Manual for Anomaly Simulation Tasks (M.A.S.T.)

NASA Guide for Designing Tasks

Developed by Team Aegis

Table of Contents

Introduction

This following information is designed to provide you with valuable insights and knowledge on designing a task.

Context

During future missions to Mars, astronauts will have to endure an up-to 40 minute round-trip communication delay. When unexpected problems arise, astronauts must operate with autonomy to solve these anomalies in the absence of MCC. Our goal is to help researchers in a variety of domains to utilize this guide to develop tasks which simulate the qualities of an anomaly using a standardized framework.

Statement of Purpose

This guide is intended for NASA researchers who are looking to create tasks which simulate anomalies using an empirical-based approach. The purpose of this guide is to develop a standardized method for creating these tasks and ensure that the creation process is research-backed. By extracting qualities of anomalies and ensuring they are highlighted in the task-development process, we can ensure we are creating the proper contextual environment to be able to eventually assess crew members. We are also supplementing our insights and findings with research; we have conducted interviews with current NASA HRP researchers and have combed through scientific literature to support our recommendations. This document may be revised as technological advances and/or new information is uncovered.

Anomaly Criteria

Anomalies in this context are unanticipated events which disrupt normal operations, requiring immediate attention and effective problem-solving strategies to mitigate potential risks and ensure mission success. This provides the overarching structure for each of these criteria and discusses the parameters which define these criteria. Off-nominal scenario criteria describe anomalies that have the following characteristics (McTigue et al., 2023)[1].

Causal relationships are not immediately understood[1]

- Competing alarms across systems – challenge of isolation the initiation
- Specific expertise required; challenge of “from 80+ people to 4” working the problem
- Complexity of system and of anomaly
- Challenge of safely perturbing the system to gain understanding of cause and effect

Limited intervention options[1]

- Creativity required to generate workaround options
- Systems thinking to perform risk assessments
- Rapid synthesis and decision-making
- Resource limited environment, limited redundancy, sparing, etc.
- Procedures may have unexpected outcomes

No perfect information during initial stages[1]

- Sensors data may be incorrect or incomplete
- Sensors are limited resource, do not cover all parts of the system
- Historical data may be limited or unavailable
- Challenge to parse out relevant data

Time pressure[1]

- Short time-to-effect (to prevent adverse outcomes)
- Time pressure on execution/completion of procedure
- Competing priorities (e.g., inattention to other critical operations)
- Simultaneous efforts required (safing, investigation, downstream impact)

Task Qualities

These criteria have been extracted by researchers from the NASA Human Research Program (HRP), working on anomaly resolution in relation to upcoming missions to Mars. Our task qualities have been extracted from the anomaly criteria in an attempt to operationalize the definitions and make them more contextually relevant to our environment of task creation. Below is a description of how the task qualities map to the anomaly criteria.

Information Prioritization

No perfect information during initial stages

Maps to the idea that critical information is often not delivered in a linear manner when problem-solving. During the initial problem solving stage, it is first critical to determine what knowledge is possessed by the team and what knowledge is needed. It is also important to question the reliability of said information.

Cascading Problems

Causal relationships are not immediately understood

In an anomaly, you do not necessarily know every possible outcome of your action, especially in a new and unpredictable situation. You may not be able to form associations without repeated exposure to problems (i.e., how one system affects another)

Multiple Stressors

Time pressure

Maps to the idea that some problems are time-critical and that, when solving competing problems, time required for completion must be considered for each anomaly at every stage.

Task Qualities

Continued

Induces Creative and Systematic Thinking

Limited intervention options

Requires using resourcefulness to come up with solutions to new solutions with limited existing resources and also performing risk-assessments based on existing knowledge

Built for Teams

Since missions to Mars will involve communication delays, astronauts will need to be given greater autonomy in anomaly resolution. As a result, the training paradigm for astronauts may shift during this time to incorporate more team-structured exercises. In light of this, tasks should be built for teams and should aim to help researchers be able to assess team dynamics and collaboration.

Tasks

What are tasks, what are our tasks, and how we will be referencing them throughout this document.

