

Three Key Competencies and Other Frameworks for HCI and Design Education

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Abstract

This article updates and tabulates some Design theory and frameworks for teaching Design in the context of an Human-Computer Interaction Design (HCI/d) program. A perspective on implications for HCI/d programs is also shared, based on my own reflections about my experiences as program director and faculty.

Keywords

Design Education

Transdisciplinary Design .

Should do, Can do, Can know, Forms

Design Process

Design Motivations

Design Presentation

Content Theory

Three Key Competencies

Some students arrive in our program¹ in human-computer interaction design (HCI/d) with the belief that they will learn how to design the front-end interfaces for smartphone software applications—that is, *screens for apps*. As I write this in 2019, it is easy to find work designing screens for apps. There are many apps available that make it easy for designers—or anyone at all—to design screens for apps, without the need to know anything at all about programming, about how the infrastructure of digital materials work. Most of my colleagues, indeed all who are actively engaged in scholarship and research, worry about the sustainability and lack of ambition of this 2019 reality.

Many other students are more ambitious. What could their collective ambitions be? I argue that a lower bound is understanding the motivations and consequences of design decisions. I argue that this understanding cannot be achieved in any meaningful sense without *transdisciplinary* competencies and perspectives².

Susanne Bødker holds that the field of Human-Computer Interaction (HCI) has developed along three waves successively, namely *computing*, *cognition*, and *ethnography* in historical order. HCI nowadays includes all three waves cumulatively. I hold that there is a fourth wave³, namely *transdisciplinary design*. Knowledge of the elements of each of these waves

¹ I teach in an HCI/d program at a Department of Informatics in Bloomington. I also teach in the summers in an Interaction Design program at a School of Design in Hong Kong. I refer to both programs in the paper, distinguishing between them as needed.

² I am not arguing that the design of screens for apps is not part of the *métier*. I am arguing that even screens for apps have much larger implications and that interaction designers have much broader responsibilities. The word *transdisciplinary* is a portmanteau of *transcend* and *disciplinary*. It is not the same concept as *interdisciplinary*. For an accurate definition, please see Manfred A. Max-Neef. “Foundations of transdisciplinarity.” *Ecological economics* 53, no. 1 (Elsevier, 2005), 5-16.

³ The notion of three waves of HCI owes to Susanne Bødker. “When second wave HCI meets third wave challenges.” In *Proceedings of the 4th Nordic conference on Human-computer interaction: changing roles NordiCHI '06*, Eds. Anders Mørch, Konrad Morgan, Tone Bratteteig, Gautam Ghosh, and Dag Svanaes. (New York: ACM, 2006), 1-8. It was introduced into our local curriculum by Jeffrey Bardzell. Speculation that the fourth wave is transdisciplinary design is reported in Eli Blevis, Kenny Chow, Ilpo Koskinen, Sharon Poggenpohl, and Christine Tsin. “Billions of interaction designers.” *interactions*

are foundational to understanding how HCI is implicated in nearly any interaction design nowadays and in any vision of the future of interaction design.

The fourth wave in my view—*transdisciplinary design*—holds three values as central tenets, namely *tolerance*, *openness*, and *rigor*. In his “Manifesto of Transdisciplinarity,” Basarab Nicolescu states:

“Rigor, opening [openness], and tolerance are the fundamental characteristics of the transdisciplinary attitude and vision. Rigor in argument, taking into account all existing data, is the best defense against possible distortions. Opening [Openness] involves an acceptance of the unknown, the unexpected, and the unforeseeable. Tolerance implies acknowledging the right to ideas and truths opposed to our own.”⁴

We can see that understanding computing entails especially *rigor*, cognition especially *openness*, and ethnography especially *tolerance*. Thus, the *transdisciplinary gaze*⁵ embraces all of the essential elements of the successive waves of HCI. Of course, these tenets *transcend* all waves and all waves embrace all tenets in some and many ways.

The introduction of the waves of HCI and the tenets of transdisciplinary design can and should serve as the foundation that enables each designer to articulate her or his vision of what truly matters in design with the materials of digital technologies. To be very clear:

The Key Competencies are Rigor, Openness, and Tolerance

At the highest level, the key competencies designers can and should have are rigor, openness, and tolerance, where:

Rigor

Rigor in HCI/d means knowledge of computing materials, theory, principles, and associated sciences.

HCI/d is not strictly a science, but our designers must seek out and make use of evidence in a principled way as a matter of design ethics, as well as a matter of feasibility⁶.

Openness

Openness in HCI/d means creativity and adaptability to changing global conditions, especially in designing for the use of technologies on the one hand and prevention of misuse of technologies on the other.

21, 6 (New York: ACM, 2014), 34-41. It is also reported in Huaxin Wei, Jeffrey C. F. Ho, Kenny K. N. Chow, Shunying An Blevis, and Eli Blevis. “*Should do, Can do, Can know: Sustainability and Other Reflections on One Hundred and One Interaction Design Projects.*” In *Proceedings of the Fifth Workshop on Computing within Limits (LIMITS '19)*. (New York: ACM, 2019), Article 6, 18 pages.

⁴ Basarab Nicolescu. (Translation: Claire Voss). *Manifesto of transdisciplinarity*. (Albany: SUNY Press, 2002), Article 14, page 151. The print form of this translation uses the term “opening” rather than “openness.” Later online versions of the Manifesto apparently prefer the term “openness.” The same quotation also appears in Eli Blevis and Erik Stolterman. “FEATURE: Transcending disciplinary boundaries in interaction design.” *Interactions* 16, 5 (New York: ACM, September 2009), 48-51.

