



# Innovation for the Future of Nuclear Energy – A Global Forum

Gyeongju, Korea  
June 10-12, 2019

JUNE 10-12 2019  
GYEONGJU SOUTH KOREA

**BREAK DOWN BARRIERS**  
**ACT NOW**

**BRIGHT FUTURE**

**TECHNOLOGY & INNOVATION**

**CLEAN energy**  
**Safe & TRANSPARENT**

A.I. ✓ **TECHNOLOGY & PROCESS INNOVATION**  
A.R.

**INNOVATION FOR THE FUTURE of NUCLEAR ENERGY**

TRANSPARENCY  
CO-OPERATION  
SUPPORT  
**WHAT IS OUR LEGACY?**

OUR JST

23 PLANTS

26 PLANTS

ON TIME  
ON BUDGET

✓ **CONVERGENCE**

✓ **COMMUNICATION with PUBLIC**



**JAE HOON CHUNG**  
PRESIDENT - CEO KHNP

**NEIL WILMSHURST**  
VICE PRES. EPRI

**YOUNG JOON JOO**  
DEPUTY MINISTER  
MIN. TRADE, INDUSTRY  
& ENERGY

WHY WILL PEOPLE JOIN

IMAGE

LETTING GO OF THE PAST

KOREAN ECONOMY

**Why Not US?**

**WE COLLABORATE WELL**

LET'S TALK POSITIVELY

THE STORY OF **INNOVATION**

- 1978
- 1. NUCLEAR SAFETY
- 2. ECONOMIC FEASIBILITY
- 3. DISPOSAL OF NUCLEAR RESIDUAL

HOW CAN WE COME TOGETHER TO RE-DEFINE THIS INDUSTRY?

WE ARE VERY NIMBLE

IS THAT PROJECTION GOOD ENOUGH?

ADDRESS CLIMATE CHANGE

IS IT GOOD ENOUGH?

WHAT WOULD GRETA SAY?

