UK Atomic Energy Authority

Engineering & project delivery – a case study in the world of fusion

Sarah Ridder, September 2026

Fusion Industry School - Fusion CDT (Universities of York and Oxford)

A quick intro

APM Fellow Member FAPM

OVER 17 YEARS EXPERIENCE

IoD

Public sector my whole career, ranging from: P3M, leadership, strategy, business transformation, investment, skills, regeneration, central government funding, housing, civil engineering, film studios & creative industry, railway, business & sustainability, executive education, tertiary education sector…
and now fusion

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OXFORDSHIRE COUNTY COUNCIL

THE PRINCE OF WALES'S BUSINESS & SUSTAINABILITY PROGRAMME
UNIVERSITY OF CAMBRIDGE INSTITUTE FOR SUSTAINABILITY LEADERSHIP

GREATER LONDON AUTHORITY

leapfrog

eauc

A project creates one change. A programme creates a bigger change.

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PROJECT

ONE CLEAR CHANGE

A project creates something new or changes how things work.

The project ends when the series launches.

PROGRAMME

CONNECTED PROJECTS

Together, they improve the whole Netflix experience.

The programme succeeds when the bigger goal is achieved.

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Delivery in fusion

How does delivery in fusion compare to other organisations?

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MOST ORGANISATIONS

The challenges are familiar.

COMPLEXITY interdependent systems

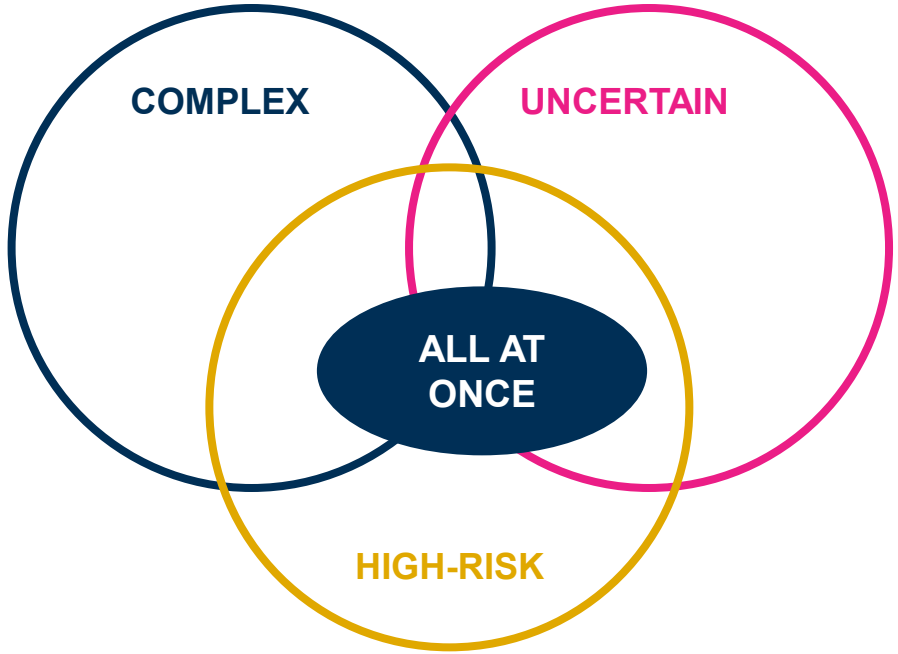
UNCERTAINTY evolving pathways

RISK high stakes

Projects and organisations everywhere manage these forces.

FUSION DELIVERY

The difference is the combination at exceptional scale.



Building technology + supply chain + ecosystem — ready to use and scale.

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Complex fusion programmes reveal common approaches

Today's insights come from patterns across our most complex programmes

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BUILT FROM CASE STUDIES ACROSS

HIGHLY COMPLEX PROGRAMMES

LIBRTI **JET** **JDR** **H3AT** **STEP** **FOSTER**

…AND MORE

I'm not here to speak for - or disclose - any one programme

Instead, I'll share the common trends that repeat across them

A combined view - not a programme-by-programme account

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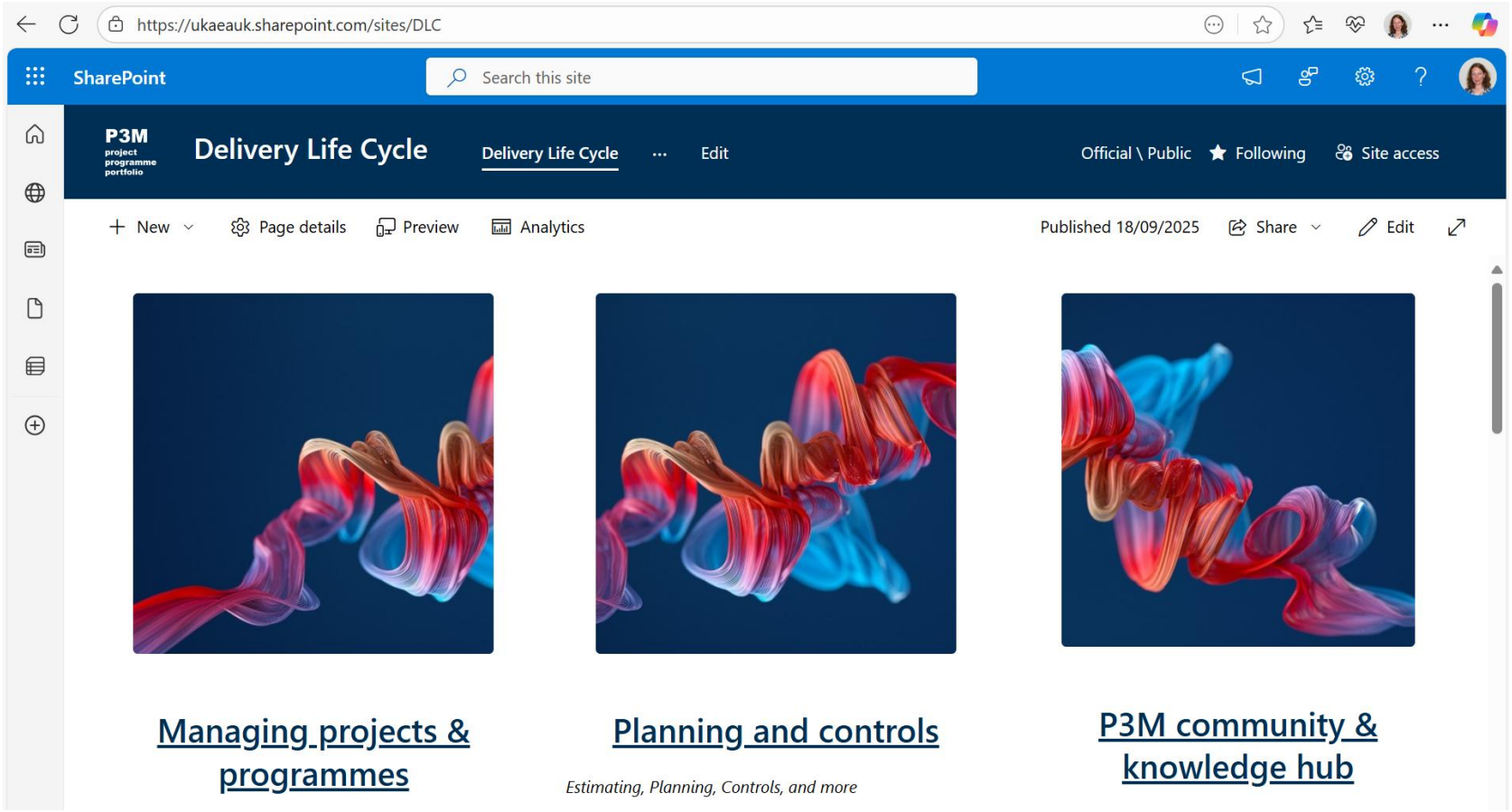
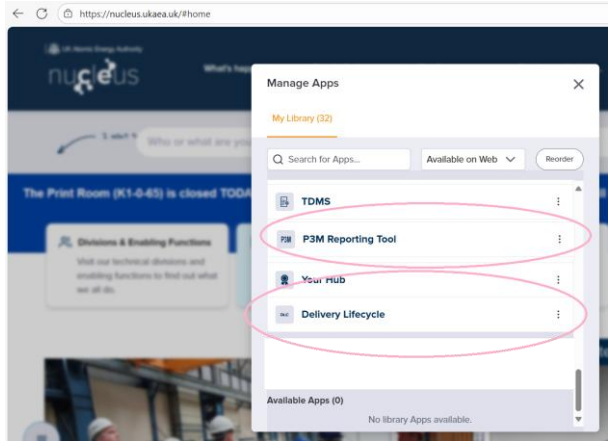
Delivery Life Cycle Framework





