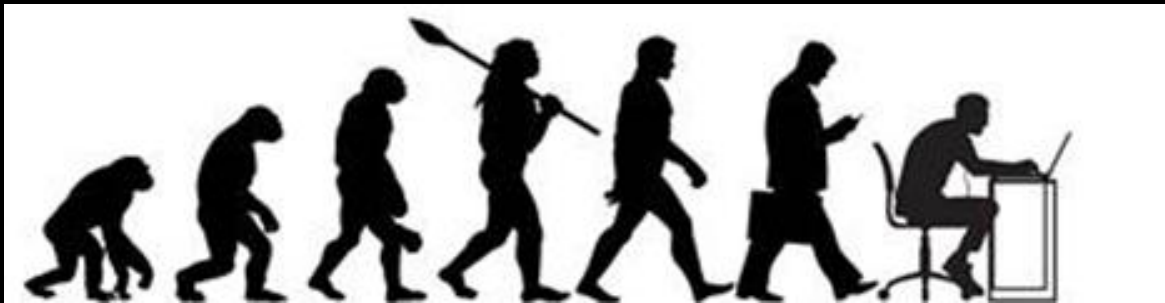# BCS QSG Executive Webinar
QUALITY ASSURANCE
AS A CYBERNETIC PROCESS

Framing Quality Management for Complex Systems, Human Conduct, and Ethical Artificial Intelligence

BCS SQM XXXII 2025 INTERNATIONAL QUALITY CONFERENCE

Quality SG
Friday, 19 September 2025
Webinar

bcs
The Chartered Institute for IT

Overview

- Interactive exercise – Audience POV pre-Lecture survey (fun with AI)

- The Cybernetic View of Quality

- Quality Assurance Layers

- Bringing it all together – Have I provided some actionable methods and tools to address any ethical concerns raised by today's Audience in the survey?
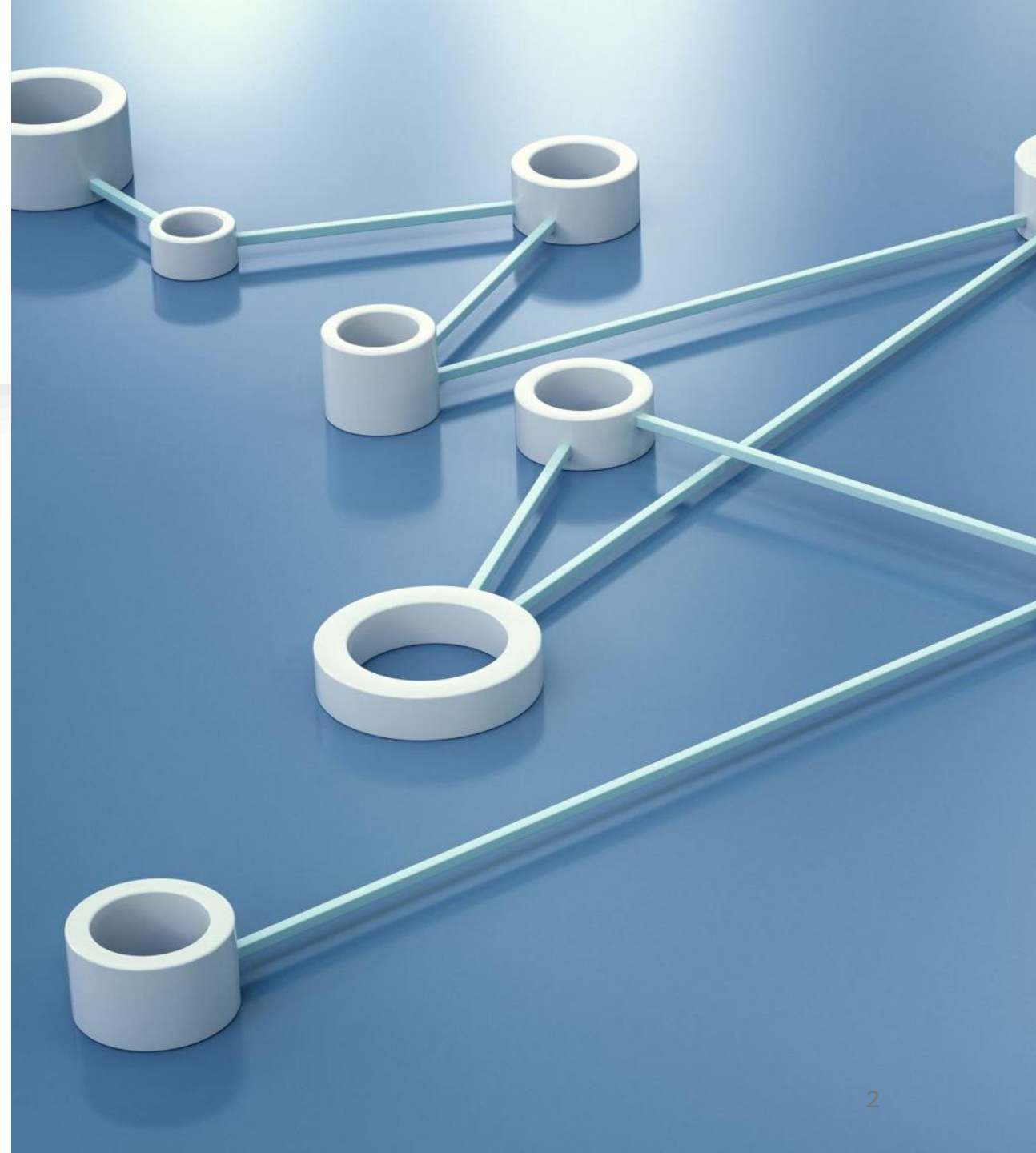
Using AI for QA – What ethical implications come to mind for you?

