Product Experience Design (PXD): A Pedagogical Framework for Experience-Driven Product and Systems Design With Emerging Technologies in Industrial Design Education

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Abstract
Traditional Industrial Design (ID) education has focused on teaching students how to create physical products that are functional, manufacturable, and aesthetically appealing. However, the rapid advancement of emerging technologies and the increasing complexity of modern design challenges necessitate a shift in design education toward a more holistic and integrated approach. This paper presents *Product Experience Design (PXD)*, a pedagogical framework developed for graduate-level ID education and applied to a graduate PXD Studio that incorporates *experience-driven design, systems thinking, and technology integration*. The PXD framework introduces a structured three-phase methodology: (1) *Experience Analysis*, in which students define experiential gaps and conduct user research to identify challenges; (2) *Systems Integration*, where students apply systems thinking to understand the interactions between users, products, and environments; and (3) *Technology Implementation*, which explores the role of emerging technologies such as artificial intelligence (AI) and spatial computing in enhancing product experiences. Two case studies from the PXD studio course illustrate how this methodology encourages innovative and systemic design thinking. The first case study, CareMate, focuses on an AI-driven medication management system that helps older adults maintain medication adherence with contextual AI-agent support tailored to the user's needs. The second case study, SPACIAL, highlights spatial computing technology to assist creative professionals in ideation, collaboration, and workflow optimization. By embedding emerging technologies into the design process and bridging physical and digital experiences, the PXD framework equips students with the skills necessary to address real-world challenges in an increasingly interconnected design landscape. This paper discusses the structure of the PXD framework, its pedagogical strategies, and its impact on design education. It contributes to a new paradigm in ID education that prepares students for 'experience-driven innovation and systems-level thinking.

Keywords: Industrial Design Education, Product Experience Design (PXD), Systems Thinking, User Experience (UX) Design, Emerging Technology, Spatial Computing, AI in Design

Introduction

Industrial Design (ID) education has traditionally focused on creating tangible, functional, and aesthetically refined products. However, as technology advances and user expectations shift, designers must move beyond standalone physical objects to consider integrated systems of digital interfaces, services, and intelligent interactions. This shift necessitates a new design approach that blends physical and digital experiences, addressing the increasing complexity of real-world challenges.

The Product Experience Design (PXD) framework was developed to bridge this gap, emphasizing experience-driven design, systems thinking, and emerging technology integration. Unlike conventional ID approaches, PXD encourages designers to view products as part of larger ecosystems, ensuring seamless interactions between hardware, software, and services. This approach equips students to tackle interdisciplinary challenges and design for the evolving landscape of hybrid physical-digital experiences.

This paper introduces the PXD framework and its implementation in a graduate-level studio course. It explores case studies to highlight its pedagogical structure and real-world applications. The paper then demonstrates how PXD fosters a holistic design perspective, preparing students to create user-centered, adaptable, and future-ready solutions.

The Need for a New Industrial Design Education Model

Addressing Complex, Systemic Challenges

The world is facing increasingly complex challenges, from climate change and sustainability to healthcare accessibility and digital transformation. Industrial designers create standalone products and develop integrated systems holistically to address user needs (Meadows, 2015). The traditional ID curriculum, emphasizing product-centered design, does not provide students with the necessary tools to design for these systemic challenges (Meyer & Morman, 2020).

The Shift From Physical to Hybrid Product Experiences

The proliferation of digital interfaces, IoT devices, and AI-powered products has shifted the design landscape. Today, products are often embedded within digital ecosystems, requiring designers to think beyond traditional physical design constraints (Buchanan, 2019). For example, wearable health devices are not just physical objects—they rely on data analytics, AI decision-making, and cloud-based user interactions. Digital transformation is a key driver of this shift, influencing how businesses and users interact with technology (Verhoef et al., 2021).

