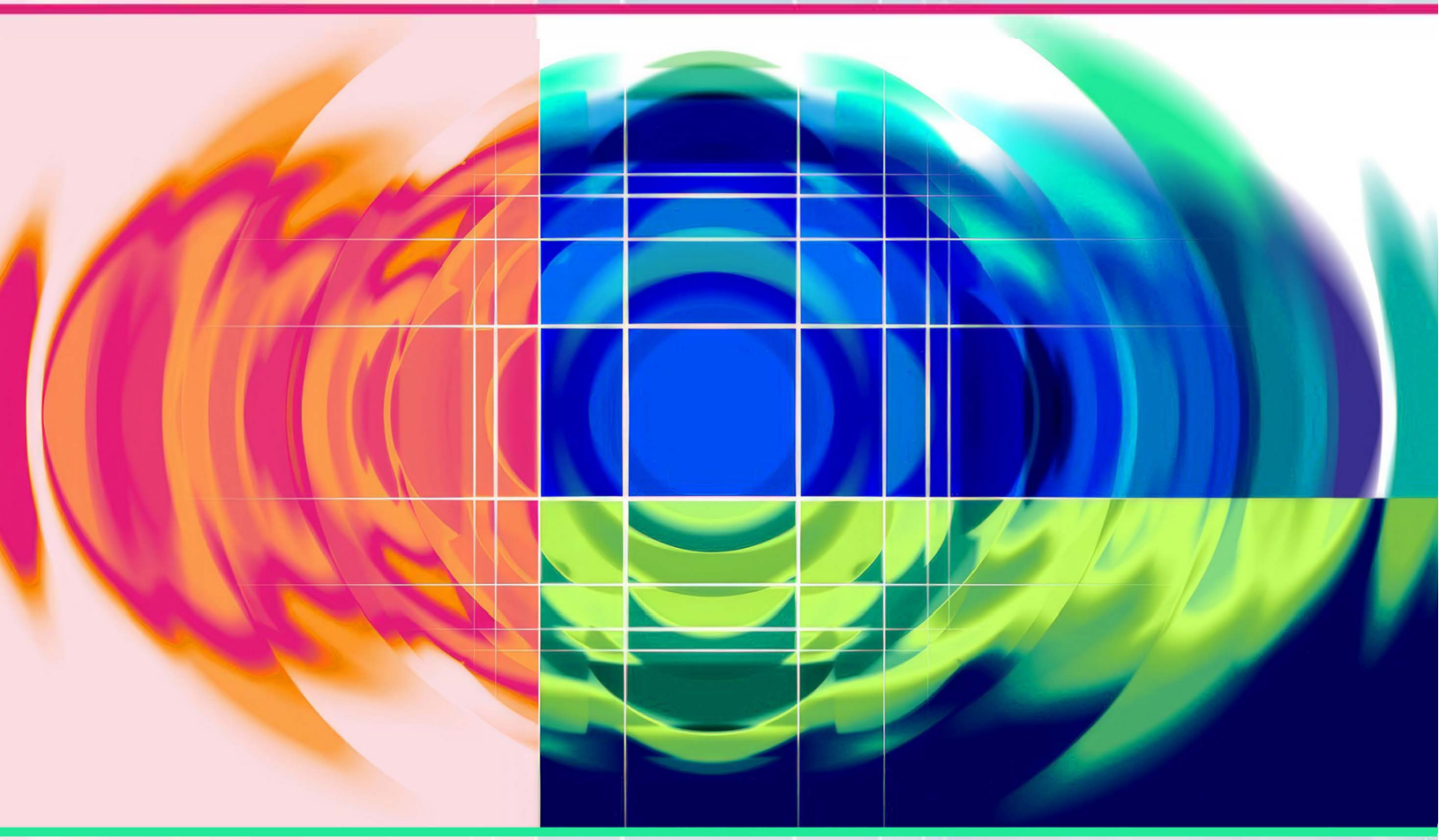
GLOBAL FORUM FOR NUCLEAR INNOVATION

HACKATHON SESSION HANDBOOK



EPRI FPL IAEA NATIONAL NUCLEAR LABORATORY NEA Nuclear Energy Agency NEXTera ENERGY

Introduction to Nuclear Grand Challenges

No Talent, No Sector

A skilled and adaptable workforce is essential for the nuclear energy sector to achieve its full potential, particularly for the construction and operation of nuclear power plants. According to the U.S. Department of Energy, approximately 375,000 workers will be needed by 2050, a significant increase from the current 100,000 [1]. This need is compounded by a declining labor force participation rate, projected to drop from 61.7% in 2021 to 60.1% in 2031, due to retirements and a shrinking population [2]. EPRI-Nuclear Energy Institute (NEI) emphasizes the importance of workforce development for the large-scale deployment of advanced nuclear power plants [3]. This includes building a pipeline of skilled trades, attracting, and retaining talent, and maintaining the existing workforce. The Institute of Nuclear Power Operations is advancing continuous learning through innovative training methods based on modern learning science [4]. Future approaches might involve a learner-centric workforce development model and the use of best practices and emerging technologies to effectively engage and cultivate the future nuclear workforce.

