Crafting Operational Resilience in Nuclear Domain (CORE)

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Project activities

- Learning from successes
- Work-based learning
- Supporting distributed cognition
- Supporting stress mgmt
- Severe accident mgmt
- HUMTOOL
CORE themes in terms of capabilities of operational resilience

- Learning
- Anticipating
- Responding
- Monitoring

- HUMTOOL
- Learning from successes
- Self-reflection
- Operator stress
- Multitasking
Learning from successes
Learning from successes - Rationale

- Increasing emphasis has been put on the contribution of successful activities on safety
  - E.g., Resilience Engineering, “Safety-II” principle

- Some potentially relevant, practical reasons to focus on successes:
  - Understanding successes can reveal the factors that ensure system performance in both expected and unexpected situations
  - Understanding successes can avoid complacency and organization drift
  - Understanding successes can provide a huge amount of additional information to that provided by accident/incident investigations
Learning from successes -
Insights from empirical studies

- There has been genuine interest towards the idea of learning from successes among NPP personnel
- A variety of potentially useful practices or forums for learning from success already exist, including:
  - Informal “corridor talks”
  - Casually discussing successful experiences in periodic group meetings
  - Noting positive aspects during event-investigation meetings
  - Encouraging to bring up successes in post-job reviews or feedback meetings

- HOWEVER, while some existing practices do acknowledge/document successes,
  - Successes are rarely profoundly analysed, or
  - Successes are shared locally among teams or pairs
    - Actual lessons might not be effectively generated
    - Ineffective organizational learning may result
    - Knowledge might be lost in turnover or organizational changes
Learning from successes
- Development of tools

- To address the potential shortcomings in learning from success, we have developed
  - Tools and principles to **identify and generate** lessons from successful experiences, and
  - Tools and principles to facilitate the **acquisition and sharing** of lessons learned from successes from/to others

- A set of **guidelines** has been developed regarding learning from successes
  - Proposes eight **basic principles** that should be considered when promoting learning from successes
  - Proposes a **generic process** for performing an analysis of successes
    - E.g., who to involve and how to organize the analysis, what steps are recommended to go through and examples of guiding questions for each step

- Further tools are under development...
Work-based learning development
Identified shortcomings in operator training

- No possibilities to observe colleagues in one’s own tasks
  - not sufficient dissemination of good work practices
- Uncertainty about sufficient “routine” for handling emergencies
  - not enough simulator training opportunities
- Uncertainty about developing problem-solving capabilities
  - simulator training focusing on procedure execution
- Mostly top-down approach to training in which operator specific needs and wants are ignored
  - Operators and their know-how not the source of new learning sufficiently
Self-reflection method for operator training

- Aims for method:
  1. **Self-evaluation**
     - thinking and writing about one’s own simulator performance by structured criteria
  2. **Group reflection**
     - team discussion on simulator performance
  3. **Dissemination of good practices**
     - discussion between shifts

- Preliminary findings about the method:
  - Operators seemed positive about it: “could be actualized after some training sessions”
  - Has been taken into testing even without researcher presence
  - Lively discussion within the shifts emerged about safety-relevant themes
    → plant dynamics, stress, collaboration and use of procedures
We assessed human contribution in the current safety management system in nuclear industry.

We modified and tested a Human Factors (HF) tool as an investigation method in operative event (OE) analysis of nuclear industry.

Contents of HF Tool:

- **Individual factors and actions**: 12 items, e.g. mastery of work, cognitive factors, motivation.
- **Work characteristics**: 10 items, e.g. time pressure, work environments, system usability, procedures.
- **Organizational factors**: 8 items, e.g. co-operation between units, mutual understanding, resources.
- **Group/team factors**: 7 items, e.g. shared situational awareness, communication, mutual support.
HUMTOOL – Highlights (2)