How do I categorise (Tier) my project/programme?

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Project DLA

Tier	Parameters	Approvals Required *In line with Green Book Guidance*	Approval Body *In line with CD/MAN/12*
Tier 1	Strategic Highest Risk Highest Cost	**3 Stage Business Case** SOC, OBC, FBC Peer Review, and IPA Gateway Review (GMPP Only)	DESNZ >£5m Capital >£10m Expense Treasury >£25m
Tier 2	Strategic High Risk High Cost	**3 Stage Business Case** SOC, OBC, FBC Peer Review	ExCo >£5m <£10m Expense >£2m⁺ (VoP) <£5m Capital
Tier 3	High Potential Medium Risk Medium Cost	**Single Stage – Medium Cost or Risk** Business Justification Case Independent Review	Director < £5m Expense >£250K < £2m⁺ (VoP)
Tier 4	Key Operational Low Risk Low Cost	**Single Stage – Low Cost and Risk** Business Justification Case SRO Review (Internal)	Director <£250K⁺ (VoP)
Tier 5	Support Low Risk Low Cost	**Internal Justification** Project Mandate PM Review	Budget Owner Within DLA

Programme DLA

Tier	Parameters	Approvals Required *In line with Green Book Guidance*	Approval Body *In line with CD/MAN/12*
Tier 1	Strategic Highest Risk Highest Cost	**Programme Business Case** IPA Gateway Review Peer Review, and IPA Gateway Review (GMPP Only)	DESNZ >£5m Capital >£10m Expense Treasury >£25m
Tier 2	Strategic High Risk High Cost	**Programme Business Case** Peer Review	ExCo >£5m <£10m Expense >£2m⁺ (VoP) <£5m Capital
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Tier 5	Support Low Risk Low Cost	**Internal Justification** Programme Brief PM Review	Budget Owner Within DLA

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Understanding delivery in a diverse world of fusion….

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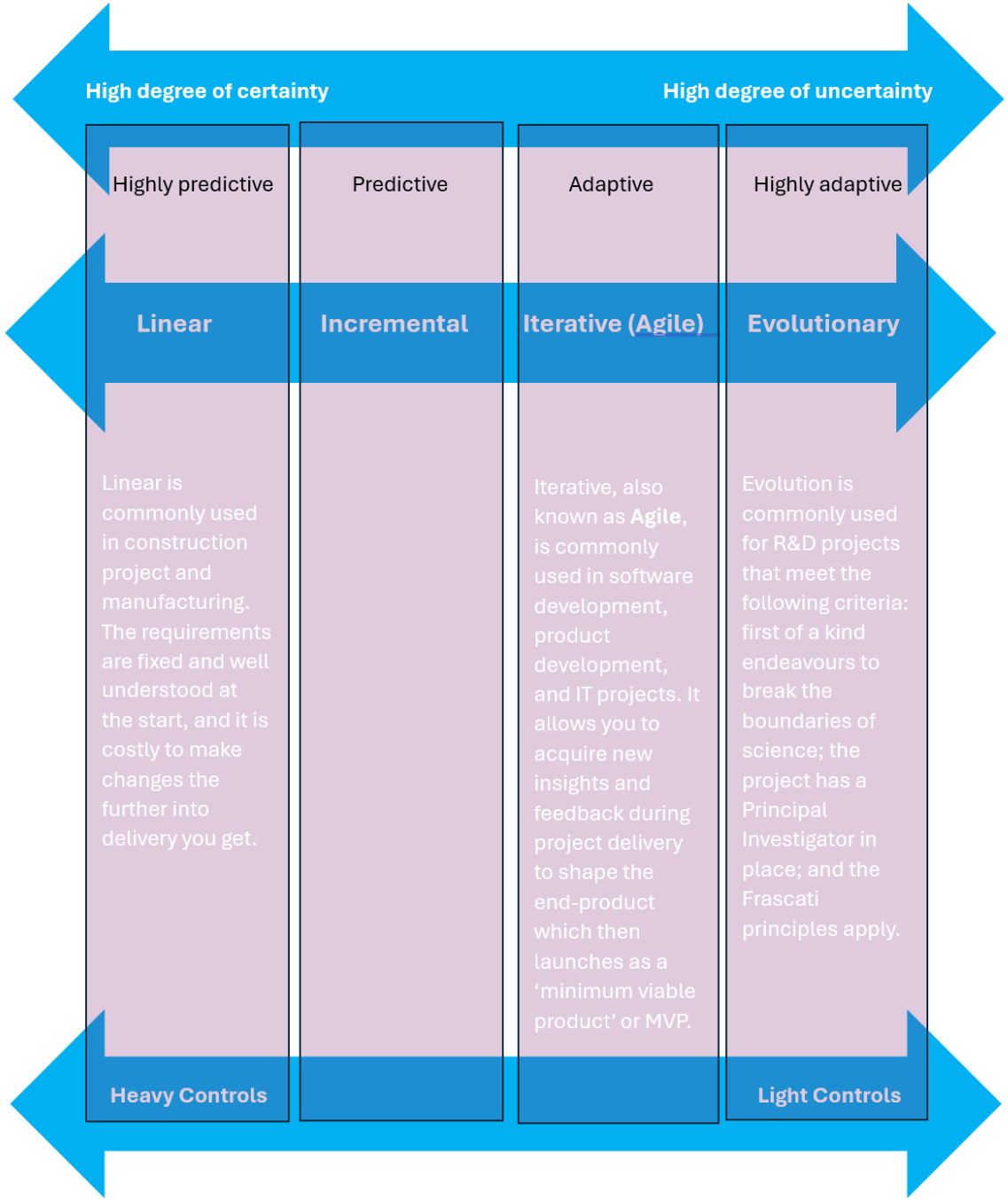
Apply the right level of controls



