Training for Human Autonomy Teaming

October 23rd-24th, Tromsø, Norway

6th Workshop on Training & Assessment
The Role of Autonomy in Maritime Education, Training and Operations

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The Ruhr-University Bochum (since 1965)

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- ~5,600 employees
- 480 professors
- 42,718 students
- 3,387 international students
- 2,251 students with immigration background
- about 830 foreign doctoral students and international guest researchers
Our research focus

**Taskwork**
- Skill acquisition and retention
  - The threat of skill decay
  - Effects of refresher trainings
- Cognitive readiness for non-routine/abnormal situations
  - Information overload
  - Task overload cognitive readiness & skill retention under stress
- Training for decision making under stress
  - Stress exposure training
  - Training for surprise
  - Task technology fit and technical support (App for fault diagnosis)

**Teamwork**
- Team training for high responsibility teams and performance under stress („Team Performance Breakdowns“)
  - Training for adaptability
  - Task reprioritization
  - Task allocation
  - Mutual support
  - Back up behavior

**Organization**
- Safety management in high reliability organizations
- Organizational learning from errors
- Organisational forgetting (adaptation to information overload)
  - Stressors as antecedence for safety related rule violations („work safety tension“)

The role of Collective Orientation (CO)
Training - Which steps need to be considered?

1. Needs assessment
2. Training Objectives
3. Organisation Analysis
   - Team Task Analysis & KSA
4. Development of Evaluation Criteria
5. Selection of Training methods
6. Training
7. Use of Evaluation Models
8. Training Validity
9. Transfer Validity

NEEDS ASSESSMENT
Needs Assessment: Human Autonomy-Teaming (H-A-T)

The difference between „supervisory control“ und H-A-T?

• Human-agent Teams build a relationship that goes beyond what we know if a human agent controls or supervises a technical agent (Chen & Barnes, 2014)
• Is based in mutual understanding (smart collaboration, Iganaki, 2008)
• Requires conflict resolution (resolving opposing interpretations) (Kluge 2014)
• Is characterised by mutual trust, cohesion, transactive memory, shared SA, shared mental models, back-up behavior...

https://www.youtube.com/watch?v=JLmOteqmDYc


Human Agent (HA) Teaming for Multirobot Control

Chen & Barnes (2014)

Human Agent roles:
H-A teams particularly effective for open-ended missions
The agent is always the subordinate, who can be given permission to act autonomously under specific conditions

Human Agent Communication
Effective H-A communication should be as natural as H-H communication

Teaming agents should support team behavior, e.g.
• support opt. task allocation,
• planning,
• flexible execution of the plans,
• allow graceful degradations of the plans and
• Recognition primed decision making

A Model for Types and Levels of Human Interaction with Automation- and the issue of Autonomy

<table>
<thead>
<tr>
<th>HIGH</th>
<th>10. The computer decides „everything“, acts autonomously, ignoring collaborating with the human</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>9. Informs the human only if it, the computer, decides to</td>
</tr>
<tr>
<td></td>
<td>8. Informs the human only if asked, or</td>
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<tr>
<td></td>
<td>7. Executes automatically, then necessarily informs the human, and</td>
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<td></td>
<td>6. Allows the human a restricted time to veto before automatic execution, or</td>
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<td></td>
<td>5. Executes that suggestion if the human approves, or</td>
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<tr>
<td></td>
<td>4. Suggest one alternative</td>
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<td></td>
<td>3. Narrows the selection down to a few, or</td>
</tr>
<tr>
<td></td>
<td>2. The Computer offers a complete set of decision/action alternatives, or</td>
</tr>
<tr>
<td>LOW</td>
<td>1. The computer offers no assistance: human must take all decisions and actions</td>
</tr>
</tbody>
</table>

(Sheridan, 1992)
What is needed? SA-based Agent Transparency (SAT) Model

What’s going on and what is the agent trying to achieve?

Level 1
- Purpose
- Desire (Goal selection)
- Process
- Intentions
- Planning/execution
- Progress
- Performance

Why is the agent doing it?

Level 2
- Reasoning process (Belief/Purpose)
- Environmental and other constraints

What should the operator expect to happen?

Level 3
- Projection to the future/End state
- Potential Limitations
- Likelihood of error
- History of performance

The Team Task Analysis

Arthur et al. (2005)
What is the **task work**? = team‘s effort to understand and perform the requirements of the job, task and equipment to be used.

What ist the **team work**? = team‘s efforts to **facilitate interaction** among team members in the accomplishment of team task

TRAINING OBJECTIVES
Training - Which steps need to be considered?