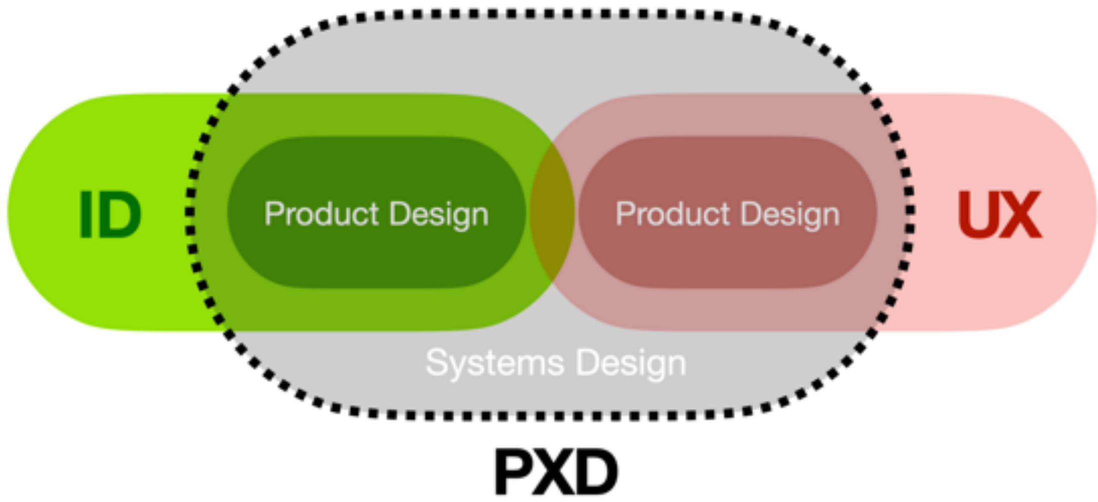
The Role of Emerging Technologies in Design

Emerging technologies such as spatial computing (AR/MR), AI-driven automation, and smart systems fundamentally reshape how users interact with products by making experiences more immersive, intelligent, and adaptive. Spatial computing extends interaction beyond screens, allowing users to engage with digital elements in physical space, leading to more intuitive and seamless product experiences. AI-driven automation enhances personalization and efficiency, enabling products to anticipate user needs, automate repetitive tasks, and offer real-time adaptive interfaces. Smart systems, including IoT and connected ecosystems, ensure that products no longer function in isolation but operate as part of larger, data-driven environments, improving convenience, usability, and long-term engagement. By integrating these technologies, the PXD framework enables designers to create functional and responsive products, evolving alongside users and their environments. Digital transformation has accelerated the need for designers to consider multi-modal interactions across physical and digital touchpoints (Verhoef et al., 2021).

The Product Experience Design (PXD) Framework

The Product Experience Design (PXD) framework represents a comprehensive approach that spans three key domains: Industrial Design (ID), User Experience (UX), and Systems Design as illustrated in the diagram (Figure 1). This framework provides a unified perspective on how these different areas of design interact and complement each other in the modern design landscape.

Figure 1: Product Experience Design Domains



Industrial Design (ID) is the physical aspect of product design. Its roots are deeply embedded in hardware development, tangible product design, and manufacturing processes. ID practitioners focus on the concrete elements of design, such as form, function, materiality, and ergonomics. Their approach is traditionally product-centric, emphasizing the physical creation, manufacturing, and use of objects.

On the digital side, User Experience (UX) design focuses on creating meaningful digital interactions. UX designers prioritize usability and cognitive interactions to create seamless user flows. Their methodology aligns closely with software-centric design, emphasizing digital tools and experiences that enhance user interaction.

Where these two domains intersect, we find a fascinating space of hybrid physical-digital solutions. This overlap represents a crucial area where ID and UX contribute to product innovation. Industrial design brings expertise in creating tangible, functional forms, while UX design contributes to understanding interaction models and user interface (UI) design. This collaboration results in products that successfully bridge the physical and digital worlds.

Systems Design is the foundational layer of PXD, bridging physical and digital product design. This approach extends beyond individual products to consider service design, platform ecosystems, and multi-modal experiences. It enables designers to think beyond isolated solutions and create harmoniously interconnected design systems.

The overarching scope of PXD differs from traditional design approaches in that it places experience at the center of the design process. Rather than focusing solely on physical or digital aspects, PXD encourages holistic problem-solving that ensures products function effectively within larger interoperable systems. This comprehensive approach incorporates emerging technologies such as AI, XR, and spatial computing to enhance user engagement, creating more meaningful and integrated product experiences.