PRO NUCLEAR

CO<sub>2</sub> REDUCTION

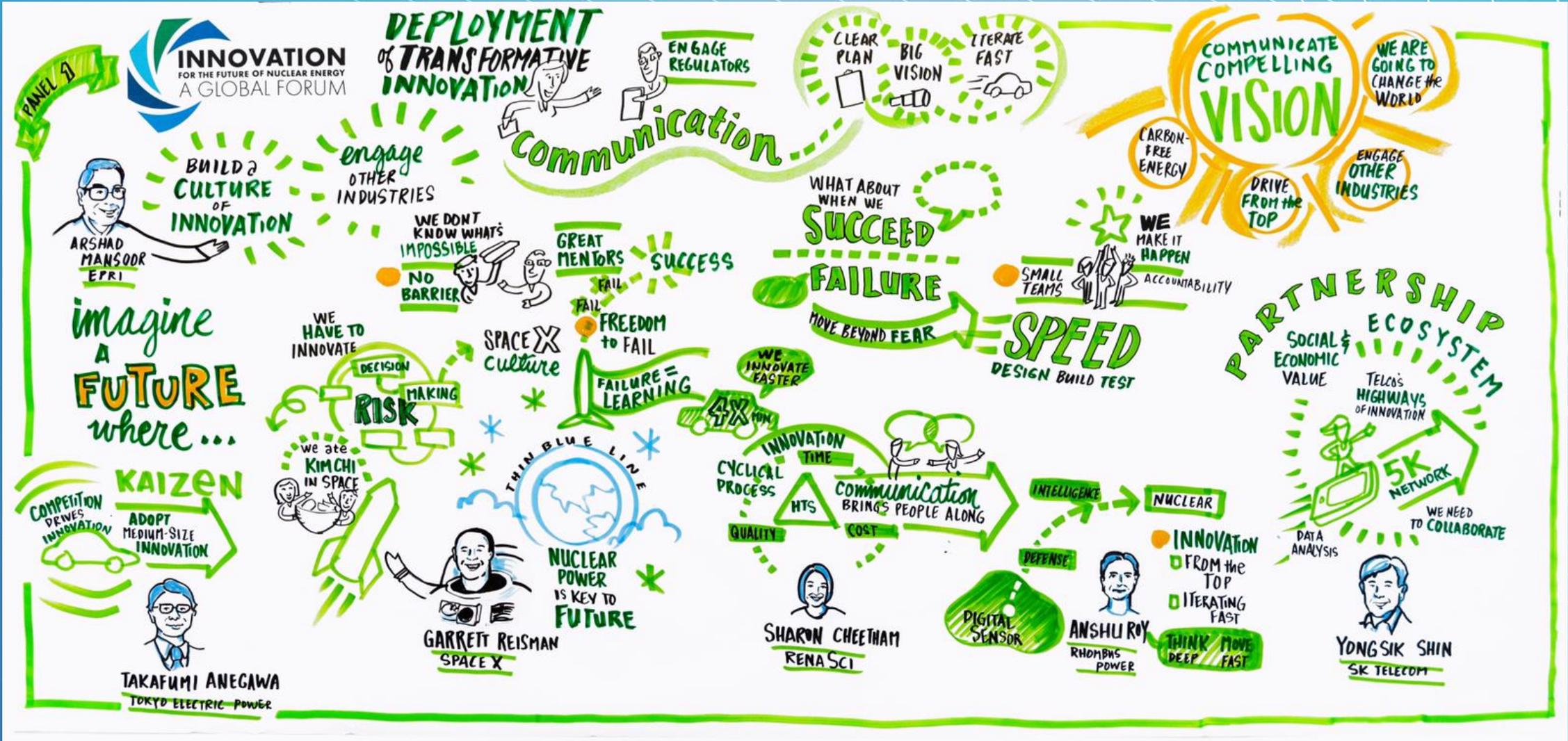
DECARBONIZATION

DIGITAL CONTROL ROOMS

HOW LONG WILL IT TAKE?

TEAM HANSON • THINKER 132 • ART OF ANIMATING

# Welcome, Opening Remarks, and Keynote



# Deployment of Transformative Innovation – Sharing Across Sectors

**PANEL 2**

**TRANSFORMING NUCLEAR FOR OUR FUTURE**

CONTINUOUS IMPROVEMENT  
**look beyond...**

GOOD QUESTIONS  
**SPARK INNOVATION**



**FRED DERMARKER**  
CANAD GROUP

**SAFETY**

PRA QUALITY

**FUTURE**

**GAP**  
POPULATION  
CURRENT



**MASAYUKI YAMAMOTO**  
TEPCO

MAKE INNOVATION AS IMPORTANT AS DAY TO DAY...

UNDERSTAND NEEDS  
FOCUS ON BIGGER INITIATIVES  
**Share INFORMATION**

**ACT NOW**  
AUTONOMOUS OPERATION

FLEXIBLE POSITIVE  
**Self-Reliance**  
NUCLEAR INDUSTRY  
ACCEPT CHANGE

DECISION MAKING

WHAT'S POSSIBLE DIGITAL  
DIGITAL POWER PLANT  
BIG DATA



**SHIN WHAN KIM**  
KEPCO ENGINEER'S

NUCLEAR-RENEWABLE HYBRID ENERGY SYSTEM

HOW TO GET PEOPLE TO **embrace CHANGE?**



LEADER  
IT'S MY JOB TO INFLUENCE & DRIVE CHANGE

VISION OF FUTURE

INNOVATION CREATES HAPPINESS

WE NEED HELP:  
MULTI-SCALE MONITOR INSTRUMENTATION  
A-I  
LEADERS



EXPERT



**ABDERRAHIM AL MAZDUZI**  
NUGENTIA

COLLABORATION

COMMUNITY  
ENGAGE REGULATORS  
CONVERSATIONS

**TECHNOLOGY**

ENGAGE WITH REGULATORS  
BUILD ON REGULATIONS  
INNOVATE TOGETHER WITH US

**REGULATORS**

HOW DO YOU BRING R.O.I. INTO SOMETHING NOT DONE BEFORE

**INNOVATION VELOCITY**

HOW OFTEN DO YOU SEE INNOVATION INTEGRATED INTO everything



**JASON WIGHT**  
PNCS - ONTARIO POWER

IS IT PHYSICS... OR IS IT ME?



TIM HAMONS + JIHYUN LEE  
ART OF AWAKENING

MAKE IT EASY FOR PEOPLE TO INNOVATE  
SAVE THE WORLD



CONNECT WITH THE ECOSYSTEM

PURPOSE ECOSYSTEM

QUALITY PROCESS ENTERPRISE LOCAL



# PANEL 4 INNOVATION FOR THE NUCLEAR SECTOR

JUNE 10-12 2019 GYEONGJU, S. KOREA

TAKE A RISK... IT ALWAYS PAYS  
MAKE the VISION A Reality



FIONA RAYMENT  
NUCLEAR INNOVATION & RESEARCH

HOW CAN REGULATORS ENCOURAGE INNOVATION

REGULATORS  
NEW RELATIONSHIP WITH  
MORE STANDARDIZIN



TECHNOLOGY FOR HUMANITY  
CARBON-FREE AFFORDABLE energy

ASK THE RIGHT QUESTIONS

BRING PEOPLE INTO THE INDUSTRY

SIMPLE THINGS WE CAN DO...

