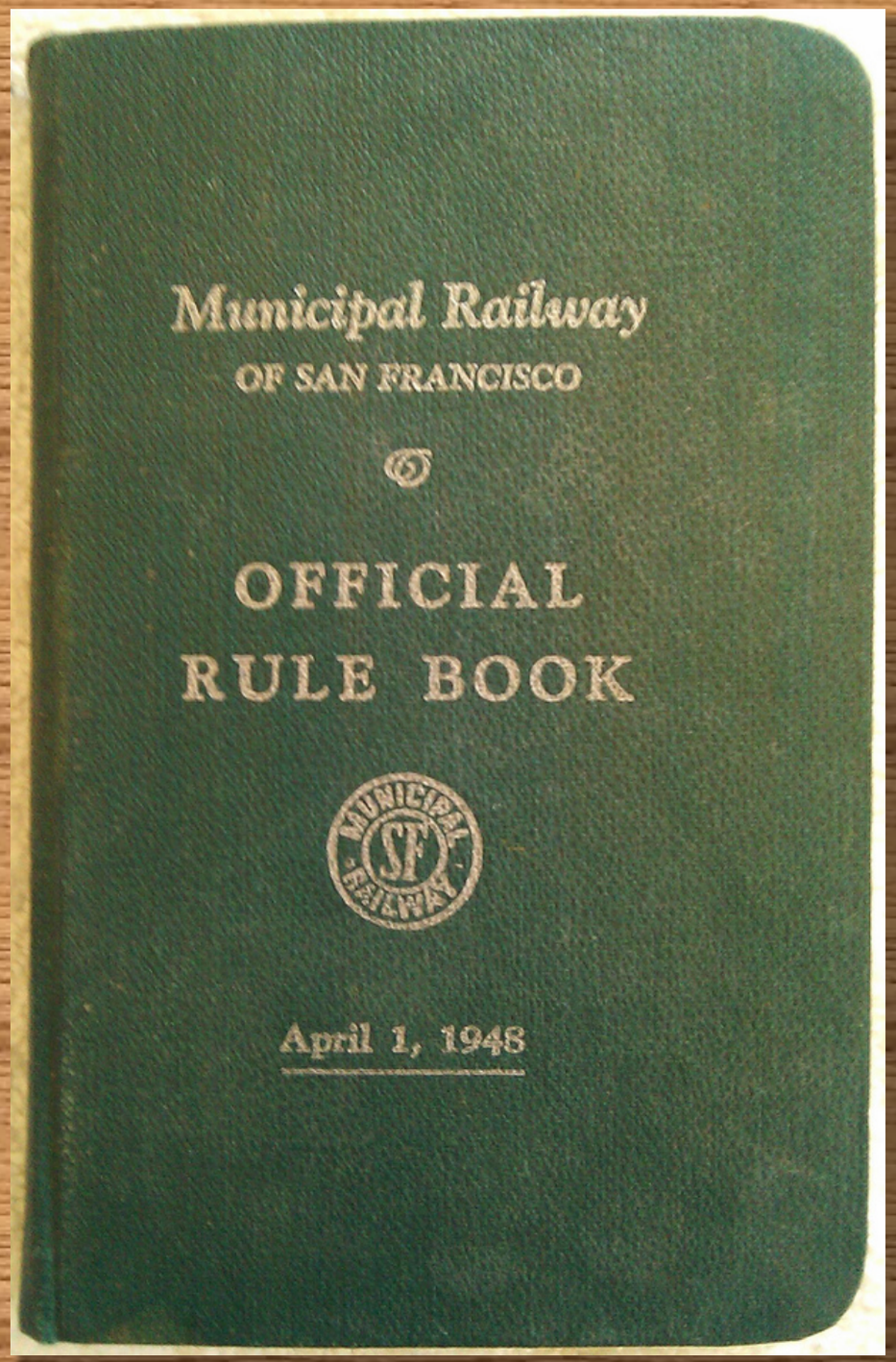
Where do new ideas come from?

“I can tell you things all day long, but you have to put your ass in the seat to really learn.”

We also come at this
from the other direction
- over from the Simple,
in real-time action,
across **the edge of panic**…

Across the edge of panic





The Rules.

(Everything You Need To Know For Your Job)

FUEL INJECTED CESSNA 172 CHECKLIST

- Fuel — CHECK (122.85)

CABIN CHECK

• Ignition Key	ON GLARESHIELD
• Documents (AROW)	CHECK
• Hobbs Meter	CHECK TIME
• Control Lock	REMOVE
• Electrical & Avionics	OFF
• Master Switch	ON
• Avionics Master Switch	ON-CHECK FAN-OFF
• Annunciator Panel Switch	TEST LIGHTS
• Fuel Gauges	CHECK
• Flaps	DOWN
• Exterior Lights	CHECK
• Master Switch	OFF
• Parking Brake	ON

EXTERIOR INSPECTION

• Fuel Sumps	SAMPLE (5)
• Fuselage Left Side	CHECK
• Elevator/Rudder	CHECK
• Tail Tie-down	REMOVE
• Fuselage Right Side	CHECK
• Right Flap & Aileron	CHECK
• Wing Tie-down	REMOVE
• Fuel Sumps	SAMPLE (5)
• Main Wheel Tire/Brakes	CHECK
• Chocks	REMOVE
• Fuel Quantity (Right Tank)	CHECK VISUALLY
• Engine Oil Level	CHECK (MIN. 5 QTS)
• Fuel Strainer/Selector Drains	SAMPLE (2)
• Propeller & Spinner	CHECK
• Alternator Belt	CHECK
• Landing Light	CHECK (CONDITION)
• Engine Air-Intake Filter	CHECK
• Nose Wheel Strut & Tire	CHECK
• Nose Chocks	REMOVE
• Static Source	CHECK
• Fuel Quantity (Left Tank)	CHECK VISUALLY
• Wing Tie-down	REMOVE
• Pitot Tube Cover	REMOVE
• Fuel Tank Vent	CLEAR
• Stall Warning Horn Opening	CHECK
• Left Flap & Aileron	CHECK
• Main Wheel Tire/Brakes	CHECK
• Chocks	REMOVE
• Move Airplane	CHECK TIRES
• Overall Condition	REVIEW