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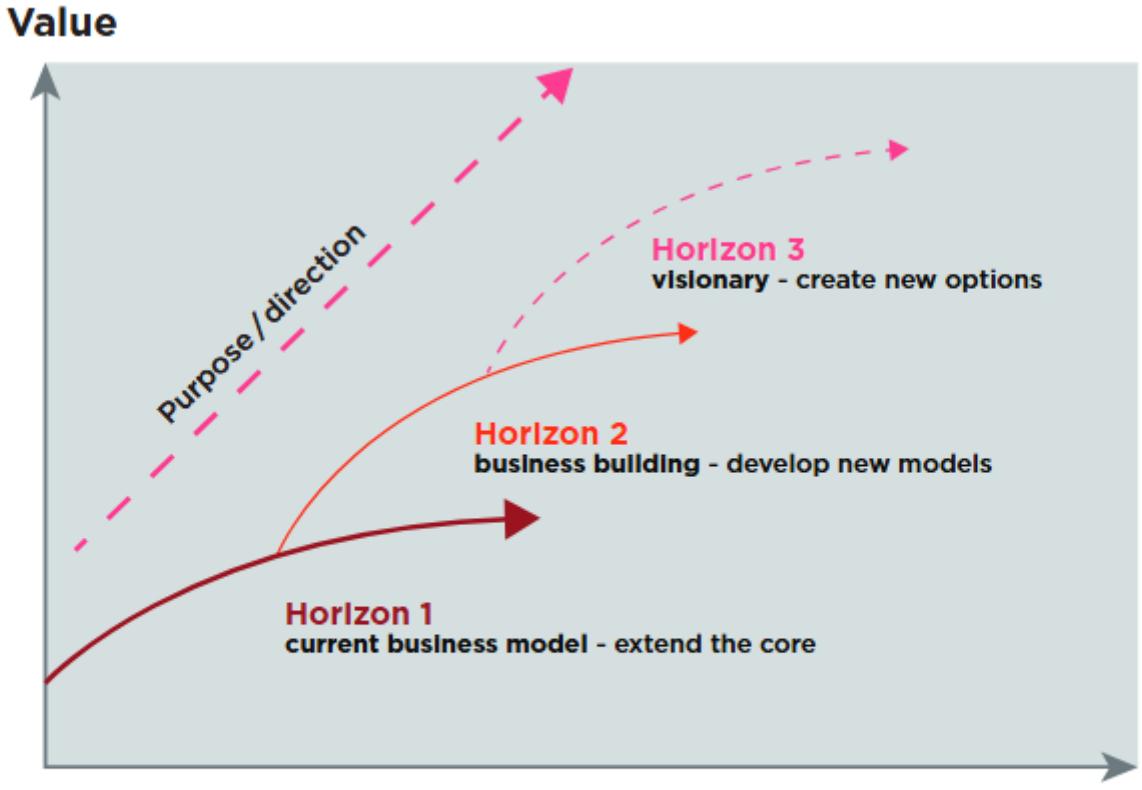
Thinking of fusion in the context of horizons helps



Horizon 3 – 'fundamental research' / 'fundamental science' (science r&d)
What remaining gaps do we have to make commercial fusion a reality? Things we must bridge.

Horizon 2 – prototyping and nearing reality
Examples in current strategy are LIBRTI, H3AT

Horizon 1 – BAU (current facilities, etc)

IP & Patents

Pioneering + reaping commercial reward for the UK plc

International Partnerships

Blue ocean – red ocean Horizon scanning To keep us ahead of the global race to fusion, pivot & partner to keep in the game/race

De-risking investment

Adjacent industries and spin-outs

Figure 3.2 Business horizons. Adapted from McKinsey Horizons. Original exhibit from 'Enduring Ideas' series, July 2008, McKinsey Quarterly, www.mckinsey.com. Copyright © 2017 McKinsey & Company. All rights reserved. Reprinted by permission

Contingency should reflect uncertainty, then reduce as evidence grows

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Broad planning allowances at the outset

FOAK / R&D — **25–50%+**

High technical uncertainty, emergent scope and possible failure or iteration.

COMPLEX / INTEGRATED — **10–20%**

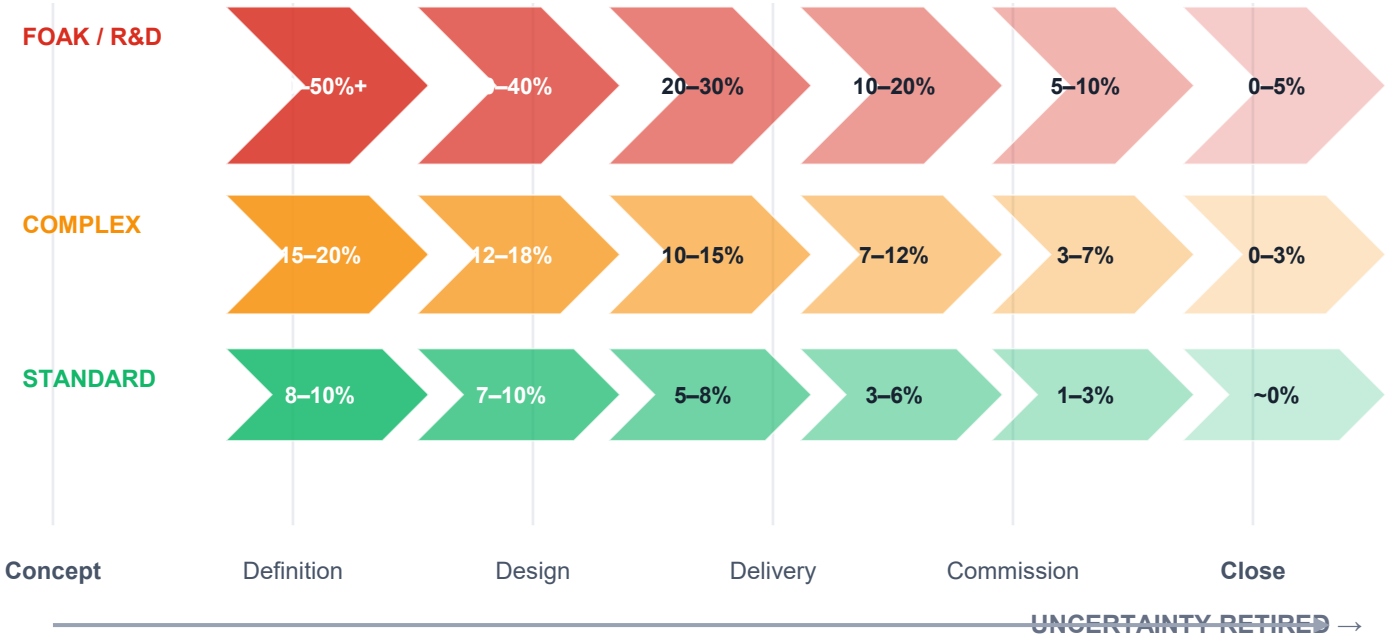
Novel interfaces, constrained delivery environment or immature design.