What Are Tasks

Tasks are essentially a medium to simulate the critical criteria's of an anomaly, specifically for anomalies that are time-critical and require urgent diagnosis. Based on existing NASA research and our own research and insight, we have extracted anomaly criteria's into task qualities and further broke them down into operationalized heuristics. We have also created two of our own tasks that follow the heuristics defined in this document (Space Race & Robo Run), and we will be referencing them throughout the document in the *Example* section of each heuristic.

Space Race (SR)

The purpose of this task is to achieve the greatest possible distance while effectively troubleshooting various errors that arise on your mission. The game involves using data visualizations to monitor spacecraft mechanics such as thrust and cabin pressure. Based on these levels, participants manipulate an Arduino board to get the spacecraft back to stasis.

Robo Run (RR)

Through navigating multiple components of the robot, users have to collaborate on helping the robot reach the end of the course while dealing with various problems before time runs out. Users have to determine the what type of issue they're faced with, and swiftly respond before their resources deplete by changing broken components.

Heuristics

This following information is to give an overview of heuristics, their purpose, and what they describe.

What Are They

Heuristics explain how to operationalize and implement the task qualities into tasks to simulate time-critical anomalies. They provide an expanded definition of the task qualities. In designing these heuristics, we provide broad guidelines on how to design a task to achieve this goal. These should serve as an initial point of reference for researchers to be able to customize and adopt a specific task to meet their own research goals.

Presenting Heuristics

The following pages will list the heuristics, empirical evidence we gathered which informed our heuristic-creation, the reasoning why these heuristics are important to include, and examples from each of the two tasks regarding how the heuristic was applied.

Information Prioritization

Tasks will provide one participant with no more than 5–9 chunks of information at any given time. (IP1)

Research

Miller argued that the limited capacity in short-memory processing was bound by seven, plus or minus two chunks of information (Miller, 1956)[2]. Chunking "involves breaking large amounts of complex data into smaller sections that are easier to remember" (Indeed, 2023)[3]. This makes it easier for people to remember more information; for instance, chunking may involve using association to form connections between different concepts or pieces of information.

Reasoning

We do not propose that astronauts violate existing principles of the field of human factors or have abilities that exceed those found in the average human. In fact, preliminary research has found that "some crew members experienced cognitive decline and issues in several categories during the early phase of flight" (Leonard, 2024)[4]. Since we want to be able to evaluate crew members through their performance in these tasks, we want to ensure we are not setting up participants for failure. If participants feel too overwhelmed at the start and know success is not possible, they may feel less inclined to continue completing the task and may not engage in creative problem solving. We aim to remove this barrier from task testing.

Example
RR TASK

For each component that needs monitoring, there are data bars that provide players a quick understanding of how high/low the data is.

Example
SR TASK

The instrument panel is chunked into two categories: power and cabin. This prevents overloading participants with the amount of controllable inputs.

Information Prioritization

Must incorporate data visualization elements into tasks. Data visualizations must allow participants to monitor trends in data and draw conclusions from the visualization as well. (IP2)

Research

In a study conducted by Faiola et al. (2015), implementing data visualizations were able to "reduce cognitive strain during decision-making" when implemented in the ICU of one hospital which resulted in improved accuracy (Faiola et al., 2015)[5]. In an interview we conducted with a senior designer and lecturer at the Georgia Institute of Technology, one of the ways to solve a difficult design problem is to draw out and diagram relationships between data using visualizations (Kevin Shankwiler, 2024).

Reasoning

In many spacecrafts including the Boeing CST-100 Starliner, data visualizations take a largely statistical approach, using graphical representations to display information. Currently within spacecrafts, these visualizations depict "the value of a data point is generally compared with a set of pre-defined and static limits to determine if it is normal, out of range, or in error state" (Li et al.)[6]. We should be providing participants with tools that allow them to reach the maximum threshold of their ability while also mimicing real-life scenarios.

Example
RR TASK

For each component that needs monitoring, there are data bars that provide players quick understanding of how high/low the data is.