FUEL INJECTED CESSNA 172 CHECKLIST

BEFORE ENGINE START

• Seatbelts/Shoulder Harness	FASTENED
• Brakes	TEST & SET
• Fuel Selector	BOTH
• Fuel Shutoff Valve	ON (IN)
• Circuit Breakers	CHECK
• Beacon	ON
• Avionics Switch	OFF
• Master Switch	ON
• Throttle	OPEN 1/4 INCH
• Mixture	IDLE CUTOFF
• Aux. Pump	ON
• Mixture Rich 3-5 GPH	CUT OFF
• Aux. Pump	OFF
• Propeller Area	CLEAR

AFTER ENGINE START

• Ignition Switch	START
• Mixture (At Engine Start)	RICH
• Engine RPM	1000 RPM
• Oil Pressure	CHECK
• Mixture	LEANED MAX
• Flaps	RETRACT

TAXI

• Brakes	CHECK
• Magnetic Compass	MOVEMENT FREE
• Flight Instruments	CHECK

BEFORE TAKEOFF

• Parking Brakes	SET
• Flight Controls	FREE & CORRECT
• Flight Instruments	SET
• Fuel Selector	BOTH
• Elevator & Rudder Trim	SET
• Mixture	RICH FOR RUNUP
• Autopilot	CHECK DISCONNECT
• Throttle	1800 RPM
• Ammeter	CHECK
• Engine Instruments.	CHECK
• Suction	CHECK
• Magnetos	CHECK (125/50)
• Throttle	IDLE CHECK
SMOOTH & 600 RPM ± 25 THEN	1000 RPM
• Radios	SET
• Brakes	RELEASE
Final Items	
• Door/Windows	CLOSED
• Flaps	AS REQUIRED
• Mixture	RICH (BELOW 3000 FT)

FUEL INJECTED CESSNA 172 CHECKLIST

TAKEOFF

• "LIGHTS" (ALL)	ON
• "CAMERA" (Transponder)	ON
• "ACTION" (RPM, Oil Pres., Time)	FULL POWER
• Climb Speed (172R)	74 KTS
(172S)	79 KTS

BEFORE LANDING

• Seatbelts	ADJUST
• Fuel Selector	BOTH
• Engine Gauges	CHECK
• Heading Indicator	ALIGNED
• Altimeter Setting	CHECK
• Radios	SET
• Autopilot	OFF
Final Items	
• Mixture	RICH
• Flaps	DOWN
• Approach Speed	65-75 KTS

AFTER LANDING CHECK

• "LIGHTS" (Except Beacon)	OFF
• "CAMERA" (Transponder)	OFF
• "ACTION" (Mixture, Flaps)	