Operating a Lean Machine

Operating nuclear power plants involves numerous repetitive tasks, requiring significant labor hours. To enhance efficiency, it is essential to modernize equipment, processes, and embrace digital transformation. For example, collaboration with Idaho National Labs showed substantial operation and maintenance savings ($50M–$80M USD) by updating digital safety systems [5]. EPRI is developing a foundation for the digital transformation (DX) of nuclear fleets, leveraging research to enhance productivity and reduce labor needs. DX efforts focus on automating processes and utilizing technologies to improve efficiency, safety, and affordability. Implementation may require cross-functional teams and agile project execution. The Operating a Lean Machine Grand Challenge seeks to explore DX advancements through collaborative research. Modernizing nuclear plants with digital technologies can optimize the workforce, reduce labor demands, and attract new talent, as emphasized in the No Talent, No Sector Grand Challenge.

Safe Doesn’t Have to Be Slow

The nuclear industry's "safety first" commitment ensures reliability but often slows down licensing, construction, and operations due to regulatory and capital challenges. Streamlining these processes is essential for bringing new plants online while maintaining safety. Innovative research, such as the Gateway for Accelerated Innovation in Nuclear (GAIN) initiative, is advancing new fuel coatings and molten salt microreactor technologies to enhance safety and efficiency. The IAEA's Nuclear Harmonization and Standardization Initiative (NHSI) promotes regulatory efficiency through collaboration. EPRI is also exploring AI to automate regulatory review processes, aiming to reduce the time and labor required for compliance [6]. These efforts collectively aim to modernize the industry, maintaining safety while expediting operations.

Beyond Electricity

Nuclear energy, discovered in the 20th century, revolutionized marine propulsion and electricity generation, standing out as the most energy-dense clean energy source. It is utilized globally across diverse climates to meet energy demands. In the 21st century, the role of nuclear energy is set to expand beyond traditional electricity production to support various markets, including grid support, low-carbon fuel production, industrial processes, district heating, data centers, water treatment, and even space applications. Innovative uses for current reactors are being explored, such as district heating, hydrogen production, desalination, and powering data centers. The Beyond Electricity Grand Challenge aims to determine the best nuclear technologies for these emerging applications and to maximize the use of all energy outputs, including residual heat traditionally considered waste. This initiative envisions a broader deployment of nuclear energy, reimagining its potential far beyond conventional applications.

Select a Micro-Challenge Under Your Assigned Grand Challenge

No Talent, No Sector	Operating a Lean Machine
1. Create an innovative approach for global talent development and talent acquisition in the nuclear sector. 2. Propose a modern mechanism/system to address and ensure critical knowledge transfer from the ageing workforce to the next generation. 3. Create a model for baseline training that is applicable to the entire sector to allow horizontal movement between job functions. 4. Develop training programs or models to re-purpose the energy sector worker moving from one technology to another (i.e. coal to nuclear).	1. Propose a solution to optimize tasks and processes within the work planning and scheduling process. 2. Propose a solution to reduce repetitive manual tasks within design engineering process. 3. Propose a solution to reduce administrative and repeat tasks to optimize the outage contractor onboarding and training process. 4. Propose a solution to replace the need to manually update outage work status tracking.
Safe Doesn't Have to Be Slow	**Beyond Electricity**
1. Propose a solution to address resource challenges in nuclear plant construction. 2. Propose an initiative or set of practices for navigating community engagement and review to help a utility planning on siting a new plant. 3. Propose innovative strategies to address the challenges posed by the lack of design standardization in the nuclear supply chain. 4. Propose AI-driven solution to streamline decision-making in a common regulatory process.	1. Propose an energy integration system to enhance grid stability using AI. 2. Propose a safe and innovative strategy for hydrogen storage and transportation. 3. Design the next generation 100% clean energy "super" power plant. 4. Propose a mechanism for efficiently utilizing residual heat from nuclear power plants.