Example
SR TASK

A digital dashboard that shows real time data of critical systems. Participants must identify which of the systems requires the most urgent diagnosis.

Information Prioritization

Tasks will introduce problems of varying degrees of risk. The higher the likelihood of fatality, the greater the risk posed. (IP3)

Research

Based on expert solicitation, being able to prioritize actions based on what the "next worst failure" is (Kritina Holden [Discipline Scientist & EIHSO, Risk management at NASA Ames Research Center], 2024), is an important skill to identify actions or information to prioritize.

Former astronaut Jerome Apt discussed the importance of gathering as much information as possible in order to assess risk before taking action in the face of an anomaly (Jerome Apt, 2024).

Reasoning

In space, astronauts will face a variety of problems of different magnitudes; some will be critical to mission success and others may not be as consequential. It is in the astronauts best interest to be able to identify risks that are the biggest threat to their survival and prioritize solving those before moving on to others.

Example
RR TASK

Users have to prioritize fixing energy-related issues over other issues.

Example
SR TASK

There are two types of failures: regular failures and critical failures. Some failures can lead to other issues but aren't immediately game-ending. Critical failures, like a loss of oxygen, can be fatal for astronauts, while other problems, such as engine failure, can cascade into further complications without instantly terminating the mission.

Cascading Problems

Each cascading problem will have a minimum of two levels of complexity. (CP1)

Research

There are several models within the scope of game design which depict cascading problems. However, both of these tasks have a strict time limit and, as a result, we cannot embed too many layers of complexity. As a result, we have determined that each cascading will have a minimum of two levels of complexity. On the next page, a possible diagram of cascading problems to use in task creation is depicted.

Reasoning

We need to take every effort to standardize our tasks so that the process is replicable in the future. Scoping the amount of cascading problems help us to prevent the tasks from becoming overly complicated and obscuring the objective of the task.

Example
RR TASK

When the robot encounters corrosive gas, there's a risk that the gas will erode the pipes, causing those connected to the energy core to start leaking. This leakage results in a loss of energy from the core, and if the issue isn't realized by the participants and attended to promptly, the energy loss will accelerate.