5-10 mins to swamp chat   –   Pre-lecture survey

DEFINED TERMS

Artificial Intelligence

Cybernetics

Artificial Intelligence (OECD definition)

On the proposal of the Digital Policy Committee:

I. AGREES that for the purpose of this Recommendation the following terms should be understood as follows:

-   *AI system*: An AI system is a machine-based system that, for explicit or implicit objectives, infers, from the input it receives, how to generate outputs such as predictions, content, recommendations, or decisions that can influence physical or virtual environments. Different AI systems vary in their levels of autonomy and adaptiveness after deployment.

Cybernetics

◆ INFORMAL DEFINITIONS OF CYBERNETICS

1. "The science of steersmanship"

   – From the Greek *kybernetes*, meaning "helmsman" or "governor".

2. "How systems control themselves and adapt to change."

3. "The art and science of communication and control across any system."

4. "A way of thinking about how things influence each other in loops."

5. "How living things, machines, and organizations stay on course."

6. "The study of systems that think, adapt, or regulate themselves."

7. "Thinking in terms of feedback and interdependence."

8. "Seeing the world in terms of relationships, not things."

9. "Understanding the observer as part of the system being observed."

   – Informal understanding of second-order cybernetics.

10. "It's what makes thermostats, brains, companies, and ecosystems all follow rules or change when needed."

◆ HISTORICAL NOTE ON THE TERM

- The word "cybernetics" was coined by Norbert Wiener in 1947 and comes from the Greek "kybernētēs" (κυβερνήτης) – meaning *steersman*, the same root from which the word "governor" and modern terms like "governance" and "cyberspace" derive.

◆ FORMAL DEFINITIONS OF CYBERNETICS

1. **Norbert Wiener (1948)** – *Originator of the term*

   "The scientific study of control and communication in the animal and the machine."
   – *From "Cybernetics: Or Control and Communication in the Animal and the Machine"*

2. **Ross Ashby (1956)**

   "Cybernetics is the science of communication and control, especially in the living organism and the machine."
   – *From "An Introduction to Cybernetics"*

3. **Heinz von Foerster (1970s)** – *Distinction between first- and second-order cybernetics*

   "Cybernetics is the art of creating equilibrium in a world of constraints and possibilities."
   "First-order cybernetics is the cybernetics of observed systems; second-order cybernetics is the cybernetics of observing systems."

4. **Stafford Beer (1972)** – *Management cybernetics*

   "The science of effective organization."

5. **Gordon Pask (1975)**

   "Cybernetics is the science of defensible metaphors."
   – Suggesting its role as a conceptual framework for systems understanding.

6. **Gregory Bateson (1972)**

   "A branch of mathematics dealing with problems of control, recursiveness, and information, closely allied to systems theory and systems thinking."

7. **American Society for Cybernetics (ASC)**

   "Cybernetics is a transdisciplinary approach for exploring regulatory systems—their structures, constraints, and possibilities."

8. **IEEE Systems, Man, and Cybernetics Society**

   "Cybernetics deals with understanding and designing systems with goal-directed behaviors and feedback control mechanisms."

9. **International Federation for Systems Research (IFSR)**

   "Cybernetics focuses on circular causality, self-regulation, feedback, and control mechanisms in systems."

10. **British Cybernetics Society**

    "The interdisciplinary study of the structure of regulatory systems, regardless of whether they are mechanical, biological, social, or cognitive."

The Cybernetic view of Quality

Meta-QA: When the observer is part of the system

AI and Autonomy: When the system thinks back

A call for urgent ethical reflection

- QA as a **regulating system** within a system-of-systems

- Recursive control: Monitoring the monitors

- Ross Ashby's Law of Requisite Variety in quality functions

- A call for urgent ethical reflection in the face of growing technological power

Quote:
"We have modified our environment so radically that we must now modify ourselves to exist in this new environment. The hour is very late, and the choice of good and evil knocks at our door."