NO TALENT, NO SECTOR

1. **Micro-Challenge**: Create an innovative approach for global talent development and talent acquisition in the nuclear sector.
   Problem Description: The nuclear energy industry is at an exciting juncture with the emergence of advanced reactor designs. These innovative reactors promise improved safety, efficiency, and sustainability. However, realizing their potential requires a robust talent pool equipped with specialized skills. Developing, operating, and maintaining advanced reactors demand specialized knowledge in areas like materials science, thermal hydraulics, and digital instrumentation. Navigating complex regulatory frameworks requires expertise in nuclear safety, licensing, and compliance. Advancing reactor technology necessitates research and development skills.

2. **Micro-Challenge**: Propose a modern mechanism/system to address and ensure critical knowledge transfer from the ageing workforce to the next generation workforce.
   Problem Description: The challenge of knowledge transfer from the aging workforce to the next generation workforce is multifaceted and critical for the continuity of the nuclear sector. As experienced employees retire, they take with them valuable tacit knowledge, expertise, and insights accumulated over years of service. Ensuring a smooth transition of this knowledge to younger employees is essential to prevent organizational memory gaps and maintain operational efficiency. However, capturing complex processes, safety protocols, and unwritten rules poses difficulties. Bridging generational differences, motivating older workers to share their expertise, and implementing structured transfer mechanisms are key steps.

3. **Micro-Challenge**: Create a model for baseline training that is applicable to the entire sector to allow horizontal movement between job functions.
   Problem Description: The nuclear industry is a complex and highly regulated field that encompasses various job functions, from reactor operators and engineers to radiation safety specialists and waste management experts. However, one persistent challenge faced by professionals in this sector is the lack of standardized baseline training that can facilitate lateral mobility across different roles.

4. **Micro-Challenge**: Develop training programs or models to re-purpose the energy sector worker moving from one technology to another (i.e. coal to nuclear).
   Problem Description: The energy sector is experiencing significant transformations due to decarbonization efforts and the growing prominence of nuclear energy. As coal-fired power plants retire, there's a critical need to transition the existing workforce. Workers familiar with coal mining and maintenance must acquire new skills related to nuclear reactor operation, radiation safety, and waste management. While coal and nuclear technologies have some transferrable skills such as mechanical expertise bridging this gap requires comprehensive training programs.

SAFE DOESN'T HAVE TO BE SLOW

1. **Micro-Challenge:** Propose a solution to address resource challenges in nuclear plant construction.
   Problem Description: Building nuclear power plants frequently faces the challenge of cost overruns. Despite initial projections, the actual construction costs often exceed expectations by a significant margin. Several factors contribute to this issue, including the need for specialized engineering services, meticulous labor supervision, and the tightening safety regulations. While safety remains paramount, the rigorous safety protocols can occasionally slow down construction processes, leading to further cost increases. Ultimately, these high construction costs hinder the expansion of nuclear capacity, impacting the industry's growth and affordability.

2. **Micro-Challenge**: Propose an initiative or set of practices for navigating community engagement and review to help a utility planning on siting a new plant.
   Problem Description: The utility company faces the challenge of effectively engaging with thecommunity and navigating the review process while planning to establish a new plant.Balancing community interests, regulatory requirements, and transparency is crucial. Howcan they create an initiative or adopt practices that foster positive community relations and ensure a smooth review process?

3. **Micro-Challenge**: Propose innovative strategies to address the challenges posed by the lack of design standardization in the nuclear supply chain. Consider safety, cost-effectiveness, and efficiency in your solution.
   Problem Description: The nuclear supply chain faces challenges due to the lack of standardized designs for specialized nuclear components. Limited facilities can design and certify these components, creating bottlenecks. Reactor designs evolve over time, necessitating different components. Manufacturers struggle to adapt without substantial investment and certification requirements. Collaborative efforts are needed to optimize the global supply chain while balancing safety, cost, and efficiency.

4. **Micro-Challenge**: Propose an AI-driven solution to streamline decision-making in a common regulatory process.
   Problem Description: Nuclear energy faces the challenge of navigating complex regulatory processes. Regulatory bodies meticulously assess applications, licenses, and permits, considering safety and environmental factors. However, this thorough evaluation, along with consultations and adherence to stringent standards, often leads to significant delays in project timelines.