REPEATABLE / STANDARD — **5–10%**

Known solution, mature scope, proven suppliers and established rates.

These are conversation-starting ranges, not policy thresholds.

How the allowance should evolve through delivery



The principle

Hold more where uncertainty is real. Release it only when risks are retired, design matures and evidence supports the reduction.

Be clear on what is being held as Contingency vs what is being held as Management reserve

Indicative ranges only. Set contingency from quantified risk and estimate maturity, not a blanket percentage.

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Research and Innovation considerations

During the course of the review, AtkinsRéalis were asked to share any knowledge of what other organisations have in place to govern and control research and innovation projects, which may not fit within the standard P3M delivery models. This topic has subsequently been explored through an extended network of organisational and individual relationships to identify some key considerations. The organisational and individual experiences in this area cover sectors such as healthcare, drug development, medical research, infrastructure technology innovation, Universities, defence technology research and SMEs within AtkinsRéalis who lead the application of P3M in novel scenarios. The conclusion from a review of approaches within these organisation is that applying effective P3M management, governance and controls is possible and expected by organisations who invest heavily in R&D. It does require a tailored approach to each organisation with some considerations as follows:

Investment and Authorisation

- Clearly aligning research to strategic objectives is an essential foundation
- Funding based on different hypothesis – with further authorisation based on demonstrating evidence against each hypothesis
- Greater evidence may be needed in demonstrating likely applicability of research rather than pure milestone progress (i.e. progressively increasing confidence in the likely benefits of the investment)

Governance & Assurance

- Pure R&D can be separated from more predictable enabling infrastructure (which can be governed under more traditional methods)
- Governing boards for these projects may require adapted terms of reference and attendees/quorum, with a greater representation from the science and engineering community to validate scientific progress and value (e.g progress may be deemed reduction of risks and assumptions, rather than tangible output)
- Alternative assurance routes may be required (e.g. independent verification of benefits)

Delivery lifecycle structure

- Needs to be tailored to wider organisational processes and ways of working
- Can be considered against common requirements, milestones or phases which remain true for the majority of research projects (e.g. in medical research, moving into clinical trials is a step change in investment and therefore requires a more robust gateway decision). A tailored UKAEA lifecycle should be possible.
- Whilst there may be greater uncertainty in exact activities and outcomes, control can be tailored to not disrupt an experimental mindset, but to put in outline guardrails to manage overall scope, cost and alignment to objectives.

Planning & Risk

- May need greater early challenge on timelines and approach given the potential higher levels of optimisms bias in very uncertain environments
- A risk model against scale of uncertainty may need defining, which identifies relatively high contingency at a project or research portfolio level and is gradually reduced through phases of improving confidence in outcomes

Reporting

- This will likely need tailoring against key phases, outcomes, reduction of risk. Value could be considered based on scale of difficulty in demonstrating an outcome or capability and used as a measure of progress

Cultural enablers

- Recognise and tailor the approach to an R&D mindset, including perception of failure or ‘moving backwards’
- Many organisations have had to move away from a mindset of ‘we will always find more money’

Embracing an agile culture in R&D portfolios

Move decisions closer to the work - within clear guardrails

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Complex fusion programmes need freedom to adapt without losing accountability.

ADAPT • DECIDE •

1

SET DIRECTION

Anchor on the end benefit. Keep sight of the global horizon and partner where it gets everyone there faster.

2

DELEGATE DECISIONS

Push decisions to the lowest practical level — sometimes just beyond what feels comfortable.

3

KEEP GOVERNANCE LEAN

Use proportionate controls. Be explicit about accountability, then remove bureaucracy that adds no value.

4

BUILD RESILIENCE

Equip teams to absorb setbacks, pivot quickly and keep learning through tough periods.

NON-NEGOTIABLE BASELINE

Safety • clear accountability • clear responsibility

High risk. High reward. No ambiguity.

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Complex fusion programmes bring different delivery cultures together

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CULTURE INTERFACE

ENGINEERING & DELIVERY

Freeze enough to build
Plan, control and assure
Manage cost and schedule
Deliver a working asset

CERTAINTY • PACE

SCIENCE & OPERATIONS

Learn through experiments
Adapt as evidence changes
Protect room to explore
Prove what works

LEARNING • FLEXIBILITY

Neither culture is wrong. The risk appears when the interface is left unmanaged.

Make it explicit: shared outcome • decision rights • requirements • controls • handovers

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Mindset for delivering in uncertainty

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In fusion, technical excellence is not enough.

The people who thrive are not always the most obvious choice.

TOLERATE UNCERTAINTY

Act without every answer

STAY RESILIENT

Recover and keep momentum

ADAPT QUICKLY

Pivot as evidence changes

FOCUS ON INFLUENCE

Work the problem, not the frustration

LEARN AS YOU GO

Turn setbacks into insight

LEAD THROUGH AMBIGUITY

Give direction before certainty

"The best person for a high-uncertainty programme may not be the neatest planner. It is the person who remains effective when the map is missing."

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Trust

Creating a psychologically safe space in fusion

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Design for uncertainty without losing control

Fusion delivery needs room to learn, but also deliberate points of stability, protected funding and disciplined choices.

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1 FREEZE ENOUGH TO BUILD

Stabilise selected requirements, interfaces and configuration so engineering, procurement and construction can proceed.

