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Securing project resilience in a complex world

Project controls – more than just technical skills

Risk management in mega projects: navigating challenges and maximizing value

Minimizing threats while maximizing opportunities

ACOSTE

Securing project resilience in a complex world

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Traditional approaches to managing risk have fallen out of step with contemporary project environments. Previously, when projects could predominantly be described as *clear* or *complicated*[1], a blend of good practice, best practice, and expert judgment was sufficient for their delivery. However, as we increasingly encounter complex and chaotic project environments, these traditional methods ~ which assume linear relationships between cause and effect ~ are proving far less effective.

This contention is supported by the sobering statistic put forward by Professor Bent Flyvbjerg that ***'91.5% of projects go over budget, over schedule, or both'***[2], and highlights the need to change our approach to one that embraces complex systems thinking.

Whilst this next exciting evolution of risk management is still in its infancy, the Institute of Risk Management's Risk & Complexity (R&C) Special Interest Group has recently published an accessible set of good practice guidelines aimed at equipping organisations and projects with the tools they need to thrive in complex and chaotic environments.

Figure 1 - Model from upcoming IRM's Risk & Complexity Good Practice Guidelines (GPG)

[1] Snowden, D. J. (2023). *Cynefin Framework and its Practical Applications*. The Cynefin Company.
[2] Flyvbjerg, B., & Gardner, D. (2023). *How Big Things Get Done*

Practical, Accessible, Usable ~ below is the ACostE's summary on how projects can use these Good Practice Guidelines (GPG) to function and even thrive in the increasing norm of complex and chaotic domains.

1. What is complexity and how do we identify it?

Whilst no single accepted definition covers all fields, there is consensus on the common features of complex systems.

"Common" features of complex systems:

- self-organisation into patterns (as with flocks of birds or shoals of fish)
- sensitivity to initial conditions (as per the 'butterfly effect')
- fat-tailed behaviour, past-perceived rare events happen more frequently than standard models would predict (think market crashes)
- adaptive interactions (where agents in the system respond to changing conditions based on experience)
- feedback loops, where changes compound on each other, amplifying/ dampening the impact of the change (positive/negative feedback)
- display 'emergent behaviour' (similar to the property of consciousness arising from the neurons in the human brain)

These features give rise to behaviour that cannot be explained as the simple sum of the parts, a critical determinant of complex systems is known as '*emergence*'. An example of this is the property of consciousness arising from the interaction of neurons in the human brain.

Though the latest version of ISO 31000 – Risk Management defines risk as the *'effect of uncertainty on objectives'*, there remains no universally accepted definition of '*complexity risk*'. However, the IRM's Risk & Complexity Good Practice Guidelines (GPG) define complexity risk as '*the effect of emergence on objectives*'.

2. Why should we look out for complexity?

A project may encounter complexity as it progresses through its lifecycle. Moreover, complexity may be present in some areas of the project while not in others from one day to the next.

Given the colloquial use of the word, it is understandable that the organisational perception of complexity can be negative. However, it is important to note that complexity is not something that can or should be stamped out, rather it should be understood and embraced to create value.

Understanding the nature of complexity and how it might manifest in a project can offer many benefits, empowering staff at all levels to better navigate potential challenges, capitalise on opportunities, and ultimately build more resilient projects.

It is also important to recognise complexity ***as opposed to complicatedness***. The distinction is that *complexity* refers to non-linear and compounding casual-effect relationships that are unpredictable and only knowable in retrospect.

Conversely, *complicatedness* can be assessed more empirically by considering elements in the problem space such as the number of possible future states, measurable objectives, possible actions, constraints, and relationships between the variables.

It can be useful to consider the root words in Greek and Latin respectively. *Complex* stems from the Greek word 'plexus' meaning 'woven together', whereas *complicated* comes from the Latin word 'complicare' meaning 'folded together'[3].

Benefits of understanding complexity can include:

- More responsive decision making
- More effective resource allocation
- Improved problem-solving capacity
- Better communication
- Increased scope for innovation
- More adaptable processes

To set complexity in context, it is useful to delineate complex systems from clear, complicated, and chaotic systems. Professor Dave Snowden's Cynefin framework provides a succinct way to assess what domains your project and its constituent parts are operating in, offering guidance as to how best to respond:

[3] Snowden, D. J. (2007). *A Leader's Framework for Decision Making*. **Harvard Business Review**, November 2007.