OPERATING A LEAN MACHINE

1. **Micro-Challenge**: Propose a solution to optimize tasks and processes within the work planning and scheduling process for outage tasks.
   Problem Description*:* Nuclear power plants face the critical challenge of efficiently managing outage tasks. During planned maintenance or refueling outages, numerous complex activities must be coordinated. These include inspections, repairs, equipment replacements, and safety checks. However, suboptimal work planning and scheduling can lead to extended downtime, increased costs, and potential safety risks. To maintain reliable nuclear power generation, it's crucial to streamline processes, allocate resources effectively, minimize outage duration, and adhere to safety protocols while balancing operational efficiency.

2. **Micro-Challenge**: Propose a solution to digitize, catalog and securely manage relevant design modifications (e.g., equipment upgrades, safety enhancements, or efficiency improvements) to reduce tedious manual tasks and errors.
   Problem Description: Nuclear power plants established decades ago often store their design documentation in paper archives or outdated digital systems. These documents hold critical information about plant components, systems, and safety features. Ensuring accurate design information is essential for safe and reliable plant operation. Errors during design modifications can lead to severe consequences. Regulatory bodies demand up-to-date design documentation to maintain safety standards. Efficient design modifications not only reduce downtime but also enhance performance while minimizing costs. Unfortunately, manual extraction of data from these legacy documents can cause project delays.

3. **Micro-Challenge**: Propose a solution to reduce administrative and repeat tasks to optimize the outage contractor onboarding and training process.
   Problem Description: Contractor training is essential for outage work including maintenance, repairs, and upgrades to ensure safety and performance. Managing many contractors involves performing administrative tasks include scheduling training sessions, tracking attendance, and managing certifications. Ensuring that contractors meet safety standards and possess the necessary qualifications is essential. Coordinating administrative tasks for numerous contractors can be a burden on plant performance and can cause delays.

4. **Micro-Challenge**: Propose a solution to replace the need to manually update outage work order/status tracking.
   Problem Description: Nuclear power plants undergo regular outages for maintenance, refueling, and other critical tasks. During these outages, thousands of activities take place over several weeks. One significant need is the ability to determine, communicate, and assess work status in real-time. Manual tracking methods are error-prone, time-consuming, and inefficient. Therefore, there's a strong case for replacing such manual systems with more advanced solutions.

NUCLEAR BEYOND ELECTRICITY

1. **Micro-Challenge**: Propose an energy integration system to enhance grid stability using AI.
   Problem Description: Ensuring grid stability is critical in today's dynamic energy landscape. Nuclear energy presents a promising avenue for achieving this goal, but traditional reactors lack the flexibility needed to adapt to fluctuating energy demands.

2. **Micro-Challenge**: Propose a safe and innovative strategy for hydrogen storage and transportation.
   Problem Description: Integrating hydrogen production with existing nuclear power plants necessitates significant modifications and careful planning for compatibility and efficiency. Developing a hydrogen storage and transport network poses additional challenges due to the need for safe and cost-effective solutions, requiring significant investment and safety measures.

3. **Micro-Challenge**: Design the next-generation 100% clean energy "super" power plant. **Problem Description**: The urgent need for clean, reliable, and resilient energy arises from environmental degradation, security concerns, and economic imperatives. Transitioning away from fossil fuels mitigates climate change, reduces pollution-related health risks, and enhances energy security by diversifying sources and improving grid resilience. Moreover, clean energy presents significant economic opportunities through job creation, innovation, and cost competitiveness, driving sustainable economic growth.

4. **Micro-Challenge**: Propose a mechanism for efficiently utilizing residual heat from nuclear power plants.
   Problem Description: In nuclear power plants, a significant challenge arises from the wastage of residual heat, a byproduct of the energy generation process. Once electricity production is completed, these plants continue to emit heat, which is often dissipated into the environment without further utilization. This represents a missed opportunity to extract additional value from the energy production process. Moreover, the release of this excess heat can contribute to environmental concerns such as thermal pollution of nearby water bodies or inefficient resource allocation.

Schedule of Hackathon

PHASE	Actions	Tools	Duration
1	Build the Ambition	Challenge Canvas	15 minutes
	Define the Outcomes	Newspaper Headline	15 minutes
	Craft a narrative	Storytelling Framework	15 minutes
2	Find the Right Model	Model Selection	15 minutes
	Create an Action Plan	Ambition Ring	15 minutes
	Track and Communicate Progress	Action Table	15 minutes
3	Calibrate the Attribute List	Attribute List	15 minutes
	Identify Enablers	Actions & Attributes Options	15 minutes
	Counter-balance the Barriers	Refining Actions & Attributes	15 minutes
PITCH			

Phase 1 – Task 1	**Build the Ambition**
Task	Utilize the Challenge Canvas to systematically deconstruct the problem statement.
Outcomes	Populate the Challenge Canvas tool, follow the questions outlined.