⁵ The phrase *transdisciplinary gaze* is inspired by the late David Hakken’s notion of *ethnographic gaze*, in David Hakken. *The knowledge landscapes of cyberspace*. (New York: Routledge, 2004).

⁶ A now infamous example of the harms of ignoring scientific feasibility in design is Elizabeth Holmes and her onetime company Theranos. Holmes put lives at risk by grossly overstating her company’s ability to automate blood tests from small samples. She was convicted of defrauding investors on the order of nine billion USD. The case is well documented. For a starting point, see Nick Bilton. “‘She Never Looks Back’: Inside Elizabeth Holmes’s Chilling Final Months at Theranos.” *Vanity Fair*. (New York: Condé Nast, February 20, 2019).

For example, we nowadays have global supply chains that allow for wealth and prosperity for many at the expense of many others. This wealth and prosperity also comes with the expense of unsustainable resource use and an unequal sense of responsibility to the global environment at the level of nations. Interaction design and its underlying technological infrastructure enables both the access to information and also the trafficking in misinformation that makes much of this possible. The conditions these circumstances create dynamically change the stakeholder maps of design projects.

Tolerance

Tolerance in HCI/d means designing with the materials of computing technologies for respect, especially between nations.

Failure to account in design for the above-mentioned variety and shifts of stakeholder perspectives risks *war* in its modern *forms*—*cyber war*, *trade war*, *fear war*, *information war*, *tweet war*, and others. Success in this accounting scaffolds peace. The connection of HCI/d to the risk of war may seem dramatic. It is not—the modern battlefield includes cyberspace, remotely piloted drones, twitter, and other digital world phenomena. Tolerance is not a nicety, but rather a requirement for peace. Elsewhere I write,

“Nowadays, wars may be fought in cyberspace (cyber war) or with myopic nationalist trade policies (trade war) or even with nuclear threats (fear war), for examples. The threat of war is a limit on sustainability, including the viability of digital infrastructures.”⁷

An Example: Even the New York Times

As an example, Figure 1 shows how a privacy browser extension uMatrix reveals the various cookies, scripts, third-party sites, and other details of *invasive* code running on the New York Times website. Some of the code is designed to restrict access to non-subscribers in order to promote subscriptions. Most of the invasive code—the cells appearing in red—is designed to serve advertising and track viewers.

Rigor: Readers as Products

In order to be rigorous, interaction design students need to have the technical knowledge to at least be able to understand what is displayed by uMatrix in Figure 1. Without this knowledge, students may not understand how their designs may be complicit in how the New York Times site and sites like it treat their readers as a product, by selling their reading habits on to third party trackers and advertisers. These intrusions are not just for site visitors, but also apply to subscribers who log into the site. These practices are especially troubling when a site like the New York Times leverages subscriptions against its own subscribers’ privacy. To many, the New York Times is the gold standard of responsible journalism. I am not arguing that the New York Times is particularly egregious in its invasions of privacy. I am arguing that *even* the New York Time is egregious in its invasions of privacy.

⁷ The analysis is from Eli Blevis. “Seeing What Is and What Can Be: On Sustainability, Respect for Work, and Design for Respect.” In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems CHI ‘18*. (New York: ACM, 2018), Paper 370, 14 pages. The aforementioned draws its inspiration for these particular ideas from Allison’s account of how Thucydides’ Paradox applies historically and in modern times in Graham Allison. *Destined for War: Can America and China Escape Thucydides’s Trap?* (Boston: Houghton Mifflin Harcourt, 2017), and Graham Allison. “The Thucydides Trap: Are the U.S. and China Headed for War? In 12 of 16 past cases in which a rising power has confronted a ruling power, the result has been bloodshed.” *The Atlantic*. (Boston: The Atlantic Monthly Group, September 24th, 2015).

