The Futures of Design Pedagogy, Learning, and Education.

Peter Scupelli,[*a] Arnold Wasserman[b], Doris Wells-Papanek[c], & Judy Brooks[d]

a School of Design, Carnegie Mellon University.
b Collective Invention, San Francisco, CA, USA.
c Design Learning Network, Cross Plains, WI, USA.
d Eberly Center for Teaching Excellence and Innovation, Carnegie Mellon University.

In the 21st century, change is exponential. Products and services are designed and developed faster, and their shelf-life disrupted by a constant flow of new offerings. Thus, design for the 21st century requires different skills and design educators are challenged to teach new skills within an already packed curriculum. We describe four case studies as futures signs of a changing design profession and teaching and learning landscape. "Remaking Singapore as an innovation and world design hub" describes the role of design in helping a nation re-invent its education system and jumpstart a creative innovation economy." "INDEX" describes how a design competition was invented to instigate and crowd source the exploration of design to improve life. "Dexign Futures," a required undergraduate course, describes leveraging a flipped class format to provide students with sufficient practice to develop deeper expertise with new design methodologies. "Design Learning Network" describes leveraging the learning sciences and design-based strategies to challenge K-12 students as they develop the habits of mind to investigate problem sets and propose innovative solutions. We explore three critical questions for 21st century design learners: who teaches/learns design; where/how is design taught/learned; and when is design taught/learned.

Keywords: *Innovation; Design Thinking; Futures Thinking; Design Learning*

* Corresponding author: scupelli@cmu.edu

Introduction

The 21st century brings a world that is changing at an exponential rate in increasingly uncertain times. As design disciplines engage in larger and more complex problems, new methods and skills are necessary. Design education needs to keep pace and anticipate these changes. Many thought-leaders have articulated shifts in the field of design over time:

Design beyond craft: John Chris Jones described four levels of design – components, products, systems, and community – to advocate for new design methods that go beyond craft to cover new challenges such as traffic congestion and air quality (Jones, 1992).

Levels of complexity for product design: Jay Doblin described three levels of complexity: (a) products – the simplest form of design; (b) unisystems – coordinated products and the people that operate them; and (c) multisystems – the sets of competing unisystems (Doblin, 1987).

Levels of complexity for communications design: Meredith Davis explains that complexity expands within the field of communication design according to breadth of system and resulting human experience (Davis, 2008). As complexity and human experience increase, communication design goes from logo design to corporate identity, to branding, to service design.

Orders of design: Richard Buchanan introduced four orders of design to contrast the traditional understandings of the disciplines of communication design (symbol), industrial design (product), interaction design (action), and systems design (thought) with new understandings of design that blur the distinctions between types of design (Buchanan, 1992).

Exponential Design: Arnold Wasserman (2011) describes four versions of design to include design 1.0 as artifact-centric (e.g., making and selling); design 2.0 as human-centric (e.g., strategic field building and embedding; design 3.0 as Socio-centric (e.g., changing the world); and Design 4.0 as the post-anthropocene (e.g., sustainable prosperity @ one planet). (Figure 1)

Elizabeth Pastor (2013) co-founder of Humantific articulated the differences between four types of design that shift as levels of complexity increase: Design 1.0 traditional design thinking, Design 2.0 Product / Service Design thinking, Design 3.0 as Organizational Transformation Design thinking and, Design 4.0 as Social Transformation Design Thinking.

DesignX was a nomenclature created to get beyond the number of designs (e.g., Norman, 2014) to a broader version of design that shifts from a focus on products and services to a broader range of complex societal issues.
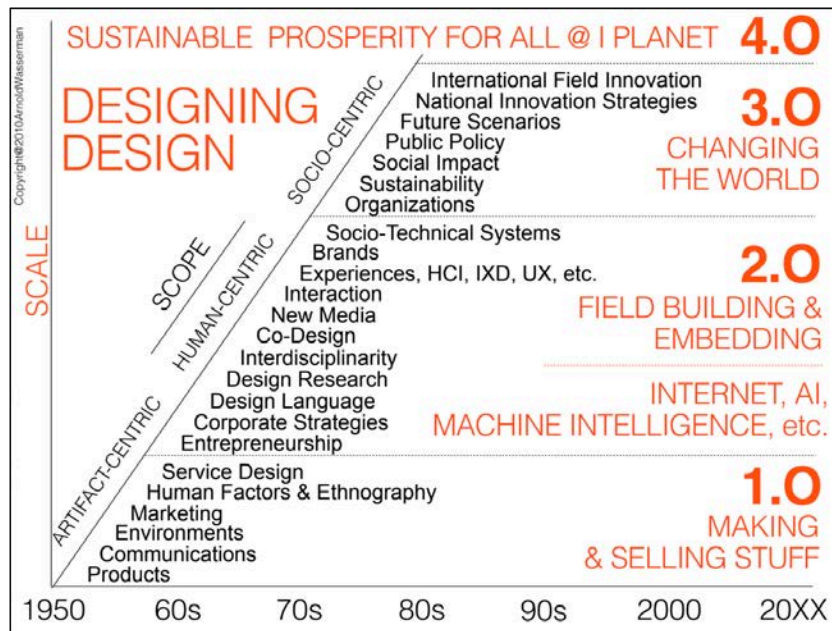
Figure 1. A brief timeline showing how the scale and scope of design have shifted across three different conceptions of design. (Wasserman, 2010)

In short, design shifts as the world shifts; design thinking and design methodologies evolve to address the complexity of ongoing and emerging societal challenges. Teaching design thinking to today's learners seems at least a priority, if not a necessity. Teaching design students who have not yet shifted their thinking to design for complexity is a requirement, even as this complexity evolves exponentially. The challenges for educational systems require a more rapid response to creating relevant curricula; thus the gap widens between where learners are and what they need to be able to do. Students' prior knowledge gaps and diversity of experience become out of sync with new course requirements, presenting ever-greater challenges for teachers.