[3] Norbert Wiener 1954, The Human Use of Human Beings: Cybernetics and Society

When THE Observer is Part of the System

- Humans as **agents** within complex systems, not just overseers

- **Reflexivity** in assurance (a system that observes its environment and perpetually modifies itself)

- Auditing the values and ethics, not just the data

- Example of a high assurance role:
  - SE/QA roles in mission-critical environments
  - Continually test to continually check if ethics have been applied correctly

- **Assurance itself must be adaptive** when assuring adaptive systems

[4] Image source: ChatGPT 4o, 24th July 2025

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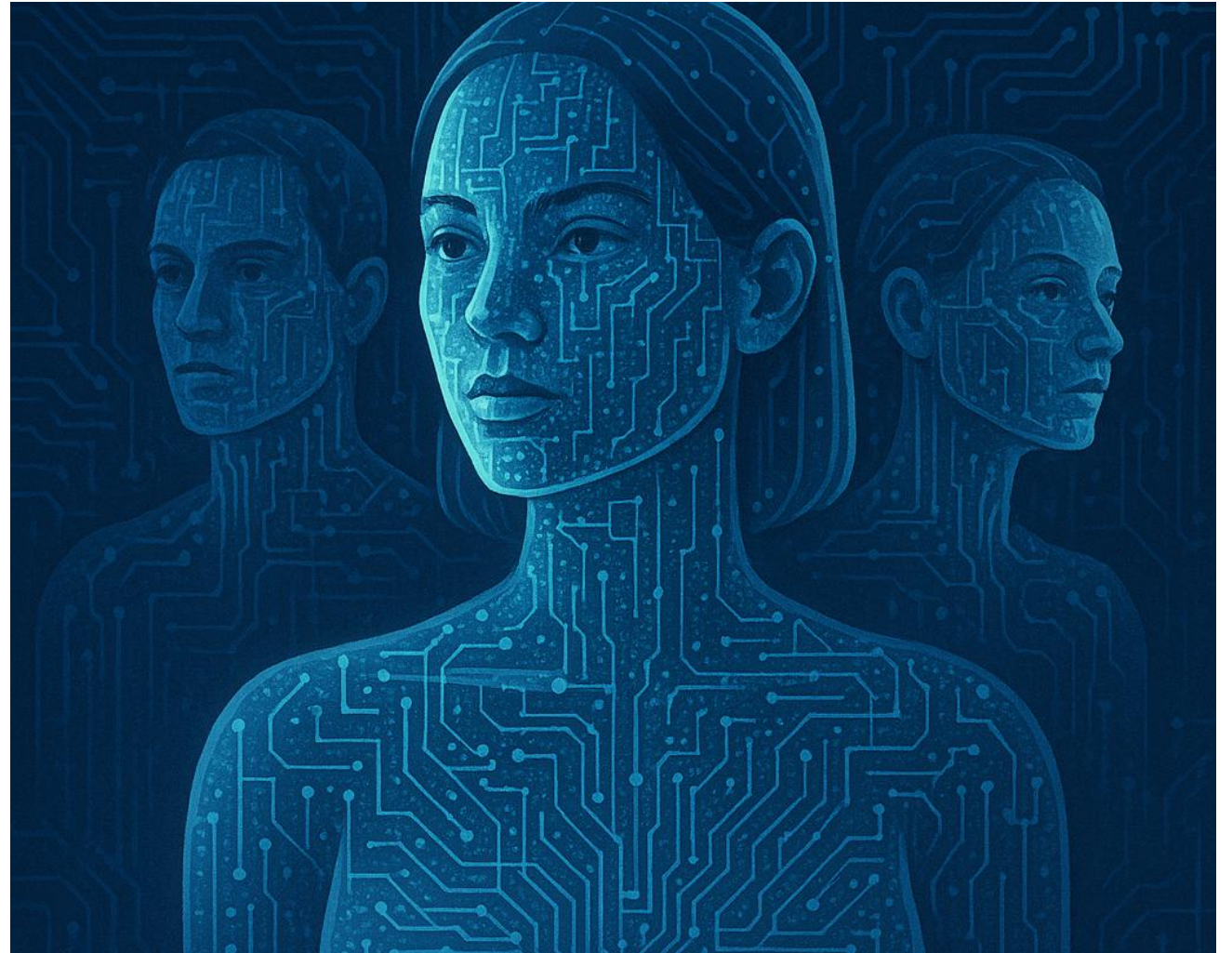
AI and Autonomy: WHEN the System Thinks Back

- The shift from deterministic systems to **learning systems**

- QA implications for:
  - ML model drift
  - Human-AI teaming
  - Black-box decision chains