MORE YOUNG PEOPLE  
WORK OUTSIDE THE INDUSTRY

COMMUNICATION  
ONBOARDING + EDUCATION

PUBLIC PERCEPTION

COLLECTIVE KNOWLEDGE

EXPERIENCE

WHAT ARE WE DOING WITH IT?

HIGHER EDUCATION  
CASE STUDIES DOCUMENTATION

COMPETENCE

OPERATIONAL MAINTENANCE

TECHNICAL & MANAGERIAL

WHAT'S RELEVANT

USE DATA  
SAVE MONEY

TRAINING

GENDER DIVERSITY

MOTHERS FOR NUCLEAR

KEEP NUCLEAR COMPETITIVE ATTRACTIVE

LOOK AT QUESTIONS A DIFFERENT WAY

TECHNOLOGY SCOUTS

UNIVERSITIES

HOW TO KEEP NUCLEAR COMPETITIVE RELEVANT?

HOW TO GET TO WORK TOGETHER



GOVT PRIVATE SECTOR

SMALL MODULE REACTORS ARE THE FUTURE

WILLIAM D. MAGWOOD IV  
NUCLEAR ENERGY AGENCY

EARLY DETECTION & DIAGNOSIS



YUNHO KIM  
KHNP

OPTIMIZE DESIGN

CONSTRUCTION

DIGITAL TWIN

COST

HOW CAN WE BRING IT DOWN

REDUCE DISCRIMINATION

WORK WITH SCHOOLS + TEACHERS

TECHNOLOGY PARTNERSHIPS



JEFFREY MERRIFIELD  
PILLSBURY WINTHROP SHAW PITTMAN LLP

SMALL FIND THE RIGHT & NOT ALL INNOVATIONS ARE WORTH DEVELOPING



PATRICK MORILHAT  
EDF FRANCE

EVERYTHING WE DO IS ABOUT INNOVATION



NEIL WILMSHURST  
EPRI

OUR ROLE: REDUCE COSTS

INVITE PEOPLE TO THE INDUSTRY

TIM HAMONS  
JHYUN LEE

ART-OF-AWAKENING



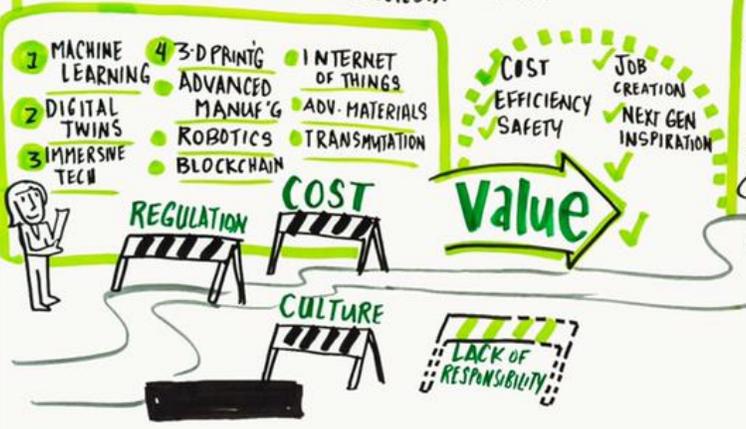
# Innovation in the Nuclear Sector

JUNE 10-12 2019  
GYEONGJU, SOUTH KOREA

# REGULATOR PERSPECTIVES ROUND TABLE



TIM HAMONS + JIHYUN LEE  
ART OF AWAKENING



**SMALL GROUP DISCUSSION INSIGHTS**

**FRAMEWORKS**



Gather together TO RE-INFLUENCE VALUE

PURPOSE

VALUE

**LEADERSHIP & CULTURE, COLLABORATION**





# ACTIONS to DEPLOY INNOVATION



# Top 4 Innovations

1. **machine learning** to make better use of the 'big data' already available in the nuclear power sector for optimizing maintenance;
2. **using more innovative frameworks** for information exchange, to share data on research and development, operations and maintenance
3. **digital twinning** (the virtual recreation of a process into a computer-based model) to improve NPP performance and to reduce costs
4. **advanced manufacturing**, including 3D printing, to address supply chain challenges