(The Cynefin Co, 2024)

Clear	Complicated	Complex	Chaotic
Cause-and-effect relationships are well understood, and solutions are straightforward.	Cause-and-effect relationships exist, but they require expertise or analysis to uncover.	Cause and effect are only apparent retrospectively, and multiple factors interact dynamically.	No clear patterns or predictability.
E.g., Work instructions on a production line.	E.g., Within construction, where SOPs exist, but specialist knowledge is still required.	E.g., Stock trading where patterns emerge on market behaviour.	E.g., UK Summer riots where disparate events and feedback loops led to unpredictable behaviour.

The benefits of understanding which domain you are operating in at any one time include:

- Selecting the most appropriate decision-making process to follow.
- Avoiding oversimplification and making decisions more adaptable to environmental changes.
- Having a better understanding of when to apply or abandon a certain response.
- Generating feedback to identify the *right* problem to solve.
- Allowing the grouping of challenges in the same domain.

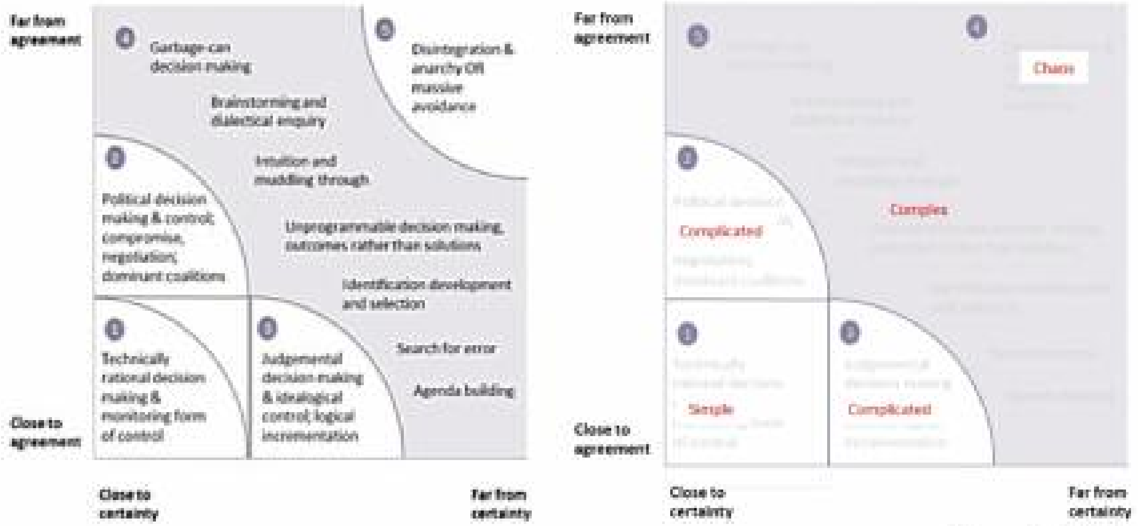
Tiantian Zhu, Xue Yang, Stein Haugen, Yiliu Liu, propose the following 7 dimensions to describe the features of risk-related decision problems.[4]

[4] Tiantian Zhu, Xue Yang, Stein Haugen, Yiliu Liu, "A multi-dimensional approach for analyzing risk-related decision problems to enhance decision making and prevent accidents", Journal of Loss Prevention in the Process Industries, Volume 87, 2024

1. Criticality (negligible to critical)	The degree of criticality (risk level) of a problem is determined by the importance of the safety objective and the gap between the actual and desired states and proximity to hazard.
2. Uniqueness (common to unique)	Unique problems are often ill-structured. Variation in the degree of uniqueness will lead to differences in problem recognition, plausible objectives, availability of alternative plausible solutions, and consequently the decision-making process.
3. Structuredness (well-structured to ill-structured)	The degree of structuredness of a problem has a strong impact on decision-making behaviour.
4. Complicatedness (simple to complicated)	Complexity refers to a non-linear (and compounding) causal-effect relationship, so it's unpredictable and unknown, whereas the degree of complicatedness is more empirical.
5. Dynamic (static to dynamic)	Complicatedness, uncertainty, and dynamics are positively associated with each other. For example, when decision-makers are not sure which state will be the future state, they tend to assign a likelihood to each future state.
6. Problem trigger (proactive vs reactive)	A reactive problem is triggered by external signals from events and the environment, while a proactive problem is triggered by a desire to achieve certain goals.
7. Residual uncertainty (low to high)	Causality refers to the active anticipation and monitoring of cascading 2nd and 3rd order effects from a given intervention.