- "Quality of training data" as ethical risk

- The **illusion of control** when behaviour emerges from algorithms
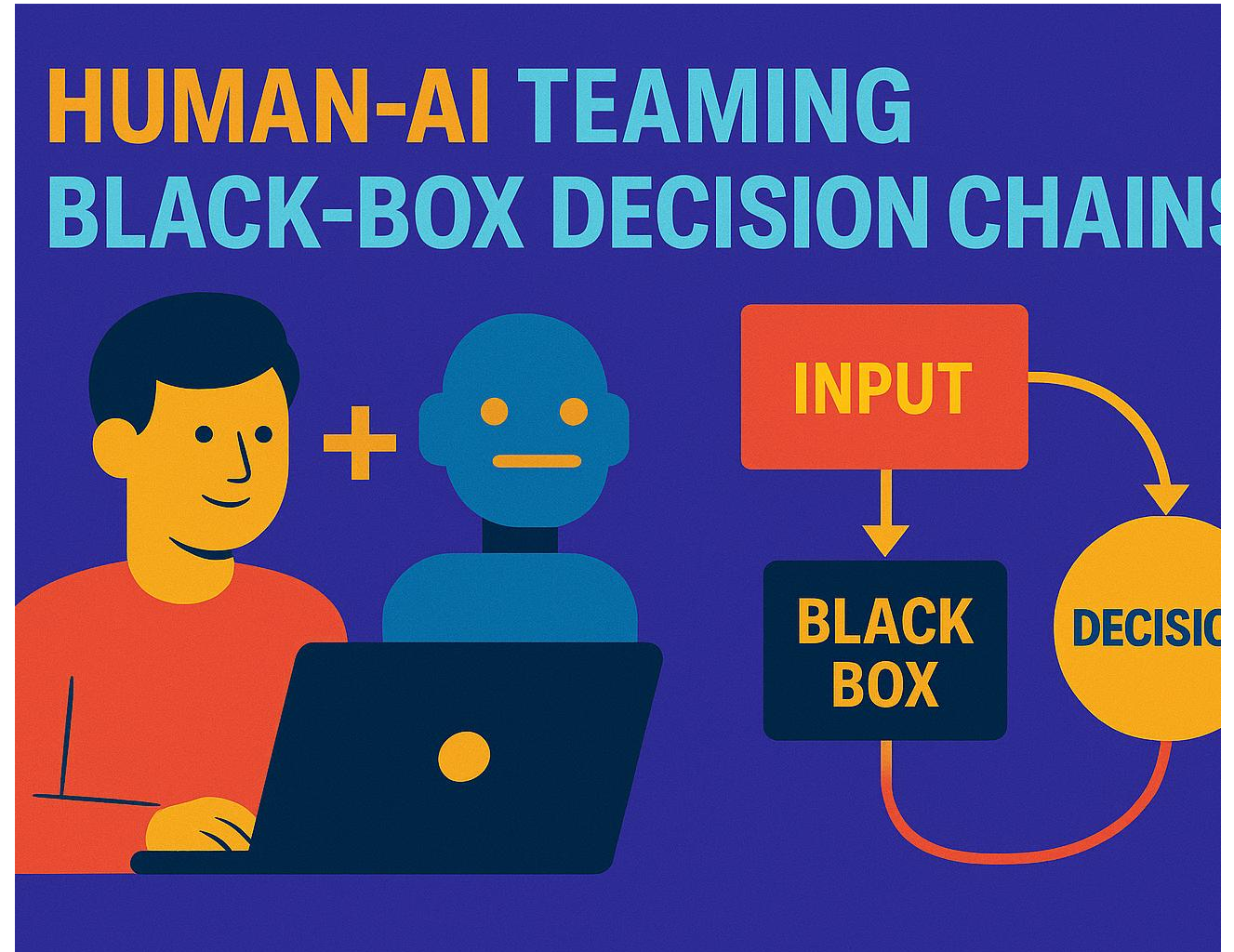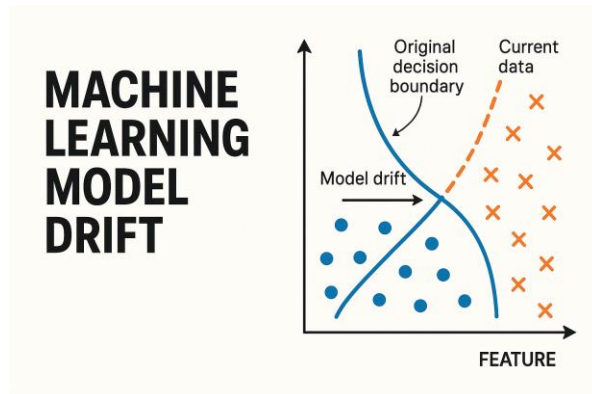
[5] ChatGPT 4o, 24th July 2025 (images generated)