# Top Innovations from Each Category

<b>Technology</b>	<b>Framework</b>	<b>Culture and Leadership</b>
Machine Learning / Big Data	World wide transition from the linear no-threshold model	Accepting failure. Learning from failure.
Digital Twins	Global supply chain coupled with financial framework to reduce costs and improve efficiencies	Provide budget and resources.
Immersive Technologies	Coordinated, multi-lateral risk-informed regulatory approval process	Develop commitment and strategy
Advanced Manufacturing / 3D Printing	Frameworks to share comparable, reliable data - R&D, operations, maintenance	Improve diversity

“Now this is not the end. It is not even the **beginning** of the end. But it is, perhaps, the end of the **beginning**.”

-- Sir Winston Churchill

# Top 12 Innovations

# Top 12 Innovations that Were Ranked

- Machine learning/big data
- Digital twins
- Advanced manufacturing
- Immersive technologies
- Worldwide transition from the linear no-threshold model
- Framework to share comparable, reliable data – R&D, operations, maintenance
- Clean Energy Centers integrating nuclear and renewables
- Coordinated, multi-lateral risk-informed regulatory approval process
- Accepting / Learning from Failure
- Develop Commitment and Strategy
- Provide Budget, Resources
- Improve Diversity

# Machine learning/big data

## Examples:

- Replace reactor operator
- Automation of processes
- Predictive maintenance
- Guiding regulatory inspections

## • Key Benefits:

- Operator efficiency
- Safety improvement
- Improved reliability
- Cost savings

## • Technology Readiness:

- High – Technology mature and used in other industries

## • Key Stakeholders:

- Supply chain
- Regulator
- Plant operator
- Vendor

# Digital twins

## Examples:

- Plant/sub-components/systems
- Fuel and waste casks
- Operating parameters
- Training/education applications

- Key Benefits:
  - Operational efficiency
  - Safety improvement
  - Cost savings
  - Public acceptance
  - Improved reliability
- Technology Readiness:
  - Medium – Technology ready for first use
  - High – Technology mature and used in other industries
- Key Stakeholders:
  - Supply chain
  - Regulator
  - Plant operator
  - Vendor

# Advanced manufacturing

## Examples:

- HIP
- Electron beam welding
- Component modularization and standardization

- Key Benefits:
  - Cost savings
  - Reduced inspections e.g. no welds
  - Fabrication speed
  - Reliability
- Technology Readiness:
  - Medium – Technology ready for first use
  - High – Technology mature and used in other industries
- Key Stakeholders:
  - Regulator
  - Plant operator
  - Vendor
  - Supply chain

# Immersive technologies

Virtual reality, augmented reality

Examples:

- Maintenance
- Training
- Design validation

- Key Benefits:

- Improved engagement – fun!
- Cost savings
- Improved communication/knowledge transfer
- Environmental impact (less travel)

- Technology Readiness:

- High – Technology mature and used in other industries

- Key Stakeholders:

- Supply chain
- Regulator
- Plant operator

# Worldwide transition from LNT model

- Endorsed by the World Health Organization
- Right-size emergency zones and precautionary actions

- Key Benefits:
  - Operational efficiency / cost reduction
  - Safety Improvement
  - Enhance public trust
- Technology Readiness:
  - Medium – Framework developed with few use cases
- Key Stakeholders:
  - Legislator
  - Regulator
  - Utility
  - Vendor
  - Research Organizations

# Framework to share comparable, reliable data – R&D, operations, maintenance

- Builds international database of operating data to enable AI and advanced analytics
- Optimizes operations and maintenance
- Decreases uncertainties in risk assessment
- Key Benefits:
  - Operational efficiency / cost reduction
  - Safety Improvement
- Technology Readiness:
  - Medium – Framework developed with few use cases
- Key Stakeholders:
  - Regulator
  - Utility
  - Vendor
  - Research Organizations
  - International organizations

# Clean Energy Centers integrating nuclear and renewables

- Positions nuclear as a clean-energy enabler in public perception
- Advances integrated energy systems
- Sustains nuclear technology as an option
- Key Benefits:
  - Enhance public trust
- Technology Readiness:
  - High – Framework well developed and used broadly in other industries
- Key Stakeholders:
  - Utility, grid operator
  - Vendor
  - Research Organizations

# Coordinated, multi-lateral, risk-informed regulatory approval process

- Increases regulatory certainty in export markets to underpin business case and financing
- Accelerates global deployment of innovations

