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Learning Design Thinking Through a Hands-On Learning Model

Norman Gwangwava, Botswana International University of Science and Technology, Palapye, Botswana

ABSTRACT

Design thinking is a human-centered, team-based, creative, and iterative process for problem-solving. The process focuses on the end-user and applies empathy skills to gain an understanding of the problem. Unlike other design methodologies, design thinking dwells on the most prominent user of the design solution. Industry 4.0 is characterized by fast-changing technology, which requires quick time-to-market solutions. Industry 4.0 applications involve more end-user interaction. In order to design products, applications, and systems that end-users will be comfortable using, designers should engage users throughout the design process. Design thinking brings together key parameters for achieving innovative user-centered design solutions. In addition to bringing together designers to work as multidisciplinary teams, the process factors in a creative environment under which the teams work. The article presents a case study for hands-on learning of design thinking where groups of students were engaged in solving pressing problems encountered by skilled craftsmen in the digital era.

KEYWORDS

Creative Thinking Teaching, Design Methods, Design Thinking, Digital Society, Empathy, Hands-On Learning, Ideation, Industry 4.0, Inquiry-Based Learning, Problem-Based Learning

INTRODUCTION

Approaches to design of products and systems have evolved over the years. Traditional design approaches have been regarded as "over the fence" methods, referring to their fragmented nature where silos of teams of disjointed departments work on part of the solution and pass on the output to subsequent departments until the final stage of launch. Sequential design methods are generally slow and ineffective. The need to involve the whole design team from the onset bore Concurrent Engineering (CE). CE is a simultaneous process, has team approach, and focuses on the customer. Other techniques such as Quality Function Deployment (QFD), complement concurrent engineering by bringing in customer focus. The history of CE dates back to the 1970s, when Japanese companies started using the method informally. First formal application of the method was by the Defense Advanced Projects Agency (DARPA) in America in 1982 (Menon & Graham, 1996). CE gained the hype in American, Japanese and European companies for formalizing and simultaneous execution of product-process design activities for new products. Although the customer centricity and multi-disciplinary team approach in CE brings innovation, the method is largely a formalized approach to traditional engineering of new products and enhancement of research and development (R&D) in companies. Among great achievements of CE, are shortening of time-to-market, convergence of diverse

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ideas through multi-disciplinary teams, customer focus, iterative simulation and rapid prototyping, and fewer Engineering Change Orders (ECO) issued after product launch.

The modern economy has transited to an "as a service economy". The 4th industrial revolution (Industry 4.0) is taking place in the digital and knowledge based economy. Simply put, Industry 4.0 is the transition from traditional means of doing work to smart automation, using modern smart technologies. The major enablers of Industry 4.0 are integrated technologies that include Internet of Things (IoT), Cyber Physical Systems (CPS), and Cloud Computing (CC) (Baena, Guarin, Mora, Sauza, & Retat, 2017; Posada et al., 2015; Kagermann, Helbig, Hellinger, & Wahlster, 2013). Cyber-physical systems (CPS) are physical and engineered systems, whose operations are monitored, coordinated, controlled and integrated by a computing and communication core (Rajkumar, Lee, Sha, & Stankovic, 2010). CPS-enabled smart factories have a network of intelligent objects linking products and assets with information from the internet, as well as capturing context information. Many factors contribute to the progression of manufacturing trends through to the current phase (Industry 4.0) and beyond. Some of them include shorter product life cycles, increasing product variation (mass customization), volatile markets, cost reduction pressures, scarce resources, cleaner production, lack of skilled workforce and aging community (Gwangwava, Mpofu, & Mhlanga, 2016). Modern technologies involve the use of connected sensors that enable data to be shared and accessed by people and machines across bigger networks in the services and manufacturing industries. These technologies extend the internet into the real world, embracing everyday objects (Mell & Grance, 2011). Individuals and corporate end users access the cloud through internet and access spans over different enterprises and platforms. Industry 4.0 is sustained by a new kind of worker—a knowledge worker. Industry leaders, managers and workers must possess skill sets to adapt and manage their operations in Industry 4.0. Critical thinking, problem solving, innovation, and communication are some crucial skills required in Industry 4.0. Business, education, and government must be innovative in training and retraining the Industry 4.0 compliant workforce.

The concept of design thinking emerged in the early 1980s, but gained increasing attention in the 2000s (Hassi & Laakso, 2011). The 21st century brought about a shift from product-process oriented design to business sector and service-oriented design. Design thinking helps people to define and solve unstructured problems, which have no historical references. This is typical of Industry 4.0 problems. Design thinking has five major stages: Empathize, Define (the problem), Ideate, Prototype, and Test. Design thinkers are innovators who design better products, services, processes, strategies, spaces, architecture, among various innovative initiatives. The method empowers anyone to solve complex problems that occur around us - in our companies, our countries, and even our planet. Benefits of design thinking include elimination of organizational silos, hence promoting a culture of collaboration and experimentation, helps broaden the design focus beyond functional needs to designing a user experience with an emotional touch, optimizes resources, and rests at the core of organizational strategy and change management.

Increasing complexity in design-oriented problems require innovative approaches of teaching and learning design methods. The greater part of the introduction looked at the progression of design methods up to the current preferred design thinking approach. The education sector is battling to incorporate design thinking in the regular curriculum (Li, *et al*, 2019; Melles, Anderson, Barrett, & Thompson-Whiteside, 2015). Renard (2014) presents a hands-on learning model as a vehicle for developing design thinking capacity in students. A studio-based, hands-on, material focused learning model was examined through case studies and in the context of recent scholarship on the topics of design thinking, design process, and studio culture. Noel and Liub (2017) assert that development of design thinking education interventions at primary school level leads to a paradigm shift in education, developing 21st century skills and predictors of student success such as a growth mindset.

Subsequent sections of the article focus on the literature around design thinking. Attention is drawn towards steps for executing design thinking, iteration from idea to solution launch, requirements engineering, and agile development systems. In order to bring discussions into context, Industry 4.0

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