The PXD Methodology: Three Phases of the Framework

The PXD framework is designed to bridge the gap between traditional Industrial Design education and the demands of a rapidly evolving technological landscape. By integrating experience-driven design, systems thinking, and emerging technology, PXD provides students with a structured approach to problem-solving that extends beyond individual product creation to holistic systems-level thinking. This framework is built on a three-phase methodology: *Experience Analysis, Systems Integration, and Technology Implementation*. Within the graduate PXD studio course, these three phases serve as the foundation for hands-on learning, guiding students as they explore real-world design challenges and develop innovative solutions.

Experience Analysis: Defining Experiential Gaps

The first phase of PXD begins with an in-depth analysis of how users experience a product, service, or system. This step is crucial in uncovering experiential gaps—the space between what users currently encounter and what would create an ideal interaction. To guide students through this process, the PXD studio course incorporates various research methods that encourage deep inquiry into user behavior, expectations, and frustrations.

Students start by conducting user journey mapping, breaking down each touchpoint in an interaction to understand where friction, inefficiency, or discomfort exists. They then apply ethnographic research methods, including direct observation and interviews, to capture the nuances of real-world product usage. Through context mapping, they explore the broader environmental, social, and technological factors that shape a product's impact on its users.

An essential part of this phase is reframing the problem statement. This practice challenges students to look beyond surface-level issues and consider the more profound, systemic reasons behind a poor user experience. In one example from the studio course, students investigating medication management among elderly individuals found that while many existing apps provided reminders, they failed to account for contextual factors such as forgetfulness, confusion, or reluctance to take medication due to side effects. By shifting the focus from simply providing reminders to developing a holistic, AI-driven support system, the students redefined the problem and opened new avenues for more meaningful solutions.

Through this process, students see design as improving human experiences rather than just creating objects. By the end of this phase, they have a clear understanding of user needs, pain points, and opportunities for innovation, setting the stage for deeper exploration into system-wide integration.

Systems Integration: Understanding Context and Relationships

With a well-defined experiential gap, the next phase of the PXD framework encourages students to explore how their proposed solutions interact within a broader system. In contrast to traditional product design, which often isolates an object from its environment, PXD requires students to consider the interdependencies between users, products, services, and technology.

At this stage, students engage in system mapping, a process that enables them to visualize the relationships among stakeholders, touchpoints, and external factors. This approach helps them move beyond a single-product mindset and develop solutions that consider the entire ecosystem of interactions. One technique utilized in the studio course is service blueprinting, where students outline how a product or service operates across multiple layers of engagement, from front-end user interactions to back-end infrastructure and support systems.

For instance, in the CareMate case study, the student initially focused on an AI-driven medication reminder system. However, through systems integration, he realized that addressing medication adherence required more than just reminding users to take their pills. The design had to integrate with caregiver networks, healthcare providers, and pharmacy services to create a seamless and supportive experience. As a result, the final concept included an AI agent-driven application that communicated with caregivers, automatic prescription refill notifications, and contextual AI adjustments based on the user's habits and routines. This system possibly incorporates a potentially wearable product to help the AI agent better understand the users' context at moments that matter most in critical health situations.

By working through this process, the student gains a critical systems-thinking mindset, which prepares him to create design solutions that are adaptable, scalable, and relevant to larger societal challenges. This phase emphasizes the importance of seeing design not as an endpoint but as part of an evolving ecosystem in which every decision impacts multiple stakeholders.

Technology Implementation: Leveraging Emerging Technologies for Meaningful Innovation

The final phase of the PXD framework focuses on technology as a bridge between experience and innovation. Students now explore how emerging technologies such as AI, spatial computing (AR/MR), IoT, and multimodal interfaces can be harnessed to enhance user interactions and create new engagement possibilities.

Unlike traditional Industrial Design programs, where technology is often introduced as a separate discipline, the PXD studio course integrates technology directly into the design process. Students learn to prototype AI-driven interactions, build immersive spatial computing experiences, and develop connected ecosystems that enable more fluid user-product interactions.