Challenge Canvas Tool:

Phase 1 – Task 2	**Define Outcome**
Task	Describe the world as it would appear once this ambition has been realized.
Outcomes	Write a newspaper headline along with supporting text that announces the successful achievement of the ambition.

Newspaper Tool:

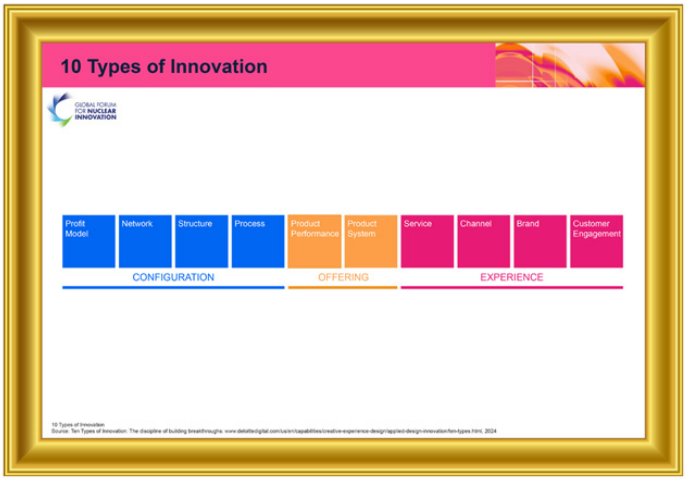
Phase 1 – Task 3	**Craft a Narrative**
Task	Craft a compelling narrative using the story framework to inspire and energize your workforce.
Outcomes	Create a visual representation of the storytelling framework on a sheet of paper for your narrative.

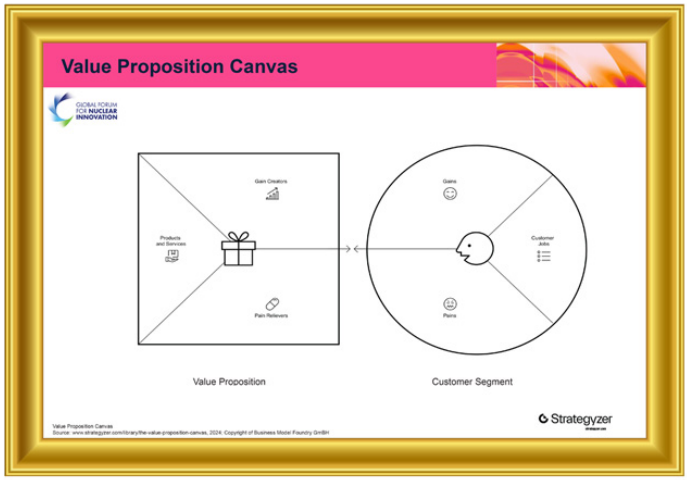
Storytelling Framework Tool:

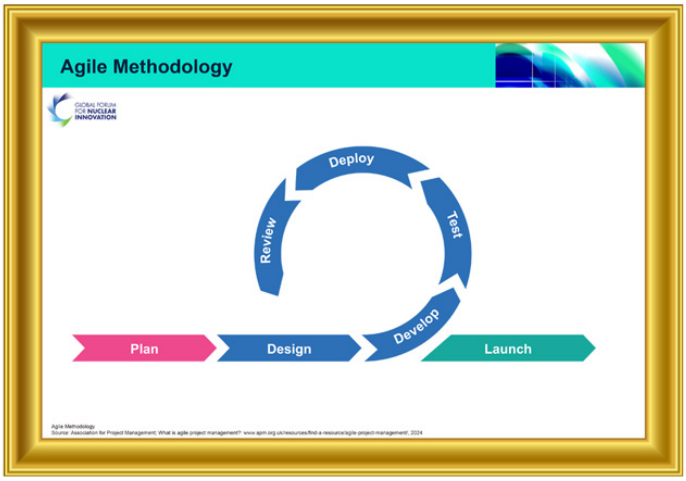
GRAB ATTENTION		ADD TENSION	
Use an intriguing opening – this could be an interesting title, a question, or a challenging statement. It can be useful to do this part last!		Outline what is particularly challenging, what can and did go wrong, or what the risks are.	
ESTABLISH THE SETTING		EUREKA MOMENT	
Background such as date, location, organization, technical or scientific discipline.		A realization, solution, breakthrough, or insight.	
HUMANIZE		OUTCOME	
Make it about a person or group of people – either directly (e.g. listing those involved) or indirectly (the people this impacts/benefits).		What was different because of all the above taking place? This is where you reiterate the key message or 'take away' for your audience.	