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3. Organisation Analysis
   - Task Analysis & KSA
   - Person Analysis
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Training Objectives

Acquiring technical and non technical knowledge, skills & attitudes (KSAs)

- *Task-related team knowledge* relatively unchanging knowledge about the task and duties for which the team in the plant is responsible.

- *Team-related team knowledge*: mental structures concerning the characteristics and qualities of one’s teammate or of the team as a holistic social entity.

- *Process-related team knowledge*: the mental representation of the teamwork and interpersonal, team interaction processes involved.

- *Goal-related team knowledge*: mental representation of goals and how to achieve them, for example strategic consensus (Kluge, 2014; Wildman et al. 2012).


Additional Training Objectives: „Lessons learned“ from Automation

Technical and non technical knowledge, skills & attitudes (KSAs)

6 factors have been identified as contributing to human-automation interaction:

1. Situation awareness
2. Decision Biases
3. Trust in Automation
4. Overtrust and Complacency
5. Mental Workload and
6. Workload management

What can be additionally used?
„Lessons learned“ from Automation

Challenges

- Misuse → over reliance on automation
- Disuse → neglect or underutilization of automation,
- Automation abuse → or the automation of functions by designers and implementation by managers without due regard for the consequences for human performance
- Misunderstanding or Lack of Understanding of System, Mode confusion

Human Performance in Automated Systems - Trust in Automation

Factors influencing operators’ trust:
- Reliability of the system → monitoring performance should improve as the reliability of the system decreases

Subjective trust in automation
- If trust in automation is greater than self-confidence
- The interaction between trust and self-confidence could itself be moderated by the risk associated with the decision to use or not use automation

If automation is implemented in a „clumsy“ manner (e.g. executing an automated function requires extensive data entry or reprogramming) by human operator at times when s/he is very busy, workload is not reduced
- Studies found that automation does not always translate into a reduction of workload because it creates sometimes new demands, new coordination challenges that are difficult to manage and need to be monitored

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TRAINING DESIGNS FOR HUMAN AUTONOMY TEAMING-TRAININGS
The logic of team work training

Training designed to develop **task-relevant skills** should be directed at individual team members
(Dyer, 1984)

Alternatively, **training teamwork skills**, or those focused on the behaviors and attitudes necessary for effective team functioning, are believed **to be best delivered to intact teams** rather than to individual members
(Cannon-Bowers, Tannenbaum, Salas & Volpe, 1995; Moreland, Argote, & Krishman, 1998)

The logic underlying this position is that **training intact teams provides opportunities for members to integrate their teamwork skills and to jointly practice complex coordinated actions**
(Kozlowski, 1998; Kozlowski, Brown, Weisbein, Cannon-Bowers, & Salas, 2000)
Perspective of learning theory and human factors that needs to be incorporated into training

- The integration of task work and teamwork skills is a concurrent task demand. It shares elements of a dual task, which requires time-sharing and attention allocation.

→ time sharing and attention allocation needs to be trained

- The in-process integration of teamwork and task work skills can best be learned according to the learning mechanism which is also effective for dual-task performance.

→ use training methods that proofed to be effective for dual-task performance

- Pre-process and post-process coordination activities are assumed to be valuable and supportive for the creation, learning and activation of task-related, team-related, process-related, and goal-related team knowledge.

→ Use briefing and debriefing techniques before and after team training
Perspective of learning theory and human factors

- Equivalently to learning task work skills, learning teamwork skills includes a cognitive component (knowledge), such as a schema concerning teamwork characteristics, as well as a behavioural component, in which specific concrete behaviours, e.g. scripts and skills, need to be acquired and applied.

→ train technical and non technical skill

- Teamwork is learned through the accumulation of instances of teamwork episodes.

→ train with a large variety of scenarios with increasing difficulty

- Teamwork skills, focused on the behaviours necessary for effective team functioning, are believed to be best learned in intact teams rather than individually.

→ Train with the real autonomous team mate

Training - Which steps need to be considered?

Needs assessment

Training Objectives

Organisation Analysis
Task Analysis & KSA
Person Analyse

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Evaluation Criteria: SA-based Agent Transparency (SAT) Model

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Conclusion

- Training for Human Autonomy
  Teaming is similar to Human-Human Team Training
- Both parties need knowledge about capabilities and limitations of the team member
- Coordination and orchestration of task work and team work is based on mutual understanding of intentions
- HAT team training requires training as intact teams
Thank you for your attention!

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