Quality Assurance Layers

Engineering QA: Engineering Intelligent Systems (bake in the goodness to design)

Project/Program QA: Testing the models – The Missing Link between V&V

Governance QA: Assuring the tests meet the Standard

Meta-QA: Auditing the auditor, triggering remediation when QA itself drifts

Engineering QA (First-Order)

Engineering QA

Using AI for QA in Sys Eng

- MBSE – Human-AI teaming to form use cases & perform functional analysis

- Connect system structure > behavior > parametrics

- Embedding design for testability (DfT) from top to bottom (User Need to component specification)

- The foundation for links between V&V

Quote:

"Use Cases are nature's way of letting you know how sloppy your requirements are"

IBM WatsonX (example toolkit)

- Uplifting the quality & efficiency for requirements management

[6] Barclay Brown (2023), *Engineering Intelligent Systems*, pp. 165-272

[7] IBM WatsonX Governance - Scale trusted AI with watsonx.governance

Project/Program QA: (**Second-Order**)

The Missing Link between Verification & Validation

- Is the system built right?

- Did we build the right system?

- Needs to be applied over the whole of life cycle

- Ongoing monitoring and T&E
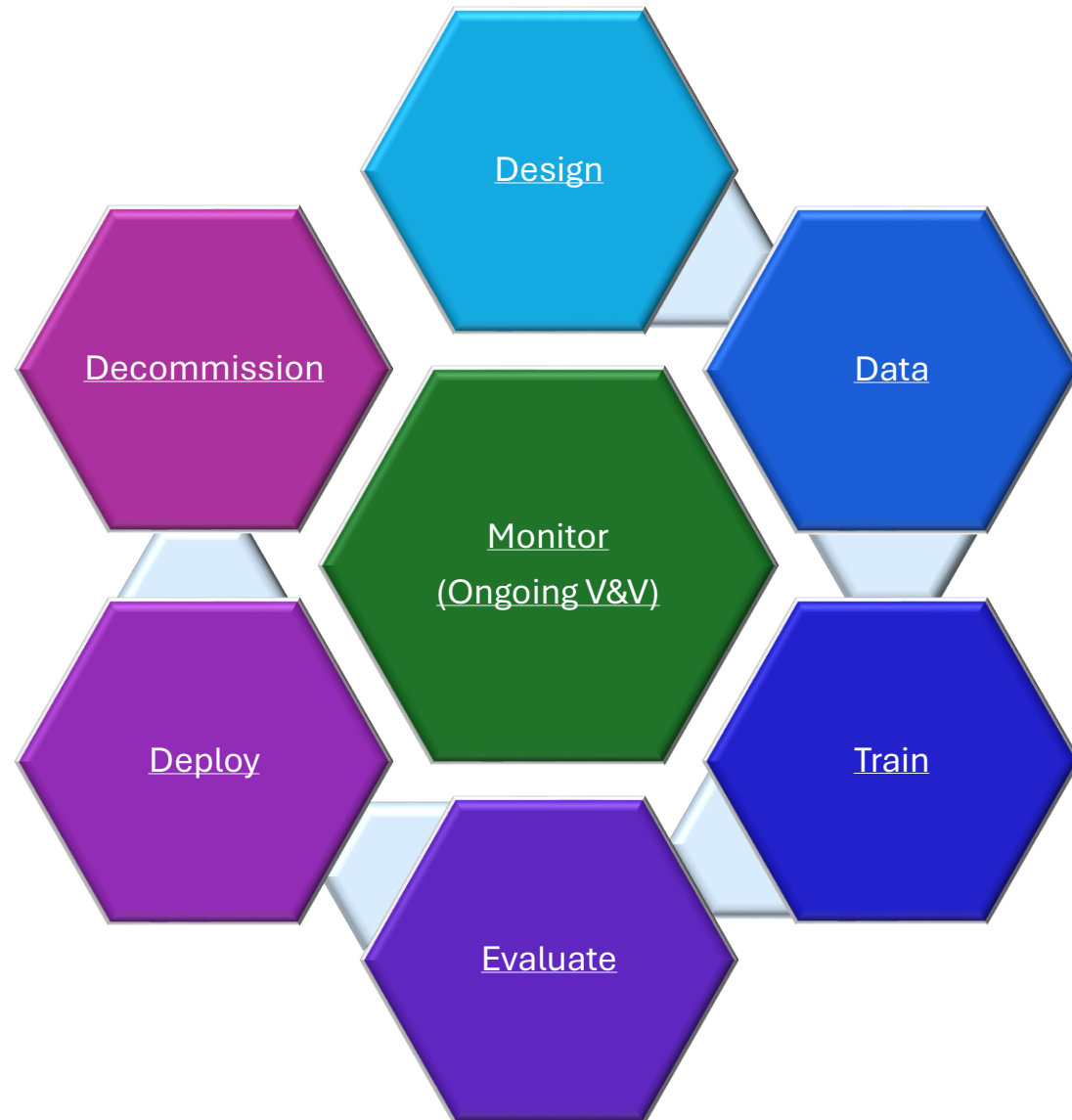
- The connective tissue of the Four Orders of QA

