BUILDING A NEW SAFETY CONSTRUCT FOR ENERGY: BRINGING THE SOCIO-POLITICAL FACTORS TO BEAR
Marc’s disclaimer

- The following slides are my opinion and do not represent the opinions of ASME or any other organization that I belong to or represent. The thoughts are my own.
• Billions of people
• Limited, fragile resources
• Poverty and hardship
• Urban growth

World Challenges

• More complexity in integrated systems
• Aging infrastructure
• Aging energy workforce

Image Source: National Geographic (Interactive: Where and How We Live, 2009)
• Half of world’s population already live in urban areas

• 2.6 billion lack basic sanitation

• 1.3 billion lack access to clean water

• 1.4 billion lack access to electricity
Here’s the problem

Getting clean energy to all the world
Population Growth by 2025

World Urbanization Prospects, the 2009 Revision
Figure 3: Urban and rural population by development regions (in millions)

- Less developed regions: Urban Areas
- Less developed regions: Rural Areas
- More developed regions: Urban Areas
- More developed regions: Rural Areas

Sources: United Nations, Department of Economic and Social Affairs, Population Divisions, World Urbanization Prospects, the 2009 Revision, New York, 2010
Global Trends

• Energy more widely traded
  – LNG, oil, refined products, coal

• Energy technology more widely dispersed and more rapidly adopted

• Desire for energy consuming devices increasing

• Engineering more widely practiced and shared

• ASME standards and certification more international

• Energy and security are linked
More Livable Cities = Competitive Commerce

Clean, resilient, accessible energy

- **Revolutionize** electricity production
- **Reinvent** transportation
- **Transform** infrastructure
- **Promote** sustainable industry
- **Empower** innovation
Clean, Resilient, Accessible

- Diverse, technically sound energy choices
- Designing for low-probability events
- Risk-informed, performance-based approach to an enhanced safety culture
- Active standards development on a global scope
Electrical Energy Disrupters?

- New technology, materials and applications
- Integrating into the smart grid
- Storage
- Climate and water
- Scale matters
The Engineers’ Energy Challenges

• Revolutionize electricity production
• Reinvent transportation
• Transform infrastructure
• Promote sustainable industry
• Empower innovation
Engineering is the only profession that can:
• Design complex systems efficiently
• Construct, maintain and operate
• Understand system vulnerabilities
• Identify and quantify threats
• Reduce the probability of failure, and
• Mitigate the consequences of failure
• Do so economically
Role of the Engineer

- Asking the right questions
- Thinking critically about solutions
- Expanding socio-political dialogue
- Using resources wisely
- Balancing the energy portfolios globally
- Making energy production, transportation, delivery and use safer
- Advocating and responding globally to energy strategies
- Building public trust in technology
Guiding Principles

Engineers uphold and advance the integrity, honor and dignity of the engineering profession by

— Using their knowledge and skill for the advancement of human welfare

— Being honest and impartial, and serving with fidelity the public, their employers and clients...

— ASME Code of Ethics
Vision of the Future

- Balance of energy technologies
- More complexity in integrated systems
- Scale matters
- All risks considered — including rare yet credible events

✓ Sustainable, risk managed, complex systems improving human quality of life
Energy Technology — Fact or Fiction?

• Natural gas — Can natural gas meet all our energy needs?
• Smart grid — Need it? Want it?
• Renewables — Will they do it all? Without environmental damage?
• Climate change — Will it go away?
• Zero risk — Is there such a thing?
• Can we live with coal and nuclear power?
What Drives Power Supply Balance Requirements?

- Reliability
- Cost
- Environment

Weather
Water
Technology

Risk
Workforce Knowledge
Scale

Growth

- Human needs
- Quality of life
- Sustainability
Ask the Right Questions

• Should anything ever be designed without sustainable values?
• Which risk factors get priority?
• How far is enough?
  – Going beyond the design basis
  – Going global
• What are the appropriate risk metrics?
• What can be done to reduce fear?
• What are the right time frames for solutions?
Nuclear Power’s Role in Balanced Supply

• Projected value based on historical performance
  – Low carbon emissions
  – Low long-term fuel cost
  – Base-load power
  – Small comparative land use
  – Long term lower cost risk (up-front high, then done)

• Sustainable resource depending on technology
• Diversifies environmental impact
“The future is inherently uncertain and always will be.”

— Energy Technology Perspectives 2010
“Managing the risks of climate change will require a profound systematic and global transformation in the production and consumption of energy.”