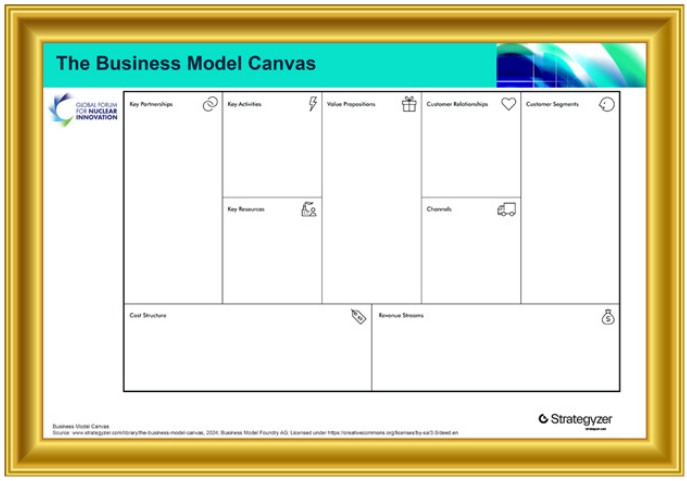
Phase 2 – Task 1	**Find the Right Model**
Task	Review the models and determine which one is most relevant for bridging the gap between the ambition and the action.
Outcomes	Select a model.

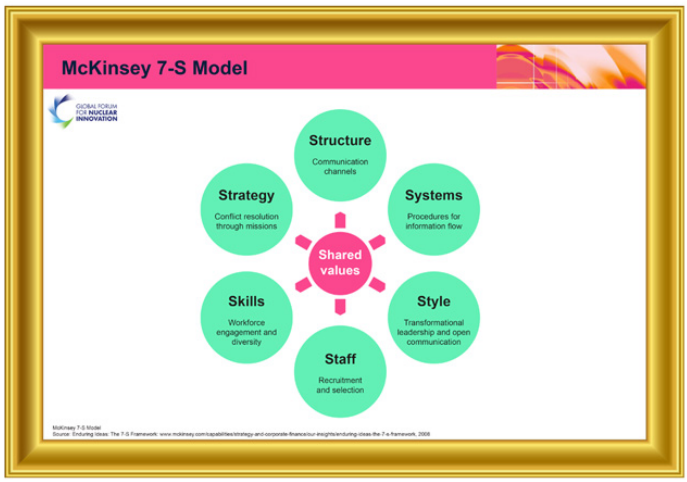
Model Selection Tool:





