

Performance, Rendering, and Interaction for Competitive Esports (PRICE)

Josef Spjut
jspjut@nvidia.com
NVIDIA
Durham, USA

Benjamin Watson
bwatson@ncsu.edu
North Carolina State University
Raleigh, USA

Madison Klarkowski
mw.klarkowski@qut.edu.au
Queensland University of Technology
Brisbane, Australia

Rulon Raymond
rulon@infinityward.com
Infinity Ward
Woodland Hills, USA

Mark Claypool
claypool@wpi.edu
Worcester Polytechnic University
Worcester, USA

Paul Ritaldato
paulritaldato@gmail.com
Epic Games
Cary, USA

Abstract

The global phenomenon of esports has created new and demanding challenges for computer graphics, interactive systems, and human-computer interaction. Competitive gaming pushes the boundaries of real-time rendering, latency reduction, and perceptual fidelity, where milliseconds and pixels can determine the outcome of multi-million dollar competitions. This workshop is a new, interdisciplinary venue for researchers and practitioners to discuss the state-of-the-art and challenges in esports technology. We invite contributions from a wide range of fields, including Computer Graphics, HCI, CSCW, Systems, and Human Factors (including Psychophysics), to foster collaboration and advance the science behind competitive play. Our goal is to unite scattered research efforts and establish a community focused on the technological foundations of esports.

CCS Concepts

• Human-centered computing → User studies; • Applied computing → Computer games.

ACM Reference Format:

Josef Spjut, Benjamin Watson, Madison Klarkowski, Rulon Raymond, Mark Claypool, and Paul Ritaldato. 2026. Performance, Rendering, and Interaction for Competitive Esports (PRICE). In *Special Interest Group on Computer Graphics and Interactive Techniques Conference Technical Workshops (SIGGRAPH Technical Workshops '26)*, July 19–23, 2026, Los Angeles, CA, USA. ACM, New York, NY, USA, 3 pages. <https://doi.org/10.1145/3799828.3811414>

1 Motivation and Rationale

Esports is no longer a niche hobby; it is a major cultural and economic force, with a global audience in the hundreds of millions and a market size exceeding \$1 billion. The performance and experience of both players and spectators are critically dependent on the underlying technology. Success in competitive games hinges on a complex interplay between hardware capabilities, software optimizations, and the limits of human perception. For example, the "peeker's

advantage" in first-person shooters is a direct consequence of network latency [Tokey et al. 2024], while player performance can be significantly impacted by display refresh rates and input-to-photon latency [Spjut et al. 2019]. Currently, research in this domain is fragmented, with relevant work appearing in disparate conferences across graphics, systems, networking, and HCI. There is no single venue that brings these communities together to focus specifically on the unique challenges posed by esports, and workshops at area-specific conferences help bridge these gaps [Kriglstein et al. 2022; Watson et al. 2021a,b].

SIGGRAPH is an ideal home for an esports workshop. As the premier conference for computer graphics and interactive techniques, it attracts a unique mix of leading academic researchers and industry pioneers from game studios, hardware manufacturers, and engine developers. By situating the workshop at SIGGRAPH, we can bridge the gap between academic inquiry and industrial application, fostering crucial dialogue that will drive innovation in this rapidly evolving field. This workshop will provide a much-needed focal point for this emerging research area.

2 Topics of Interest

We invite submissions on a broad range of topics related to the technology of esports and competitive gaming. These papers will be reviewed by the workshop organizers and invited reviewers if needed. Topics include:

- **Graphics and Rendering:**
 - Real-time rendering for high frame rates (> 240 Hz)
 - Latency reduction (e.g., NVIDIA Reflex, AMD Anti-Lag)
 - Perceptually-based rendering and visual clarity
 - Graphics for broadcast, spectating, and overlays
 - Novel display technologies for competitive environments
- **Systems and Performance:**
 - Low-latency input processing (OS, driver, and hardware)
 - Network protocols and models for competitive integrity
 - Performance analysis and optimization of game engines
 - Hardware co-design for competitive gaming
 - Matchmaking and netcode for low population servers
- **Human Factors and HCI:**
 - Psychophysical studies of latency, displays, and motion
 - UI/UX design for high-stakes, information-dense games
 - Player performance modeling, metrics, and data analytics
 - Haptic feedback and alternative modalities for player input

SIGGRAPH Technical Workshops '26, Los Angeles, CA, USA

© 2026 Copyright held by the owner/author(s).

This is the author's version of the work. It is posted here for your personal use. Not for redistribution. The definitive Version of Record was published in *Special Interest Group on Computer Graphics and Interactive Techniques Conference Technical Workshops (SIGGRAPH Technical Workshops '26)*, July 19–23, 2026, Los Angeles, CA, USA, <https://doi.org/10.1145/3799828.3811414>.