2 PROTECT A RETROFIT RESERVE

Hold funding for late integration and retrofit where essential R&D matures after related systems have moved ahead.

3 PRICE THE UNCERTAINTY

Match contingency to delivery type and risk. FOAK R&D should not carry the same allowance as repeatable linear work.

4 MANAGE THE INTERFACES

Actively manage dependencies between evolving R&D and linear work, built on trust and respect across disciplines.

5 KEEP OPTIONS ON THE SHELF

Maintain credible alternatives that can be mobilised quickly if a critical route fails or slows.

6 CONTRACT FOR THE REAL RISK

Explicitly allocate cost risk and recognise that failure is a legitimate outcome when pushing the boundaries of science.

A design freeze is not the end of R&D.
It fixes what must remain stable while learning continues elsewhere.

THE GUARDRAIL

SWAP. SEQUENCE. PIVOT.

Do not quietly increase scope. Extra scope requires extra funding and approval.

Contracting for honest risk supports the right culture: transparency, learning and no pretence that every experiment must succeed.

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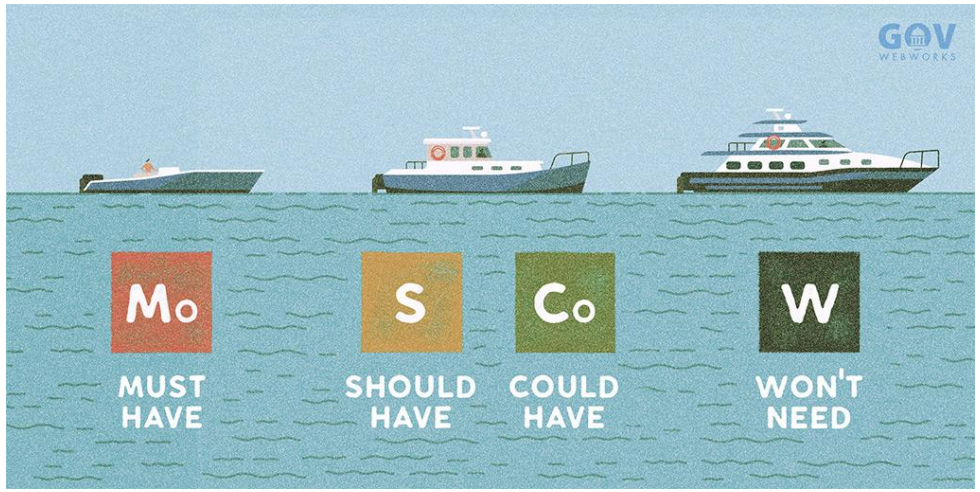
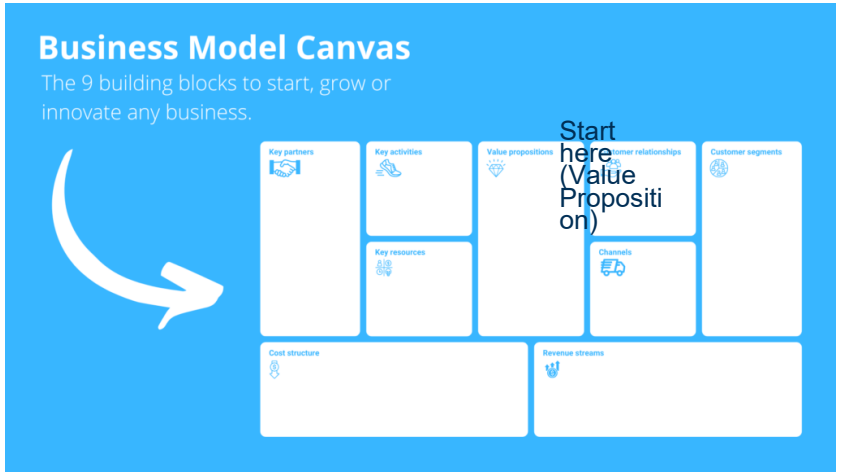
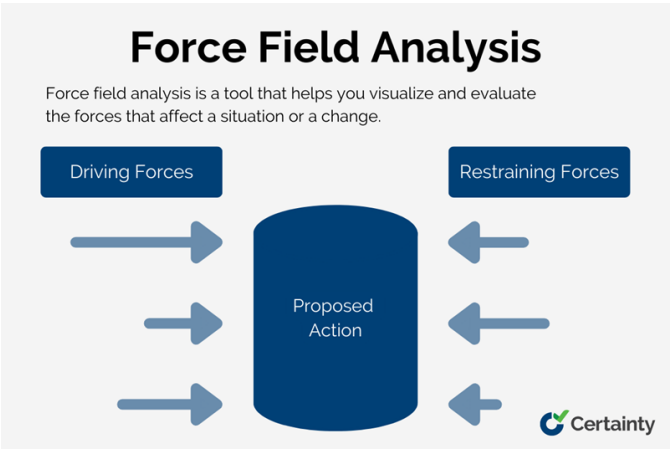
Don’t keep trying to do it all

Uncertainty in fusion also means trade-offs happen… How to establish what to cut …







Are you excited or yawning?

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GOVERNANCE

- DESNZ & Treasury
- UKAEA Board
- UKAEA Executive Committee
- Programme Board
- Project Boards

DELIVERY

- Programme Director &/or Programme Manager
- Business Change Managers (BCM)
- Project Managers
- Project delivery teams
  (e.g. Lead Engineer &/or Lead Scientist, engineers, scientists, enabling functions, partners, industry…)

LEADERSHIP AND ACCOUNTABILITY

- Accountable Officer
- Senior Responsible Owner (SRO)
- Project Sponsors

ASSURANCE

- PfMO Department
- DLC Three lines of Assurance
- Delivery Framework (DLC)
- P3M Data & Insights
- Gateway Reviews / (UK Treasury) NISTA Reviews
- UK National Audit Office (NOA)
- QSHRA (Quality, Safety, Health, Risk & Assurance Teams)

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Be clear on this model! There are different approaches...