— Global Energy Technology Strategy Program
Sustainability =
✓ Future generations
✓ Connectivity (people-centered)
✓ Livable, vibrant cities
✓ Appropriate, technically sound technology
Engineering Technology Goals in the Energy Value Chain

Revolutionize  Reinvent  Transform  Promote  Empower
Thinking Outside the Nuclear Box

• For example, fewer if any land telephone lines in Africa

• No more slide rules
The Nuclear Box

Large Light Water Reactors
Thinking Outside the European Box

- Fear of Chernobyl-type event
- Less/more fear of Eastern European/Asian natural gas
- Long-term acceptance of middle eastern oil
- More understanding of extended electrical power outage impacts
- Optimism about renewables
- Political euphoria around current natural gas prices
Is there an Outside-the-Box?

• Sure is!!

• We already have small:
  – gas-cooled reactors
  – heavy water reactors
  – light water reactors
  – Reactors using other coolants, neutron speeds, etc.

• We don’t have:
  – Modular
  – Digital
  – Standardized
  – Publicly trusted
Outside the Box

We are —

• Already there internationally
• Not there from a regulatory perspective which is “one size fits all”
• Not innovating as we are risk inhibited
• Changing the social construct but not the mental construct
• Not balancing power source design criteria
• Not balancing power supply with no energy supply
• Looking at history — to not repeat it — but we aren’t learning from it
What’s Outside-the-Nuclear Box?

• Different coolant (gas, heavy water, liquid metal, molten salt)

• Different fuels and neutron speeds (Fast vs. thermal, Thorium, U-238, Pu-239, enrichment or MOx)

• Different scales or size (SMR vs. 1200MWe)

• Different financial criteria (affordability $/KW vs. Total Project Cost [$])

• Different risk profiles for different events
## Out of the Box Today

### Operating

<table>
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<tr>
<th>Name</th>
<th>Capacity</th>
<th>Type</th>
<th>Developer</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNP-300</td>
<td>300 MWe</td>
<td>PWR</td>
<td>CNNC, operational in Pakistan</td>
</tr>
<tr>
<td>PHWR-220</td>
<td>220 MWe</td>
<td>PHWR</td>
<td>NPCIL, India</td>
</tr>
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</table>

### Under Construction

<table>
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<tr>
<th>Name</th>
<th>Capacity</th>
<th>Type</th>
<th>Developer</th>
</tr>
</thead>
<tbody>
<tr>
<td>KLT-40S</td>
<td>35 MWe</td>
<td>PWR</td>
<td>OKBM, Russia</td>
</tr>
<tr>
<td>CAREM</td>
<td>27 MWe</td>
<td>PWR</td>
<td>CNEA &amp; INVAP, Argentina</td>
</tr>
<tr>
<td>HTR-PM</td>
<td>2x105 MWe</td>
<td>HTR</td>
<td>INET &amp; Huaneng, China</td>
</tr>
</tbody>
</table>

Source: WANO
Nuclear Safety Construct

• Design for very low-probability events

• Socio-political and economic consequences are unacceptable

• Safety principles are universally applicable — a global safety construct is needed to ...

build public trust
Change the Safety Culture

• More robust
• Flexible
• High assurance in Emergency Preparedness systems

Like scales on a sailfish —

• Powerful protection
• Great flexibility
• Fulcrum for safety, mobility and speed
Respond to Failures

• *Initiative to Address Complex Systems Failure: Prevention and Mitigation of Consequences*, published June 2011 by ASME ...and follow up

• Forum on Disaster Prevention and Mitigation, at the Sino-American Technology & Engineering Conference 2012

• Continued forums for further discussion
“Give me a place to stand, and I will move the Earth.

— Archimedes

A new safety culture based on a risk-informed, performance-based approach
Risk-informed Performance-based Approach for Emergency Preparedness

• Regulations based on best-available science
• Predictability promoted
• Uncertainty reduced
• Innovative tools to achieve regulatory ends
• Quantitative and qualitative benefits and costs
• Large socio-political and economic impacts
Studying Failures — Students “Get It”

- Both technical and social implications
- Special design needs
- Hidden and incidental interactions
- Small failures cascade in nonlinear responses
- Complexity
- Lifelong learning
- Global perspective
Re-envisioning the Engineering Safety Culture

• Integrating risk management
• Carrying “lessons learned” into design practice and education
• Building trust — through global unity in learning and advocacy
• Continuing discussion on ethics
Energy Engineering in a New Europe

• Using resources that are locally appropriate
• Designing new technology
• Reinventing safety across the energy regulatory compact & borders
• Reducing cost and risk in the same equation
• Creating independent fuel sources
• Understanding long term regional and global environmental and security impacts
Engineers Bringing the Socio-political Factors to Bear

• Energy
  – Understanding the long life of power plants and the impact of fuel price forecasts
  – Reconstructing the energy regulatory compact
  – Rebuilding nuclear affordability
  – Innovating across the energy portfolio

• World and the New Europe
  – Recognizing quality of life is dependent on energy
  – Bringing engineering knowledge to the public
  – Building public trust
You shape the future.
THANK YOU!

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ASME Immediate Past President

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