

RESEARCH REVIEW 2022

Transformative Gamification: Making Impact across the Federal Workforce

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Panel



Rotem Guttman

Rotem Guttman is a senior researcher and team lead at the Software Engineering Institute. His research focuses on leveraging non-traditional methods to reach the cybersecurity audience. His research interests include network security, cyber-physical modeling and simulation, cybersecurity training and education, gamification techniques for cybersecurity, cyber forensics and incident response.



Jessica Hammer

Jessica Hammer is the Thomas and Lydia Moran Associate Professor of Learning Science, jointly appointed in the HCI Institute and the Entertainment Technology Center at Carnegie Mellon University. Her research focuses on transformational games, which are games that change how players think, feel, or behave. She is also an award-winning game designer.



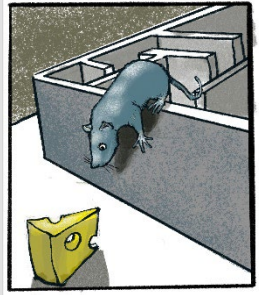
Dominic Ross

Dominic Ross is the broadcast media team lead at the SEI where his work focuses on multimedia research and transformative gamification. In that role, he designs and engineers production studios and systems used to acquire training, conferences, webinars, and broadcast video used by the federal cybersecurity workforce, Carnegie Mellon University, and the SEI.

Transformational Games



Hands On
Experimentation



Align Incentives



Increase Receptivity



Measure/ Improve
Teamwork



Skill Transfer

Hands-on Experimentation - Rapid Feedback



Early, fast feedback can be critical to avoiding disaster.

- Wargaming
 - Long DoD History – since 1800's
 - Modern era:
 - Two broad categories:
 - Data-generating / analytical
 - Exploratory / interactive
 - Must maintain analytical rigor
- These two are not mutually exclusive

Extending Training Beyond Cyber – Cyber Kinetic Effects Integration (CKEI)

Integrating Cyber-Kinetics

- Allowing combined arms training
 - Cyber effects propagate into kinetic domain and vice versa
 - Cyber supports larger mission
- Every team failed on the first attempt
 - Rapid Iteration



Three Envelopes



Cybersecurity & Risk Board Game

- Requires no prior knowledge of networking, programming, or risk assessment
- Replicates organizations across different sectors of critical infrastructure
- Creates intuitive understanding of balancing risk and operational capabilities.

Improved Teamwork



Worst-case scenario – Ad Hoc workgroup

- Build trust
- Create willingness to share ideas
- Move rapidly to productivity

Strong data backing

- Randomized controlled trial
- Flow
- Cohesion

Large Team Coordination

- Massive scale
- Native coordination
- Replicable to DoD context
- GIS Arta

Rank: 34 Score: 9455,364
Soloist 223: Core and Tail Design 2
▶ No conditions

Group Competition		
#	Group Name	Score
1	Contenders	9628
2	Richard Dawkins Foundation	9627
3	GoFOLDers	9613
4	Natural Abilities	9611
5	Another Hour Another Point	9596
6	Czech National Team	9590
7	Void Crushers	9584

Soloist Competition			
#	Player Name	Current	Best
1	BootsMcGraw	-	9628
2	vertex	-	9627
3	thamarquis	-	9625
4	Mark-	-	9624
5	infjanc	-	9613
6	Mr_Jotly	-	9611
7	kevnad5	-	9604

Chat - Group auto show
Chat - Puzzle auto show

shpalmina: and so?
BletchleyPark: and left me with an unanswered question
NatanaelL: what's up?
BletchleyPark: what is a tab-complete ? :)
NatanaelL: Have you used IRC?