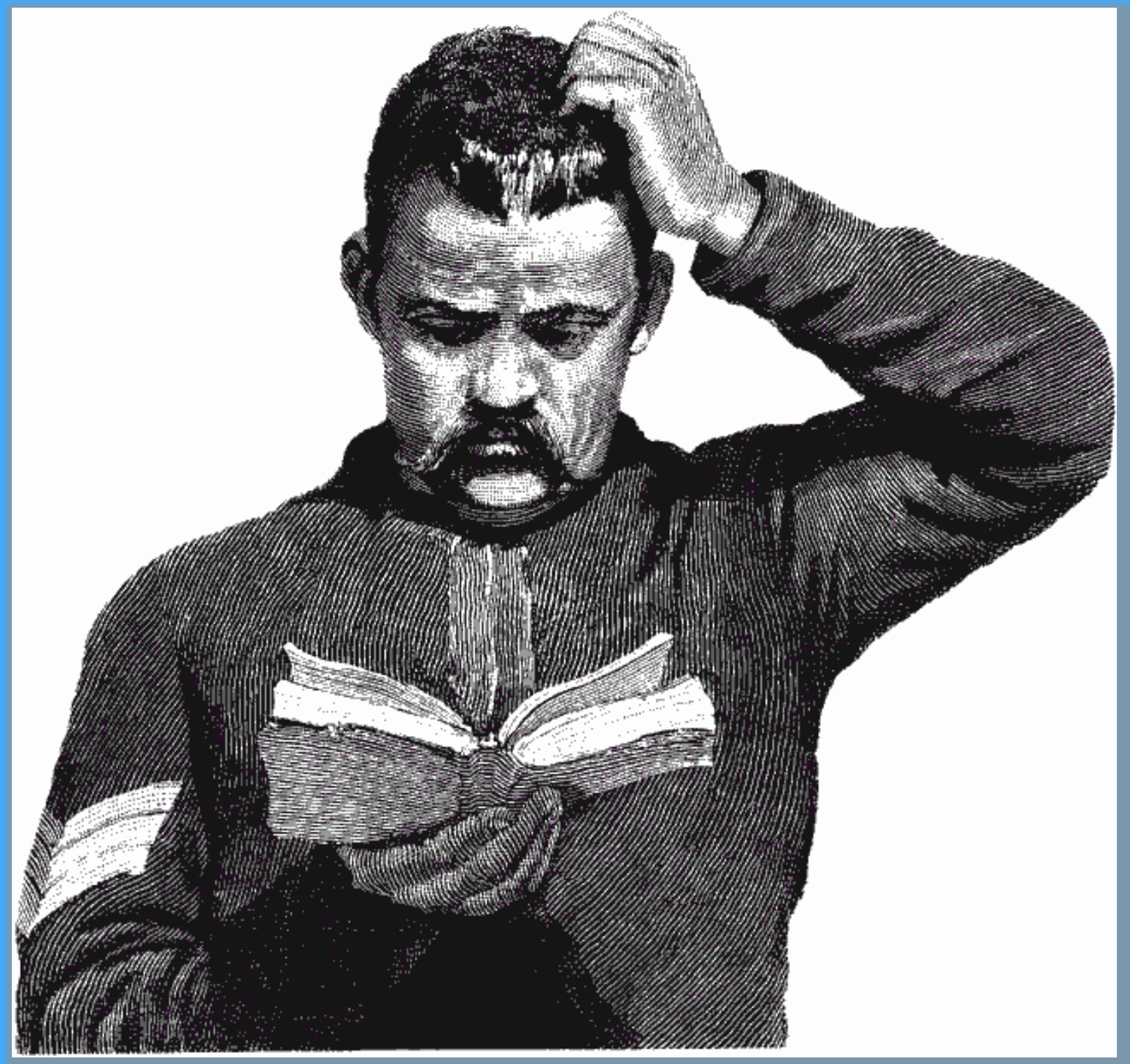
ENGINE SHUTDOWN

• Throttle	IDLE
• Mags	GROUND CHECK
• Throttle	1000 RPM
• Avionics/Electrical Equip.	OFF
• Mixture	CUTOFF
• Master/Alternator Switch	OFF
• Ignition Switch	OFF
• Ignition Key	GLARESHIELD

SECURING AIRCRAFT

• Hobbs & Tach	RECORD
• Control Lock	INSTALL
• Tiedowns/Chocks	INSTALL
• Propeller (For Fuel)	VERTICAL
• Fuel	RIGHT TANK

HUH?



the real-world don’t match the rules??

WAAAAHHH!!!

…which is why there's
the <u>other</u> side
to that **checklist**…

- to keep the panic at bay…

EMERGENCY PROCEDURES

AIRSPEEDS FOR EMERGENCY OPERATIONS

- Engine Failure After Takeoff 65 KTS
- Maneuvering Speed:
  2450 LBS/99KTS • 2100 Lbs/92 KTS • 1600 Lbs/82 KTS
- Maximum Glide 65 KTS
- Landing Without Engine Power:
  Flaps Up 65 KTS Flaps Down 60 KTS

ENGINE FAILURE IMMEDIATELY AFTER TAKEOFF

- Fuel Selector BOTH
- Mixture RICH

IF ENGINE FAILS TO RESTART

- Airspeed 65 KTS
- Mixture CUTOFF
- Fuel Shutoff Valve OFF (PULL OUT)
- Ignition Switch OFF
- Master Switch OFF

ENGINE FAILURE DURING FLIGHT

- Airspeed 65 KTS

FLY THE AIRPLANE

- Fuel Shutoff Valve ON (IN)
- Fuel Selector BOTH
- Aux. Fuel Pump ON
- Mixture RICH
- Ignition Switch BOTH

EMERGENCY LANDING WITHOUT POWER

- Airspeed 65 KTS
- Mixture CUTOFF
- Fuel Shutoff Valve OFF (PULL OUT)
- Ignition Switch OFF
- Wing Flaps AS REQUIRED
- Master Switch OFF
- Seatbelts TIGHT
- Door UNLATCH
- Touchdown SLIGHTLY TAIL LOW
- Brakes APPLY HEAVILY

ALTERNATOR FAILURE

- Avionics Power Switch OFF
- Alternator Circuit Breaker CHECK IN
- Master Switch OFF
- Master Switch ON
- Low Voltage Light CHECK OFF
- Avionics Power Switch ON

IF LOW VOLTAGE LIGHT ON AGAIN

- Alternator OFF
- Nonessential Electrical Equip OFF
- Land As Soon As Practical

FIRE DURING START OR GROUND

- Cranking CONTINUE FOR START

If Engine Fails To Start

- Throttle FULL OPEN
- Mixture CUTOFF
- Master Switch OFF
- Ignition Switch OFF
- Fuel Shutoff Valve OFF (PULL OUT)
- Aux. Fuel Pump OFF

ENGINE FIRE IN FLIGHT

- Mixture CUTOFF
- Fuel Shutoff Valve OFF (PULL OUT)
- Aux. Fuel Pump OFF
- Master Switch OFF
- Cabin Heat & Air OFF
- Increase Airspeed BLOW OUT FIRE
- Forced Landing EXECUTE

ELECTRICAL FIRE IN FLIGHT

- Master Switch OFF
- Avionics OFF
- All Other Switches OFF
- Cabin Heat & Air OFF/CLOSE

COMMUNICATION LOSS

- Frequency CHECK
- Volume/Squelch CHECK
- Speaker/Phones Switch CHECK SELECTION
- Headset Jacks RESET
- O/H Speaker-Handmike TRY BOTH
- Circuit Breakers CHECK
- Other Radio IF AVAILABLE
- VOR Frequency MONITOR
- Squawk 7600
- Tower Lights Signals OBSERVE

EMERGENCY FREQUENCY 121.5

Orange County FLIGHT CENTER
19711 Campus Dr., #150
Santa Ana, CA 92707
(949) 756-1300 • Fax (949) 756-0727
www.ocflightcenter.com

Key items that users may forget in panic…

FLY THE AIRPLANE

ENGINE FAILURE IMMEDIATELY AFTER TAKEOFF

• Fuel Selector	BOTH
• Mixture	RICH
IF ENGINE FAILS TO RESTART	
• Airspeed	65 KTS
• Mixture	CUTOFF
• Fuel Shutoff Valve	OFF (PULL OUT)
• Ignition Switch	OFF
• Master Switch	OFF