Throughout the course, students engage with hands-on prototyping tools such as:

- Unity and Bezi for developing AR/MR interfaces for Apple Vision Pro
- Figma for UI/UX wireframing and prototyping the interaction design

A notable example from the studio is the SPACIAL project, where a student designed an MR workspace for creative professionals. Recognizing that traditional screens limit ideation and collaboration, the project explored how spatial computing could transform designers' interaction with content in three-dimensional space. The system integrated gesture-based controls, AI-powered organization, and immersive 3D sketching tools, enabling users to ideate and iterate dynamically rather than being constrained by flat 2D displays.

By the end of this phase, students move beyond theoretical applications of technology to develop tangible, working prototypes that showcase how emerging tools can fundamentally reshape human-product interactions. This hands-on engagement prepares them for real-world challenges and equips them with the skills to lead innovation in physical and digital product ecosystems.

Case Studies: Applying PXD in Graduate Studio Projects

As part of their PXD project, the students were challenged to create products that solve everyday problems using advanced technology. The PXD Studio project involves research and design phases for physical and digital products. The students must consider the latest technology integration to enhance the design solution and provide an ideal user experience for the identified issues. This section introduces the design challenge students are working on, followed by two case studies from the course.

Design Challenges

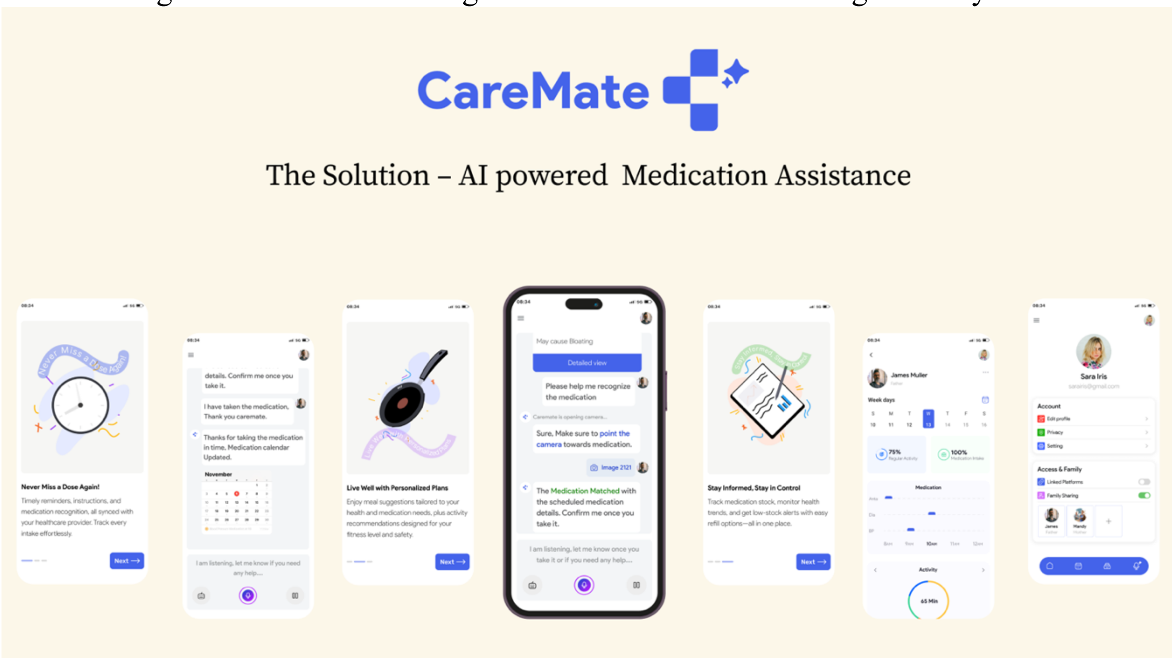
- Identify a critical issue at home or work based on individual interests and research discoveries.
- Conduct focused research on specific human needs, define the ideal experience, develop concepts, and test the designs.
- Define the ideal user experience that students want to help their users achieve.
- Specify the gaps between the current state and the ideal user experience.
- Explore design opportunities for products they largely control in size, functionality, and testing.
- Familiarize yourself with the various advanced technologies and have in-depth knowledge of the promising technologies to apply.
- Be an expert in explaining the technology you are applying to your solution.
- Determine the most promising and appropriate technology for their design to bridge the experimental gaps.
- Functionally creative and practical while aesthetically pleasing as an offering to the target user segments.