Fundamental Shifts in Teaching and Learning Design

The diffuse adoption of design, design thinking and learning, along with the shift toward public and civil sectors (Design 3.0), and the rise of ethical concerns (Design 4.0)— disrupted the tradition of making and selling of stuff

3

(Design 1.0), as well as collaborative approaches to branding and designing the user's experience (Design 2.0) (Figure 1). These fundamental shifts require the exploration of new ways of teaching design effectively and efficiently, at a much broader scale and continuum of learners (K-12 through post-graduate levels).

Who **is teaching/learning design?** New providers and formats have emerged. Entrepreneurial design educators are popularizing design thinking through online courses and workshops.[1] In the case of K-12, design professionals are becoming design educators;[2] art educators and general education teachers are integrating learning-centered design thinking methods into their instructional best practices.[3] Formats include: online courses and degree programs (e.g., SCAD[4], COURSERA, UCSD[5]); online master classes (e.g., masterclass[6]); post-graduate education courses; and new providers: (e.g., IDEO U[7], IDEO.org[8], Luma Institute[9], Cooper Interactive University[10], Acumen.org[11]). How might we leverage this network of educators and resources?

Where/How **is design taught/learned?** Formerly, one would attend a four-year design school to have access to a design program or course on, for example, design thinking or human-centered design. Now, anyone anywhere can sign up for any number of options: online courses, short workshops, crowd-sourced competitions, customized executive education for teams embedded within organizations, and so on. What does this "where" mean for design schools and educators? How might we leverage where and in what time scales our formal design schools/educators teach design (e.g., online-blended offerings, micro-courses)?

Design schools change their curriculums on faster timelines to address new design topics and approaches. Design educators feel pressure to deliver more to underprepared students in the same amount of time. This forces us

---

[1] https://dcc-edu.org/
[2] http://studio-h.org/
[3] http://www.designlearning.us/kc2016
[4] https://www.scad.edu/
[5] https://www.coursera.org/specializations/interaction-design
[6] https://www.masterclass.com
[7] https://www.ideou.com/
[8] https://www.ideo.org/
[9] https://www.luma-institute.com/
[10] https://www.cooper.com/training
[11] https://acumen.org/

to rethink how we teach new subjects effectively and more efficiently to students who do not have prior knowledge or previous exposure to design thinking and design-based learning strategies as they relate to newer and/or emerging fields (e.g., sustainability, machine learning, futures design).

When is design is taught/learned? Traditionally taught in 2- 4- 6-year time-cycles in degree programs at universities, polytechnics, and beaux art schools, design courses today are available as lifelong learning offerings from K-12 through post-graduate executive education and beyond. How might we leverage this continuum of teaching and learning?

The Learning Sciences Guide the Future of Design Education

Requisite shifts in 21st century design teaching and learning call for new understandings of who our students/future designers are, what they need to learn, and how to evolve our teaching practices. To prepare our students to address these unprecedented challenges, it is critical that we invest in the learning sciences. Students will be expected to dive much deeper into strategic and reflective thinking processes—as they tackle complex issues such as unpredictable futures design, dynamic public policies, and social transformations within highly diverse contexts.

John Hattie's ground-breaking research and synthesis of over 800 meta-analyses has taught us that effective creative thinking and problem-solving learning activities are anchored in strategic and reflective thinking, gathering and defining information, building and showing understanding, and productive/generative thinking. (Figure 2)

Based on the learning sciences, we know that well-facilitated creative thinking and problem-solving experiences have high impact on the learning process and outcomes. Preparing students to engage, process, and retain new content via hands-on activities results in opportunities to access new thoughts and develop authentic understandings. As creative problem-solvers acquire deeper understandings, so do their abilities to apply cognitive flexibility and insightful interpersonal skills across diverse sets of domains. Positive effects are constant across all disciplines: mathematics (effect size = .89), science (effect size = .78), reading (effect size = .48) (Hattie, 2009).
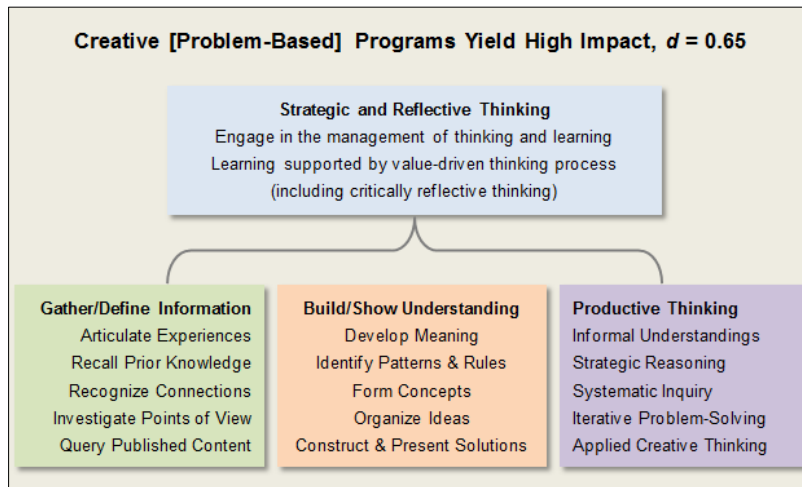
Creative [Problem-Based] Programs Yield High Impact, $d = 0.65$

Strategic and Reflective Thinking
Engage in the management of thinking and learning
Learning supported by value-driven thinking process
(including critically reflective thinking)

Gather/Define Information	**Build/Show Understanding**	**Productive Thinking**
Articulate Experiences	Develop Meaning	Informal Understandings
Recall Prior Knowledge	Identify Patterns & Rules	Strategic Reasoning
Recognize Connections	Form Concepts	Systematic Inquiry
Investigate Points of View	Organize Ideas	Iterative Problem-Solving
Query Published Content	Construct & Present Solutions	Applied Creative Thinking

Figure 2.   Adapted from Hattie, John. Visible Learning: A Synthesis of over 800 Meta-analyses Relating to Achievement. London: Routledge, 2009.