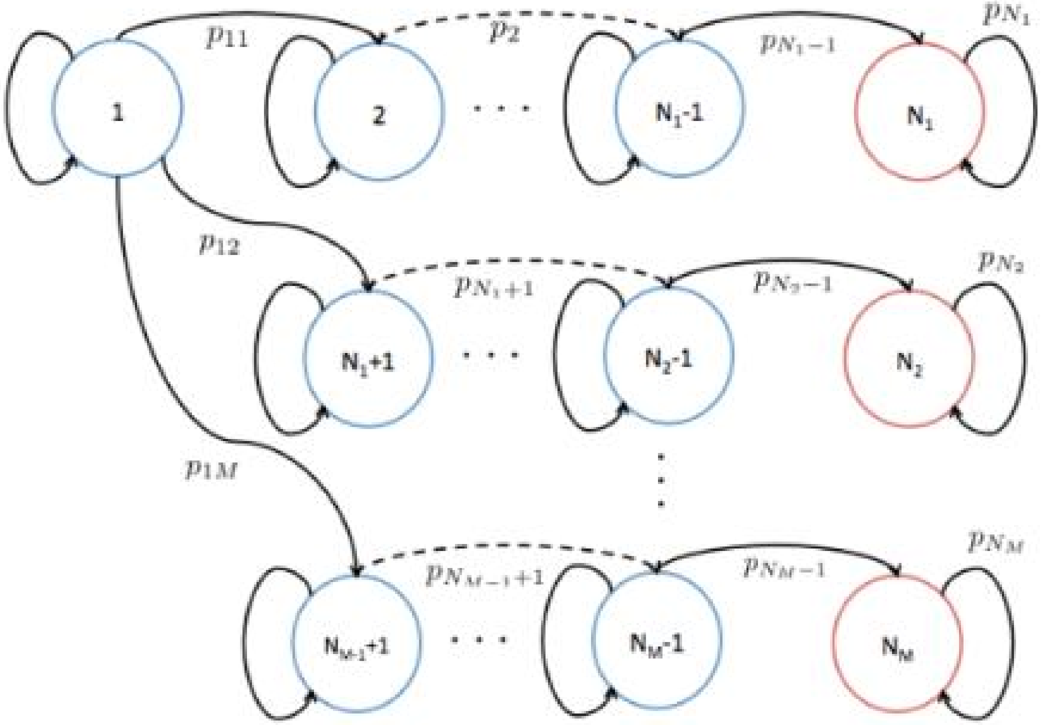
Example
SR TASK

If the participant are too slow with the amount of speed they use, they are more susceptible to being hit by a meteor. Being hit by meteor can cause damage to the cooling loop which would fill the cabin with toxic fumes and drain the oxygen.

Cascading Problems

Each cascading problem will have a minimum of two levels of complexity. (CP1)

Image[7]



7 Zhu & Başar, (2012)

Cascading Problems

The effects of cascading problems in the task will be both anticipated and unanticipated. (CP2)

Research

In an article by Inoue, the author discusses how the presence of unanticipated problems can increase an individual's ability to problem solve (Inoue, 2005)[8]. These types of problems do not necessarily have rehearsed procedures associated with their solutions. As a result, individuals have to be more creative in their attempts to problem solve, perhaps challenging preconceived notions and forcing more "outside-the-box" thinking[8]. The article poses, "It is suggested that cognitive functioning in problem solving is highly dependent on an individual's contextual interpretation of the activity" [8].

Reasoning

Without unanticipated problems arising, astronauts may not be able to repeat tasks during the training process, as learnability would increase and render the task futile.

Example
RR TASK

Unanticipated problems include scenarios such as the pipes leaking, where the energy being provided to the robot starts to leak energy and the robot isn't as fast as it should be when being provided that much energy. They must deduce this on their own, as it is not outlined in the manual. Anticipated events, on the other hand, are those explicitly described in the tutorial and manual section of the task.

Example
SR TASK

Unanticipated problems include scenarios such as the engine overheating, where a water cooling process begins automatically in the background without directly informing the participants. They must deduce this on their own, as it is not outlined in the manual. Anticipated events, on the other hand, are those explicitly described in the manual.

Cascading Problems

Some effects of cascading problems will be immediate, while others may not manifest until later stages. (CP3)

Research

One of our goals is to increase system complexity. We know that "time delay increases with parameter...and the size of the cascading failure decreases accordingly, which indicates that the larger that the time delay is, the stronger the [network comprehensive robustness index]" (Jing et al., 2019)[9]. Some effects of cascading problems will be immediate while others may not be actualized until further into gameplay.

Reasoning

Technical complexity is essential because of the vast depth and breadth of material that astronauts will have access to. When working to solve an anomaly, one must parse out information that is relevant to the situation and determine what must be manipulated to return to stasis. Connections between systems are not necessarily laid out, and it is up to astronauts to be able to discern these connections.

Example
RR TASK

When participants are unable to utilize the Energy Core fully due to issues unchecked, the load on the Battery increases, depleting it's reserves faster. This could lead to the players not having enough backup energy in the later game, forcing players to go at a slower speed and become unable to jump.

Example
SR TASK

If participants use thrust conservatively, they won't be hit by a meteor right away. However, if they remain too slow for an extended period, they will eventually be struck, leading to a cascading problems.

Multiple Stressors

Tasks will incorporate both time and situational stressors using different modalities. (MS1)

Stressor Types

Research

- "Time Stress revolves around the increased tension caused by the pressure of being exposed to temporal limits or deadlines" (Habibi et al., 2023)[10]. According to Starbuck & Farjoun (2009), "Specific deadlines create a culture that promotes a high sense of time urgency, heightens the experience of time pressure and constrains decision-making"[11]. Many anomalies may be time-critical and require astronauts to use foresight to budget time accordingly, particularly if they are dealing with multiple problems at once.

- "Situational Stress entails unanticipated occurrences in the real world where participants expect to see a different result or do not anticipate an unsolvable outcome"[10]. Accordingly, even if astronauts believe that they have a certain amount of time to resolve a problem, another unexpected problem may come their way, and it is their responsibility to adjust for these accordingly.