(Zue, T. et al, 2024)

The Stacey Matrix, published by Ralph Douglas Stacey[5], is based on two dimensions: agreement and certainty. Projects are close to certainty when cause and effect relationships are well known, and similar projects have been performed in the past.



(Stacey RD, 2002)

Within the two axes, Stacey identified five areas:
1. Close to agreement, close to certainty (Agree on HOW and agree on WHAT)
2. Far from agreement, close to certainty (Disagree on WHAT, but Agree on HOW)
3. Close to agreement, far from certainty (Agree on WHAT, but disagree on HOW)
4. The zone of complexity (Not even about WHAT, but about HOW)
5. Far from agreement, far from certainty (No idea about HOW, no idea about WHAT)

[5] Stacey RD. Strategic management and organisational dynamics: the challenge of complexity. 3rd ed. Harlow: Prentice Hall, 2002.

3. How can we manage it?

By promoting a systems thinking approach, we can view the project as an ecosystem and manage it accordingly.

The process outlined in the recently published Risk & Complexity Good Practice Guidelines from the Institute of Risk Management (IRM) demonstrates how decision-makers can secure a "sense of place" from which to understand and respond to complexity risk.

The process is made up of six iterative phases which guide the user as to how they can start to manage complexity and the associated risk to build resilience against disruption.

In the *Investigate* phase, the user is taken through preparatory steps to assess the current internal position of the project in terms of alignment to the corporate vision, mission, and strategy to lay foundations for future work in managing complexity risk-taking account of (1) granularity, (2) essential outcomes, (3) structural & procedural vulnerabilities, (4) cultural vulnerabilities, and (5) how to identify complex systems features for management.

The *Anticipate* phase outlines how to design and implement a weak signal detection and emerging risk process tailored to the specific needs of the project.

This enhances the existing risk identification process, capturing weak signal trends and emerging risks for early action, both originating within the project organisation and its external environment.

The *Prepare* phase is where the vulnerabilities identified during the Investigate and Anticipate phases are addressed.

This might include simplifying the project structure and processes, addressing cultural misalignments, and implementing proactive mitigations whilst developing reactive actions for impacting risks across the domains.

This *Respond* phase is where predefined plans are put into action and the resilience of the structure is put to the test.

Depending on the domain in which the risk is impacting, this might involve initiating crisis response and complex systems management techniques to manage the system from a disordered state to an ordered one.

The *Adapt* phase is where the project organisation is actively managed and altered to secure resilience following a disruption.

It allows us to 'bounce forward' to create a stronger and more flexible project in all senses, creating efficiencies and capitalising on opportunities.

In the *Learn* phase, continuous improvement is implemented and maintained through adaptive learning.

Here, data is collated and sanitised from combined experience to generate meaningful and actionable lessons which inform the other iterative phases.

4. How "complexity" changed the name of the game

4.1. The impact on Estimators and Cost Managers:

Systems Learning lessons from "Investigate" phase:

- Systems thinking to identify systemic risk rather than stochastic events to manage system boundaries.
- Identify *Risk Champions* that focus on Constraints to risk mitigation actions, and which can champion Risk Fall-Back barriers.
- Executive reporting to focus more on an overarching risk narrative, rather than top "n" risks, which may not change month-to-month.
- Model circular feedback loops, and secondary risks in your risk assessments.
- Work-flow automation tools to trigger email notifications and action plans to alert "agents" of breached triggers.
- Use of new technology (e.g., AI/ML) to model boundary management.

Systems Learning lessons from the "Anticipate" phase:

- Use Natural language processing (NLP), and web-scraping techniques, to scan unstructured data internally, and externally to support PESTEL analysis.
- Configure benchmark groups to assess impact against vision, mission, strategy, objectives, and essential outcomes.
- Plot potential risks by severity & sensitivity to prioritise mitigation efforts.
- Collaboration tools (e.g., Yammer) can create digital suggestion boxes and innovation hubs to foster a '*human sensor network*'.
- Use insights from above to assess existing resilience plans.

4.2. The impact on Risk Managers:

Systems thinking from GPG's 6-phase Risk & Complexity framework can enhance traditional Enterprise Risk Management (ERM) best-practice frameworks such as King IV principles; the COSO; and ISO 31000:2018 risk management approaches through (1) objective setting, (2) event identification, (3) risk assessment, (4) risk response, (5) control activities, (6) information and communication.