Case Study 1. CareMate: AI Agent-Driven Medication Management System

One project, CareMate, addresses medication adherence for older adults (Figure 2). Designed by graduate student Muhammad Akanda (2024) in the PXD studio course, the system integrates AI-powered reminders, wearable sensors, and smart home technology to provide a seamless, context-aware medication management experience. The AI agent personalizes reminders based on user habits and offers real-time support through voice or mobile interfaces.

This project demonstrates the power of combining AI, systems thinking, and user-centered design to create solutions that enhance accessibility, usability, and patient independence.

Figure 2: CareMate: AI Agent-Driven Medication Management System



At the heart of the CareMate system is an AI agent that tailors reminders based on the user's habits and daily routines. As the user interacts with the system, the AI learns and adapts, becoming increasingly effective. If a user forgets their medication at a particular time, for example, the system adjusts the reminders or even offers different ways to notify the user, ensuring they stay on track.

Another key feature is the system’s integration with wearable sensors. These sensors monitor a range of health metrics, from physical activity to sleep patterns, providing the AI with real-time data. By continuously analyzing this information, the system can make informed, context-aware decisions. For instance, if the sensors detect that the user is experiencing a fluctuation in health, the AI might adjust the medication schedule or send a warning about a possible interaction.

To make the medication management experience as seamless as possible, CareMate also connects to smart home devices like Alexa or Google Home. These devices become part of the caregiving ecosystem, allowing reminders and notifications to be delivered directly through familiar channels. Whether through a spoken reminder or a notification on a smart speaker, the system ensures that the user is never far from the support they need.

The mobile app provides a comprehensive overview of the user's medication schedule for those who prefer to manage their health on the go. It displays upcoming doses, health data, and relevant information in an easy-to-understand format. The app also enables family members or caregivers to monitor the user's medication adherence, ensuring a support network is always in place.

In addition to passive reminders, the AI offers real-time support. If users have doubts or questions about their medication, they can quickly interact with the system through voice commands or the mobile app for immediate assistance. This feature provides clarity, reduces anxiety, and makes users feel confident in managing their health.

The user-centered design of CareMate ensures that it is accessible and intuitive, taking into account the unique needs of older adults. Large text, voice-activated commands, and simple navigation make it easy for users with limited technical literacy or mobility issues to interact with the system. Moreover, the system empowers users to take control of their medication regimen while maintaining their independence. Caregivers are also included in the design, so they can stay informed and provide help when necessary.

The CareMate project is a perfect example of systems thinking in action. Instead of viewing medication management as a standalone issue, the system considers the broader context of the user's life. Incorporating an AI agent-driven assistant into the system creates a holistic, personalized experience that addresses the physical and environmental factors affecting medication adherence. This integrated approach ensures that medication is taken on time, but it also contributes to better overall health management and improves quality of life.

The potential benefits of the CareMate system are immense. First and foremost, it improves medication adherence, reducing the likelihood of missed doses and related health complications. Greater accessibility enables users with varying levels of tech-savviness or mobility to stay engaged in their health management. Perhaps most importantly, it gives older adults the tools to remain independent while being supported by a seamless network of technology and caregivers. With better health outcomes as the ultimate goal, CareMate is poised to make a real difference in the lives of older adults, helping them lead healthier, more independent lives.