Creative problem-based learners engage in experiential activities to engage, process, and retain new information. In high contrast, learners who are required to engage in scientific (fact-based) information tasks or passive (non-interactive) conceptual (theoretical) assignments are far less successful. Thus, it is essential to focus on the application of knowledge, not simply the development of knowledge (Hattie, 2009).

Four Cases: Trajectories of 21st Century Design

Four real-world cases offer a basis for discussing current and likely future trajectories of 21st century Design. These cases,in which the authors are engaged as lead designers, illustrate our three main points related to the future of 21st century design; i.e.:who teaches/learns design; where/how design is taught/learned; and when design is taught/learned.

Two case studies, "Remaking Singapore" and "INDEX: Design to Improve Life," illustrate how design is changing in the professional world and internationally. The other two cases, "Dexign Futures" and "Design Learning Network" illustrate changes to how and where design is being taught.

Figure 3 illustrates the relationships between the four cases based on two dimensions: locus and sector. The locus ranges from hyper-local to multi-local. The sector ranges from design-based learning to design-based socio-economic development.
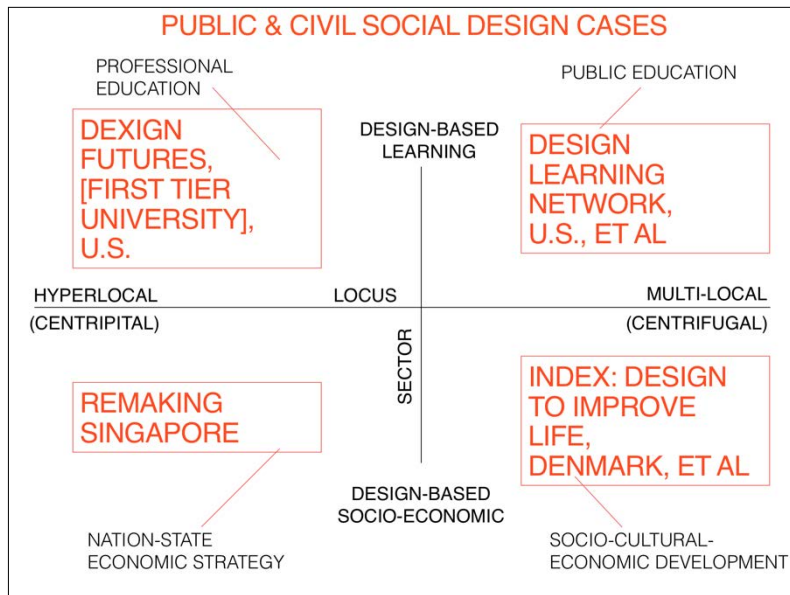
6

Figure 3. The relationships between the four cases based on two dimensions: locus and sector. The locus ranges from hyperlocal to multi-local. The sector ranges from design-based learning to design-based socio-economic development. (Wasserman, 2018)

CASE 1: Remaking Singapore

Remaking Singapore illustrates three main themes. First, a broad range of people involved in learning design thinking: government officials, administrators, teachers, and students being taught design thinking skills. Second, the efforts of a design consultancy, The Idea Factory, to facilitate the spread of design thinking into government agencies, schools, and curriculums. Third, shifts in where design thinking was taught (e.g., government ministries, schools, classrooms and private industries).

A National Innovation System

In 2002, the government of Singapore launched a ten-year plan to transform Singapore from an efficiency/productivity culture to a creativity/innovation economy. The program was called Remaking Singapore. The nation's economic success in recent years had priced it out of the market for low-cost contract manufacturing. Other Asia Pacific

countries were challenging Singapore's dominance as the region's premier shipping port.

Singapore had to move up the curve of value-added goods and services. This meant that Singaporeans had to learn how to originate, invent and innovate – capacities that had not been cultivated in the past. All ministries and agencies of Singapore government were charged to come up with a plan for embedding a new culture of innovation in their own organizations and, in turn, in their national policies and programs.

To assist in this effort, Wasserman's innovation consultancy, The Idea Factory, worked with the Ministries of Environment; Community Development and Sports; Information, Communication and the Arts; the Economic Development Board; and the Media Development Authority.

Redesigning Education First

We began working first with the Ministry of Education (MOE). A disruptive transformation of the scope planned by Remaking Singapore had to begin with education – **how students are taught to think, the methods they are given to do it, and the criteria for assessing educational success**.

A superb education system had produced two generations of Singaporeans highly skilled in mathematical, scientific, analytical, and critical thinking[12]. These skills made Singapore a world leader of efficiency, reliability, and execution. Excellent solvers of well-defined problems, Singapore's students were uncomfortable with ill-defined, unstructured problems – the "wicked" problems for which there is no single correct answer and that characterize most innovation. Creative innovation requires a high tolerance for uncertainty, confusion, paradox, and the willingness to "fail forward fast and frequently."

In order to "Remake Singapore," Singaporeans would have to develop new habits-of-mind, new thinking skills, and new social norms defining success. This would have to begin in K-12 schools. And before that could happen, it would have to happen within the MOE organization itself, where all curricula programs, teaching materials, and assessment methods originated.

---

[12] OECD PISA has always ranked Singapore in the top tier since 2000 and highest in 2015 rankings published 2017: http://www.oecd.org/education/singapore-tops-latest-oecd-pisa-global-education-survey.htm

Singapore is a test meritocracy. America is a talent meritocracy.
Singapore must become a talent meritocracy.
– Lee Kuan Yew, Minister Mentor, 2000

In 2001, The Idea Factory began training a team of MOE senior officers in the skills of human-centered innovation and design thinking. The first group of twenty officers went on to train others, who trained still others, until it was embedded in the practice of hundreds of MOE managers and staff. We then cascaded the same training to administrators, principals, faculty, and finally students and parents in K-12 schools.