- Accessibility in competitive gaming
- Spectator-facing UIs for tournaments or livestreaming
- **CSCW, Data, and AI:**
 - Tools for collaborative team strategy and communication
 - Data visualization for post-game analysis and coaching
 - AI-driven coaching systems and training bots
 - Computer vision techniques for game state analysis
 - Methods for cheat detection and prevention

3 Format

The workshop will be a 3.25 hour half-day event. The format is designed to encourage discussion and community building, while allowing for novel research sketches to be presented and high-quality keynotes and invited talks to bring in more attendees. The tentative schedule (see Table 1) includes:

- **Invited Keynote:** A one-hour keynote presentation(s).
- **Technical Sketch Sessions:** Peer-reviewed presentations of research sketches, highlighting the latest scientific contributions. We plan for 6 and allow for 12 minutes per talk, including a 2-minute question and answer period.
- **Sketch Panels:** Two, 15 minute panel discussions related to the issues raised by the technical sketches.
- **Breaks:** Two breaks between sessions for discussion among attendees to further research ideas and collaborations.

Start Time	Duration	Event
0:00	0:05	Intro
0:05	1:00	Keynote
1:05	0:14	Break
1:19	0:36	Sketches (12 min each)
1:55	0:15	Sketch Panel
2:10	0:14	Break
2:24	0:36	Sketches (12 min each)
3:00	0:15	Sketch Panel
3:15	–	End

Table 1: Tentative Event Schedule

All accepted papers will be published in the conference’s proceedings as sketches. Depending on the level of interest of sketch contributions and the quality of submissions, we may opt to reduce or increase the length or number of invited talks to maintain a compelling workshop agenda. After careful review, the organizers decided to accept five of the seven submitted sketch proposals:

- **AI Level of Detail: Distance-Aware ML Model Precision Selection for Real-Time Human Motion Prediction in Games.** [Varghese 2026]
- **Towards Field Experiments in Esports Competition.** [Madhusudan et al. 2026]
- **Understanding Emergent Non-Verbal Communication in the Delta Force Competitive Video Game through Multimodal AI Analysis.** [Guo and Spjut 2026]
- **Improving Interaction by Transforming the Render-Display Pipeline.** [Fulmer et al. 2026]

- **What Do Competitive Players Do With Their Settings? A Multi-Game Esports Configuration Survey.** [Rajpurohit et al. 2026]

4 Intended Audience

This workshop will be of interest to a broad audience, including:

- Academic researchers and graduate students in graphics, HCI, systems, and related fields.
- Industry professionals, including game engine developers, graphics programmers, and game designers.
- Hardware engineers and researchers from GPU, CPU, and peripheral manufacturers.
- Esports professionals, including analysts, coaches, and technology consultants.

We anticipate an audience of 50-100 participants, fostering an environment for close interaction and networking. We have seen similar esports-focused frontiers workshops at SIGGRAPH reach these numbers of attendees in past years [Spjut and Watson 2025; Watson et al. 2024], and a similar workshop at SIGCHI in 2021 yielded 11 high-quality technical paper contributions that fit well into the half-day format [Watson et al. 2021a].

5 Organizers

Josef Spjut is a Senior Research Scientist at NVIDIA and an Adjunct Professor at Duke University and, in addition to conducting novel esports-related research over the last decade, has organized multiple SIGGRAPH Frontiers workshops and panels on esports in the past. His research interests include esports-optimized latency, high refresh rates, and the emerging applications of generative ai to video games.

Benjamin Watson Benjamin Watson is Associate Professor at NC State. His Visual Experience Lab focuses on the engineering of visual meaning, and works in the fields of gaming, graphics, visualization, interaction and user experience. His current work centers on emerging displays, esports and socially rich video conferencing. Watson co-chaired the Graphics Interface 2001, IEEE VR 2004 and ACM Interactive 3D Graphics and Games (I3D) 2006-7 and 2025-26 conferences. Watson is an ACM and senior IEEE member. He earned his doctorate at Georgia Tech’s Graphics, Visualization and Usability Center.

Dr Madison Klarkowski is a Lecturer at the Queensland University of Technology (Brisbane, Australia) and founding member of the Games Research and Interactive Design Lab. She publishes extensively in the areas of understanding and cultivating high performance in esports contexts, player behaviour and interactions, and social connectedness in competitive gaming communities.

Rulon Raymond (He/Him) is a Sr. Director of Technology at Infinity Ward. He’s been working on core engine technology at Activision, with a focus on high-performance graphics, for over 23 years. Past projects include the Tony Hawk and Guitar Hero series, with the majority of the time focused on the Call of Duty franchise. A particular focus of his work has been striking a balance between the always-growing expectations that gamers have around competitive gameplay and compelling visuals.

Mark Claypool is a Professor in Computer Science and Interactive Media & Game Development at Worcester Polytechnic Institute

(WPI). He's an expert on the effects of latency on computer games, with over 75 peer reviewed publications in this area alone, funded by research support from NSF, MIT Lincoln Labs, Intel, Microsoft, Google, Viasat, and NVIDIA.