Reasoning

According to Tina Holden, one of the most common ways NASA induces stress is by utilizing time pressure (Tina Holden, 2023). In real-time scenarios, astronauts will have to rely heavily on creative thinking in order to come up with innovative solutions within this time boundary. We selected time stress because this aspect is already embedded in our task qualities, and we selected situational stress because this type of stress involves "having no control over a current difficult situation"[10].

Multiple Stressors

Continued

Modalities of Stress

Research

- "Stress has been manipulated using various techniques, including the use of visual countdown timers to create a sense of urgency. This method has been shown to increase physiological markers of stress, such as heart rate and cortisol levels, and can lead to impaired cognitive functions such as attention and decision-making." (Dismukes et al., 2015)[12].
- Alarms with multiple tones are currently used in spacecrafts to indicate to astronauts that there are irregularities. In fact, the system "...relies on the crew's ability to remember what each tone represents in a high stress, high workload environment when responding to the alert" (Sandor & Moses, 2016)[13].

Reasoning

The purpose of including these stressors is to prepare astronauts for the intensity of their mission to Mars; we can in no way replicate life-threatening stress, so using multiple stressors is the closest thing we have in terms of triggering this stress response.

Example
RR Task

During the task, participants can see a visual timer in the top left corner of the screen counting down. Additionally, an alarm is both visually and audibly indicated, with part of the screen lighting up red and an alarm sound playing.

Example
SR Task

During the task, participants can see a visual timer at the top of the instrumentation panel counting down. Additionally, visual LEDs light up red, accompanied by an alarm sound, to indicate when a system is broken or needs attention.

Induces Creative and Systematic Thinking

According to the Consensual Assessment Technique (CAT), the task must have an average creativity score of 4 or above (out of a high score of 7). (CST1)

Creative Thinking

Definition

We are defining this as being able to have multiple (more than one) paths that can be taken to solve the problem. This is to embed the opportunity to be creative within the task. Since creativity can be subjective, we propose to use the Consensual Assessment Technique (CAT) measure in order to assess creativity within a task.

Research

The definition of creativity may vary across different domains and fields. Creativity is also subjective; where one person believes creativity is present, others may not. However, our definition of creativity is informed by the idea that "Creative thinking involves, among others, the ability to break conventional rules of thinking or to develop new strategies" (Fink et al., 2007)[14].

Reasoning

The CAT involves surveying experts in the domain you are working within and asking them to assess whether or not something is creative. This is a standardized and tested measure and is known as the “Gold Standard” of creativity measures (Creative Huddle)[15]. We are taking inspiration from the version of the assessment in the paper written by Denson et al. (2015)[16].

Example
RR TASK

We adapted the CAT measure survey and administered it to experts in the field of anomalies to assess if they considered the task creative. The experts gave it an average score of 5.4, which is above the threshold for being considered creative.

Example
SR TASK

We adapted the CAT measure survey and administered it to experts in the field of anomalies to assess if they considered the task creative. The experts gave it an average score of 5.1, which is above the threshold for being considered creative.

Induces Creative and Systematic Thinking

According to our definition of systematic thinking, tasks should extend beyond one-to-one problem relationships. They should facilitate system-wide thinking, demonstrating how various parts are interconnected and allowing for multiple solutions to the problem. (CST2)

Systematic Thinking

Definition

We are defining this as having a guide or instruction manual which players have to follow in order to complete the task. Holistically identifying how all pieces involved in a problem are interconnected in order to come to a logical solution.

Research

According to Donna Dempsey, most of NASA training is procedure-based (Donna Dempsey, 2023). There must be some parallels between training and these tasks; some anomalies may involve troubleshooting using existing procedural-based approaches before the need to resort to creative thinking arises. In these situations, astronauts should be trained to respond more programmatically. "Systems thinking is superior to other approaches when dealing with complexity" (Maani, 2001)[17].

Reasoning

Incorporating levels of complexity contributes to one's ability to be able to exhibit systematic thinking.