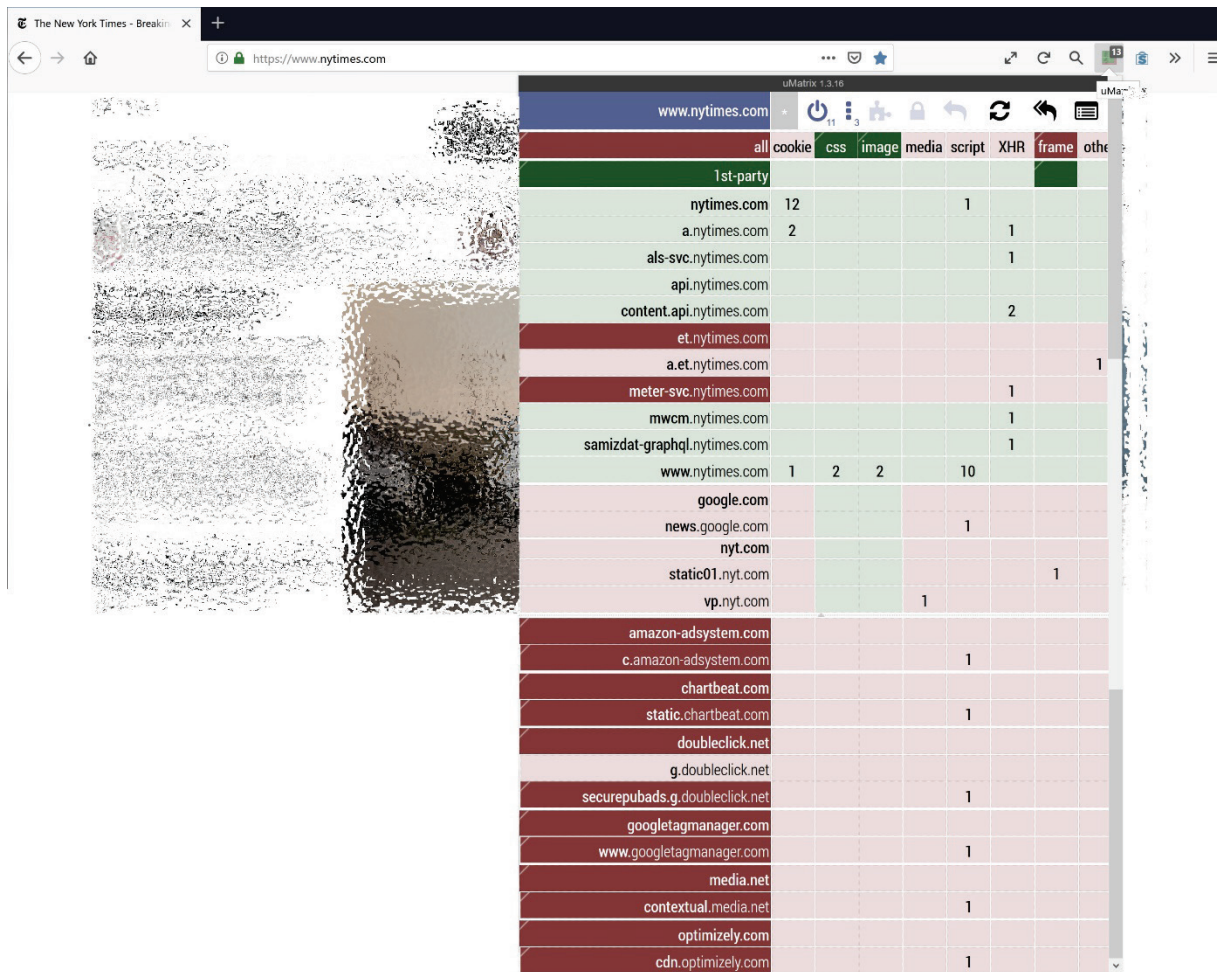


Figure 1. Scripts running on the New York Times website.