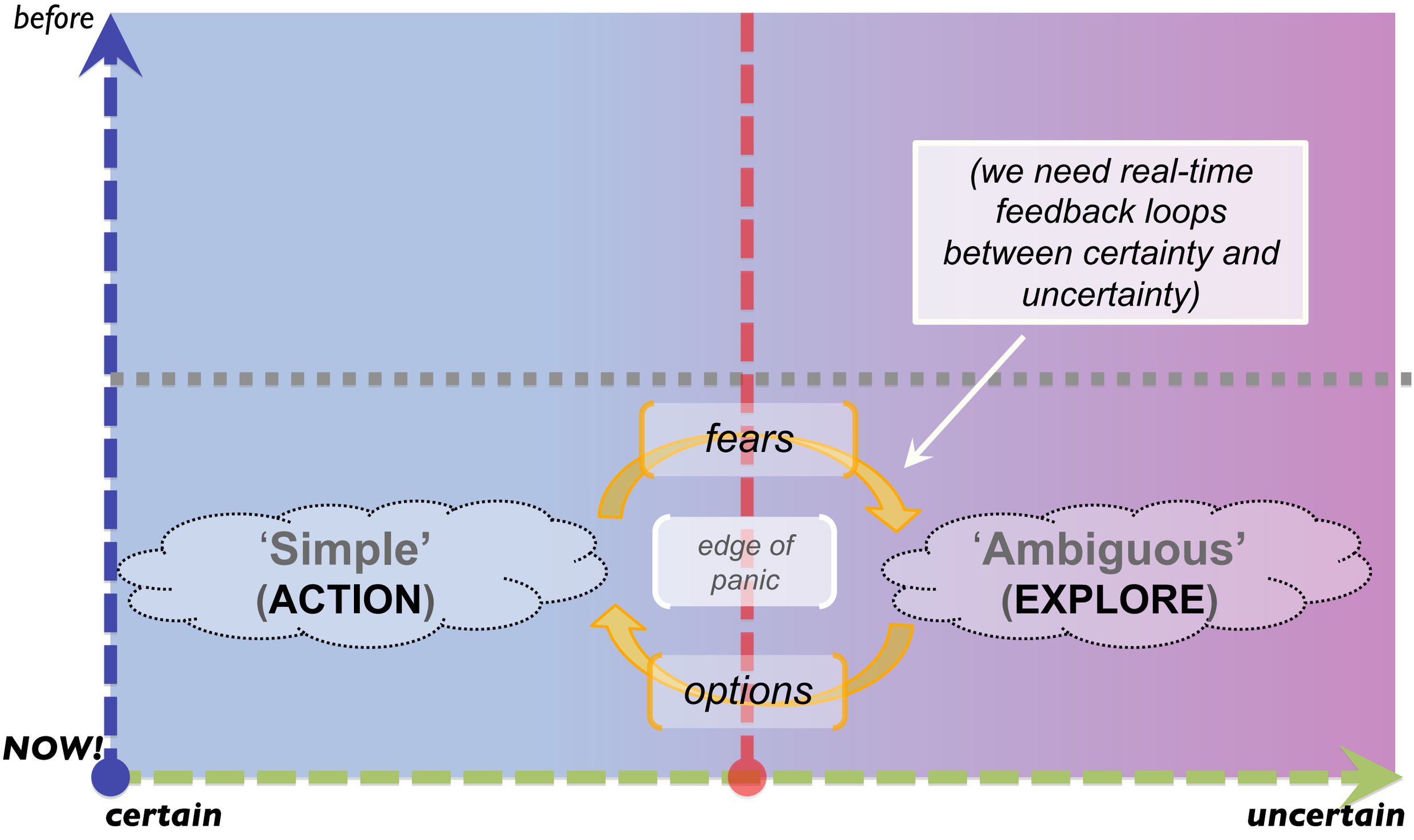
ENGINE FAILURE DURING FLIGHT

• Airspeed	65 KTS
FLY THE AIRPLANE	
• Fuel Shutoff Valve	ON (IN)
• Fuel Selector	BOTH
• Aux. Fuel Pump	ON
• Mixture	RICH
• Ignition Switch	BOTH

EMERGENCY LANDING WITHOUT POWER

• Airspeed	65 KTS
• Mixture	CUTOFF
• Fuel Shutoff Valve	OFF (PULL OUT)
• Ignition Switch	OFF
• Wing Flaps	AS REQUIRED
• Master Switch	OFF
• Seatbelts	TIGHT
• Door	UNLATCH
• Touchdown	SLIGHTLY TAIL LOW
• Brakes	APPLY HEAVILY

The other learning-loop…



That feedback-loop
across *the edge of panic*
is where, and how,
on-the-spot answers arise
out there in the field…