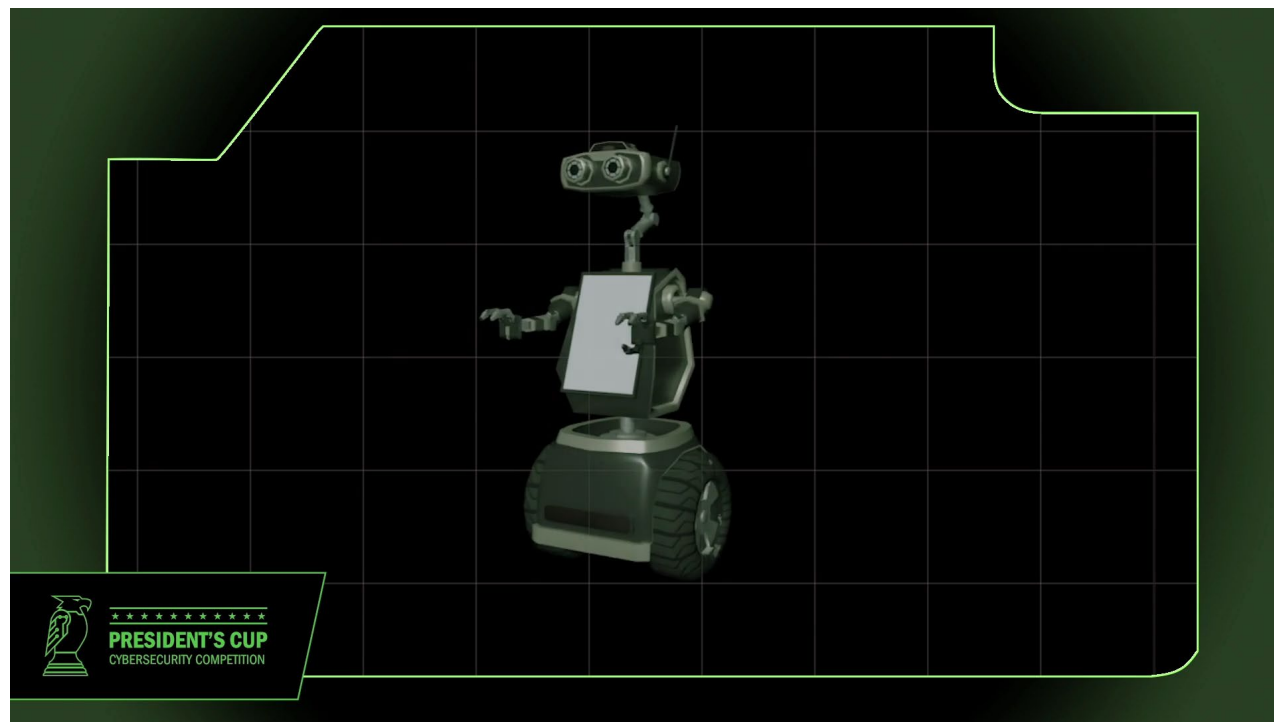
Shake Sidechains Mutate Sidechains Wiggle All Wiggle Backbone Wiggle Sidechains Freeze Protein Remove Bands Disable Bands Align Guide Reset Structures Reset Puzzle Help Glossary

Image courtesy of Animation Research Labs, University of Washington

Measurement

Mandate from EO 13870:

- “to identify, challenge, and reward the United States Government's best cybersecurity practitioners and teams across offensive and defensive cybersecurity disciplines.”
- Team Finals Client
 - Immersive
 - Team oriented challenges
 - Narratively driven



Human-AI Decision Evaluation System (HADES)



A demonstration of the HADES test harness in use

Narratively driven example

- Evaluating the effect of:
 - Stakes
 - AI recommendations
 - Not all explainability is helpful!
- Simulated AI with drop-in capability
 - Full lifecycle support

Aligned Incentives



You get the behavior you incentivize, not the behavior you ask for.

