Training for Long-Duration Space Missions:

A Literature Review into Skill Retention and Generalizability

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NASA Moon to Mars

Current Training

Goals of training:

1. Skill acquisition
2. Transfer of training

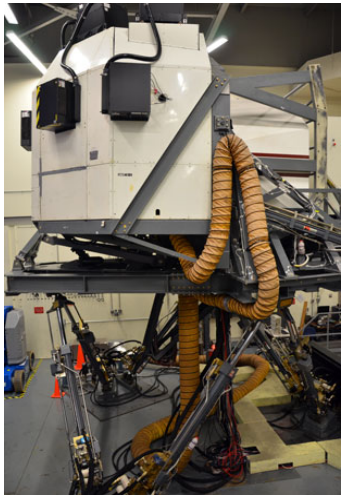
Training characteristics:

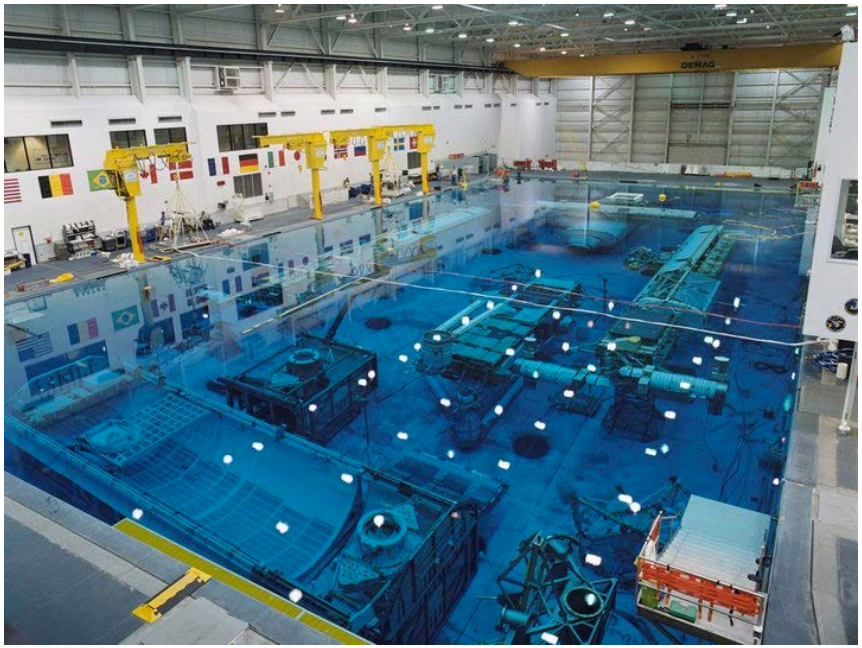
- Mission specific training is two years
- Training-to-mission time ratio is 10:1
- Every single specific task is trained

Training Facilities

- T-38 Jets
- Neutral Buoyancy Laboratory
- Space Vehicle Mockup Facility and Space Station Training Facility
- Virtual Reality Lab
- Dynamics Skills Trainer, Robotic On-Board Trainer
- Sim City
- KBRwyle Medical Lab
- Exercise Lab
- Flight Controller Part Task Trainer
- Ops LAN Part Task Trainer
- Part Task Trainers

- Onboard training equipment (laptops/VR)





Training for Long-Duration Space Missions

Long-duration space missions require more self reliant crews:

1. Not everything can be trained before launch
2. No real-time support from mission control
3. No ability to send up specialized crews
4. Loss of skills before launch and in mission

Training for Long-Duration Space Missions

Goals of future training:

1. Skill acquisition
2. Transfer of training
3. Skill retention
4. Skill generalizability

← Simulator fidelity

Literature Survey

Literature survey on skill retention and generalizability and the impact of simulator fidelity:

1. Summarize the research to date
2. Define research gaps

Method:

1. Resources: journal articles, conference papers, technical reports
2. Key words: skill decay, acquisition, retention, training, transfer of training, simulator fidelity
3. Focus: individual skills, no group skills

