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Bridging the Gap: A Situated Pedagogical Framework for Interdisciplinary Graphic Design and Human Factors Research

ABSTRACT

As graphical user interfaces (GUI) evolve beyond static screens into dynamic, high-stakes interfaces—such as autonomous vehicles and healthcare control units—the traditional silos separating visual communication from human factors psychology and broader human-computer interaction (HCI) present a critical barrier to effective education. This paper outlines a seven-year pedagogical framework developed at California State University, Long Beach (CSULB) that structurally bridges the School of Art Graphic Design Program and the Master of Science in Human Factors (MSHF) Psychology program. Informed by Activity Theory (Kaptelinin & Nardi, 2006), this interdisciplinary model evolved from ad hoc usability testing of Environmental Control Units (ECUs) at the VA Hospital into a formalized "Design-as-Research" infrastructure. By establishing a shared laboratory environment equipped with a BeamNG.drive physics simulator, graphic design students shifted from designing static visual aesthetics to engineering "XUI in Motion"—interfaces shaped by the temporal, physical, and cognitive constraints of driving. This framework shows that pairing graphic design students with rigorous human-factors testing produces joint peer-reviewed publications, advances human-factors capstone research, and prepares graphic design students for successful placement across leading technology and automotive sectors.

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Interdisciplinary design education, human factors psychology, Human-Computer Interaction (HCI), XUI in motion, Right-to-Left (RTL) localization, simulation

1. Introduction

Traditional graphic design pedagogy is rooted in visual communication, typography, and aesthetics, often teaching students to design static displays. However, professional engagements in the automotive and technology sectors show that interfaces are situated systems that require effective human-computer interaction strategies (Shneiderman, 1986). Direct exposure to cutting-edge automotive interface projects—facilitated through independent design consulting with agencies—highlighted a severe pedagogical gap: traditional design tools do not account for temporal constraints, divided attention, and physical motion.

Meanwhile, human factors and ergonomics (HF/E) focuses on human cognitive load and user safety yet often lacks the rapid prototyping capabilities needed to build the interfaces it tests. To address this friction, an applied pedagogical incubator was established at CSULB, combining the aesthetic and structural expertise of the Graphic Design program with the behavioral-science rigor of the Psychology Department's Stress & Technology Applied Research (STAR) Laboratory.

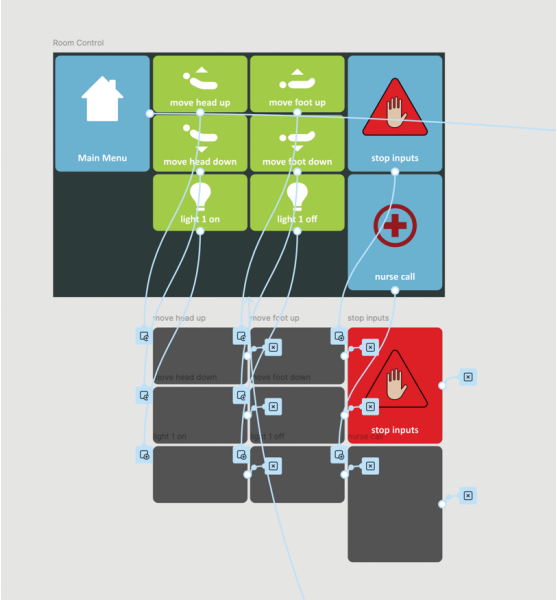
This framework treats graphic design and human factors research as two sides of the same coin for GUI design projects: one shapes how an interface communicates, the other empirically measures how people actually use it and/or how effective the design is in achieving user goals. Bringing them together in the classroom is a practical response to interfaces that now operate in dynamic, high-stakes environments, producing graduates with hands-on training in this collaborative process: graphic designers who understand how their work will be tested, and researchers who understand how interfaces get built.

2. The beginning of the collaboration: the VA hospital project

This interdisciplinary workflow began in 2019 with a project focused on optimizing usability for the autonoME Hospital Environmental Control Unit (ECU; Accessibility Services, Inc., Homosassa, FL). The objective was to redesign an interface for paralyzed veteran users with spinal cord injuries and disorders (SCI/D), enabling them to complete daily tasks autonomously.

Inspired by professional design agency workflows, the team created a design and evaluation process. Seven trained human factors students, together with Hancock and Anvari, conducted an on-site heuristic evaluation of the ECU's touchscreen interface at the VA hospital, applying established usability frameworks (Nielsen, 1994; Shneiderman, 1986). The evaluation identified specific usability issues—including a missing back button and inconsistent placement of functions across screens—and was published as the team's first paper on the project (Hancock et al., 2020a), directly informing an enhanced redesign of the interface. When the COVID-19 pandemic suspended physical access to the VA facility in 2020, the team built an interactive prototype based on the original screens and planned for four representative tasks—placing a phone call, adjusting the bed, watching a video, and composing an email—to A/B test the enhanced design against the original (Figure 1).