PROJECT MANAGER LEADS

Project Manager

Overarching lead and decision maker for delivery

Lead Engineer / Lead Scientist

Reports into the PM

LEAD ENGINEER / LEAD SCIENTIST LEADS

Lead Engineer / Lead Scientist

Overarching lead and decision maker for delivery

Assistant PM

Be clear on the SQEP needs of the project professional

Upskill the engineer / scientist in delivery

EVEN-KEEL

Project Manager ⟷ Lead Engineer / Scientist

On even-keel

I'm still not convinced on this model

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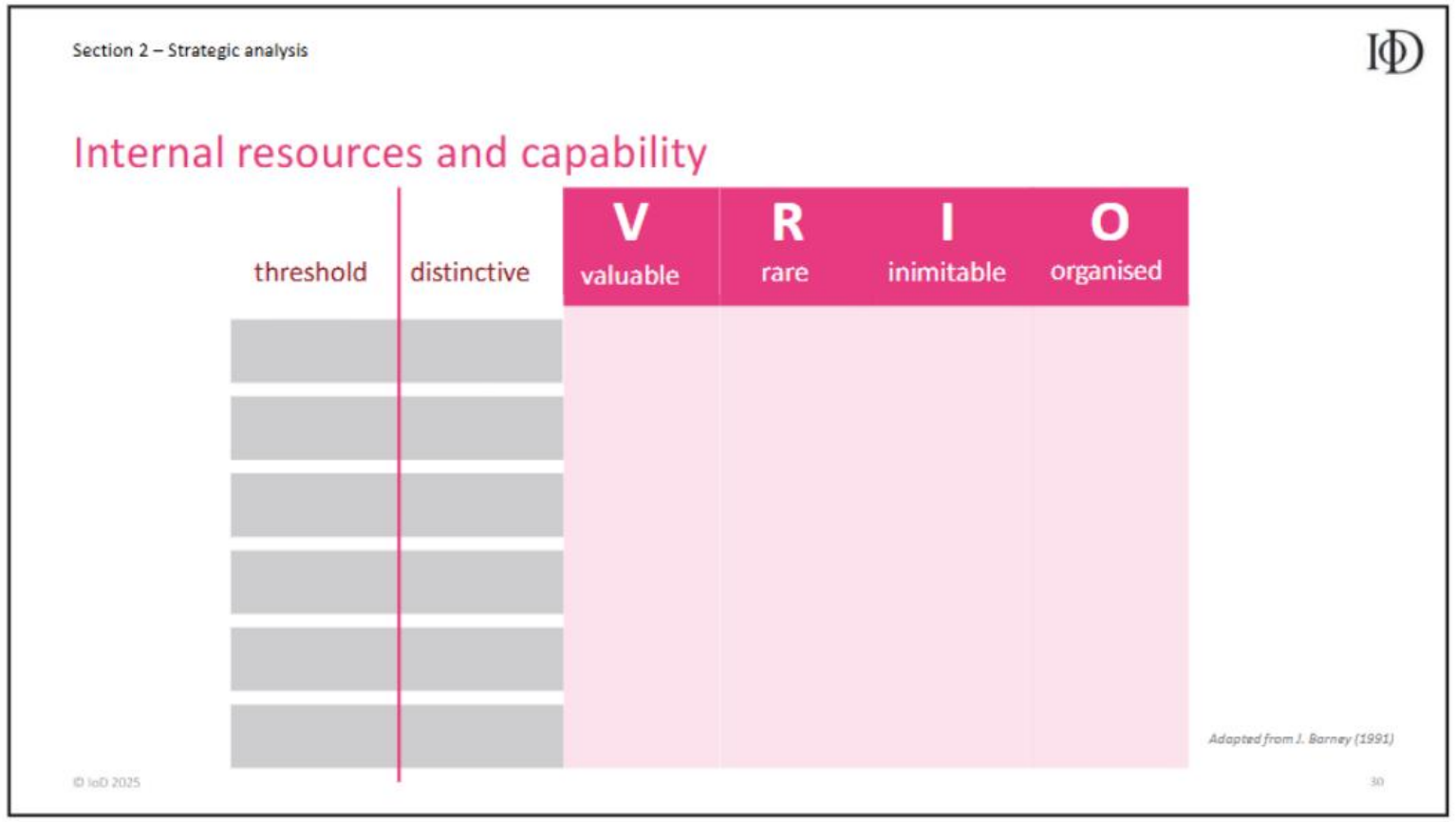
Deliver at pace….

Can be helpful to use VRIO strategic analysis –internal analysis to identify our ‘distinctive capability’



30

1. VRIO – which are our organic bits (our ‘distinctive capabilities’?
2. VRIO – Where should we consider inorganic approach (partnering), re threshold capabilities?
3. Will this still be the case in 2030 globally or are some on the horizon who might start to manoeuvre into one of our distinctive capabilities re fusion (if so, weight lower or think to partner now to keep your companies position)