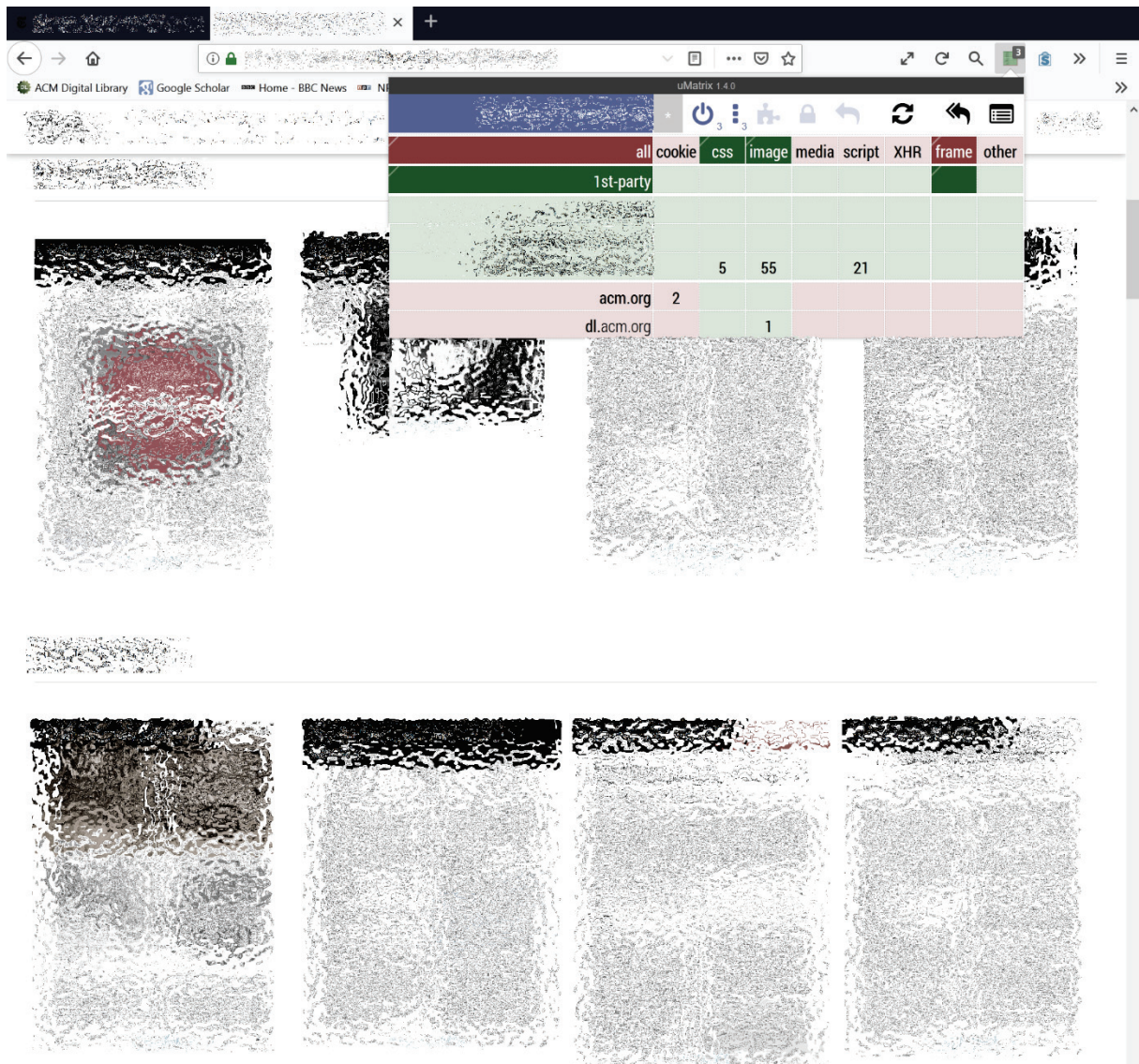


Figure 2. Scripts running on the author's personal website.

Figure 2 shows the author's own personal website. It is minimally invasive. It does request access to the Association for Computing Machinery (ACM) digital library as third-party site, only in order to allow courtesy access to the author's papers published by the ACM.

Otherwise, it does not track visitors in any way. In order to be able to design a site that is minimally invasive, one needs to be able to code it oneself. The sites that make it easy for non-coders to build their own sites integrate invasive code by and large.

Openness: Tensions between Subscription Models and Advertising Models

Openness means that design students must understand the perspectives of all stakeholders. Readers are not the only stakeholders, in the case of the New York Times and other journalism outlets. Journalists, editors, and shareholders are obvious additional stakeholders. Print newspapers traditionally employed both subscription and advertising models to be economically viable. Technology has changed the directionality and the progression of technology makes future disruptions certain. To survive, news sources need to find new viable economic models, and adapt to changing conditions.

Tolerance: Triangulating the News

Tolerance means accepting the validity of perspectives of others. In the case of news, this means that tolerance depends on access to many sources of responsible journalism from differing perspectives. One of the threats to the survival of responsible journalism are digital-world news aggregators that amplify individual bias by serving only news items that feeds that bias. One possible way out would be for responsible news organizations to form an alliance together to offer a single point of payment, advertising-free, non-tracking subscription to all services, turning the differences of perspectives between the Economist and the Atlantic, Al Jazeera and the Jerusalem Post, and so forth into a feature. This is just one idea. Perhaps this particular idea's time will arrive and perhaps it will not. Either way, tolerance is an essential tool of any designer's imagination.

Competencies and Values

Rigor, openness, and tolerance are not just strategic competencies, but also values. They are values worth having as a matter of quality of life. There are other notions of values worth having. Rigor, openness, and tolerance are sensible values, not exclusive. It's clear that not everyone who achieves material wealth does so by means of rigor, openness, and tolerance. Not every community, not every corporation, not every government. It's clear that not everyone who values rigor, openness, and tolerance enjoys a carefree quality of life. This can't be resolved here. Some students of design will be happy to discover that there is a hopeful way out of Papanek's account of design folly⁸. Others, not so concerned.

The important step in the perspective of pedagogy is to give students of design the means to

⁸ Victor Papanek famously wrote "*There are professions more harmful than industrial design, but only a very few of them. And possibly only one profession is phonier. Advertising design, in persuading people to buy things they don't need, with money they don't have, in order to impress others who don't care, is probably the phoniest field in existence today. Industrial design, by concocting the tawdry idiocies hawked by advertisers, comes a close second. Never before in history have grown men sat down and seriously designed electric hairbrushes, rhinestone-covered file boxes, and mink carpeting for bathrooms, and then drawn up elaborate plans to make and sell these gadgets to millions of people. Before (in the 'good old days'), if a person liked killing people, he had to become a general, purchase a coal-mine, or else study nuclear physics. Today, industrial design has put murder on a mass-production basis. By designing criminally unsafe automobiles that kill or maim nearly one million people around the world each year, by creating whole new species of permanent garbage to clutter up the landscape, and by choosing materials and processes that pollute the air we breathe, designers have become a dangerous breed. And the skills needed in these activities are taught carefully to young people.*" In Victor Papanek. (2nd Edition, Completely Revised). *Design for the Real World*. (Chicago: Academy Chicago Publishers, 1984), ix. Revised from Victor Papanek, and R. Buckminster Fuller. *Design for the Real World*. (London: Thames and Hudson, 1972).

operationalize such values as rigor, openness, and tolerance in a way that allows them to *see the value* of doing so, if they are so inclined. This requires a foray into many layers of additional framings and explanations. I unpack these in all that follows.

Concepts and Skills

Tables 1-4⁹ are provided to unpack these layers. The tables summarize the concepts and skills needed in my account to develop the key competencies of tolerance, openness, and rigor. As I write above, there are many layers to unpack. Explanations of each layer follows.

Should do, Can do, Can know, and Forms

The ideas of rigor, openness, and tolerance may seem too abstract from the goals students have of creating a career in interaction design. The columns of Table 1 are *labeled should do, can do, can know, and forms*. These categories form a fundamental frame that designers can use to describe design and concept spaces. The rest of Table 1 defines these terms in various perspectives with various purposes. Possibly the most accessible explanation is that (a) *should do* refers to the themes of a design space we choose as a matter of values, (b) *can do* refers to the approaches we choose as a matter of operationalizing *should do* themes strategically or tactically as a concept space, (c) *can know* refers to measures and evidence that we gather in the service of informing our understanding of a design space, and (d) *forms* refers to the actual instantiations of concepts as virtual platforms, physical prototypes or products or installations, or strategic design plans. Figures 3 and 4 [End of Document] show two student projects that focus on physical prototypes as forms, with the figure titles stating the *can do* approaches.