strange yet useful innovations…

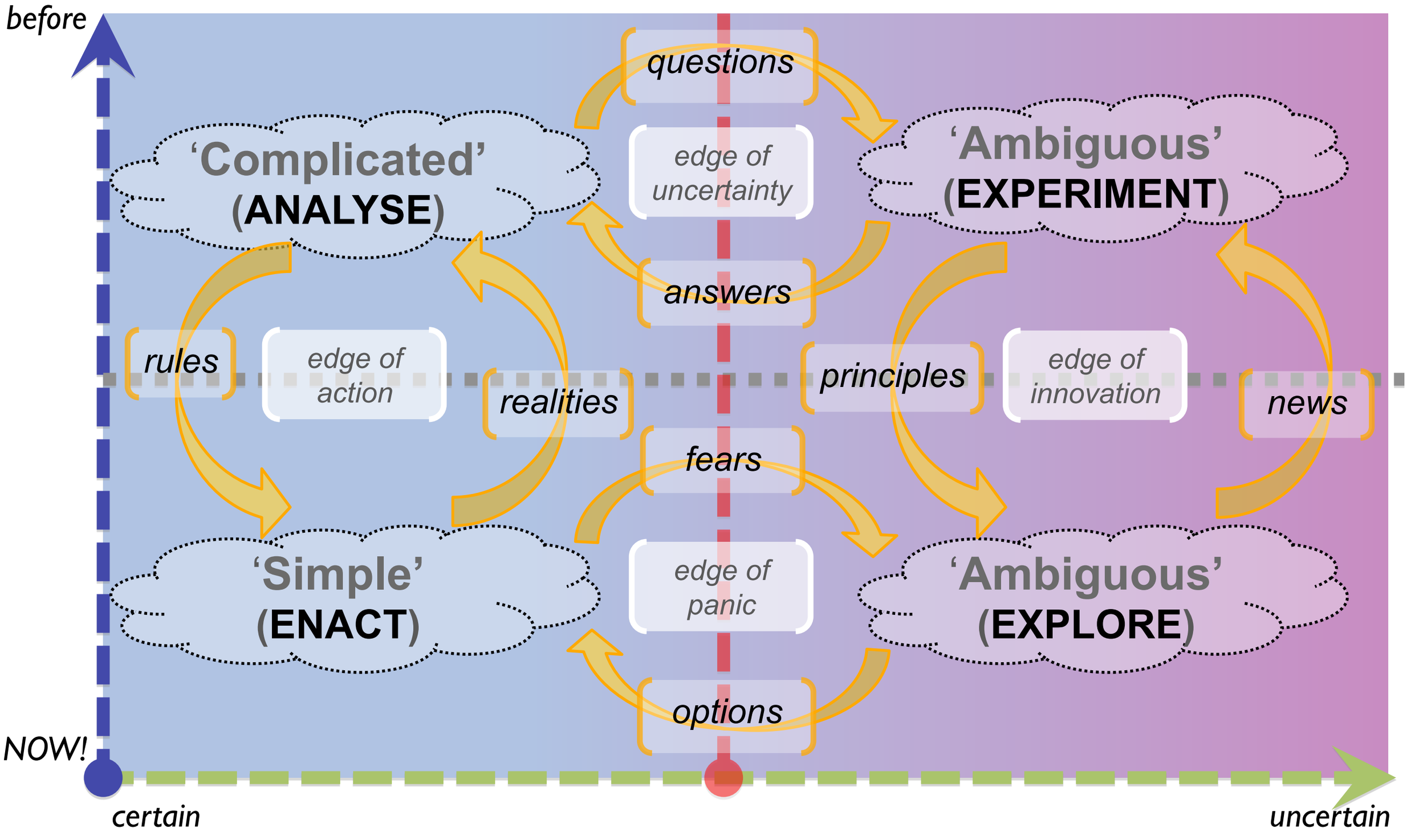
refusing to face the uncertainty
is what strands us here...