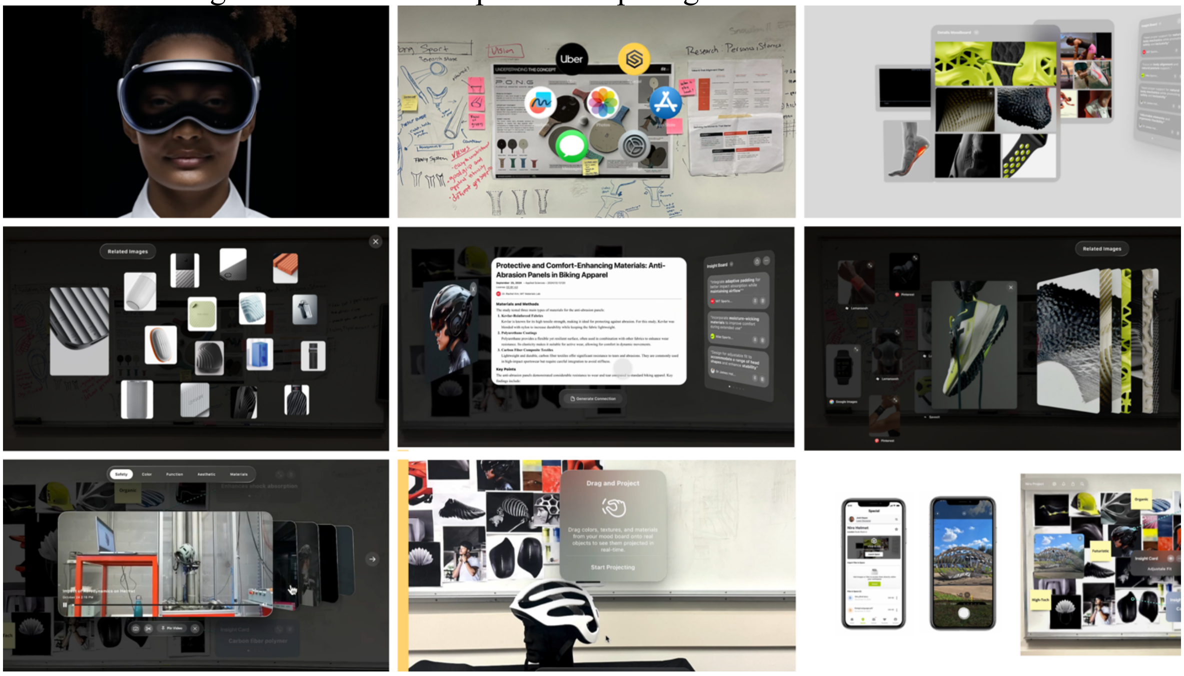
In all, CareMate demonstrates the power of combining AI, systems thinking, and user-centered design to solve a critical problem in healthcare. Integrating these elements creates a tailored, context-aware experience that enhances medication adherence and promotes overall well-being. It is a model for leveraging technology to support vulnerable populations, ultimately improving accessibility, usability, and independence.

Case Study 2. SPACIAL: Spatial Computing for Creative Professionals

The second project, SPACIAL, designed by graduate student Dillon Narcisse (2024) explores how spatial computing can enhance designers' creative workflows (Fiture 3). The system uses Apple Vision Pro to provide an immersive 3D workspace where professionals can ideate, collaborate, and prototype in a shared virtual space. AI agents assist by generating design suggestions, organizing content, and streamlining repetitive tasks.

This project redefines how creative professionals interact with their work environment by leveraging spatial computing and AI. It aims to bridge the gap between physical and digital creative processes.

Figure 3: SPACIAL: Spatial Computing for Creative Workflow



The core idea behind SPACIAL is to bridge the gap between the physical and digital realms. It utilizes the powerful capabilities of Apple Vision Pro and spatial computing to enable designers to engage with their work in entirely new ways. Through this immersive 3D workspace, designers are no longer confined to traditional screens or static workspaces. Instead, they are placed in a dynamic, virtual environment that offers unprecedented flexibility and freedom for ideation, collaboration, and prototyping.

The system's integration of AI agents elevates the experience by assisting designers in ways that go beyond simple task automation. These intelligent agents generate design suggestions, streamline content organization within the 3D space, and handle repetitive tasks, freeing up the designer's cognitive load. This support enhances the creative process and fosters efficiency, allowing designers to spend more time on their work's strategic and innovative aspects.