To illustrate, the NY Times example above may be understood in terms of (a) *should do*—preserve privacy while also making a diversity of responsible journalism available and sustainable, ... (b) *can do*—form alliances for single point of payment, advertising-free, non-tracking subscription services, ... (c) *can know*—collect an inventory of principled and evidence based news services, calculate how much does it cost to provide these services, ... and (d) *forms*—design an integrated subscription services app or site, design journalism standards ratings agencies, ...

Should do, can do, can know, and forms can be mapped to *rigor, tolerance, and openness*. In this illustration, (a) *should do* maps to *tolerance* in the form of support for a variety of perspectives on journalism and respect for the privacy of individual readers, (b) *can do* maps to *openness* in the form of considering new ways of doing business to enact the *should do* goals, (c) *can know* maps to *rigor* in the form of being able to distinguish between evidence based journalism and reporting that does not rise to the level of responsible journalism, and (d) *forms* map to the *transdisciplinary* enterprise of supporting *should do, can do, and can know* in in virtual platforms, physical prototypes or products or installations, or strategic design plans.

Should do, can do, can know, and forms as a frame owes to fundamental work in transdisciplinarity by Basarab Nicolescu and Manfred A. Max-Neef. Wei et al. have used these categories to both analyze and give shape to overarching descriptions of design projects¹⁰. I have also started using this framing in my own design classes.

⁹ These tables also appear in some of my syllabi: <https://eli.informatics.indiana.edu/indexfull.html#syllabi>

¹⁰ Please see Basarab Nicolescu. (Translation: Claire Voss). *Manifesto of transdisciplinarity*. (Albany: SUNY Press, 2002); Manfred A. Max-Neef. "Foundations of transdisciplinarity." *Ecological economics* 53, no. 1 (Elsevier, 2005), 5-16; Huaxin Wei, Jeffrey C. F. Ho, Kenny K. N. Chow, Shunying An Blevis, and Eli Blevis. "*Should do, Can do, Can know*:"

Table 1. Layers of Framings

	Should do	Can do	Can know	Forms	Source
<i>How to (process, framework, principles)</i>	Predispositions (A)	Concepts (D), Strategies (F)	Research (B), Insights (C)	Prototypes (E)	<i>Blevis (2012), after Fahnestrom, Prygrocki, & Whitney</i>
	Design Space (Expand)	Concept Space (Expand)	Design Space (Focus)	Concept Space (Focus)	<i>Bardzell's version of Double Diamond</i>
	Be People-Centered	Use an Activity-Centered Systems Approach	Understand and Address the Core Problems	Use Rapid Iterations of Prototyping and Testing	<i>Norman (2019)</i>
	Empathize (A)	Ideate (B)	Define (C)	Prototype & Evaluate (D)	<i>Stanford D-School</i>
<i>Why do (rationale)</i>	Values & Vision (desirability)	Opportunity (viability)	Research (feasibility)	Possibility Trends including Futurism and Retro-futurism	<i>Multiple Perspectives Analysis (MPA), Linstone (1981), Bowonder (1987), followed by Others</i>
	Tolerance	Openness	Rigor	Transdisciplinarity	<i>Transdisciplinary Design, after Nicolescu (2002), Max-Neef (2006)</i>
<i>Tell (presentation, argument, explanation, plan, story, proof)</i>	Values & Vision	Concepts & Strategies	Domain Knowledge*	Names/brand, Products, Services	<i>General</i>
<i>Content Meta-theory</i>	Themes	Approaches	Measures	Forms	<i>Wei, Ho, Chow, Blevis, & Blevis (2019).</i>
	Everywhere (Global)	Organize	Measurements	Virtual	
	Near (National, Community)	Connect	Collections	Physical	
	Here (Local, Personal)	Persuade Disrupt	Needs	Strategic	

* (From Research literature, Observations, Collections, & Evaluations)

Sustainability and Other Reflections on One Hundred and One Interaction Design Projects.” In *Proceedings of the Fifth Workshop on Computing within Limits (LIMITS '19)*. (New York: ACM, 2019), Article 6, 18 pages; Eli Blevis and Erik Stolterman. “FEATURE: Transcending disciplinary boundaries in interaction design.” *Interactions* 16, 5 (New York: ACM, September 2009), 48-51.