It’s almost time to wrap up this tale…

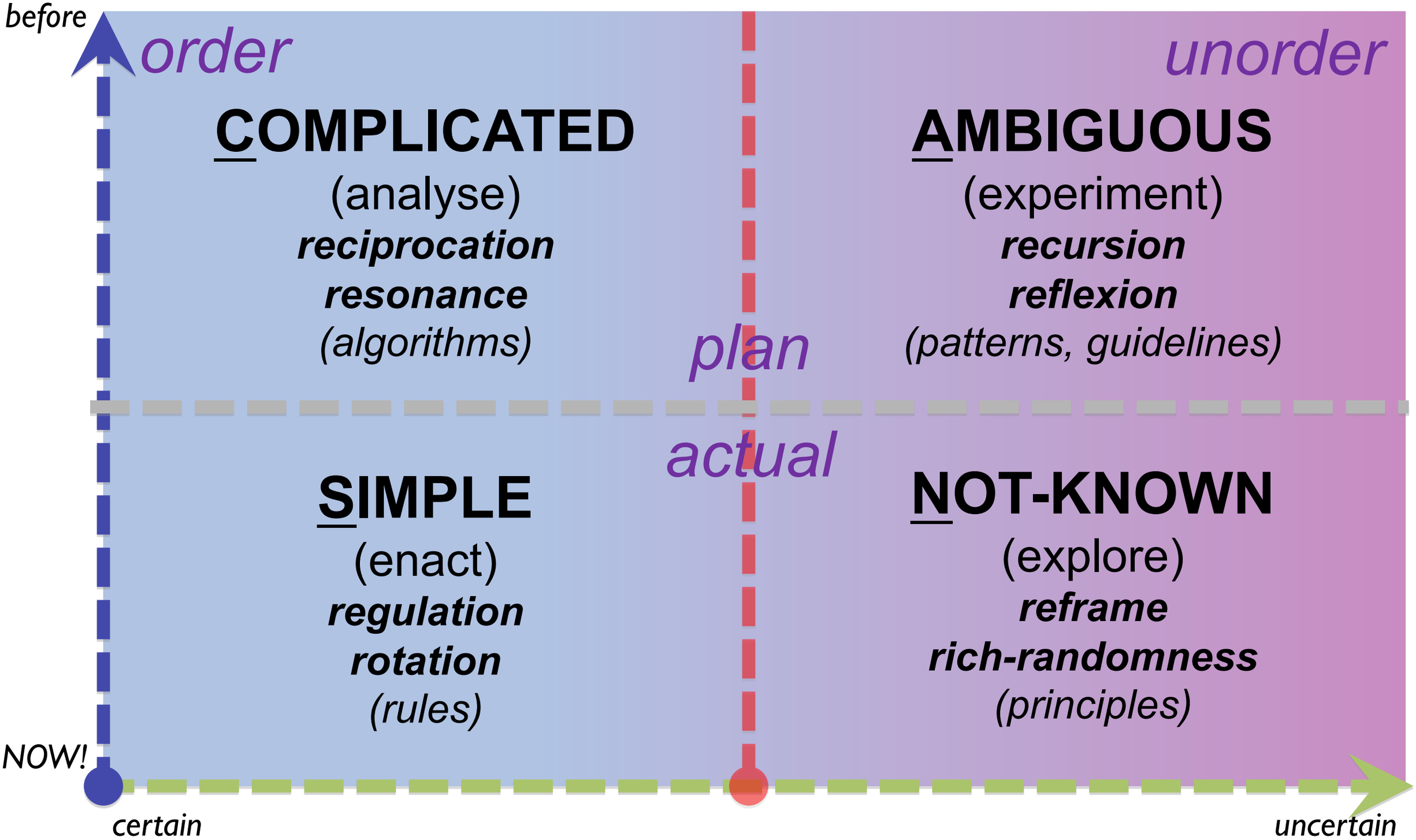
Making sense of complexity

Use context-maps such as SCAN to identify what **may** or **must** change what **is** or **is not** certain how these **vary** over time and what to **do** with each