[8] Author

Third & Fourth-Order QA

Taking us towards a viable quality future

Governance QA: (Third-Order)

Whole of AI Lifecycle Governance

- Australian Government Architecture (AGA)
  - Design
  - Data
  - Train
  - Evaluate
  - Integrate
  - Deploy
  - Monitor
  - Decommission

[9] Australian Government Architecture (AGA) requirements, 9th Aug 2025, *https://www.digital.gov.au/AI-technical-standard/summary-requirements-standard/summary-table-requirements*

Governance QA: (Third-Order) – cont.

A Method for Ethical AI in Defence – Five facets

- Responsibility
- Governance
- Trust
- Law
- Traceability
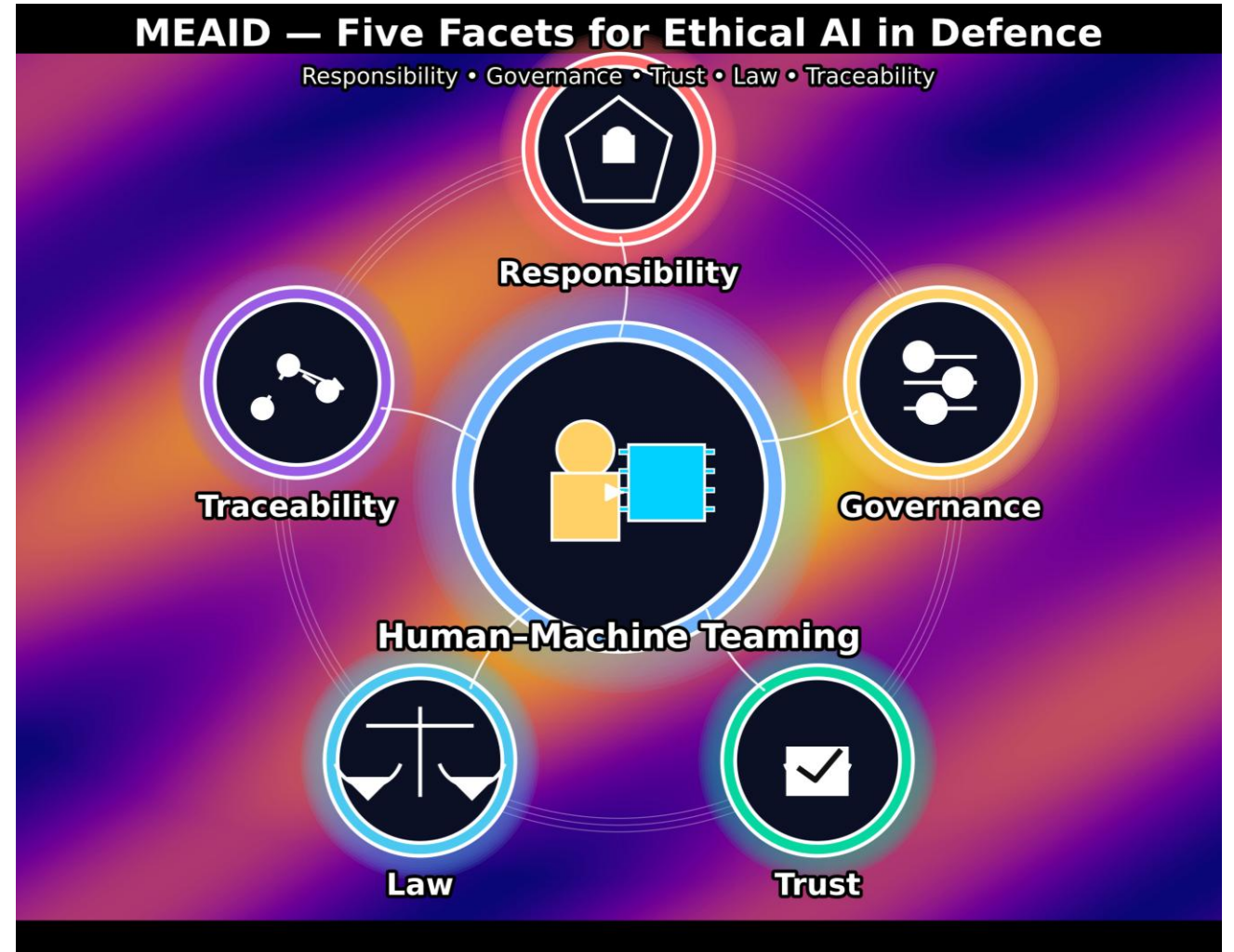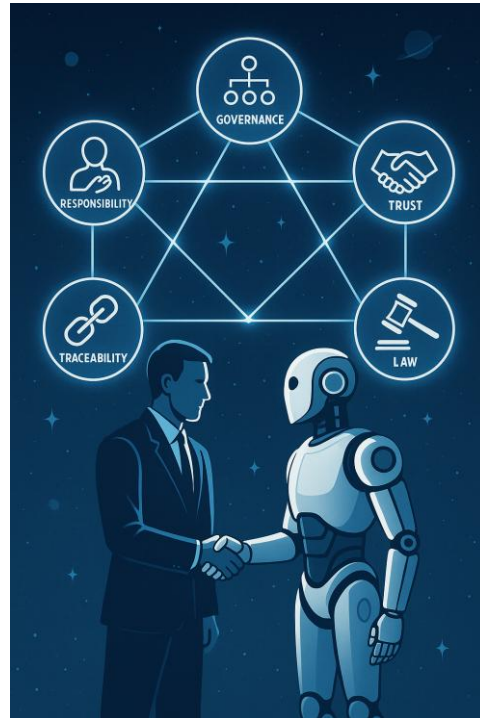
[10] Kate Devitt, Michael Gan , Jason Scholz and Robert Bolia (2020) , *A Method for Ethical AI in Defence*
[11] Images generated by ChatGPT-5 Pro, 9th Aug 2025 & ChatGPT-5 Sora 10th Aug 2025