VRIO
Questions to ask

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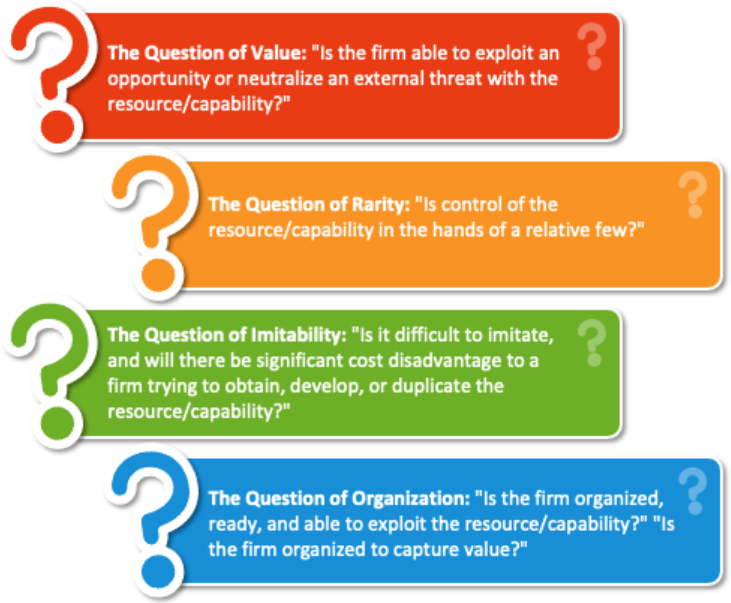
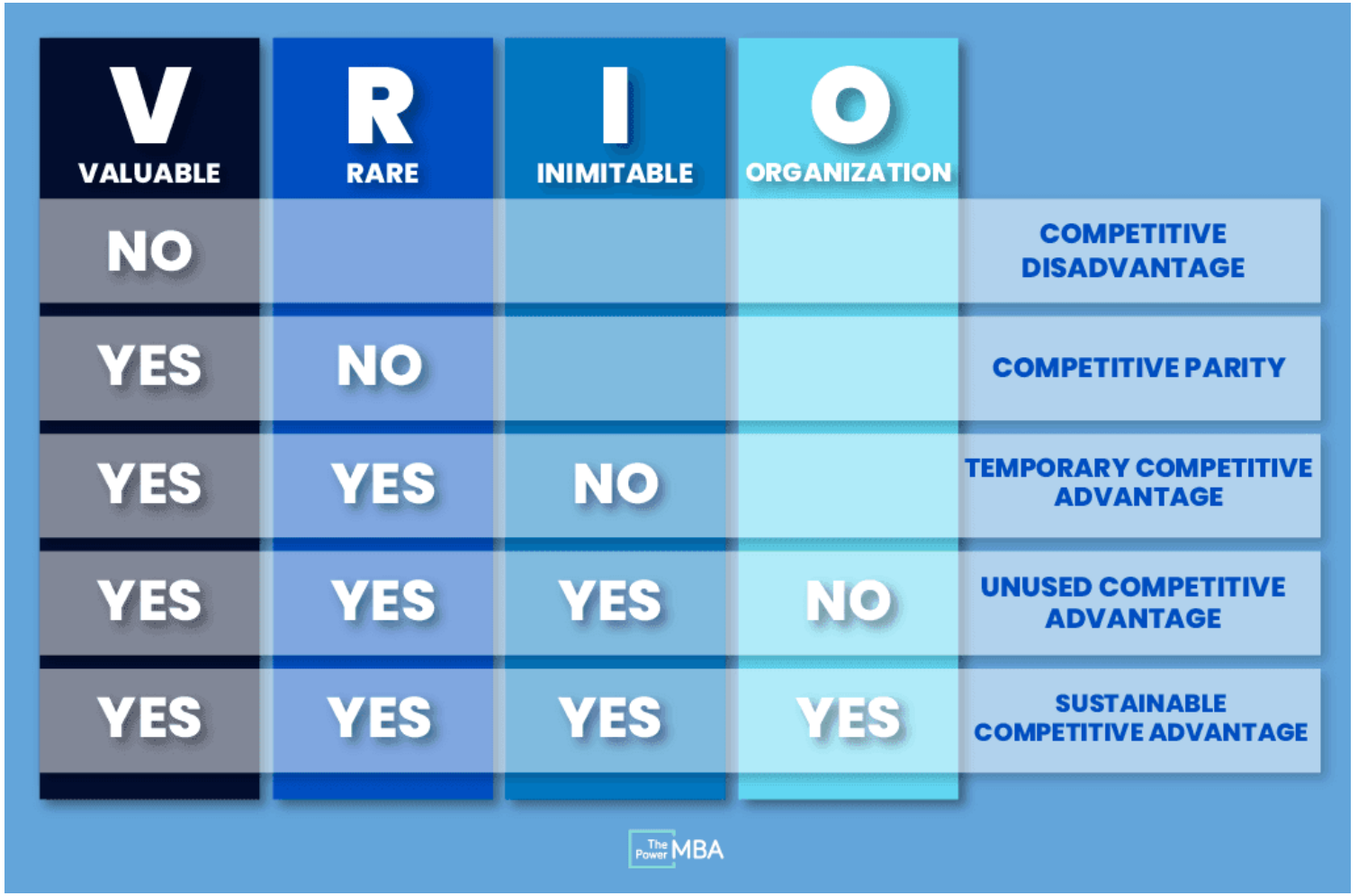
VRIO FRAMEWORK

The Question of VRIO



VRIO Component	Question to Ask
Value	Does this resource add value?
Rarity	Is this resource rare?
Imitability	Is this resource difficult to imitate?
Organization	Is the organization equipped to exploit it?

VRIO



You run this per innovation, skillset, etc… **not** for the company as a whole

Organic vs inorganic

Now figure out which you want to do as Organic (us) or inorganic (outsource, partner, etc)

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3.2.6 Inorganic development

Organic development occurs when an organisation uses its existing internal capability to deliver growth. This tends to be the dominant approach for many organisations.

It enables the organisation to build at a pace it is comfortable with, capture the entire value (as well as the learning) of commercial transactions and develop in a way sympathetic to its culture.

Capability alternatives

Possible direction	Internal development: organic	Outsource	Alliances and joint ventures	M&A
Market penetration				
Product development				
Market development				
Diversification				

Figure 3.10 Organic and inorganic development

Intelligent customer

An intelligent customer partners widely - but still owns the outcome

As collaboration grows across the supply chain and internationally, we must remain capable of setting direction, judging evidence and making integrated decisions.

THE CUSTOMER RETAINS

MISSION	Purpose and outcomes
REQUIREMENTS	System boundaries and interfaces
JUDGEMENT	Technical challenge and evidence
ACCOUNTABILITY	Decision rights and ownership

INTELLIGENT CUSTOMER

Know enough to ask the right questions, recognise a good answer and act on it.

SPECIFY **CHALLENGE** **INTEGRATE**

PARTNERS EXTEND

Specialist knowledge	**EXPERTISE**
New ideas and evidence	**INNOVATION**
Industrial capability and reach	**CAPACITY**
International experience	**LEARNING**

Partner for expertise. Keep ownership of the outcome.

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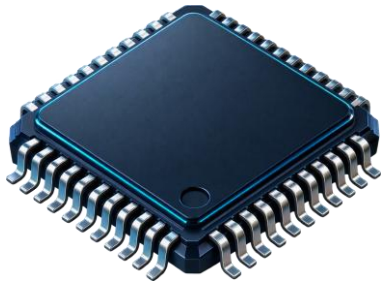
What do these six breakthroughs have in common?



Microchip

Digital audio player

Vacuum flask

Penicillin

LCD screen

MRI scanner

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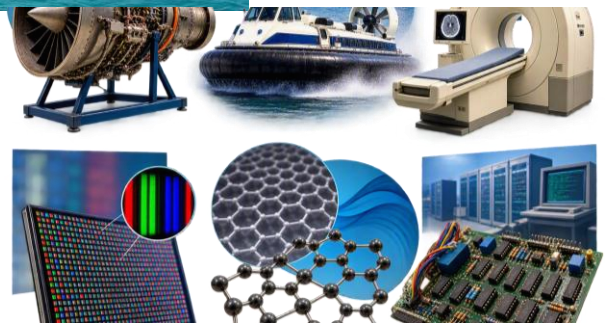
They were all pioneered in Britain.

But invention is not the same as value capture.

The UK created the breakthrough. Other countries often built more of the scale, manufacturing and commercial return.

1	**PATIENT CAPITAL**	Deep-tech needs long-term funding through the “scale-up gap”.
2	**DELIVERY & SCALE**	A prototype needs industrialisation, supply chains and disciplined execution.
3	**MARKET PULL**	Anchor customers and procurement create a credible first market.
4	**IP & INCENTIVES**	Protection, ownership and rewards must encourage commercial action.
5	**PACE & RISK**	Slow decisions and low risk appetite allow others to move first.



THE FUSION CHALLENGE

Design commercialisation into delivery from day one.

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Two readiness lenses. One route to fusion impact.

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Technology working is necessary. A viable route to use, adoption and scale is what turns progress into mission impact.

TRL **Can the technology work?**

Measures technical maturity through evidence: principles → proof → prototype → operationally proven.