4.2.1. Objective setting:

- Leadership to be flexible, open to learning, and ready to switch strategies based on emerging information.
- Incentivisation methods to reward desirable behaviours and promote desired culture.
- Leadership and Delivery Partners to have 'skin in the game' to promote accountability [e.g., via NEC ECI Option X22].
- Adjust scope as necessary to reflect new strategic goals or identified emerging trends.
- Identify 'essential outcomes' on what needs to be protected in the event of disruption.
- Ensure alignment with the wider organisation's vision, structure, and desired culture.

4.2.2. Event identification:

- Minimise impediments to information flow to promote adaptability.
- Simplify management structure and remove/relax onerous internal boundaries and constraints to allow easier communication of risks.
- Run multiple concurrent '*safe to fail*' experiments to inspect, adapt, and discover effective practices.
- Identify the constraints and complex systems features that are relevant to identified risk.
- Establish Key Risk Indicators (KRIs) to identify emerging risks and root causes.

4.2.3. Risk assessment:

- Benchmark the organisation's culture and risk appetite against those of others with desirable attributes.
- Investigate and assess emerging risks to gain insight as to their validity and potential impacts.
- Identify the key decision points because that is where the value of information is released.
- Provide the *right* information to the *right* people at the *right* time to make the *right* decisions.
- Fast feedback loops to ensure effective responses are shared swiftly and widely.
- Run QRAs on Secondary Parent/Child Risks.
- Understand the organisation's history, including significant events, milestones, and changes.

4.2.4. **Risk response:**

- Conduct interviews at different levels, where behaviours misalign with responses.
- Introduce vertical and horizontal information feedback loops to support rapid responses and continuous adaptation, in times of disruption.
- *Think big, start small, scale rapidly* ~ continual process improvement, and support iterative development.
- Test interventions from safe-to-fail experimentation to assess their impact and gauge feedback before scaling them for wider use across the organisation.
- Focus on systemic, rather than stochastic risks.

4.2.5. **Control activities:**

- Define risk response actions for each risk in line with the four Cynefin domains (Clear, Complicated, Complex, Chaotic).
- Manage the impacts and shift the domain to one which is more ordered, predictable and manageable using complex systems features e.g. boundaries.
- Use distributed decision-making to delegate authority, promote diversity and innovation.
- Use modularisation together with distributed decision-making to promote adaptability by affording autonomy to manage contained risks.
- Identify trigger points. Develop strategic responses and action plans for each trigger point.

4.2.6. **Information & Communication:**

- *Manage Information as an Asset*: clear metrics to manage benefits across the lifecycle of the project.
- *Build a Data Democracy*: Give people the license to experiment using data for additional purposes to create value.
- *Make data FAIR*: Findable, Accessible, Interoperable and Re-usable.
- *Make security an enabler*: Ensure information that flows across organisational boundaries is trusted, secure, and resilient.
- Data *stewardship*: to ensure quality and fitness for purpose of the organisation's data assets.
- *Make* the information value chain work for the project: data i) insights ii) decisions iii) actions iv) outcomes.

Risk

5. Reporting on the interconnected nature of "complex unstructured problems" using fuzzy (uncertain) sets and fuzzy logic.

How can the Project Controls community assess this degree of interconnectedness and causality?

Commercial Managers and Estimators can use of resource-based view (RBV) to examine a firm's strategic resources to achieve sustainable competitive advantage.

In mathematics, **fuzzy sets** (a.k.a. **uncertain sets**), introduced independently by Lotfi A. Zadeh,[6] are sets whose elements have degrees of membership. Membership in fuzzy sets is expressed in degrees of truth - i.e., as a continuum of values ranging from 0 to 1. In a narrow sense, the term *fuzzy logic* refers to "fuzzy," boundaries. For example, at age 45 a man is neither very young nor very old.

Fuzzy sets, or the more formal term, Qualitative Comparative Analysis (QCA) embraces **causal complexity**. This suggests that although the presence of certain conditions may lead to a certain outcome, their absence does not necessarily imply outcome absence.

*How does this **fuzzy logic** work?*

- For instance, if there were four categorical variables of interest, {A,B,C,D}, and A and B were dichotomous (could take on two values), C could take on five values, and D could take on three, then there would be 60 possible types possible combinations of variables.
- QCA uses inferential logic or Boolean algebra to simplify the logic needed to understand this complexity.
- For instance, if the presence of conditions A and B is always associated with the presence of a particular value of D, regardless of the observed value of C, then the value that C takes is irrelevant.
- Thus, all 5 inferences involving A and B and any of the 5 values of C may be replaced by a single descriptive inference "*(A and B) implies the particular value of D*".