Games allow us to change the incentive structure

- Incentives \neq Payment
- Incentives tied to motivation
- Games can provide motivation
 - Narrative Engagement
 - Competitive / Cooperative
 - Status / Power / Vengeance / Collection

Aligned Incentives

Synthetic Client Helpdesk

The screenshot shows a web-based helpdesk interface. At the top, there is a search bar and navigation options like 'Data Search', 'Advanced Filter', and 'Chart'. Below this, a filter bar indicates 'Filter by: (Category) ADMINEX11 And Category = KOREA'. The main content is a table with columns for 'A #', 'Alert', 'Category', 'Sub Category', 'Title', 'Status', 'Description', and 'Resolved'. Two records are visible:

A #	Alert	Category	Sub Category	Title	Status	Description	Resolved
105813	KOREA	NC03		Unable to use Microsoft Word	New	User Chenyan Zhou was able to start Microsoft Word, but unable to use it properly.	SharonW
105812	KOREA	NC03		User Not Logged in to his VM	New	User Aarna Doshi was not found logged in to NC03_USER111	Aarna Doshi

“Cheating” as a benefit

- Properly aligned incentives encourage beneficial “cheating”
- Rules of Engagement violation → Mission Focus
- Studying history to “Cheat” at Civilization¹, Ars Magica²
- SAT Vocabulary preparation via Magic the Gathering³

[1] K. D. Squire, *Replaying history: Learning world history through playing “Civilization III”*. Indiana University, 2004.

[2] K. Heller and J. Hammer, “Playing History: How Ars Magica Players Develop Historical Literacy,” *Meaningful Play*, 2012.

[3] A. M. Dodge, “Examining Literacy Practices in the Game Magic: The Gathering,” *American Journal of Play*, vol. 10, Art. no. 2, 2018.

Transfer of Skills



[1] G. Culbertson, S. Wang, M. Jung, and E. Andersen, "Social Situational Language Learning through an Online 3D Game," in *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, New York, NY, USA, 2016, pp. 957–968.

[2] Z. A. Wen, Z. Lin, R. Chen, and E. Andersen, "What.Hack: Engaging Anti-Phishing Training Through a Role-Playing Phishing Simulation Game," in *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, New York, NY, USA, 2019, pp. 1–12.

Learning works best *in context*

- Games can provide that context
- Games can enhance future learning

Examples:

- Foreign Language Role Playing Game
 - Avg. 8.7 words learned in ~40 min¹
- Phishing Training Game
 - 36.7% improvement in player's ability to identify phishing email compared to control group²

Transfer of Skills

Experiences must be designed to support skills transfer!

- Multiple approaches to evaluating games
- Not all games provide utility!



[1] J. D. Bransford and D. L. Schwartz, "Chapter 3: Rethinking Transfer: A Simple Proposal With Multiple Implications," *Review of Research in Education*, vol. 24, Art. no. 1, 1999.

- Preparation for Future Learning (PFL)¹
 - Clear goals
 - Immediate feedback
 - Specific knowledge
 - Outward pointers
- Limited DoD resources
- Leverage personal time by making content engaging enough for the audience to self-select during leisure time.
- Extend reach beyond DoD enterprise (defend the nation).

VR Prototyping

Examples

- F-16 Connection Requirements
- Connecting to larger scale simulations
- Forensics use case



Improved Receptivity



Games can provide an alternative reality
Properly designed these can create:

- Increased comfort asking questions¹
- Disrupt established power dynamics to elicit better data²
- Allow practice in a safe environment³

[1] A. To, J. Holmes, E. Fath, E. Zhang, G. Kaufman, and J. Hammer, "Modeling and Designing for Key Elements of Curiosity: Risking Failure, Valuing Questions," *Transactions of the Digital Games Research Association*, 2017.