TECHNICAL RISK

+

CRL **Can it create value at scale?**

Tests commercial maturity: need → customer → route to market → viable model → adoption and scale.

COMMERCIAL RISK

FUSION IMPACT

The gap matters: a project can advance the science while leaving the market, supply chain, investment case or adoption pathway behind.

How I would use this as Head of Profession

1. **BASELINE**
   Record current and target TRL + CRL at project start.

2. **GOVERN**
   Review both at gates and portfolio reviews, with evidence.

3. **ACT**
   Fund, partner, pivot or stop where one track is lagging.

"TRL tells us whether it can work. CRL tells us whether it can matter."

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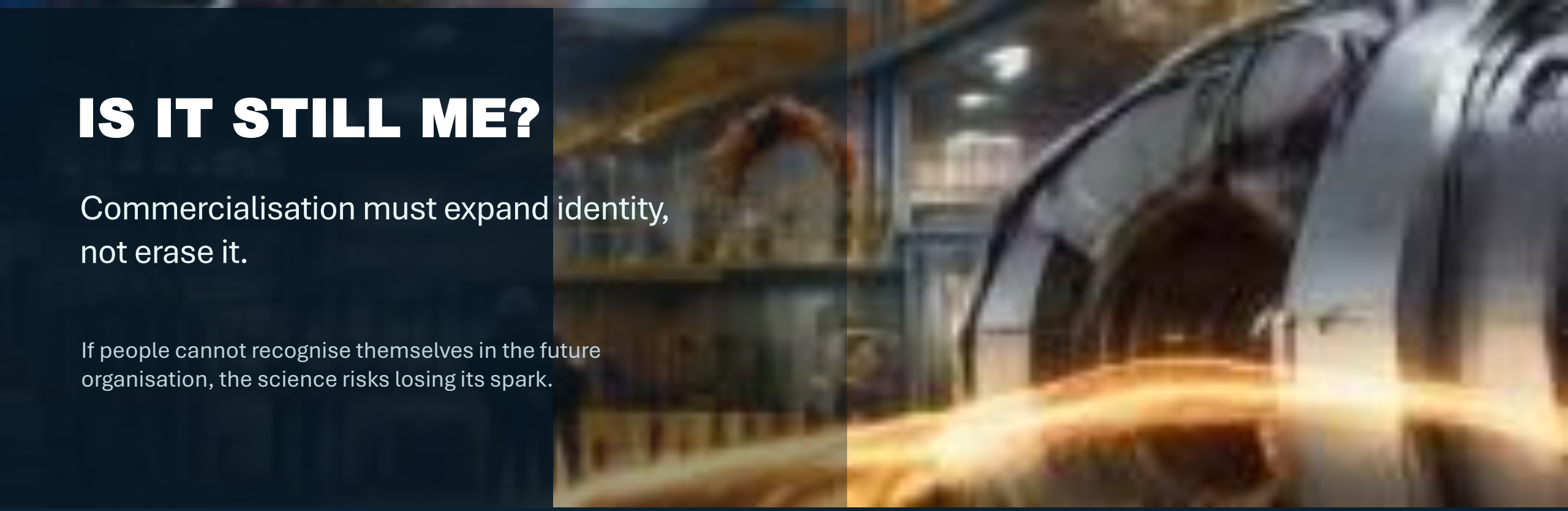

IS IT STILL ME?

Commercialisation must expand identity, not erase it.

If people cannot recognise themselves in the future organisation, the science risks losing its spark.

PROTECT THE SPARK

Keep curiosity, scientific freedom and the excitement of discovery visible in the future story.

ONE NORTH STAR

WHY

Discovery and delivery serving the same purpose

BUILD THE BRIDGE

Show how science, engineering and commercial disciplines strengthen one another, rather than compete.

Don’t lose sight of the ‘why’…

- Can they see the north star?
- Having a clear vision
- Lean into your leadership skills to keep the project/programme team inspired and holding this is mind and in sight (the benefits, etc), not just the day-to-day steps of getting there. Inspire them.

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Q&A

Any questions? Any reflections? Anything you wanted to get out of todays session that we didn't cover?

Knowledge Shares – think your company would benefit from learning about this too? Please reach out. A key part of UKAEAs mission is the positive impact on UK plc

OPTION 1

The £500m Fusion Programme Crisis

Make a defensible decision while the evidence is still emerging.

SCENARIO

Your programme has committed £200m and construction has begun. New experimental evidence suggests a critical technical assumption may be wrong.

If the scientists are right, redesign and retrofit could add 18 months and significant cost. If they are wrong, pausing wastes money and may surrender momentum.

YOUR CHALLENGE

- ✓ What do you freeze, and what continues?
- ✓ What uncertainty will you tolerate?
- ✓ What evidence would change your decision?
- ✓ What is non-negotiable?

BOARD DECISION

You must recommend a course of action tomorrow morning.

Tip: Aim your pitch at the executive level (what do they care about? What keeps them up at night?)

90-SECOND REPORT-BACK

Decision • strongest reason • biggest risk • first action

OPTION 2

Build It, Buy It, or Partner?

Choose how to secure a mission-critical fusion capability without outsourcing ownership of the outcome.

SCENARIO

Your organisation needs a capability critical to future fusion delivery, but only has enough funding for one route.

A BUILD | **B BUY** | **C PARTNER**

YOUR CHALLENGE

- ✓ Which route do you choose, and why?
- ✓ What knowledge must stay in-house?
- ✓ What can safely be outsourced or shared?
- ✓ How do you avoid losing strategic advantage?

Choose a capability

Tritium handling • robotics • advanced manufacturing • digital twins • superconductors • or your own example

90-SECOND REPORT-BACK

Chosen route • biggest risk • three intelligent-customer questions

Midway Twist

Change the context. Test whether the original decision still holds.

OPTION 1 • BREAKING NEWS

A major US fusion company announces a breakthrough and claims it can reach market before you.

Your Board asks:

"Do we keep investigating the evidence, or accelerate to avoid losing our position?"

Does your decision change? • Which risks now matter most? • What remains non-negotiable?

OPTION 2 • PARTNERSHIP OFFER

A major international organisation offers funding, specialist skills, faster delivery and global market access.

The condition:

They want access to all knowledge generated through the partnership.

Do you accept? • What will you protect or share? • What if today's partner becomes tomorrow's competitor?

POSTCARD TAKEAWAY **What is the single biggest lesson your organisation should take away from this discussion?**

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Feedback to the room & Postcards

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Individual Reflection Card

Before leaving, write down:

- One idea that challenged my thinking
- One action I will take
- One conversation I need to start
- One thing my organisation may be underestimating
- One thing my organisation should stop pretending is certain
- One thing we need to think about now, not later

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END