We embedded innovation know-how throughout the educational system by mentoring teams working on specific high-priority projects (e.g., New Assessment Methods for Experiential, Practice-Based Learning; Maximizing Use of Information Technology and Communications in Education; Structuring Incubator School Curricula; Prototype Innovation Projects; Development Programs for Beginning Teachers). We initiated courses in Innovation and Design Thinking to be rolled out to all K-12 students; we helped Singapore Universities set up new schools of design and media.

Singapore Creative Cluster Development.

A driver of Singapore's plan to become a creativity/innovation powerhouse is the "Creative Industries Development Program." The portfolio for this program is held by the Ministry of Information, Communication and the Arts, where Wasserman was a member of the International Advisory Panel from its outset. Singapore's plan states that a key contributor to the Creative Economy will be the Creative Cluster: "those industries which have their origin in individual creativity, skill and talent, and which have a potential for wealth and job creation through the generation and exploitation of intellectual property." Singapore categorized the creative industries into three broad groups:

- **Arts and Culture:** Performing arts, visual arts, literary arts, photography, crafts, libraries, museums, galleries, archives, auctions, impresarios, heritage sites, performing arts sites, festivals, and arts supporting enterprises
- **Design:** Advertising, architecture, web and software, graphics, industrial product, fashion, communications, interior and environmental design

- **Media:** Broadcast (incl. radio, television and cable), digital media (incl. software and computer services), film and video, recorded music and publishing

The creative cluster cuts across multiple economic sectors. Hence, it had not, until 2000, been recognized as a cluster in itself, requiring its own policy co-ordination and investment[13].

Design Singapore

Working with Design Singapore, the agency charged with national design development, the Idea Factory became heavily engaged not only in Education but in the areas of Innovation, Organization, Information, Communication, and Exposition. Starting from near zero in 2002, Singapore is today well advanced toward its goal to become an international design hub. In addition to year-round programs of design conferences, award competitions, and exhibitions, there has been a surge of inward design investment by premier companies setting up design and development studios (e.g., Dell, Philips, BMW, Second Life, LucasFilms Korean animation studios, IDEO and *frog)*. In 2009, Design Singapore hosted the International Congress of ICSID (The International Council of Societies of Industrial Design).[14] Arnold Wasserman originated the theme, "Design2050." We invited ten design masters from around the world to form design teams to create immersive experiences of cities, transportation, health care, food production, entertainment and sustainable production and consumption in the year 2050. A multi-part TV series of the scenario work was aired in 2011.

The roadmap below tracks the evolution of Singapore's innovation and design development from 2000 through 2012. The entries include a non-exhaustive representation of the activities in the seven target sectors that constitute the "architecture" of the programme: Policy Initiatives, K-12 Education, Magnet Schools, Tertiary Education, Design & Innovation Promotion, Entrepreneurship and Creative Industries Development. The curve represents how initiatives began to accelerate around 2005, creating a positive feedback effect that has now gone exponential (Figure 4).

---

[13] http://creative-industries.26760.x6.nabble.com/file/n37/Singapore_CI_Development-National_Policy_Forum_on_Creative_Industries_Brunei_28_May_2012_v2.pdf
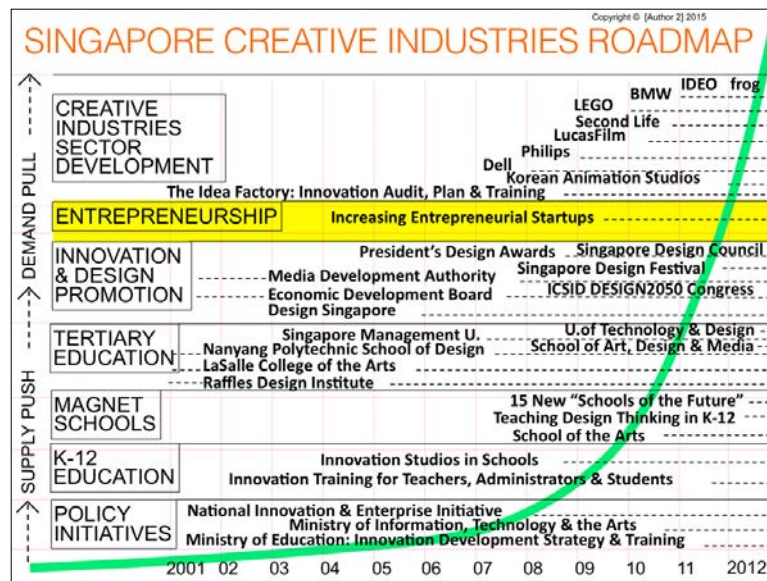[14] http://tiny.cc/icsid2009

Figure 4. Singapore creative industries roadmap illustrates the supply push and demand-pull strategy used to "remake Singapore as an innovation and world design hub." (Wasserman, 2012)

CASE 2: INDEX Design To Improve Life, Denmark

INDEX illustrates how a nation with a deep design heritage (unlike Singapore) engaged changes in 21st century design through an innovative design competition.

In 2002, INDEX pioneered "Design to Improve Life,"[15] an idea that was at the time at the outer edge of design discourse and has since moved to the center as "Social Design," "Design for Impact," "Sustainable Design," "Humanitarian Design," "Design Activism," and so on. Thanks in no small part to INDEX's intellectual leadership, nobody any longer says, "That's not design." Today Design to Improve Life is an international movement with a worldwide constituency. INDEX has evolved through three stages:

INDEX 1.0: Design Promotion

At the beginning of the 2000s, Danish understanding of design was "stuck" in the mid-20th century when Nordic design had been the very

---

[15] https://designtoimprovelife.dk

11

definition of Modernity. The Danish government decided to re-brand Denmark as a world design leader for the new Millennium.