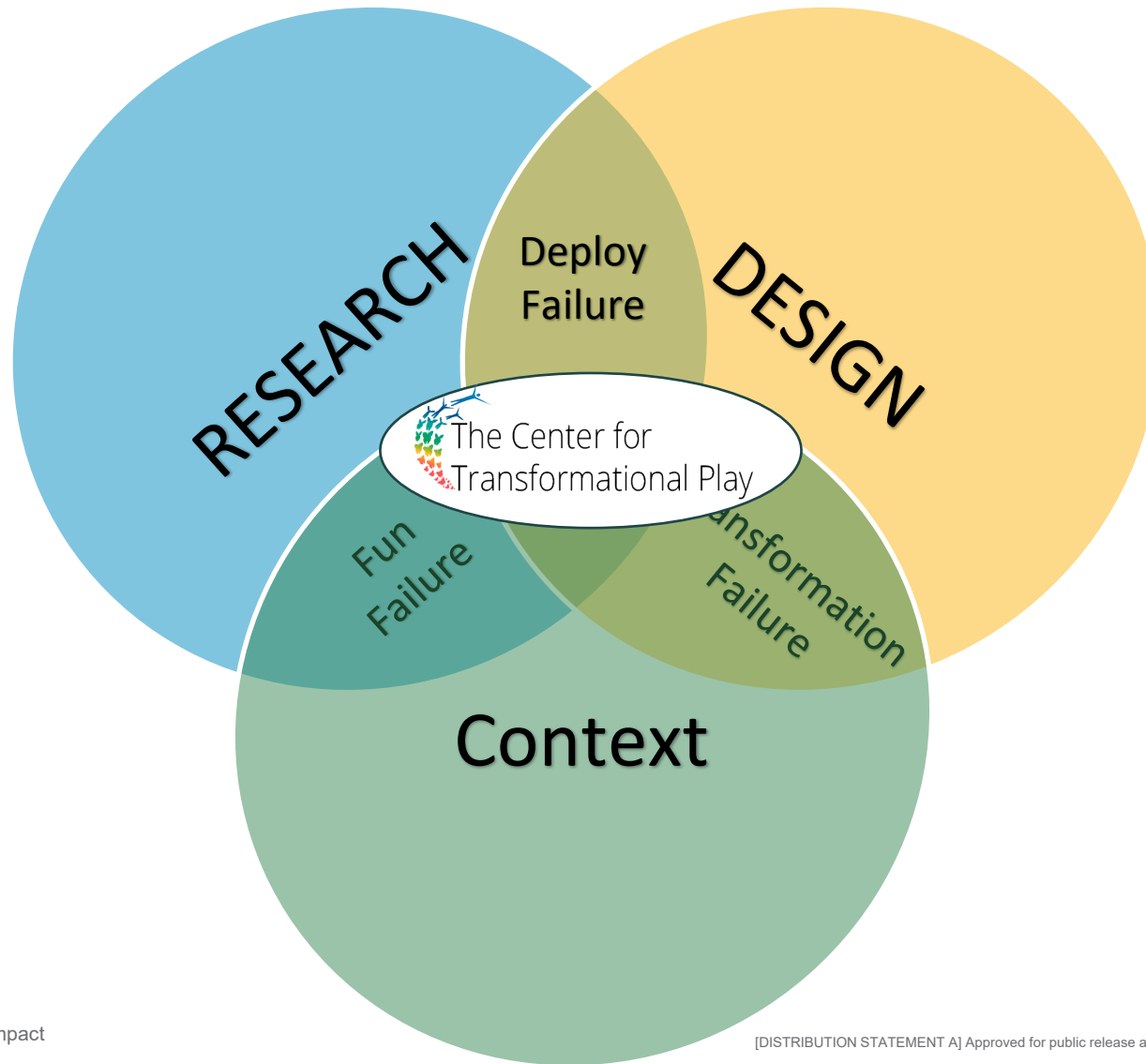
[2] K. Burgas and H. V. Yanamandala, "Ripple: A Role-Playing Game (RPG) That Shifts Power Dynamics in Healthcare," in *Proceedings of the Participatory Design Conference 2022 - Volume 2*, New York, NY, USA, 2022.

[3] T. Chen, M. Stewart, Z. Bai, E. Chen, L. Dabbish, and J. Hammer, "Hacked Time: Design and Evaluation of a Self-Efficacy Based Cybersecurity Game," in *Proceedings of the 2020 ACM Designing Interactive Systems Conference*, New York, NY, USA, 2020, pp. 1737–1749.

Improved Receptivity

- Semi-Fantastic Setting
 - Suspension of Disbelief
 - Prevent defensiveness
 - Retain applicability to prevent negative training value





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Questions?

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