A key strength of SPACIAL is its ability to foster collaboration across distances. In an increasingly remote and global professional landscape, SPACIAL enables multiple users to enter a shared virtual space, collaborate in real time, and interact with the design from every angle. This fluid interaction helps bridge the gap between teams that may be located in different parts of the world, creating a shared environment where ideas can be exchanged seamlessly and intuitively.

By rethinking prototyping, SPACIAL also significantly advances how designers test their ideas. Rather than relying on traditional methods, such as static 2D designs or physical prototypes, designers can now interact with and iterate on 3D models in real time. The ability to instantly manipulate designs within the spatial computing environment offers immediacy and responsiveness that accelerates the entire design process.

The project's focus on user-centered design ensures that the SPACIAL system is functional and profoundly aligned with the needs and preferences of creative professionals. Its intuitive interface, combined with the physical interaction of a spatial workspace, reduces barriers for designers who may be less familiar with technology, making this advanced system accessible to a wide range of users.

This graduate project demonstrates excellent potential for the future of creative industries by leveraging emerging technologies to improve workflows and enhance collaboration. Through spatial computing, SPACIAL creates a new type of creative workspace where the boundaries between the digital and physical worlds no longer exist and the environment actively participates in the design process. This reimagined approach holds significant promise for empowering designers to innovate in once inconceivable ways, redefining the future of design workspaces.

SPACIAL is an exciting exploration into how AI and spatial computing can be harnessed to push the limits of creativity, collaboration, and efficiency in professional environments. It exemplifies the forward-thinking, technology-driven design essential for the next generation of creative professionals, positioning itself as a key tool for rethinking the spaces in which they work and the tools they use to bring their visions to life.

Conclusion and Future Directions

The PXD framework represents a transformative approach to ID education. It integrates experience-driven design, systems thinking, and the adoption of emerging technology. By training students to design beyond individual products and toward complete system experiences, PXD prepares them for real-world, future-ready careers.

PXD as a Model for the Future of Design Education

The PXD framework is more than a methodology. It represents a fundamental shift in how ID education prepares students for the future. The PXD studio course fosters a new generation of designers equipped to tackle complex, interconnected challenges by merging experience-driven insights, systems thinking, and cutting-edge technology.

Unlike traditional design programs that separate physical product design from digital user interaction(UI)/UX design, PXD emphasizes a seamless, hybrid approach that acknowledges designers' evolving role as systems innovators. Students graduate from the program as skilled product designers and strategic thinkers who understand how to create holistic user experiences across physical and digital touchpoints.

Through real-world case studies, interdisciplinary collaboration, and iterative prototyping, PXD ensures that students are prepared for the evolving demands of the design industry. Whether working on AI-driven healthcare solutions, MR-enhanced workspaces, or IoT-connected smart environments, graduates of the PXD framework enter the professional world with a mindset that is adaptable, forward-thinking, and deeply rooted in experience-driven innovation.

Future Research Focus

As the PXD framework evolves, future research will focus on expanding its reach and impact within design education. One key development area is the integration of PXD principles across undergraduate and interdisciplinary programs. While the graduate-level studio course has successfully fostered experience-driven design thinking, introducing these concepts earlier in undergraduate education can better prepare students to approach design challenges holistically. Additionally, incorporating PXD into interdisciplinary programs—such as those intersecting with engineering, computer science, or business can further enhance collaboration and innovation in product and systems design.

Another crucial focus is evaluating student outcomes through industry collaborations, design competitions, and research publications. Engaging with industry partners will provide valuable insights into how PXD-trained designers adapt to real-world challenges. At the same time, participation in competitions will allow students to test their problem-solving skills against global design standards. Furthermore, publishing research on PXD-based design methodologies will help refine the framework and establish it as a foundational approach in contemporary design education.

Finally, the role of AI and spatial computing in design education presents exciting opportunities for the continued advancement of PXD. By exploring how AI-driven tools and immersive spatial computing (AR/MR) environments can support ideation, prototyping, and collaboration, design educators can further enhance the learning experience and creative process. As PXD establishes itself as the next evolution of Industrial Design—ID 2.0—it lays the groundwork for a more adaptable, innovative, and experience-driven approach to preparing future designers for the complexities of an increasingly hybrid physical-digital world.

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