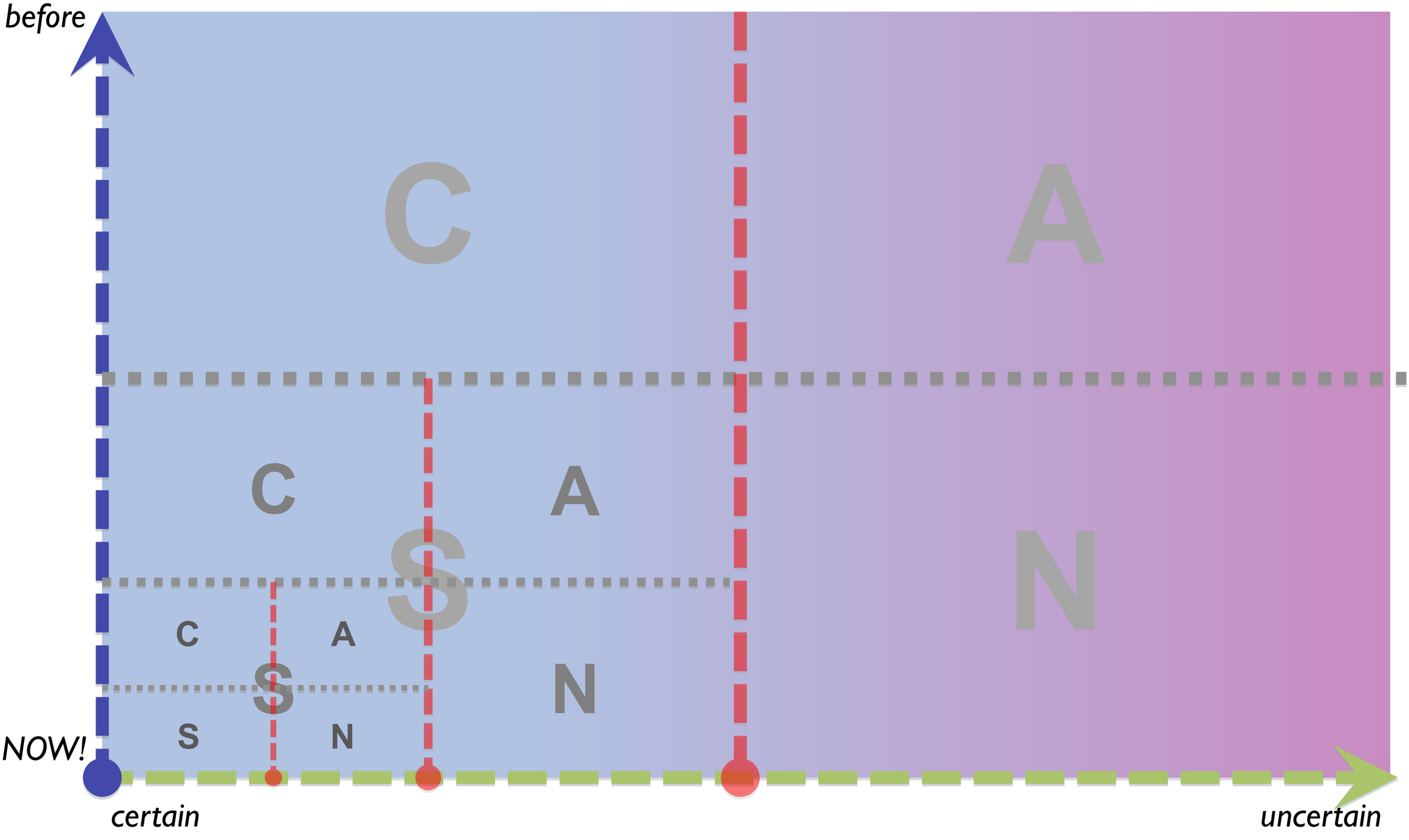
Linking it all together



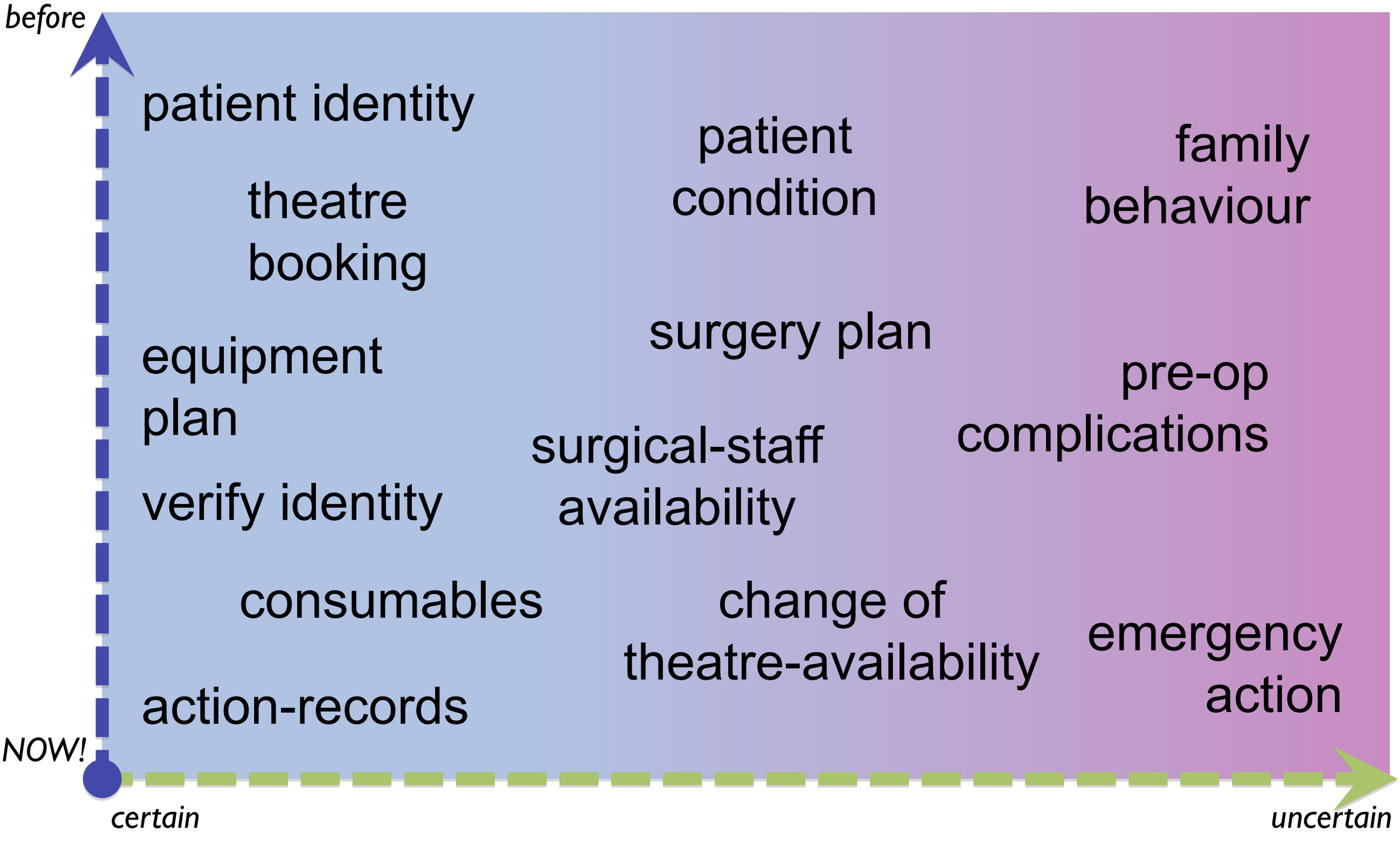
Common themes in each domain



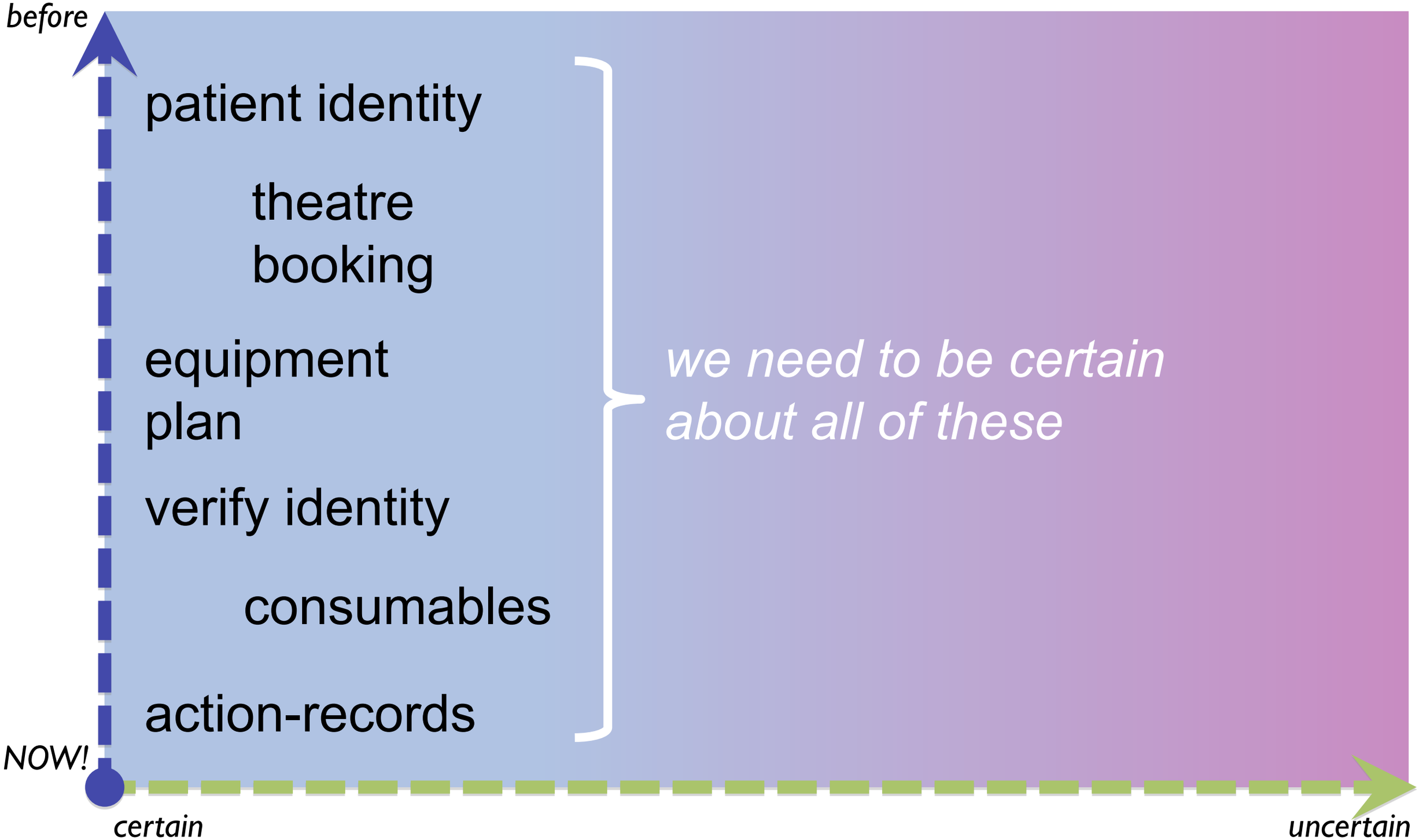
Remember that it's recursive



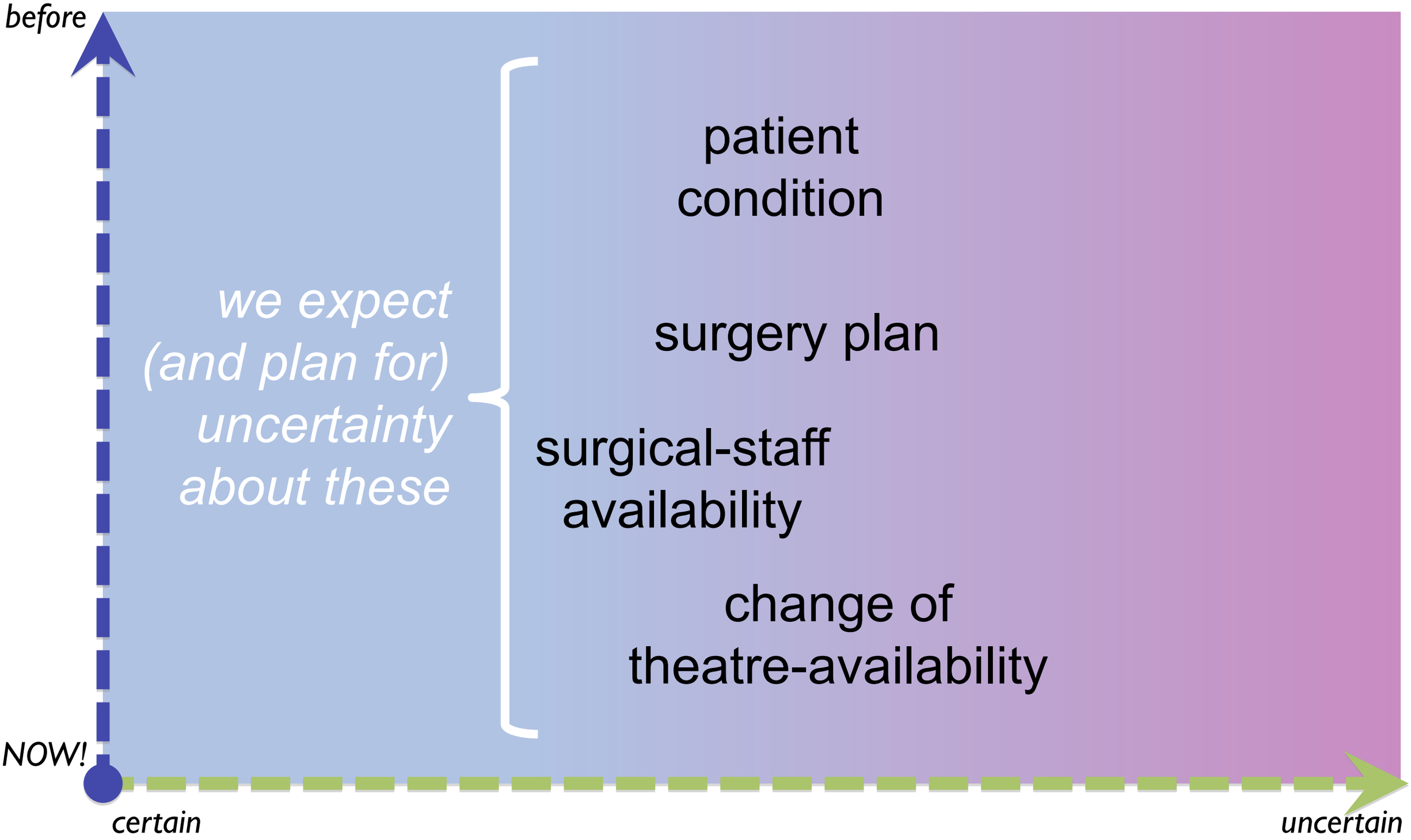
A surgical example…



A surgical example…



A surgical example…



A surgical example…

But to let our brave dung-beetle have the last words…

always remember…

in ancient Egypt…

the scarab rolled the sun along its course…

a helpmate and advisor to the gods...

and even in the present-day…

DUNG BEETLES HAVE RIGHT OF WAY

South African
NATIONAL PARKS

DO NOT DRIVE OVER DUNG BEETLES OR ELEPHANT DUNG

Thank you!

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Slidedecks: http://www.slideshare.net/tetradian

Publications: http://tetradianbooks.com

Books:

- *The enterprise as story: the role of narrative in enterprise-architecture* (2012)
- *Mapping the enterprise: modelling the enterprise as services with the Enterprise Canvas* (2010)
- *Everyday enterprise-architecture: sensemaking, strategy, structures and solutions* (2010)
- *Doing enterprise-architecture: process and practice in the real enterprise* (2009)