Example
RR TASK

Participants go through “training” first through an overview tutorial, and are given a manual to teach them how each component functions.

Example
SR TASK

Participants go through three rounds of training to become familiar with the systems and inputs. This process helps them develop a mental model and understand the interconnections between the systems, enabling systematic thinking during anomalous situations.

Built for Teams

Tasks must be multiplayer.
(BT1)

Research

According to Donna Dempsey, typically, the astronaut training largely takes place individually, with the exception of team-based, emergency training (Donna Dempsey, 2023). "Getting the space station into orbit and maintaining it is one of humanity's biggest challenges – one that required people from all over the world working together to make it possible" (Sempsrott, 2023)[18].

Reasoning

However, missions to Mars will place a higher emphasis on teamwork, seeing as MCC will not be able to troubleshoot problems as efficiently. As a result, tasks should showcase team dynamics to determine how they are affected by time-critical anomalies. Astronauts will never be alone on any mission; it is crucial for the success of any mission that they can collaborate effectively. The task needs to enable participants to be able to work together to solve a task.

Example
RR TASK

Players can join the task together online. The workload of the task requires at least two people to be able to complete. Since players share the same workspace, they'll have to communicate and work together to solve the problems.

Example
SR TASK

The anomalies that arise during the task require the diagnosis of at least two members to achieve the objective, which is to progress as far as possible within the given time.

Built for Teams

Participants are initially assigned predefined roles with specific responsibilities, but during the tasks, they are free to partake in work related to another participants role. (BT2)

Research

Currently, NASA uses measures such as the NASA Task Load Index, which acknowledge that assigning individuals specific tasks or roles can help reduce cognitive load, especially in stressful environments. However, during anomalous situations, individuals are allowed to partake in or assist with team members' responsibilities.

Reasoning

Our findings, along with current literature, indicate that teams generally perform better in time-critical situations when roles are clearly specified compared to when roles are unspecified. Therefore, when designing tasks for teams, it is beneficial to assign pre-defined roles with specific responsibilities. However, individuals should still be allowed to assist with or participate in other team members' duties if they choose to do so. This approach ensures both clarity in task allocation and flexibility in team collaboration.

Example
RR TASK

Players are divided into the Navigator role or an Engineer role. The Navigator is the only person that could move the robot but Navigator can interact and solve problems that are assigned to the Engineer.

Example
SR TASK

Players are divided into Engineer, Analyst, and Pilot roles. The Analyst's primary responsibility is to view and communicate real-time data to the rest of the team, but they can also assist the Pilot in physically manipulating the inputs, even though this is primarily the Pilot's responsibility.

Checklist

The checklist enables you to follow the heuristic and keep track of what you've added to a task or identified in an existing task.

Information Prioritization

- [ ] Tasks will provide one participant with no more than 5–9 chunks of information at any given time. (IP1)
- [ ] Must incorporate data visualization elements into tasks. Data visualizations must allow participants to monitor trends in data and draw conclusions from the visualization as well. (IP2)
- [ ] Tasks will introduce problems of varying degrees of risk. The higher the likelihood of fatality, the greater the risk posed. (IP3)

Cascading Problems

- [ ] Each cascading problem will have a minimum of two levels of complexity. (CP1)
- [ ] The effects of cascading problems in the task will be both anticipated and unanticipated. (CP2)
- [ ] Some effects of cascading problems will be immediate, while others may not manifest until later stages. (CP3)

Checklist

The checklist enables you to follow the heuristic and keep track of what you've added to a task or identified in an existing task.