- Key Benefits:
  - Operational efficiency / cost reduction
  - Enhance public trust
  - Regulatory efficiency
- Technology Readiness:
  - Low – Conceptual Framework
- Key Stakeholders:
  - Regulator
  - Utility
  - Vendor
  - Research Organizations
  - International organizations

# Accepting / Learning from Failure

- Success for this innovation is to change behaviour and recognize that innovation involves learning from failures. Leaders expect some failures in innovation.
- Key Benefits:
  - Deploy innovations more effectively or faster
  - Reduce cost / increase efficiency
  - Ability to attract and retain top talent
- Organizational Readiness:
  - Low – May need substantial shifts in culture, organizations or relationships; Resistance expected
- Key Stakeholders:
  - Regulator
  - Utility
  - Vendor
  - Research Organizations

# Develop Commitment and Strategy

- Success for this innovation is for employees to understand the importance of innovation and where to focus their innovation efforts.
- Key Benefits:
  - More diverse set of views (stimulate innovation)
  - Deploy innovations more effectively or faster
  - Enhanced safety / reduced uncertainty
  - Reduce cost / increase efficiency
  - Forward-looking industry leadership
  - Ability to attract and retain top talent
- Organizational Readiness:
  - Medium – May need moderate shifts in culture, organizations or relationships; Willingness is country-specific
  - High – Small changes to existing culture, organizations or relationships; Strong willingness for change globally
- Key Stakeholders:
  - Regulator
  - Utility
  - Vendor
  - Research Organizations

# Provide Budget, Resources

- Success for this innovation is to provide adequate space and tools for innovation to be pursued such that innovators are energized.

- Key Benefits:
  - More diverse set of views (stimulate innovation)
  - Deploy innovations more effectively or faster
  - Enhanced safety / reduced uncertainty
  - Reduce cost / increase efficiency
  - Forward-looking industry leadership
  - Ability to attract and retain top talent
- Organizational Readiness:
  - Medium – May need moderate shifts in culture, organizations or relationships; Willingness is country-specific
- Key Stakeholders:
  - Legislator
  - Regulator
  - Utility
  - Vendor
  - Research Organizations

# Improve Diversity

- Success for this innovation is to extend diversity to experiences and educational background, especially in recruitment practices and team building.

- Key Benefits:
  - More diverse set of views (stimulate innovation)
  - Reduce cost / increase efficiency
  - Forward-looking industry leadership
  - Ability to attract and retain top talent
- Organizational Readiness:
  - High – Small changes to existing culture, organizations or relationships; Strong willingness for change globally
- Key Stakeholders:
  - Legislator
  - Regulator
  - Utility
  - Vendor
  - Research Organizations

# Lists of All 28 Innovations

# Innovations - Technology

- Machine learning/big data
- Digital twins
- Immersive technologies
- 3D printing
- Advanced manufacturing
- Robotics
- Blockchain
- Internet of Things
- Advanced materials
- Transmutation

# How can frameworks that help boost innovation be designed?

1. Worldwide transition from the linear no-threshold model
2. Global supply chain coupled with financial framework to reduce costs and improve efficiencies
3. Coordinated, multi-lateral risk-informed regulatory approval process
4. Framework to share comparable, reliable data – R&D, operations, maintenance
5. Coordinated, global nuclear technology public engagement campaign, including early-years education and new technologies
6. Global innovation sharing portal
7. Framework to share the risk of innovations at national and international levels
8. Consider opportunities to coordinate/enhance dialogue between INPO/WANO and safety authorities
9. Budgetary funding process for nuclear regulatory organizations (US/Canada)
10. Clean Energy Centers integrating nuclear and renewables

# Innovations – Culture, Leadership & Collaboration

1. Foster an organizational culture of accepting and learning from failure [**culture**]
2. Leaders should grant sufficient time, budget, and resources for workers to innovate [**culture/leadership**]
3. Senior Leaders should develop a high-level commitment and strategy for innovation [**leadership**]
4. Designate 'innovation leaders' in the organization that report to institutional leadership or utilize dedicated teams that pursue innovative projects with clear scope [**leadership**]
5. Innovation activities should not be subject to the same hierarchical structure as operations [**leadership**]
6. Educate leaders on techniques and tools for leading innovation – leaders to set the stage, not have all the answers [**leadership**]
7. Improve on diversity beyond the traditional sense, including diversity of thought, experience & education [**collaboration**]
8. More effectively utilize information sharing platforms to accomplish shared objectives between institutions and international organizations [**collaboration**]