Pragmatic Tools for Considering and Managing Ethical Risks in AI for Defence

Meta-QA: (Fourth-Order)

Adaptive QA a cybernetic process

- Is the system (AI) self-checking correctly?

- Have we built the right self-checking AI system?

- Meta-QA considerations
    - Zero-Defects as a meta-commitment
    - Work-Process Analysis drives quality assurance of the quality assurer
    - Prove return on investment (ROI) via the price of nonconformance
    - Prevent the "Mr Guessingwhat" scenario

[12] Larry Kennedy 2005, *Keeping The Promise – A Work Ethic for Doing Things Right,* pp. 17-18, 56-59
[13] Larry Kennedy 2004, *Quality Management In the Nonprofit World,* pp. 38-39
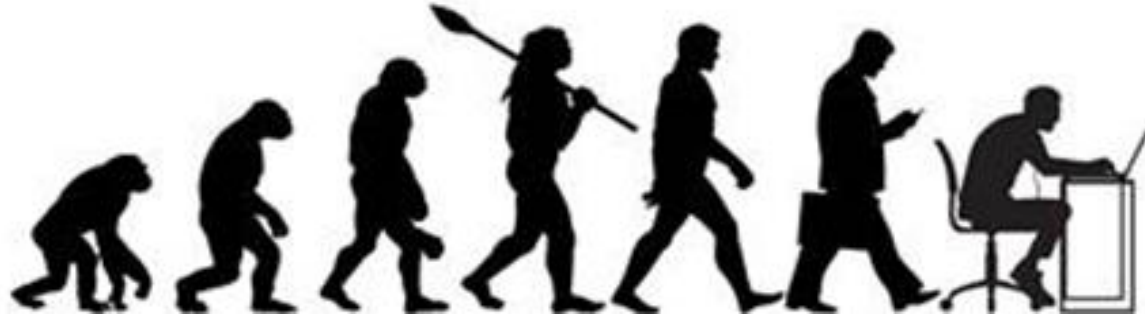
Bringing it all together

Audience POV

The Cybernetic View of Quality & Four Orders of QA

MISSING LINK SOLUTIONS®

Five Key Takeaways

- Ethics can't be outsourced to automation; it must be **embedded in the regulatory design.**

- In adaptive or AI-enabled systems, **assurance must itself adapt.**

- **Deep Learning** magnifies both predictive power and ethical risk.

- **Fourth-order QA (meta-QA) helps maintain the symbiotic relationship** between compliance and conscience when reliant upon an autonomous regulator.

- **AGA** coupled with the **pragmatic tools** presented today are just some of the actionable methods you can apply to the 4 layers of QA to ensure responsible, legal and ethical use of Artificial Intelligence.