This shift reflected more than a change of tools. Within an Activity Theory framework (Kaptelinin & Nardi, 2006), the pandemic functioned as a contradiction that disrupted the established activity system—physical access to the ECU—forcing the team to reconstruct its mediating artifact as a digital prototype without abandoning the underlying objective of the work: improving usability for SCI/D users. The same pattern recurred when the driving simulator later replaced the physical vehicle cabin as the mediating artifact for testing in-vehicle interfaces.



» **Figure 1:** *Digital replica of the ECU interface, developed in Figma for remote A/B usability testing*

The team pivoted to remote testing over Zoom with 60 student participants serving as a neurotypical comparison group, replacing the original veteran users. During this testing, Hancock administered the NASA Task Load Index (NASA-TLX; Hart & Staveland, 1988) to assess perceived workload and the System Usability Scale (SUS; Brooke, 1996) to assess perceived usability, generating over 90 hours of processed video data.

The collaboration continued after the pandemic with a separate heuristic evaluation of the ECU's eye-tracking control modality—this time conducted by Anvari alongside Hancock's human factors students and published (Hancock et al., 2020b). The collaboration formalized into an interdisciplinary research program—bridging graphic design and human factors methodologies to support veterans with SCI/D—presented at the 21st Congress of the International Ergonomics Association (Anvari et al., 2021).

The team grew accordingly, from seven students at its 2019 launch to nearly nineteen by its later years, coordinating through Slack and Microsoft Teams in a semi-realistic professional environment that encouraged cross-pollination across disciplines. Graphic design students were also recruited as test participants for the human-factors students' research, gaining firsthand experience of the user-research process from the participant's perspective, with extra credit and co-authorship used as incentives.

3. Situated simulations and XUI in motion

Building on the ECU project's success, the methodology was formalized and applied to the highly dynamic domain of in-vehicle information systems. The upper-division graphic design curriculum was restructured around the concept of XUI in Motion—teaching how interfaces, the human body, and the environment interact sequentially over time in physical space (Anvari, 2026).

To execute this vision, the team engineered a fixed-base partial-cab simulator using the BeamNG.drive physics engine (BeamNG GmbH, Bremen, Germany), which provides a controlled environment for testing cyber-physical systems and driving scenarios. Equipped with an Xbox gaming steering wheel and pedals, a short-throw projector for environmental display, and an iPad Pro center console (Figure 2), the car simulator was integrated into the Art-419 (5D) course. This integration allowed undergraduate graphic design students to physically experience their own user interface prototypes under the cognitive and visual demands of simulated Level 3 automated driving.

The surrounding hardware, including the iPad, steering wheel, Xbox pedals and panel controls, and chair, was funded by the CSULB Undergraduate Research Opportunities Program (UROP) and the College of the Arts (COTA). It was later equipped with a 45-inch monitor with just a slight curve—chosen over more curved options to sit closer to a flat cluster-panel display—mounted on a height-adjustable actuator to replicate cluster-panel and dashboard layouts. This combination of static and interactive screens supported a wide range of user testing, using Figma as the prototyping tool. A free BeamNG.drive license, obtained as the project progressed, extended the platform's capabilities to replicate both manual and autonomous driving conditions.



» **Figure 2:** *A student is preparing the fixed-base, partial-cab simulator for a capstone research project's user testing and data collection*

4. Case studies in interdisciplinary capstone research

This shared simulator infrastructure made it possible to progress from subjective aesthetic grading to empirical validation of design usability. It was also used for advanced interdisciplinary capstone projects for human factors master's students, several of which have participated in the CSULB Student Research Competition, an annual event hosted by the Office of Undergraduate Research Services (OURS) at CSULB that showcases excellence in scholarly research and creative activity through oral presentations to a jury of distinguished faculty (California State University, Long Beach, 2026):

4.1. Visual Impairments and Contrast Polarity

This capstone project investigated how varying levels of visual distortion and interface contrast (light vs. dark mode) affect driving performance and readability in a simulated environment. Preliminary results were presented as a poster at the 20th Annual HFES Student Research Chapter at California State University Long Beach, and the full findings are being prepared for a separate publication. The work also won first prize in the Creative Arts and Design category at the 2025 CSULB Student Research Competition.