Types of Training

<u>Before launch:</u>

1. Initial training
2. Refresher training

<u>In-mission/onboard:</u>

1. Initial training
2. Refresher training

3. Just-in-time training

High-fidelity sims

Three fidelity levels:

- High: Sophisticated combinations of hardware and software
- Medium: Using real systems
- Low: symbolic rehearsal

Lower-fidelity sims

Learning Models

Rasmussen's S-R-K Taxonomy:

1. Skill-based behavior/task

   Task without laborious mental effort

2. Rule-based behavior/task

   Use of stored rule or feedforward control

3. Knowledge-based behavior/task

   Mental model used to attain goal

Skill Decay Variables

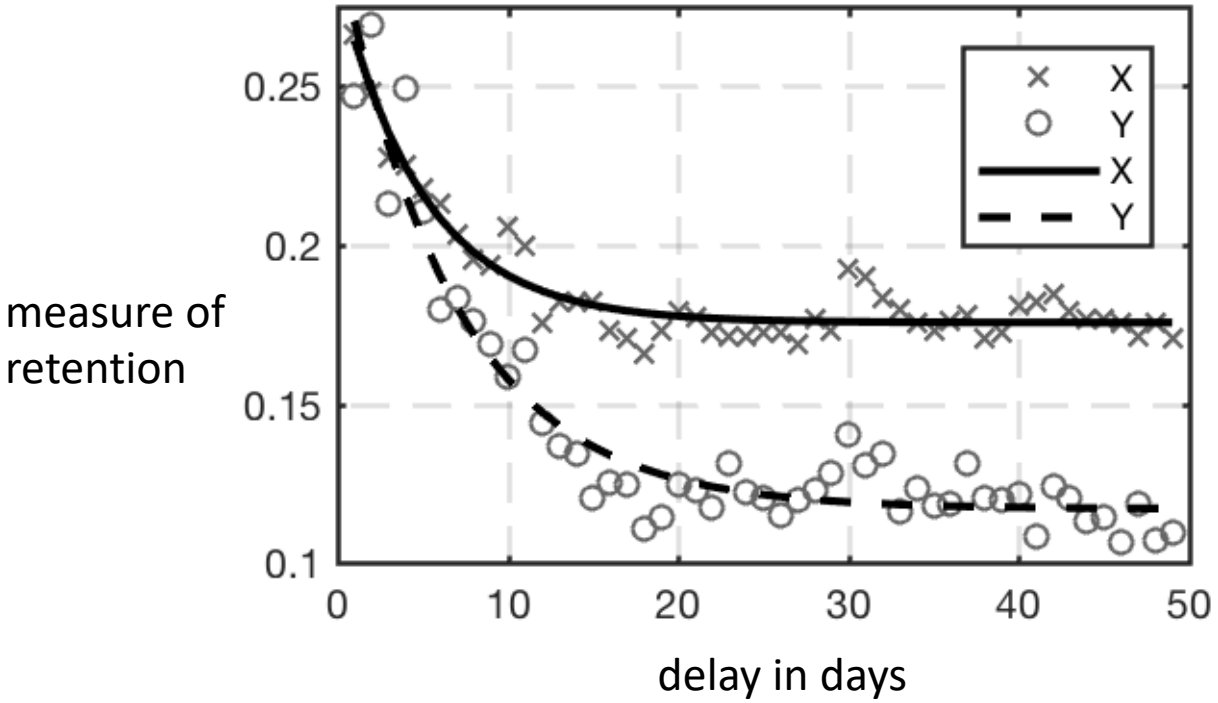
Variables influencing the retentions of skills over time:

1. Degree of proficiency after initial training
2. Amount/kind of refresher training
3. Transfer of skills from one task to another
4. Interfering activities
5. Scheduling of practice during training
6. Part-task vs. whole-task training
7. Extra training runs before final testing
8. Degree of overlearning

Skill Decay Modeling

Decay curves:

- Most often negatively accelerated
- Not universal



Simulator Fidelity

Different types of fidelity:

1. Physical, 2. Psychological, 3. Behavioral, 4. Face

Simulator fidelity and Rasmussen's S-R-K:

1. Skill-based tasks

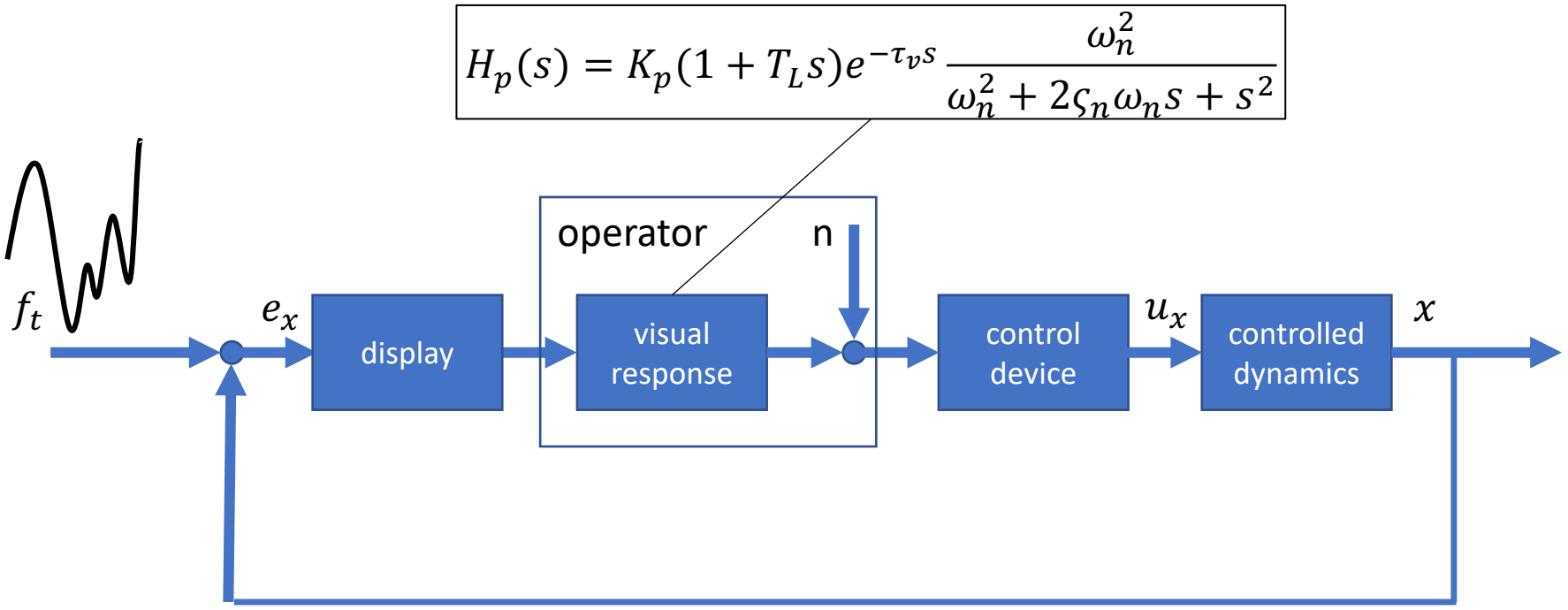
Frequent refresher training with high-fidelity sims depending on task complexity

2. Rule-based tasks
3. Knowledge-based tasks

Retained using frequent practice sessions of various nature: low-fidelity sims and symbolic rehearsal

Training and Retention Measures

Cybernetic approach:



Research Gaps and Future Work

Opportunities for research:

1. Developing skill decay functions
   - Important to plan refresher training
2. Investigating the effects of simulator fidelity on skill decay
   - Important for better utilization of simulators during training
3. Investigating the generalizability of skills learned in initial training
   - More efficient training and higher autonomy of crews
4. Developing new measures for training and skill decay

Thank you!

Questions?

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