Fuzzy set (or fsQCA) can be used to identify the configurations of conditions that lead to specific outcomes. It achieves this by providing evidence of causality in complex systems. QCA underscores that causality is complex, characterised by three principles:

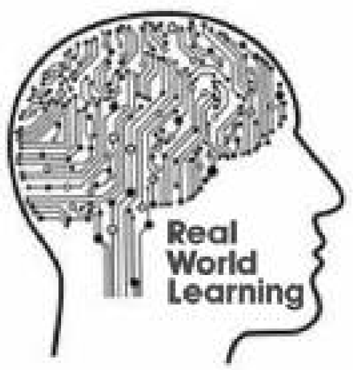
1) Conjunction: that multiple, independent causal attributes jointly produce an outcome.
2) Equifinality: that different combinations of conditions yield the same outcome.
3) Asymmetry: that both the presence and absence of attributes would be associated with the outcome.

6. How new technology allows us to cope with "complexity risk"

The benefits of Machine Learning Models when compared to data-driven methods for project risk forecasting is that they allow the application of cost & time uplift percentages for generic project categories:

[6] Ragin, C. C., & Pennings, P. (2005). Fuzzy Sets and Social Research. Sociological Methods & Research, 33(4), 423-430. https://doi.org/10.1177/0049124105274499

- Automate the application of Reference Class Forecasting (RCF) and HM Treasury's Green Book (2022) guidance.
- Experiments show that unlike applying blanket PERT distributions, Machine Learning Models forecast project delays with higher accuracy to identify Risk Lead Indicators and Delay Multipliers.[7]
- Use of Graph Neural Network (GNN) to forecast activity durations.



Each complex project is unique but can share many similarities with past projects. GNN data-driven modelling[8] has potential benefits over traditional schedules to train predictive models on project schedule data:

- **Graph Classification:** we use this to classify graphs into various categories. Its applications are social network analysis and text classification.
- **Node Classification:** this task uses neighbouring node labels to predict missing node labels in a graph.
- **Link Prediction:** predicts the link between a pair of nodes in a graph with an incomplete adjacency matrix. It is commonly used for social networks.
- **Community Detection:** divides nodes into various clusters based on edge structure.
- **Graph Embedding:** maps graphs into vectors, preserving the relevant information on nodes, edges, and structure.
- **Graph Generation:** learns from sample graph distribution to generate a new but similar graph structure

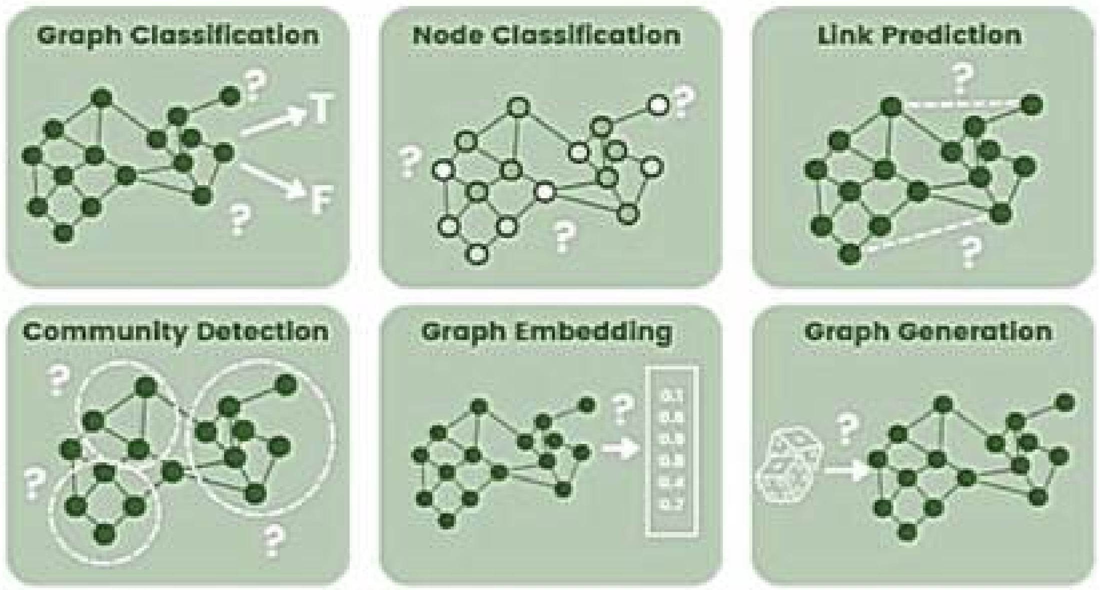


Figure 2 - Types of Graph Neural Networks Tasks (GNN)