4.2. Multimodal Takeover Requests in Semi-Autonomous Vehicles

This capstone project used the car simulator to study takeover requests in self-driving mode: while the simulated car drove itself, drivers performed non-driving-related tasks (NDRTs) such as playing video games or watching videos. The study compared the effectiveness of audio-visual alerts with combined audio-visual-haptic alerts in returning drivers to manual control. Preliminary results were presented as a poster at the 21st Annual HFES Student Research Chapter at California State University Long Beach, with full findings to be reported in a forthcoming publication. This work also won second prize in the Creative Arts and Design category at the 2026 CSULB Student Research Competition.

4.3. Adverse Weather and Interface Usability

A third capstone project examined how weather (clear, rain, fog) and interface contrast (light vs. dark mode) affect driving performance in the simulator. Perceived usability was measured separately, using instruments including the System Usability Scale (SUS; Brooke, 1996). Findings were presented as a poster at the 21st Annual HFES Student Research Chapter conference at California

State University Long Beach, and the student is preparing the work for a forthcoming publication. This project also won third prize in the Creative Arts and Design category at the 2026 CSULB Student Research Competition.

5. Industry integration and localization

Parallel to the academic research incubator, Anvari's independent industry consulting for the automotive sector—including a peer-reviewed study on localizing interfaces for Right-to-Left (RTL) languages such as Arabic and Hebrew (Anvari & Woods, 2024)—provided firsthand exposure to situated, high-stakes interface design described in the Introduction, reinforcing the practical need for the pedagogical framework outlined in this paper.

Separately, Edenspiekermann—a design agency headquartered in Berlin with a Los Angeles branch office—has worked with the Art-419 (5D) course since 2018, helping draft project briefs, guest lecturing, and running student workshops; several Bachelor of Fine Arts (BFA) graphic design students have since interned there.

6. Structured educational outcomes

This multidisciplinary approach fundamentally shifts how students frame cognitive problems. Consistent with Activity Theory's emphasis on analyzing an activity before designing a tool to mediate it (Kaptelinin & Nardi, 2006), the curriculum now guides graphic design students to analyze the user's context before designing an interface. Paired with the human factors testing described above, this approach shifts students from open-ended aesthetic exploration toward structured, evidence-based problem-solving.

This growth was also reinforced through direct cross-enrollment: human factors students were encouraged to take Art-419 (5D)class, and BFA graphic design undergraduates were encouraged to take PSY 327 Introduction to Human Factors as an elective course. Human factors students who completed Art-419 (5D) gained hands-on experience in user-centered design, presentation, documentation, and iterative design, skills central to graphic design practice.

Anvari's engineering background further enabled participation as a mentor in the university's Undergraduate Research Opportunity Program (UROP), which funded research assistants—recruited from engineering, health science, and art—to support the simulator's setup, maintenance, and data collection and analysis. Both the UROP assistants and the human factors students recruited for the capstone projects in Section 4 completed CITI (Collaborative Institutional Training Initiative) certification as a prerequisite for CSULB Institutional Review Board (IRB) approval, then conducted user testing and processed the resulting data. In the process, they gained a working understanding of graphic design, user interface prototyping, human factors, and user-centered design testing, turning the lab into a small-scale model for further cross-disciplinary exchange.

This program shows that an accessible, modestly funded infrastructure can still produce meaningful design-in-dustry outcomes, from internships to full-time jobs. Students have landed roles at BMW Designworks, Edenspiekermann, various automotive companies, Google, Activision, and the broader gaming industry.

7. Conclusion

Digital interfaces have moved well beyond the desktop screen, shaping how people interact across healthcare, transportation, smart devices, entertainment, and daily life. Design education must keep pace with this shift to address the communication challenges these new contexts create. The interdisciplinary partnership at CSULB shows that a shared, localized infrastructure enables graphic designers and human factors psychologists to integrate their methodologies effectively. The ECU interface redesign and the BeamNG-based driving simulator documented here are not isolated case studies; each began as a single course-embedded project and matured into peer-reviewed research, industry consulting, and direct student placement in the field.

To enable similar interdisciplinary research pipelines, institutions should focus on three actionable strategies. First, with thoughtful replication and creativity, accessible consumer-grade simulation tools—such as gaming engines, steering wheels, and tablet displays—can recreate authentic industry conditions in any studio setting, enabling rigorous testing regardless of institutional resources. Second, programs must support co-teaching models and joint studio critiques, in which design and engineering psychology students co-evaluate prototypes using standardized rubrics. Finally, academia must reframe design metrics by integrating quantitative human factors benchmarks, such as task completion time, cognitive load, and contrast legibility, directly into design rubrics alongside traditional aesthetic criteria. By bridging this gap, graphic design education can approximate the collaborative rigor of industry practice and produce practitioners capable of navigating emergent technological landscapes.

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