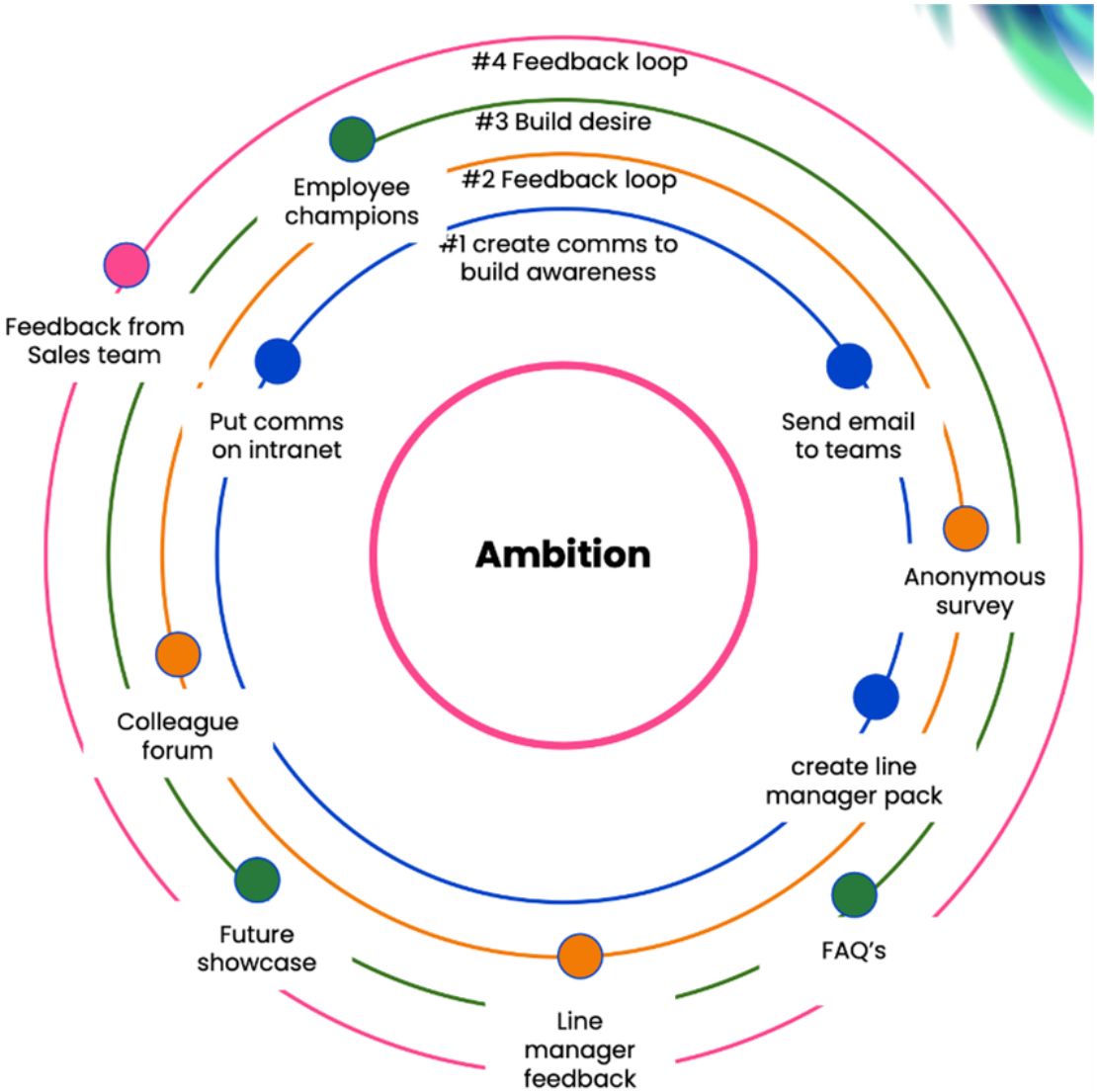






Ambition Ring Tool:

Phase 2 – Task 2	**Create an Action Plan**
Task	Using your chosen model, identify and map out the essential action rings and the actions they should contain.
Outcomes	Using your chosen model, identify and map out the essential action rings and the actions they should contain.



Action Table Tool:

Phase 2 – Task 3	**Track and Communicate Progress**
Task	For each identified action, list three different communication tools (e.g., webinar, intranet page, face-to-face) and one method to measure progress.
Outcomes	A table listing the action, the measurement tool, and three communication tools.

Actions	Action 1	Action 2	Action 3
Communication method and audience 1			
Communication method and audience 2			
Communication method and audience 1			

Phase 3 – Task 1	**Calibrate the Attribute List**
Task	Reflect on your ambition and review the attribute list. Discuss each attribute along with its enablers and barriers. Identify the sweet spot, such as a single source of communication for a safety-focused ambition.
Outcomes	Annotate the attribute list in the workbook

Attribute List Tool:

Attributes

As the action rings become populated with actions, an assessment of each action against the attribution list will help to define what success looks like and will improve the way the action is achieved.
1) Review each action against the existing attribute list, identifying what the best enabler is, and identifying what barriers may be present
2) Refine the action in a way that leverages the right enablers and mitigates the barriers

Communication			
barrier	enabler	enabler	barrier
The loudest voice wins	Clear single-source of information	Two-way communication	Too many voices

Accountability			
barrier	enabler	enabler	barrier
It's always their problem	Specific people own the ambition	Everyone has skin in the game	It's always someone else's problem

Resources (Financial/People)			
barrier	enabler	enabler	barrier
Insufficient resources to finish	Sufficient resources to be agile	Additional resources to be proactive	Inefficient use of resources

Innovation Culture			
barrier	enabler	enabler	barrier
Innovation becomes a side of desk task	It's everyone's role to be innovative	Core team live and breathe innovation	Innovators are bottlenecks to innovation

Organizational Leadership			
barrier	enabler	enabler	barrier
Too little leadership	Empowers the team	Present and engaged	Too much leadership

Systems and Processes			
barrier	enabler	enabler	barrier
Lacking structure	Guided by sufficient guard rails	Supportive of everything we do	Too much paperwork

Collaboration			
barrier	enabler	enabler	barrier
Selective decision making	One mind engaging diverse people	Diverse minds working on one goal	No accountability