[7] P Zachares, V Hovhannisyan, C Ledezma, J Gante, A Mosca On Forecasting Project Activity Durations with Neural Networks, International Conference on Engineering Applications of Neural Networks
[8] A Comprehensive Introduction to Graph Neural Networks (GNNs), https://www.datacamp.com/tutorial/comprehensive-introduction-graph-neural-networks-gnns-tutorial

7. Organising for Complexity

- Complex adaptive systems are not closed, controllable, or predictable, and dealing with them requires a level of tactical, and organisational agility for collective action on strategic, systemic risks.
- *Complex problems are here to stay.* So, how can Projects better posture for a complex adaptive future?
- Projects can invest in 3 strategies to build organisational capabilities to thrive in complexity:
  1. Systems activism
  2. Diversity of thought
  3. Social capital

Systems activism
Emerges from rethinking projects as complex adaptive systems. We can plot spheres of influence to control systems' environments.

Diversity of thought
Being able to see that the system rests on an ability to identify a set of circumstances from multiple perspectives.

Social capital
Social capital holds systems together in ways that are not immediately obvious to engage with other stakeholders.

Organisations can increase their FARness[9] (**F**lexibility, **A**daptiveness, and **R**obustness), to maximise the variety of responses they can call upon. They can do this, by improving their sensor and sense-making capabilities (e.g. by using AI and Big Data) to attenuate (filter) what they are seeking to observe and better understand what is **known** and **controllable**.

	Know	Don't Know
Control	Know that you control a system variable	Don't know that you control a system variable
Don't Control	Know that you don't control a system variable	Don't know that you don't control a system variable (or that it is even present)

Figure 3 - Knowledge-control matrix

[9] Schuck, Tod. 2021. 'Cybernetics, Complexity, and the Challenges to the Realization of the Internet-of-Things.' Procedia Computer Science 185: 45–54. As of 24 February 2023: https://doi.org/10.1016/j.procs.2021.05.040

It is possible to map this generalised model[10] of a control system to the specific context of decision-making for improved information flows and communications, enhanced cognitive capacity, agility and ability to innovate, and a flexible range of levers to use to exert an influence on the external environment.

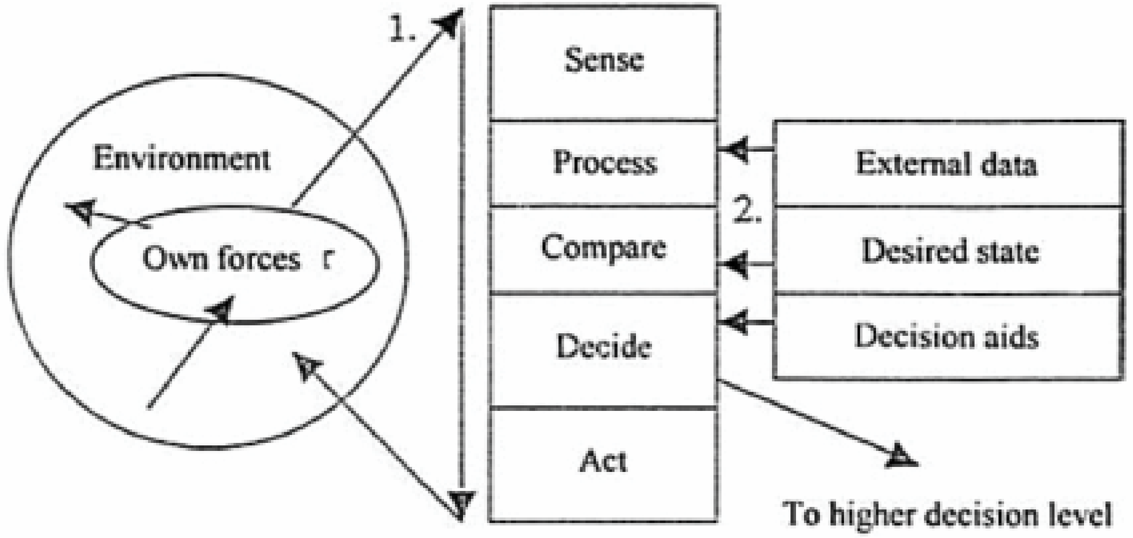


Figure 4 - Lawson's model

8. Managing Systematic Risks with Integrated Project Governance

As mentioned in our introduction, in the past, projects could predominantly be described as clear or complicated. We broadly could agree on ***what*** to do, as clear on causal factors, but perhaps disagreed on ***how***.