Arnold Wasserman became advisor and first Chairman to the project. In 2002, we decided to reframe design by creating and promoting a new kind of international showcase for where design was heading rather than where it had been. *INDEX: Design to Improve Life* would break from the traditional design award model. We wanted the most open process possible. Eschewing traditional categories like product design, communication design, environmental design, we would have a single overarching theme, "Design to Improve Life," organized in five broad collection sectors: Body, Home, Work, Play & Learning, and Community.

We did not define what "Design to Improve Life" means. Instead, we crowd-sourced that definition by letting submitters tell us what it means to them. We aggregated all those different ideas into an ever-evolving dialogue revealing the spectrum of what "Design to Improve Life," means to different people around the world.

In 2005, the inaugural INDEX Awards was decidedly ahead of the curve, causing consternation among the old-guard Danish design establishment. Each of the five winners received awards of € 100,000. In that first year we received around 200 submissions. These days we get over 1,200.

Directed by CEO Kigge Hvid & her team, INDEX semi-annual Awards have become a premier international showcase for the rapid diffusion in design practice of: open design, crowdsourcing, design-driven innovation, interaction design, experience design, design hacking, do-it-yourself, design entrepreneurship, user-created content, apps, AI, data analytics and web-based everything. INDEX has given voice to a worldwide movement of students and designers applying design thinking, methods and strategies to improve life through sustainable design and social impact.

INDEX 2.0: Design Learning

In the field of education, INDEX pioneered "INDEX Design to Improve Life Education." (DTILE). This began with annual student Design Labs around the world. The first one was the 2011 Yonsei, Korea, Design to Improve Life Summer School.[16] Subsequent initiatives include the "INDEX: Design Challenge," an international student competition in partnership with UNICEF, to address education in developing regions.

---

[16] https://designtoimprovelife.dk/yonseisummerschool/

As of 2017, INDEX had taught around 50,000 students, teachers, educators and decision-makers in the following countries: Denmark, Sweden, Norway, Finland, UK, Taiwan, China, India, Chile, and Iceland. The teaching ranges from 2-hour courses to 3-year programs. The main competencies combine didactics, design and process facilitation guided by "The Compass," a design thinking framework created by INDEX, and by the DTILE Teacher's Guide.[17]

INDEX 3.0: Design Investment

INDEX's newest initiative shifts emphasis from "Awarding Backward" to "Investing Forward," working with international partners to sponsor entrepreneurial start-ups addressing the U.N. Millennium Development Goals. Each year, we select a group of INDEX Award finalists to present their projects to a group of venture capitalists who select candidates for next-round investment.

CASE 3: Innovation in Design Education Teaching Format

The School of Design at Carnegie Mellon University updated its curriculum to prepare their students for 21st century design challenges in 2014. In this case, the focus is on how new design topics can be taught as a flipped class with interactive online materials, and how those interactive course materials can be shared with instructors and students elsewhere.

As the instructor for several design courses, Peter Scupelli looked to identify and adapt new pedagogical formats like the flipped class for effectively teaching new design topics and methods; and to use open resources/environments to create and share effective interactive online instructional materials and activities with a broader network of design teachers (Scupelli, Wasserman, & Brooks 2016).

The *Design Studies* courses focus on systems design, placing design into broader contexts, design research methods, cultural explorations into design culture, and new topics such as futures studies, etc. These required courses for all undergraduate design students are usually taught as lectures with some hands-on activities to apply key concepts. In this section, we describe design-teaching innovations around the futures course taught as a flipped classroom.

---

[17] https://issuu.com/index/docs/design_to_improve_life_education_te

Lecture courses are often described as instructor-centered teaching compared to student-centered learning. The instructor controls the flow of information. Usually, students take notes and listen with few opportunities for discussion or experiential activities (e.g., Stewart-Wingfield & Black, 2005). Strengths of lecture courses include the ability to convey concepts to many students at a time. This model assumes that lecturers are able to clearly deliver their content to students and that students learn by listening and note-taking. In lecture courses, students may hesitate to ask questions, discuss, and seek clarifications. Limited interaction in class with content, the instructor, and other students may result in superficial processing of content and not deep learning (Pellegrino & Hilton, 2012).

Flipped courses shift lectures/exposure to content to outside of class so that during class, in the presence of the instructor and peers, students have time to practice applying those concepts through hands-on activities. We developed a set of Open Learning Initiative (OLI) modules to provide students with pre-class work. These pre-class activities include reading, watching videos, and responding to questions that provide students with immediate feedback and guidance.

At the end of each conceptual unit in the online modules, students submit questions to the instructor about what is unclear. OLI's Instructor Learning Dashboard shows the student responses – this strategy helps the instructor to target areas where students will need more conceptual explanations and/or additional practice. With this in hand, the instructor can adjust the class in real-time to respond to what students need most (e.g., a mini-lecture explanation, additional practice with particular concepts).

During in-class activities, students apply futures thinking methods to a specific design problem. The instructor provides guidance and feedback as students are working. Likewise, in-class peer activities and feedback enhance student learning.

The *Dexign Futures* course is required of all third-year undergraduate design students. It is taught using the flipped-classroom pedagogy with two parts: (a) online components that serve as homework to prepare for (b) in-class hands-on application activities. The class meets twice a week for 80-minute sessions. The course covers different approaches to constructing and critiquing futures. There are four modules: Futures Narratives and People, Critiquing Alternative Futures Scenarios, Critiquing Normative Futures Scenarios, and Making Experiential Futures (Scupelli, Brooks, & Wasserman, 2016). The Dexign Futures course materials developed on the OLI platform

and in-class activities can be shared with instructors and students at other institutions.[18]

CASE 4: High School Students Envision Future Learners
Empowering K-12 Learners with Design Thinking and Learning

The *Design Learning Network* (DLN) embraces a design-based pedagogical approach to teaching and learning. Simply put, design serves as a vehicle for thinking and learning, not as the subject of design. Inclusive of all subject areas, students learn how to become confident and creative problem-solvers; act as purposeful makers; take ownership of their learning; and make mindful choices.[19]

As director of the DLN, Doris Wells-Papanek facilitates K-12 and higher education design-based learning challenges, each thoughtfully co-constructed with faculty, students, and administrators and designed to address key areas of student-learning needs. As part of a long-term partnership with Revere Public Schools (RPS), located a few miles northeast of Boston, MA, Doris is currently collaborating with high school students to tackle the challenge of crafting their own future and the future of their high school. This is the second year that the showcase has been student-driven, whereas previous years have been teacher-driven.