Stakeholder Engagement			
barrier	enabler	enabler	barrier
Distant decision making	Informed at key intervals	Collaborative with shared ownership	Involved at a level that isn't valuable

Time			
barrier	enabler	enabler	barrier
Rushed work	A sense of urgency	Sufficient time to do things properly	Slow and unnecessary

Vision			
barrier	enabler	enabler	barrier
More of an idea	Clear and simple	Detailed and comprehensive	Difficult to follow

Skills / Knowledge / Experience			
barrier	enabler	enabler	barrier
Don't know what you don't know	Fresh talent with new perspectives	Experts in the right place and right time	Been there done that

Incentives			
barrier	enabler	enabler	barrier
No reason to innovate	Intrinsic reasons to innovate	Extrinsic reasons to innovate	Money solely drives innovation

Planning			
barrier	enabler	enabler	barrier
Lack of clarity	Focus on milestones and outcomes	Planning sufficient detail	Analysis paralysis

Openness to change			
barrier	enabler	enabler	barrier
If it's not broken, don't fix it	Targeted improvement	Continuous improvement mindset	Change fatigue

Phase 3 – Task 2	**Identify Enablers**
Task	Choose 3 actions and 3 attributes for each action. Use the enablers to refine how these actions will be executed.
Outcomes	Fill in the table with the action at the top, 3 enablers in the middle, and the refined action at the bottom.

Actions and Attributes Tool:

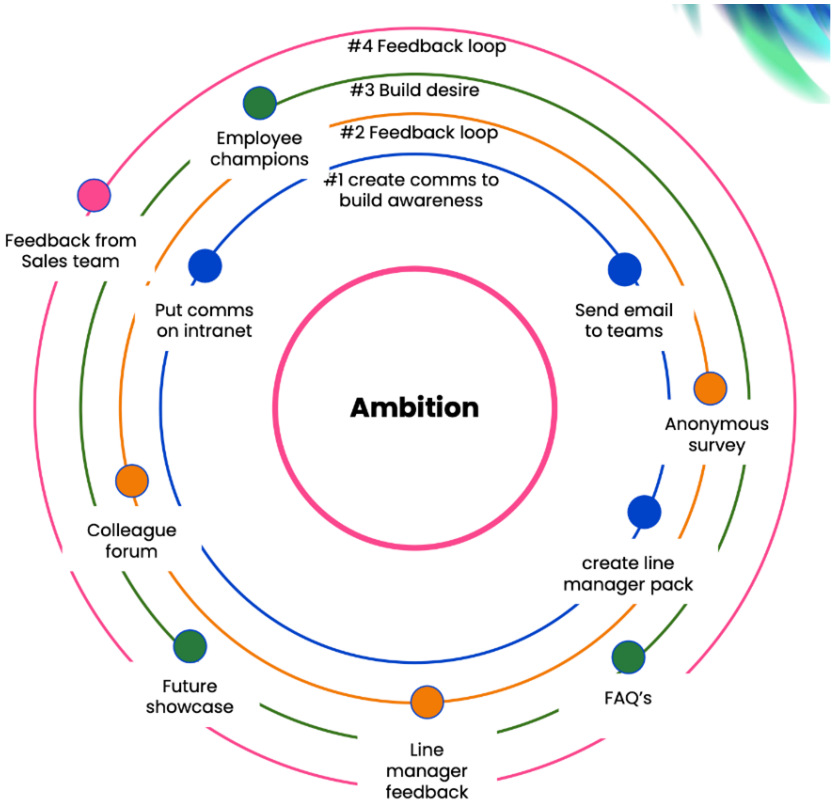
Actions	Action 1	Action 2	Action 3
Attribute 1			
Attribute 2			
Attribute 3			
Refined Action			
Reflecting on the attributes' barriers			
(guard rails) watch outs			
Final refined action			

Phase 3 – Task 3	**Counter-balance the Barriers**
Task	For each refined action, identify the highest-risk barrier (e.g., "loudest voice wins") and determine how to overcome it.
Outcomes	Add a final box at the bottom of the enablers table to outline the barrier and how to balance it.

Actions and Attributes Tool + Refinement + Enablers:

Actions	Action 1	Action 2	Action 3
Attribute 1			
Attribute 2			
Attribute 3			
Refined Action			
Reflecting on the attributes' barriers (guard rails) watch outs			
Final refined action			
Enablers			

Phase 4 – Task 1	**Putting it all Together**
Task	Prepare your pitch by filling in the framework based on the outcomes of the previous exercises.
Outcomes	Develop your action-to-ambition framework.



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