Now, however, projects are facing increasing challenges from non-linear (and compounding) causal-effect relationships. These challenges are fundamentally "new", as they pose often unique problems which are ill-structured, and whose properties are "emergent". By emergent, we mean that the combined features and challenges they pose are more than the simple sum of their parts, but by the interaction of their various elements.

The challenge then is to mitigate the potential complex web of interactions that may arise on a project whilst executing a strategy or plan, all whilst building in mechanisms to measure the effectiveness of different approaches for managing complexity, enabling adaptation, and promoting continuous learning.

Recalling Cynefin, complexity remains the domain of probing and emergent insights. A recurring theme of these types of frameworks is the need for continuous iteration, learning, and adaptation to minimise the risk of negative unintended consequences through hedging and mitigating actions,

[10] Lawson, J. 1978. 'A Unified Theory of Command and Control.' Paper presented at the 41st Military Operations Research Symposium (MORS): http://www.journal.forces.gc.ca/vo9/no4/08-lauder-eng.asp

Organisations, however, struggle to strike a balance between traditional, hierarchical, and linear approaches to sense-making, planning, and execution which are optimised to solve complicated problems.

One approach is to develop an organisation with nested loops of co-evolution of a conceptual model, system, and operational designs, and the adaptive implementation and execution of those designs[11]. One 'with non-linear interactions involving adaptive animate components, interactions that lead to emergent macroscopic properties', a subset of complex systems more generally.