Phase 1: 4R Learning Challenge Pilot Study

The RPS Districtwide 2018 Student-Centered Showcase took place on May 9, 2018. Guided by inquiry, high school students practiced what it means to develop the habits of mind to show evidence and articulate the "4Rs" – **rigor** (the capacity to go beyond surface knowledge); **relevance** (the capacity to create connections to the real world); **relationships** (the capacity to build on teammate's comments); and **resilience** (the capacity to persist when faced with a challenging situation). The goal is to empower young people to go deeper into new understandings to discover meaning beyond a label (Figures 5, 6). At the time of publication, efforts to gather and analyze survey data of student planners/exhibitors, facilitators, and principals are in process.

---

[18] https://dexignfutures.com https://dexignthefuture.com/
[19] http://www.designlearning.us/learning-from-design

Ice Breaker

1) Think about a time when you tackled one of the following 4R Learning Challenges: (complete one the following statements)

    a. I figured out how to dig deeper into the content by using this strategy _____ (rigor)

    b. I was able to connect an assignment with the real world by using this strategy _____ (relevance)

    c. I learned how to collaborate with different types of people by using this strategy _____ (relationships)

    d. I tackled a challenging assignment by persisting with this strategy _____ (resilience)

2) Now think about how that challenging experience might align with your showcase exhibit: _____

3) Next, share your story with the person sitting next to you. While you are talking, your elbow-buddy will write down what you are saying on an Post-it: (see example below)

4) Once complete, place the Post-it's on the chart paper or surface provided

5) Please do Share Out!

6) Do you see any patterns emerging? (shared ideas)

> **RELATIONSHIPS**
> (Identify the 4R)
>
> I've been able to collaborate with a lot of different community members in Revere.
> By learning how to build on their comments, I've developed new relationships with elders, recent immigrants, and local politicians.
> (Evidence and Reasoning for the 4R)
>
> Design for Change Club
> (Name of Club or Course)

Figure 5. At the kick-off of the Revere Public Schools 2018 Student-Centered Showcase planning process, high school exhibitors engaged in an ice-breaker exercise. Data gathered from the pre-assessment served as a baseline of understandings prior to designing their exhibit experiences. (Wells-Papanek, 2018)

Figure 6. The RHS exhibitor's pre-assessment culminated in a thoughtful sorting process aimed at identifying patterns and essential insights into common themes that were shared amongst students. (Wells-Papanek, 2018)

Phase 2: Envisioning 4R Learners in the Year 2029

During the 2019 showcase, students will explore the following problem statement:

Traditionally, students are taught how to be good-students (solid grades, tasks completed) with less emphasis on becoming good-learners (build capacity beyond curriculum) prepared to transform their surface knowledge into deeper understandings and transfer into new situations). Within this learning challenge, student showcase exhibitors will envision how future high school students might learn in the year 2029. Using a flexible and student-centered approach, teachers will facilitate problem-based processes designed to empower learners to take ownership of their own learning.

Showcase exhibitors will show evidence of the 4Rs:

- Students engage in Rigorous Learning: able to question assumptions, think deeply, and transfer learning into new situations
- Learners discover meaning by tackling a Relevant Challenge; able to apply to real life

17

- Students build trusting <u>Relationships with Teammates</u>; able to build on comments made by others, commit, and follow through
- Learners sustain a <u>Resilient Habit of Mind</u>; able to navigate challenging situations with confidence

While anchored in the 4Cs:

- Students practice <u>Creative Ways of Thinking</u>: explore many ideas, seek innovative solutions
- Learners exercise <u>Critical Thinking Skills</u>: use strategic reasoning when problem solving
- Students <u>Communicate Thoughts and Ideas</u>: develop new understandings, articulate concepts
- Learners <u>Collaborate with Others</u>: work effectively and respectfully with sets of diverse teams

Showcase 2019 Learning Challenge Framework

Below is the learning challenge framework that will be used during the preparation for the 2019 showcase (Figure 7).

Who are you designing this learning challenge for? In what ways might you integrate rigor, relevance, relationships and/or resilience into the learning experience?		How might your students show ongoing evidence of what they are learning? In what ways might your students share insights into their surface knowledge as well as deeper learning?		How might your students transfer lessons learned into the year 2029? In what ways might the learning experience impact your student's capacity to transfer their new understandings?	
Support Student Academic Learning Needs	Develop Challenge Plan	Scope Enduring Understandings (big ideas)	Establish Learning Targets	Connect Performance Standards	1) **Explore** Ice breaker; learners gather new information; become familiar with the problem set
Empathize with Learner Social and Emotional Growth	Describe Project Objectives	Dig into Essential Questions (critical inquiry)	Set Learning Assessment Criteria	Clarify Key Concepts and Language	2) **Define** Learners define problem; collect data; make sense of findings
Connect with Learning Progressions	Define Problem Set and Statement		Frame Evidence of Learning	Integrate High-Impact Learning Strategies	3) **Explain** Learners build new understandings, investigate problem set from multiple perspectives
	Identify Resources and References		Dive into Source of Measurements		4) **Demonstrate** Learners show evidence of new understandings; design and present plan of action
			Craft Formative Assessments and Feedback Loops		5) **Evaluate** Learners reflect and assess level of impact the learning process; evaluate in iterative fashion.