Questions?
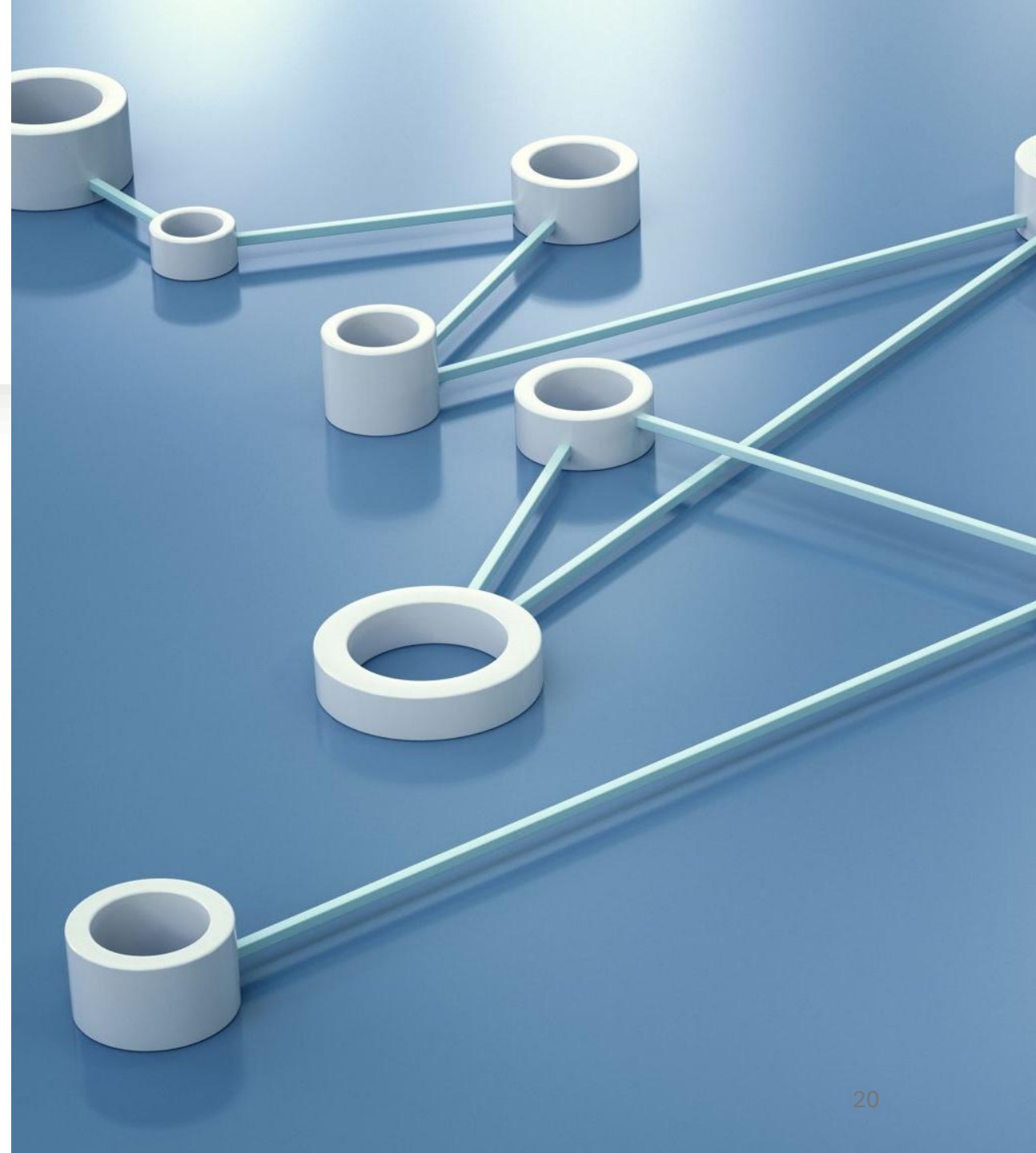
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[*] Title Page, Shutterstock image licenced

[1] OECD website, 3rd Aug 2025, https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0449

[2] ChatGPT 4o, 15th July 2025

[3] Norbert Wiener 1954, The Human Use of Human Beings: Cybernetics and Society

[4] ChatGPT 4o, 24th July 2025 (images generated)

[5] ChatGPT 4o, 24th July 2025 (images generated)

[6] Barclay Brown (2023), Engineering Intelligent Systems, pp. 165-272

[7] IBM WatsonX Governance - Scale trusted AI with watsonx.governance, *accessed 11Sep2025*, https://www.ibm.com/products/watsonx-governance?utm_content=SRCWW&p1=Search&p4=2053649838238&p5=e&p9=1564767115287&gclsrc=aw.ds&gad_source=1&gad_campaignid=2021730239 5&gbraid=0AAAAAD-_QsQtIxrhI-7-eeNNBivhaePys&gclid=CjwKCAjw2brFBhBOEiwAVJX5GJjuOoHDP3FKFmxxKtr1 EoVZr7v5g7BIHIl1Z0lPHOGwWAP59wHHixoC0FMQAvD_BwE

[8] Image of Author

[9] Australian Government Architecture (AGA) requirements, 9th Aug 2025, https://www.digital.gov.au/AI-technical-standard/summary-requirements-standard/summary-table-requirements

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