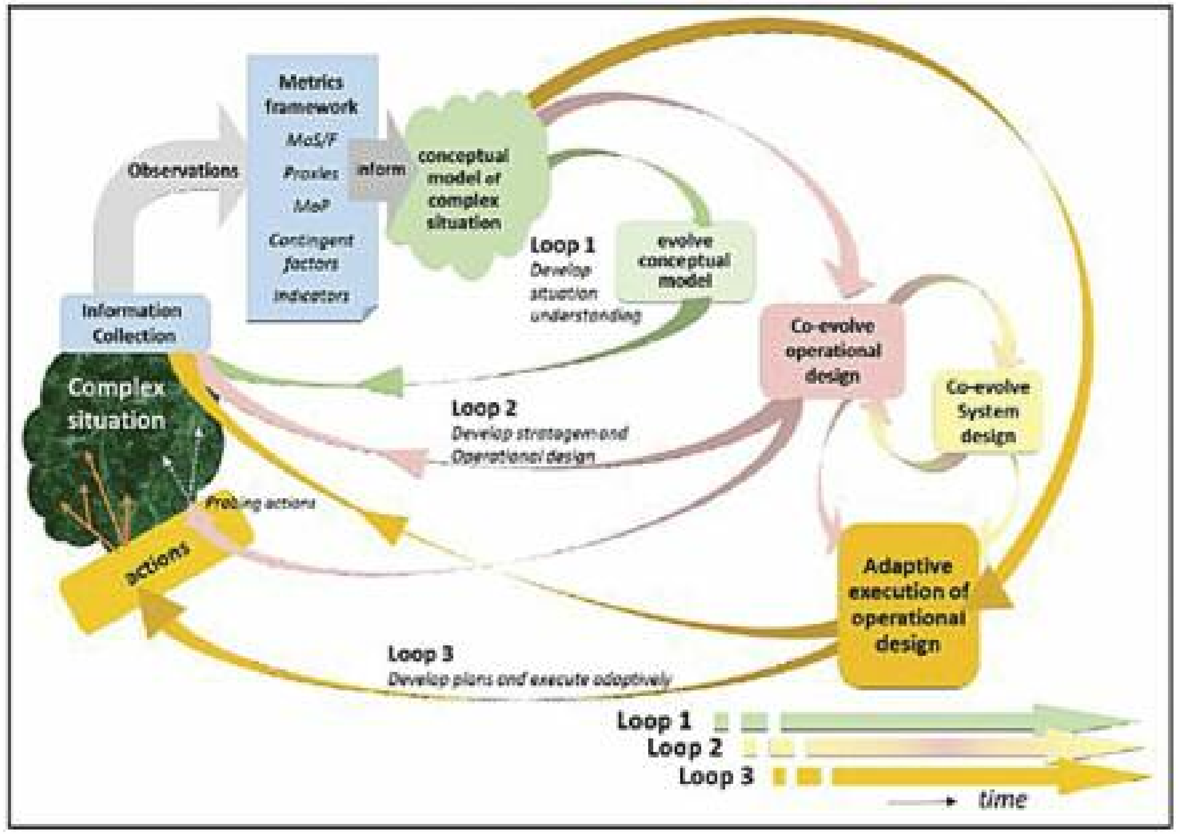
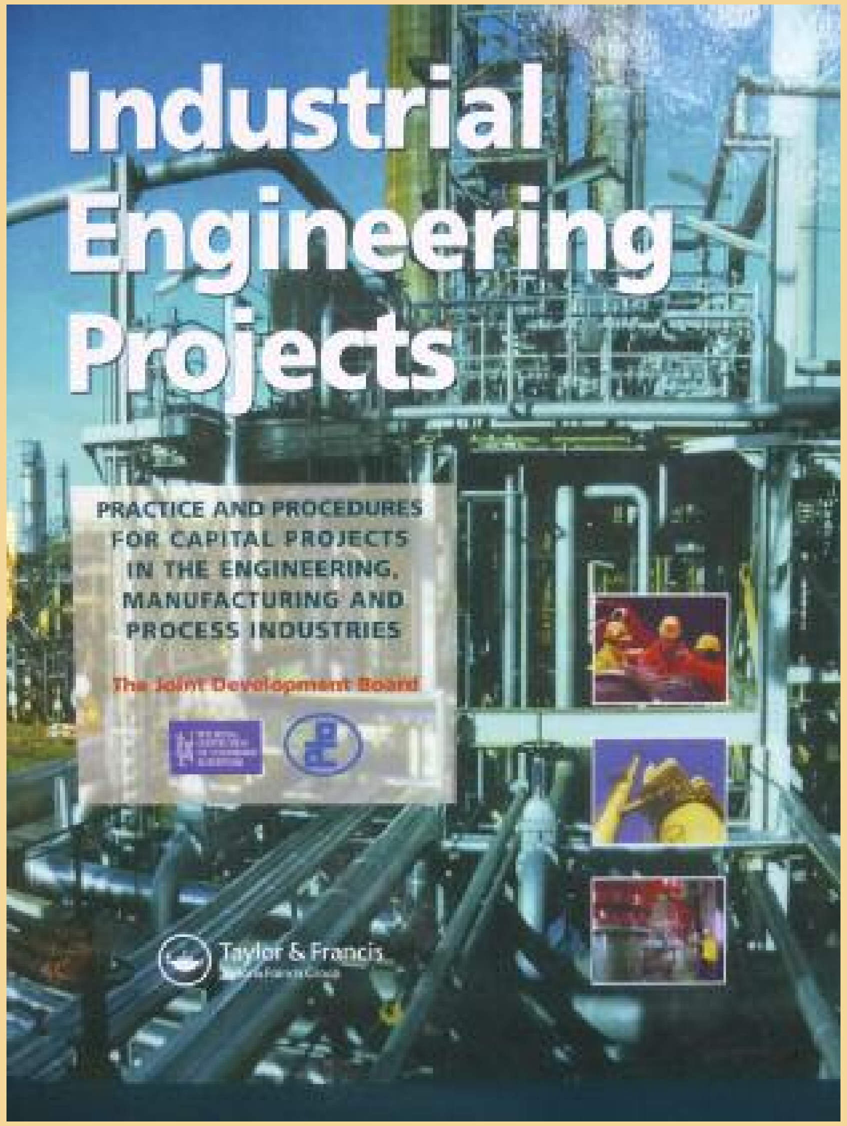


Figure 5 - Using nested loops to enhance Integrated Project Governance

The design dilemma for Executives is how to pivot between the different domains. For example, between the clear and complicated domains of the Cynefin framework. Especially given the added risks of turbulence, chaos, and confusion that can be caused by this management transition.[12]

Projects can look to replace hierarchical, and bottom-up reporting (from Project, to Programs, to Portfolio) to introduce iterative feedback loops to investigate alternative plausible solutions.

[11] Grisogono, Anne-Marie. 2019. 'On the Roles of Design in Defence.' In Design Thinking: Applications for the Australian Defence Force, edited by Aaron Jackson. Australian Defence College. As of 24 February 2023: https://aodnetwork.ca/design-thinking-applications-for-the-australian-defence-force/
[12] IT Revolution. 2021. 'Cynefin: Four Frameworks of Portfolio Management.' 5 July. As of 24 February 2023: https://itrevolution.com/articles/cynefin-four-frameworks-of-portfolio-management/



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