Paul Ritaldato is a Rendering Engineer at Epic Games, where he focuses on low level systems and rendering architecture for large scale, competitive titles. Previously, he served as a Rendering Engineer at Electronic Arts, contributing to the Madden franchise. Paul is passionate about building optimized systems designed to deliver high performance, low latency environments that are essential for eSports. His work centers on hardware level efficiency and visual quality required for eSports level gameplay.

Acknowledgments

Generative AI was used to help format the table, to brainstorm the title of the workshop, and as part of the initial rough draft of the proposal, including the list of topics of interest.

References

- Aaron Fulmer, Evan Jonson, Hee-Jin Choi, Hyoungsik Nam, and Benjamin Watson. 2026. Improving Interaction by Transforming the Render-Display Pipeline. In *Special Interest Group on Computer Graphics and Interactive Techniques Conference Technical Workshops (SIGGRAPH Technical Workshops '26)* (Los Angeles, CA, USA) (SIGGRAPH Technical Workshops '26). Association for Computing Machinery, New York, NY, USA, 1–3.
- Jinyuan Guo and Josef Spjut. 2026. Understanding Emergent Non-Verbal Communication in the Delta Force Competitive Video Game through Multimodal AI Analysis. In *Special Interest Group on Computer Graphics and Interactive Techniques Conference Technical Workshops (SIGGRAPH Technical Workshops '26)* (Los Angeles, CA, USA) (SIGGRAPH Technical Workshops '26). Association for Computing Machinery, New York, NY, USA, 1–3. doi:10.1145/3799828.3816006
- Simone Kriglstein, Anna Lisa Martin-Niedecken, Josef Spjut, Nicole B Damen, Selen Türkay, and Anders Drachen. 2022. Esports meets human-computer interaction. *interactions* 29, 3 (2022), 42–47.
- Arjun Madhusudan, Josef Spjut, Ben Boudaoud, Joohwan Kim, and Benjamin Watson. 2026. Towards Field Experiments in Esports Competition. In *Special Interest Group on Computer Graphics and Interactive Techniques Conference Technical Workshops (SIGGRAPH Technical Workshops '26)* (Los Angeles, CA, USA) (SIGGRAPH Technical Workshops '26). Association for Computing Machinery, New York, NY, USA, 1–3.
- Ashish Rajpurohit, Arjun Madhusudan, and Benjamin Watson. 2026. What Do Competitive Players Do With Their Settings? A Multi-Game Esports Configuration Survey. In *Special Interest Group on Computer Graphics and Interactive Techniques Conference Technical Workshops (SIGGRAPH Technical Workshops '26)* (Los Angeles, CA, USA) (SIGGRAPH Technical Workshops '26). Association for Computing Machinery, New York, NY, USA, 1–3.
- Josef Spjut, Ben Boudaoud, Kamran Binaee, Jonghyun Kim, Alexander Majercik, Morgan McGuire, David Luebke, and Joohwan Kim. 2019. Latency of 30 Ms Benefits First Person Targeting Tasks More Than Refresh Rate Above 60 Hz. In *SIGGRAPH Asia 2019 Technical Briefs* (Brisbane, QLD, Australia) (SA '19). Association for Computing Machinery, New York, NY, USA, 110–113.
- Josef Spjut and Benjamin Watson. 2025. Esports Rendering: Industry and Player Perspectives. In *Proceedings of the Special Interest Group on Computer Graphics and Interactive Techniques Conference Frontiers*. 1–2.
- Samin Shahriar Tokey, Zesheng Chen, Colin Mettler, Dexuan Tang, Ben Boudaoud, Joohwan Kim, Josef Spjut, and Mark Claypool. 2024. The Effects of Network Latency on the Peeker's Advantage in First-person Shooter Games. In *Proceedings of the 19th International Conference on the Foundations of Digital Games*. 1–10.
- Mathew Varghese. 2026. AI Level of Detail: Distance-Aware ML Model Precision Selection for Real-Time Human Motion Prediction in Games. In *Special Interest Group on Computer Graphics and Interactive Techniques Conference Technical Workshops (SIGGRAPH Technical Workshops '26)* (Los Angeles, CA, USA) (SIGGRAPH Technical Workshops '26). Association for Computing Machinery, New York, NY, USA, 1–3.
- Benjamin Watson, Josef Spjut, Joohwan Kim, Byungjoo Lee, Mijin Yoo, Peter Shirley, and Rulon Raymond. 2024. Is less more? Rendering for esports. *IEEE Computer Graphics and Applications* 44, 2 (2024), 110–116.
- Benjamin Watson, Josef Spjut, Joohwan Kim, Jennifer Listman, Sunjun Kim, Raphael Wimmer, David Putrino, and Byungjoo Lee. 2021a. Esports and high performance HCI. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems*. 1–5.
- Benjamin A Watson, Josef Spjut, Caitlin McGee, Amine Issa, and Wayne Mackey. 2021b. Esports as a Driving Problem in Computer Graphics. In *ACM SIGGRAPH 2021 Panels*. 1–2.