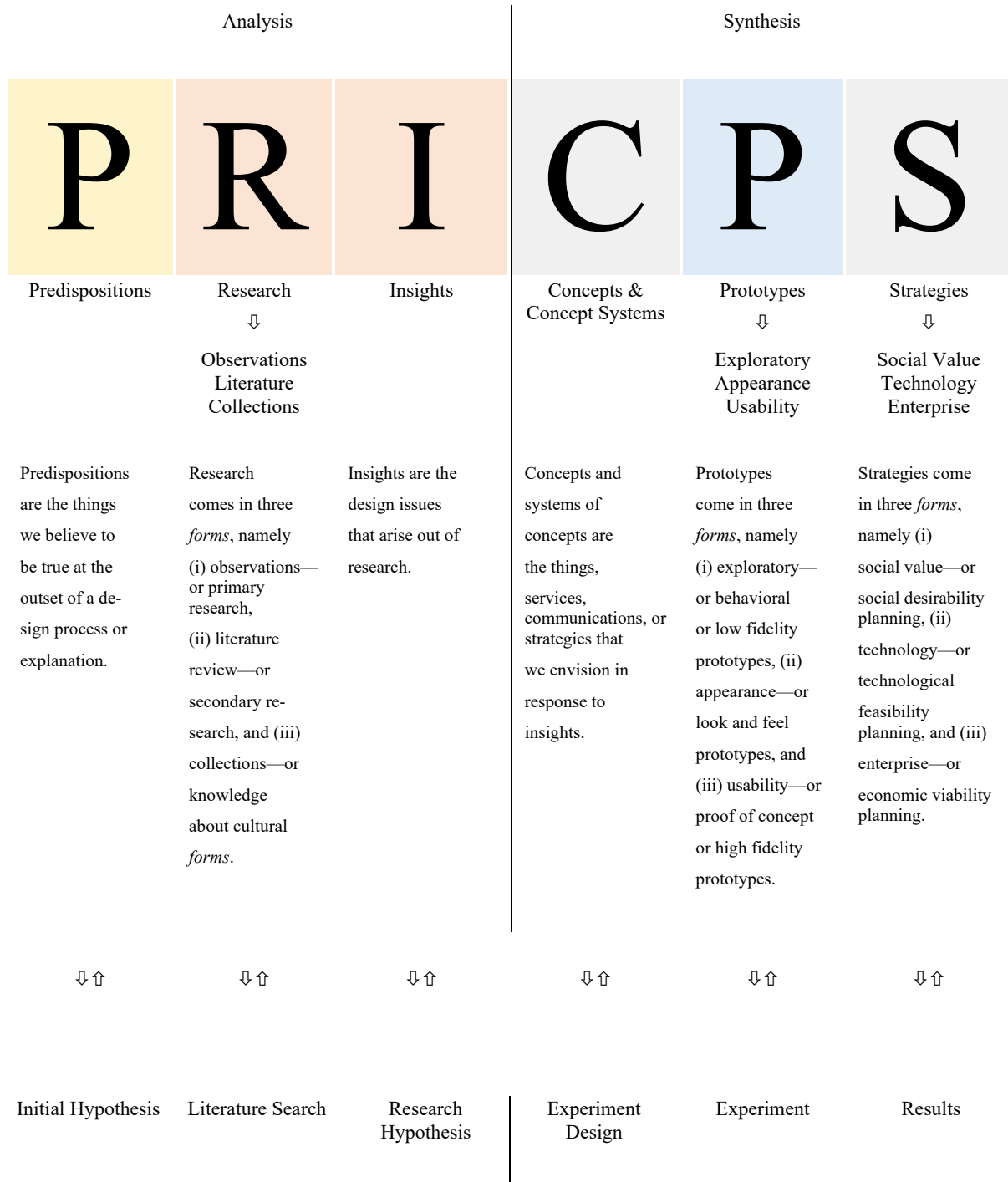
Table 2. Content Theory, Expanded¹¹.

Should do Themes		Can do Approaches	
Everywhere (Global)	Sustainability Preserve Cultural Heritage	Organize	Itinerary Annotate & Link
Near (National, Community)	Inclusivity Maintain Social Order Connecting People	Connect	Combine With Utility Distance Collaboration Match Interests
Here (Local, Personal)	Improving Health Personal Development	Persuade	Scaffold Behaviors Motivate With Metaphor Gamification Promote Awareness
		Disrupt	Redirective Practice Subscription Services
Can know Measures		Forms	
Measurements	Amount And Quality	Virtual	Mobile App Desktop App Web Site Tablet App Virtual Reality App Mobile Game
Collections	Inventory Cultural Artifact		
Needs	Psychology Travel Acculturation Needs	Physical	Interactive Product Installation
		Strategic	Service

* This content theory illustrates some of the kinds of should do themes, can do approaches, can know measures, and forms that can instantiate the abstract how to, why do, and tell frameworks in Table 1.

¹¹ From Huaxin Wei, Jeffrey C. F. Ho, Kenny K. N. Chow, Shunying An Blevis, and Eli Blevis. "Should do, Can do, Can know: Sustainability and Other Reflections on One Hundred and One Interaction Design Projects." In *Proceedings of the Fifth Workshop on Computing within Limits* (LIMITS 19). (New York: ACM, 2019), Article 6, 18 pages.

Table 3. The PRICPS design framework¹².



¹² From Eli Blevis. “The PRInCiPleS Design Framework.” In John M. Carroll, Ed. *Human-Computer Interaction Series, 1, Volume 20, Creativity and Rationale*, (Springer, 2012), 143-169.

How to, Why do, Tell, and Content

The rows of Table 1 are divided into 4 main subsections, namely *how to*, *why do*, *tell*, and *content*. The first three of these *how to*, *why do*, and *tell* correspond to a frame that owes to a colleague Jeffrey Bardzell who uses the terms *design process*, *design rationality*¹³, and *design argument* to distinguish three modes of design, respectively. That is, *process* is the notion of *how to do a design project*, *rationality* is the notion of *why a design project is worth doing*, and *argument* is the notion of *how to present a design project convincingly*.