Multiple Stressors

- [ ] Tasks will incorporate both time and situational stressors using different modalities. (MS1)

Induces Creative & Systematic Thinking

- [ ] According to the Consensual Assessment Technique (CAT), the task must have an average creativity score of 4 or above (out of a high score of 7). (CST1)

- [ ] According to our definition of systematic thinking, tasks should extend beyond one-to-one problem relationships. They should facilitate system-wide thinking, demonstrating how various parts are interconnected and allowing for multiple solutions to the problem. (CST2)

Built for Teams

- [ ] Tasks must be multiplayer. (BT1)

- [ ] Participants are initially assigned predefined roles with specific responsibilities, but during the tasks, they are free to partake in work related to another participants role. (BT2)

Citations

1. McTigue et al., (2023, February 9). Simulating the Unexpected: Assessing Human-Systems Resilience. Human Research Program, NASA
2. Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. Psychological review, 63(2), 81.Chicago
3. Parker, S. (2023, May 30). What is the chunking technique? (with tips for interviews) | indeed.com. What Is Chunking and How Can It Improve Memory? (Plus Tips). https://www.indeed.com/career-advice/interviewing/what-is-chunking-technique
4. Leonard, N. (2024, June 13). Fit to fly? Penn researchers find some temporary cognitive decline among civilians who travel into space. WHYY. https://whyy.org/articles/civilian-space-travel-cognitive-decline-penn-researchers/#:~:text=The%20team%20found%20that%20some,shortly%20after%20returning%20to%20Earth.
5. Faiola, A., Srinivas, P., & Hillier, S. (2015, June). Improving patient safety: Integrating data visualization and communication into ICU workflow to reduce cognitive load. In Proceedings of the international symposium on human factors and ergonomics in health care (Vol. 4, No. 1, pp. 55-61). Sage India: New Delhi, India: SAGE Publications.
6. Li, Z. (2016). Creating Situational Awareness with Spacecraft Data Trending and Monitoring.Chicago
7. Zhu, Q., & Başar, T. (2012, April). A dynamic game-theoretic approach to resilient control system design for cascading failures. In Proceedings of the 1st international conference on High Confidence Networked Systems (pp. 41-46).
8. Inoue, N. (2005). The realistic reasons behind unrealistic solutions: The role of interpretive activity in word problem solving. Learning and Instruction, 15(1), 69-83.
9. Jing, K., Du, X., Shen, L., & Tang, L. (2019). Robustness of complex networks: Cascading failure mechanism by considering the characteristics of time delay and recovery strategy. Physica A: Statistical Mechanics and its Applications, 534, 122061.Chicago
10. Habibi, R., Pfau, J., Maram, S. S., Li, J., Larsen, B., Xu, J., ... & El-Nasr, M. S. (2023, April). Under pressure: A multi-modal analysis of induced stressors in games for resilience. In Proceedings of the 18th International Conference on the Foundations of Digital Games (pp. 1-10).

Citations (cont.)

11. Starbuck, W., & Farjoun, M. (Eds.). (2009). Organization at the limit: Lessons from the Columbia disaster. John Wiley & Sons.
12. Dismukes, R., Goldsmith, T. E., & Kochan, J. A. (2015). Effects of acute stress on aircrew performance: literature review and analysis of operational aspects.
13. Sandor, A., & Moses, H. R. (2016, February). Speech Alarms Pilot Study. In 2016 Human Research Program Investigator''s Workshop (No. JSC-CN-34688).Chicago
14. Fink, A., Benedek, M., Grabner, R. H., Staudt, B., & Neubauer, A. C. (2007). Creativity meets neuroscience: Experimental tasks for the neuroscientific study of creative thinking. Methods, 42(1), 68-76.Chicago
15. The Consensual Assessment Technique | Creative Huddle. (n.d.). https://www.creativehuddle.co.uk/post/the-consensual-assessment-technique#:~:text=The%20Consensual%20Assessment%20technique%20has,tools%20for%20measuring%20creative%20work.
16. Denson, C. D., Buelin, J. K., Lammi, M. D., & D'Amico, S. (2015). Developing Instrumentation for Assessing Creativity in Engineering Design. Journal of Technology Education, 27(1), 23-40.
17. Maani, K. E., & Maharaj, V. (2001, July). Systemic thinking and complex problem solving. A theory building empirical study. In Proceedings of the 19th International Conference of the System Dynamics Society (Vol. 101).Chicago
18. Sempsrott, D. (2023, July 26). It took teamwork to make it to 20 years - NASA. NASA. https://www.nasa.gov/humans-in-space/it-took-teamwork-to-make-it-to-20-years/