- We have found that:
  - OEs are mainly handled from technical aspects
  - Humans are usually regarded as a source of errors
  - There is a need for more concrete and holistic HF-tools and models, representing
    - macro-ergonomics and a new paradigm
    - positive safety thinking (Safety-II), supporting safety promotion and co-operation among nuclear stakeholders

- While testing the tool we found that:
  - New HF tool offered a more accurate picture of the HFs affecting OEs
    - moving focus from individual errors to all layers of system safety
  - HF tool focused on successes and the factors that maintain safety
  - HF tool offered learning potential for safety improvements
  - Users found the HF tool clear and easy to use and useful for OE investigation
Supporting operational resilience
 Interruptions in operator work
(Example: LOCA at training simulator)
Some key findings regarding interruptions

- Tasks that were frequently interrupted:
  - Procedure reading and execution: 30%
  - Process monitoring: 20%
  - Process control (panels & desks): 7%

- Operators typically reacted immediately to interruptions
- Operators tried to avoid multitasking in procedure execution: they accomplished each procedure path from the beginning to the end without moving to the next one

![Disturbing factors chart]

- Requests: 1.5
- Background conversation: 1.5
- Phone conversation: 1.5
- Alarm sounds: 2.5
- SS notifications: 1.5
- Phone rings: 1.5
Some recommendations for interruption mgmt

1. Proper communication etiquette should be introduced
2. Irrelevant speech and noise should be minimized
3. Workplace should be made more resistant to interruptions
4. Task boundaries are suitable points for interruptions
5. User-controlled multitasking should be facilitated
6. If the interruption could not be avoided, users should be warned beforehand
7. Users should be trained to avoid interruptions
8. Cues could be delivered reminding about the previous task’s status in order to help recovery from an interruption
Stress management
Operator stress in simulated incident and accident scenarios

- **Stress affects performance**
  - Sensory systems, attention, memory, problem solving
  - Changes team dynamics: communication, decision making and situation awareness
  - The higher the stress level, the more detrimental the effects -> debilitating effects are more likely in crisis situations

- **The need for objective stress measures**
  - Sensitivity to perceive and become aware of one’s stress varies between individuals and situations (e.g., work cultures) due to differences in motivation, attention and memory
  - Querying stress levels interrupts the task and may insert bias

*Stress is a physiological state ensuring our survival, prepares for "fight or flight"
Operator stress in simulated incident and accident scenarios

- **Research questions**
  - What is the stress level of the operator during incident and accident scenarios?
  - Does the experienced stress match the physiological state i.e. the physiological stress response of the operator?
  - Does the operator instructor’s evaluation of stress match with the experienced and measures stress?

- **Stress measurements in training simulator:**
  - Three scenarios (routine testing, fire, radioactive steam leakage), normal operation, and baseline measurements (before and after scenarios)
  - 6 crews, with 3-4 operators each
  - The physiological stress response was measured with skin conductance and cardiac sensors
  - Perceived stress (operators)
  - Predicted load (operator instructors)
Operators do experience stress during simulated scenarios.

Stress is highest for the events with a possible radiation risk, moderate for the routine testing, and the lowest for normal operation and baselines.

Operators’ perceived stress is not always in line with the physiological stress response. Possibly due to individual differences in their sensitivity to perceive and ability to accurately report the stress at different phases of simulations.

Simulator instructor can predict the overall stressfulness of the different scenarios. Temporal resolution is limited.

- Physiological measurements of stress produce detailed information on the individual’s stress at different time points, without interfering with the primary task.
- Information may be more reliable as it is not dependent on participants’ memory for the events and not biased by interpretations, reasoning or motivational issues.
Conclusion
There is increasing evidence that tools/practices/guidance/interventions/procedures for

1) gathering positive operating experiences from challenging operational situations
2) promoting reflective thinking and learning and effective interruption management and troubleshooting among operators
3) management of acute stress and fatigue
4) promoting communication and coordination of activities in emergency exercises
5) analysing human contribution to nuclear safety

make the operative personnel work safer

BUT: our work is still in progress, and more conclusions can be made in the near future
Key publications