How to (process, framework, principles)

In Table 1, the topmost major grouping of rows relates to how to design—that is an account of what is the process, framework, or procedures that students can follow in order to make progress on a design project. Here, I provide four different models that are more or less isomorphic one to another, modulo our column headings of *should do*, *can do*, *can know*, and *forms*.

The first row of *how to* classifies the elements of a method known as PRICPS (or PRInCiPleS), which stands for *predisposition, research, insights, concepts, prototypes, and strategies*¹⁴. These elements are fully described per the sources in the footnote, and also in Table 4 wherein the basic definitions appear. The sequence of these elements in a notion of stepwise process are given by the letters A-F. However, PRICPS is really intended more as a framework without strict process order than a procedure. It takes some time for students new to design to accept that there are not strict stepwise procedures for design, but rather mostly frameworks. It's already familiar to students who come to our program with design backgrounds.

The second row characterizes how to design in terms of ideas of divergence and convergence within a design space. There are many versions of this *how to* framing. Here I refer to a version of a familiar *Double Diamond* diagram by Jeff Bardzell. In these terms, understanding a design space in terms of *should do* expands the space. Understanding a design space in terms of *can know* narrows the space. Similarly, understanding a concept space in terms of *can do* expands the space. Honing a concept space to specific *forms* narrows the space.

The third row fits an account of design principles¹⁵ by Don Norman into the *should do*, *can do*, *can know*, and *forms* framing. Here, Norman's advice to *be people-centered* corresponds to *should do*. Approaches are a matter of *can do*, and thus Norman's advice to *use an activity centered systems approach* fits into the *can do* category. Norman's advice to *understand and address the core problems* is a matter of *can know* rigor. Finally, Norman's prescription of the

¹³ The term *design rationale* owes in my belief to Thomas P. Moran and John M. Carroll. Eds. *Design Rationale: Concepts, Techniques, and Use*. (Mahwah: Erlbaum, 1996).

¹⁴ The PRICPS (or PRInCiPleS) framework evolved as a renaming of steps of design process introduced by Dale Fahnstrom, Greg Prygrocki, and Patrick Whitney at the Institute of Design (ID) of the Illinois Institute of Technology (IIT) during the 1990's. At ID, the process was called a *road map*. It was prescribed as the process to be used by MDes students engaged in thesis and demonstration projects. The PRICPS design process as named is first described in Mark Notess and Eli Blevis. "Integrating human-centered design methods from different disciplines: Contextual design and principles." *Proceedings of the design research society futureground 2004 conference*. (DRS, 2004), wherein it is compared to contextual design. Contextual design as a method is described in Hugh Beyer, and Karen Holtzblatt. "Contextual Design: Defining Customer-Centered Systems." (San Francisco: Morgan Kaufmann Publishers, 1998). A more complete account of PRICPS appears in Eli Blevis. "The PRInCiPleS Design Framework." In John M. Carroll. Ed. *Human-Computer Interaction Series, 1, Volume 20, Creativity and Rationale*, (Springer, 2012), 143-169, wherein its history is also described. It has been used in various courses in HCI/d at [withheld] over years. The predispositions element was not part of the *road map*, but according to Greg Prygrocki a similar concept was introduced at ID in the early part of this century.

¹⁵ Donald A. Norman. The Four Fundamental Principles of Human-Centered Design and Application. *Essay*. (jnd.org, 23 July 2019).

use of *rapid iterations of prototyping and testing* is a matter of *forms*.

The fourth row is a notion of design process stated by the Stanford D-School. *Empathize* is a form of *should do*. *Ideate* is a form of *can do*. *Define* is a form of *can know*. *Prototype and evaluate* refers to *forms*. The D-School model, understood stepwise follows *should do*, *can do*, *can know*, and *forms* as an ordering.

Why do (rationale)

In Table 1, the second major grouping of rows relates to why design—that is an account of what is the motivating rationale¹⁶ for a design project. Here, I provide two different models that vary in their accounts. These two models are unified under the column headings of *should do*, *can do*, *can know*, and *forms*.

The first of these *why do* rows is a familiar triangle model that maps *desirability* onto *should do*, *viability* onto *can do*, and *feasibility* onto *can know*. *Forms* is an orphan category in this three factor model. I suggest that it relates to trends in forms, including futurism and retro-futurism. There are many people who state this triangle model *desirable*, *viable*, and *feasible* without attribution. The earliest reference I can find to this form is called Multiple Perspectives Analysis (MPA) which owes to Linstone¹⁷. Bowonder¹⁸ uses these exact terms in 1987. In Bowonder's diagram, *desirability* is *social desirability*, *viability* is *economic viability*, and *feasibility* is *technological feasibility*. This is common and widely used.

The second row embeds the starting point of this paper into the diagram. That is *tolerance maps* onto *should do*, *openness maps* onto *can do*, *rigor maps* onto *can know*, and *transdisciplinarity maps* onto *forms*. This account has the utility in broadening the perspectives of how designers account for why they do what they do.

Tell (presentation, argument, explanation, plan, story, proof)

In Table 1, the third major grouping contains a single row that relates to how to present a design. Here, there are many ways to describe the act and substance of communicating a design, namely a presentation, argument, explanation, plan, story, or proof. The term that most appeals to any individual designer may depend on other disciplinary background. *Should do* accounts describe the *values and vision* a designer brings to a design. *Can do* accounts describe the *concepts and strategies*. *Can know* accounts describe the *domain knowledge* that scaffolds a particular design. *Forms* include an account of such elements as *names or brand*, *products*, *services*, and perhaps others.