Instructional Prep	Pre-Challenge Development	Challenge Planning

Figure 7. A learning framework for planning the Envisioning 4R Learners in the year 2029 Challenge. (Wells-Papanek, 2018)

Discussion: 21st Century Design Learning & Education

Key ideas that emerge from the four case studies provide signals about how designers might be educated in the future. We analyze this through three key questions: who teaches/learns design; where/how is design taught/learned; and when is design taught/learned.

Who teaches/learns 21st century design?

Who is a designer, *wha*t types of design are they doing, and *what* kinds of materials are they shaping?

Herbert Simon wrote in Sciences of the Artificial (1969), *"Everyone designs who devises courses of action aimed at changing existing situations into preferred ones."* Simon understands "designer" in a very broad and inclusive way.

Simon's definition anticipated the nature of expertise needed for 21st century design where "many talents and skillsets are necessary beyond traditional design skills" (Manzini, 2015).

In the cases described, who is engaged with learning includes a broad continuum from K-12 students, teachers, school administrators, university students, to government officials, and more. In the Singapore case, not only government functionaries, administrators, teachers, and students but also entrepreneurs and investors are engaged with habits of mind necessary to "remake Singapore as an innovation and world design hub."

The INDEX 2.0 case illustrates teachers, students, and organizations engaged through international partnerships with cities and institutions to improve life through design. Teachers' accreditation empowers teachers to educate students in new areas.

The CMU Dexign Futures course and the Design Learning Network K-12 Challenges seek to reach a continuum of learners and instructors through partnerships with universities and K-12 institutions; and by making effective teaching materials and practices available to instructors and their students.

These case studies reveal implications for how and when design school educators strategically engage with a continuum of learners.

Where/How is 21st century design taught?

Embracing 21st century design learning requires engaging with change, overcoming barriers, and exploring emerging paradigms. What do learners need to be able to do? We engage this question using three key practices: leverage evidence from the learning sciences to guide our pedagogies; create/use methodologies for effective teaching and learning; and use student learning data to inform iterative improvements.

Paradigm shifts: Each case describes paradigm shifts. In the Singapore case, a nation decided how to reinvent itself as a creative economy. In the INDEX case, a design awards initiative aimed to innovate design awards to explore "what is design to improve life"? In the Dexign Futures case, student expectations of a lecture-based pedagogy were transcended to a more

active model where students engaged activities to integrate futures thinking with design thinking. In the Design Learning Network case, the pedagogical paradigm shift was from a teacher-centered expert-based teaching approach to a student-centered inquiry-based challenge approach.

That which we design also needs to be measured and measures need refinement over time. A key part of this practice also involves questioning: Are the measures for success we use effective enough to signal what is/is not working? What additional measures do we need?

Use evidence-based teaching and learning practices: In the Dexign Futures and Design Learning Network cases pedagogical approaches stem from the learning science insights. The flipped classroom pedagogy shifted design studies courses from a lecture-based, teacher-centered paradigm to a learner-centered approach with the following features: alignment of learning objectives, learning activities, and learning measures; providing feedback quickly; engaging students with active learning techniques; using a data-driven iterative approach to making changes to the courses; practice with concepts through interactive online exercises to prepare for in-class hands-on design activities.

The Design Learning Network (DLN) case highlights the importance of informing pedagogy with learning science. Learners are taught a range of habits of mind to address future-oriented 21st Century Design challenges. Students direct their own inquiries. The design learning pedagogy is embedded into the students' learning trajectories. Students learn to explore, define, explain, demonstrate, assess, and reflect as they tackle the learning challenge. From the learning science literature, it is clear that feedback and active learning practices significantly improve student outcomes (e.g., Hattie, 2009).

These cases demonstrate that improvement of learning experiences requires an iterative approach, whereby learning outcomes are measured to target iterative refinements to design education.

Create data-driven iterations: The Dexign Futures case strategically uses data-driven iteration. Student activities were measured from multiple perspectives. Pre-post course assessments measure what students learned in the course. Online homework is automatically measured, and students receive immediate correctness feedback. We graded in-class assignments with detailed rubrics. During class activities, students received peer and instructor feedback.

Design educators might explore how measuring the quality of courses and student work might inform iterative improvement of courses, workshops, and degree offerings.

Creating methodologies for learning: All four cases used intentional methodologies to facilitate learning. In the Singapore case, the overhaul of the education system used learning practices to engage administrators, teachers, and students. The INDEX 2.0 strategy involved the creation of approaches, educational offerings, and disseminating ideas of "designs that improve life" on a global scale.

The Dexign the Future course materials were available on the internet (i.e., Dexign the Future,[20] Introduction to Dexign Futures,[21] Dexign Futures[22]). [Authors] are revising the Open Learning Initiative (OLI) interactive homework[23] and in-class hands-on activities to make them available to interested instructors at institutions worldwide. The Dexign Futures coursework has had significant impact on the Design Learning Network K-12 challenges. The Design Learning Network develops and shares challenge materials and methodologies many resources as well.[24]

To advance design education, it is necessary to widely share effective instructional methods, materials, and strategies.

Our four case studies situate within a larger shift toward a 21st century design that is learned and taught in a more integrated and holistic manner.

Holistic learning perspectives: We presented four cases situated on two cross-cutting dimensions: locus and sector (Figure 3). For example, the goals of "Remake Singapore" were socio-economic design, but the means to achieve those goals were grounded in design learning.

The implications for design educators and schools are to pay attention to how design-based learning is directly connected to design-based socio-economic activity. Such connections are much more explicit in 21st century realities. How then might design schools and educators engage with government and organizations for social design type challenges?

---

[20] https://dexignthefuture.com
[21] https://dexignthefuture.wordpress.com
[22] https://dexignfutures.com
[23] http://oli.cmu.edu
[24] http://www.designlearning.us

When is 21st century design learned/taught?

The fundamental shifts in design to adapt to emerging societal problems challenge designers and educators to learn and teach new forms of design.

Continuously learn to engage change: Shifting from one paradigm to the next can be difficult. Why change? A theme that runs through all four cases is the desire to respond to new societal level challenges that require new learning and inquiry. In the Singapore case, different government agencies wanted to learn to change their own operations and coordinate action for the common goal of "remaking Singapore as an innovation and world design hub." In the INDEX case the organization crowdsourced the question "what is design to improve life?" and developed award winners for the categories of body, home, work, play, and community. The Dexign Futures course empowered design students to develop skills necessary to engage with Social Design for long-term challenges such as societal-level sustainability. The Design Learning Network sought to prepare all learners for current and future societal challenges by inculcating habits of mind using evidence-based high-impact learning strategies.

Cases like these call upon design educators to create curriculums that prepare diverse learning populations to master multiple concurrent and co-constructed design paradigms addressing an accelerating stream of emerging challenges.

Summary

In response to an exponentially changing world, design education also shifts to bridge the gap between the preparedness of our learners and what they need to be able to do as professional designers. We presented four cases as futures-signs of the changing profession and changes in design education.

We critically analyzed the challenges these shifts present through three key questions for teaching and learning 21st Century design: W*ho teaches/learns design? Where/how is design taught/learned?, and When is design taught/learned?*

With the question: *Who* teaches/learns 21st Century design? We noted two subthemes: designerly roles and design learning continuums.

- *Designerly roles* describes an expanded field of designer types, activities, skills, and materials being shaped. We explore how might

       one teach core design skills and support ever specialized skills for different types of design and contexts?

- *Learner Continuums* emerged in all cases. Implications for design educators include engaging strategically with learners. We explore how might we engage: future students, current students within the department and across the university campus, alumni, industry partners, executive education, and lifelong learners?

With the question: Where/how is 21st century design taught/learned? We noted five themes in our cases: engage paradigm shifts, use learning science driven pedagogy, use data to inform iterative refinement, create effective methodologies for learning and holistic learning continuums.

- *Engage paradigm shifts* exemplified in the case studies illustrates ways in which new paradigms were inserted into existing realities. The question for design educators regards how to allow different paradigms to co-exist and create opportunities for new understandings and combinations of knowledge.
- *Use learning science driven pedagogy* ensures that changes to the instruction is grounded in measurable outcomes. Design educators should consider how higher quality offerings might ensure enduring impact.
- *Use data to inform iterative refinement.* Given increases in design education offerings, measurably higher quality of learning experiences is a critical differentiator.
- *Create methods for learning* emerged as a way to engage the learner continuum. The implication for design schools is to consider developing methods that can be used in multiple learning formats and to engage with different learners.
- *Holistic learning perspectives* ran through the four cases that mapped to sector (design-based socio-economic vs. design-based learning) and locus (hyperlocal vs. multi-local). Given the explicit connections across both locus and sector, there are opportunities for fruitful collaborations. For example, design educators might ask themselves how might learning modules from Dexign Futures course be used in "Remaking Singapore" and as part of the INDEX effort to teach design to improve life?

With the question "When is 21st century design learned and taught?" we noted a need to continuously learn to engage change in our four cases:

- *Continuously learn to engage change* describes the difficult work of addressing stressful tensions between the co-existence of multiple paradigms. It posits that design educators keep open to engage with new and emergent forms of change.

We hope this paper opens up a fruitful space to discuss futures for design education.

References

Buchanan, R. (1992). Wicked problems in design thinking. Design Issues, 5-21.

Davis, M. (2008). Why do we need doctoral study in design? International Journal of Design, 2(3), 71-79.

Doblin, J. (1987). A short, grandiose theory of design. STA Design Journal, Analysis and Intuition, 6-16.

Friedman, T. L. (2005). The world is flat: A brief history of the twenty-first century. New York: Farrar, Straus and Giroux.

Jones, J. C. (1992). Design Methods. Wiley.

Hattie, J. (2009). Visible learning: A synthesis of over 800 meta-analyses relating to achievement ; [reveals teaching's Holy Grail. The Times Educational Supplement]. (Visible learning.) London: Routledge.

Manzini, E. (2015). Design, when everybody designs: An introduction to design for social innovation. Cambridge, Massachusetts : The MIT Press

Norman, D. (2014, December 4). DesignX: A Future Path for Design. Retrieved March 25, 2016, from https://www.linkedin.com/pulse/20141204175515-12181762-designx-a-future-path-for-design

Pastor, E. (2013, November 7). The OTHER Design Thinking. Retrieved March 25, 2016, from https://issuu.com/humantific/docs/theotherdesignthinking/1

Pellegrino, J. W. & Hilton, M. L. (2012). Education for Life and Work: Developing Transferable Knowledge and Skills in the 21st Century. Washington, DC: The National Academies Press.

Scupelli, P., Wasserman, A., & Brooks, J. (2016). Dexign futures: A pedagogy for long-horizon design scenarios. Paper presented at 2016 Conference of the Design Research Society (DRS2016), Brighton, United Kingdom.

Scupelli, P., Brooks, J. & Wasserman, A. (2016). Open learning initiative dexign futures. Paper presented at Design Educators IDSA International Conference 2016: Making Things Happen, Detroit, MI.

Simon, H. A. (1996). The sciences of the artificial. Cambridge, Mass: MIT Press.

Stewart-Wingfield, S., & Black, G. S. (2005). Active versus passive course designs: The impact on student outcomes. Journal of Education for Business, 81(2), 119-123.

Wasserman, A. (2011). Thinking about 50 years of design thinking. Retrieved February 15, 2015, from http://www.design.cmu.edu/designthefuture/arnold-wasserman/ https://vimeo.com/60342260

Wasserman, A. & Scupelli, P. (2013) Dexign The Future, course materials http://dexignthefuture.com

Wells-Papanek, D. (2018) Design Learning Network, project website http://www.designlearning.us/

Wells-Papanek, D. (2014). Wicked Insights into Design Learning. Design Management Review and Innovation, 25(1), 54-61.