Content Meta-Theory and Theory

There are many accounts of design theoretic frameworks. *Should do*, *can do*, *can know*, and *forms* is both a unifying theory for these frameworks, and a means to promote breath in design education. Theoretical frameworks in and of themselves are actually not very useful to design students, absent a content theory that details how such frameworks may be applied.

¹⁶ I use the term *rationale* in the sense of Thomas P. Moran and John M. Carroll. Eds. *Design Rationale: Concepts, Techniques, and Use*. (Mahwah: Erlbaum, 1996).

¹⁷ Harold A. Linstone. "The multiple perspective concept: With applications to technology assessment and other decision areas." *Technological Forecasting and Social Change* 20, no. 4 (Elsevier, 1981), 275-325.

¹⁸ B. Bowonder. "Integrating perspectives in environmental management." *Environmental management*, 11(3), (New York: Springer-Verlag, 1987), Figure 2, page 308.

Wei et al. analyzed 101 interaction design thesis projects completed over six years since 2013¹⁹. The results of this analysis form the content meta-theory shown as the last major group of Table 1 and the substance of Table 2. Wei et al. analyzed these 101 projects in terms of *should do*, *can do*, *can know*, and *forms*. The meta-theory that emerges is shown in both Figures 3 and 4. In this content theory, *should do* are the themes that our student designers chose to work on. *Can do* are the approaches they took. *Can know* are the measures that characterized their evidence-based research. *Forms* are the artifacts and/or services they designed. The data is shared in the appendix of that paper, wherein several examples projects are more fully described in these terms.

The lists of themes, approaches, measures, and forms in Table 2 are not the only instantiations of these categories that are possible. Rather, these are the lists that emerged from our analysis. Nonetheless, these lists also serve a generative purpose in teaching. Student designers who are working on their own projects can use these lists to outline a design space. For example, a student or project team might use these lists to decide to focus on a global theme of sustainability, using a persuade approach of promoting awareness, informed by measures of amount and quality of environmental conditions, in the physical form of an installation. Designers can also use these lists to more completely consider the possibilities for themes, approaches, measures, and forms.

Methods

There are many accounts of methods in design. I use Martin and Hannington's Universal Methods of Design (UMOD)²⁰ as a required reference text in my classes. This text works well as a reference text because it presents methods in entries that are accessible due to their brevity and that are still well researched and attributed. There are many methods that are not listed in UMOD. There are new methods all the time. There are trends and fashion. Table 4A and 4B list methods that I either teach or I learn that others are teaching mapped to the PRICPS framework of Table 3.

Pedagogies

I teach in a design school in the summers and in a design-oriented HCI program of a department of Informatics during the year. The pedagogical strategies differ²¹.

At the design school, I simply ask students to choose socially motivated projects to work on and I meet with them group by group for critiques/tutorials. That is all the structure that is required. I suppose you could say that this is just-in-time²² learning. Students work on a motivated goal and I am there to give advice and more importantly point them to resources at the moments they need to use them in pursuit of that motivated goal. This works in part because the class size is on the order of 16-20 students. It also works because admissions are portfolio based and nearly all of the students have some form of design background.

¹⁹ Huaxin Wei, Jeffrey C. F. Ho, Kenny K. N. Chow, Shunying An Blevis, and Eli Blevis. "Should do, Can do, Can know: Sustainability and Other Reflections on One Hundred and One Interaction Design Projects." In *Proceedings of the Fifth Workshop on Computing within Limits (LIMITS '19)*. (New York: ACM, 2019), Article 6, 18 pages.

²⁰ Bella Martin and Bruce Hannington. *Universal Methods of Design*. (Beverly, MA: Rockport, 2012).

²¹ The programs and their curricular content are described and compared in Eli Blevis, Kenny Chow, Ilpo Koskinen, Sharon Poggenpohl, and Christine Tsui. "Billions of interaction designers." *interactions* 21, 6 (New York: ACM, 2014), 34-41.

²² My use of the term owes to Alex Kass, Robin Burke, Eli Blevis, and Mary Williamson. "Constructing learning environments for complex social skills." *The Journal of the Learning Sciences* 3, no. 4 (Taylor and Francis, 1994), 387-427.

Table 4A. Methods mapped to PRICPS, A-L

<i>Design Component</i>	Design Space			Concept Space		
	Predesign	Research	Insights	Concepts	Prototypes	Strategies
<i>AEIOU</i>			●			
<i>Affinity diagram</i>			●			
<i>Annotated photograph</i>	●	○	●	○	●	
<i>Appearance prototype</i>					●	
<i>Behavioral prototype</i>					●	
<i>Collection</i>		●				
<i>Competitive intelligence</i>		●				
<i>Cultural Probes</i>		●			●	
<i>Design fiction</i>				●		●
<i>Disposable Camera study</i>		●				
<i>Enterprise plan</i>						●
<i>Exploratory prototype</i>					●	
<i>High fidelity prototype</i>					●	
<i>Hypothesis</i>	●					
<i>Interview study</i>		●				
<i>Iteration</i>				●	●	
<i>Journey map</i>			●	●		●
<i>Literature report</i>		●				
<i>Look and feel prototype</i>					●	
<i>Low fidelity prototype</i>					●	

Table 4B. Methods mapped to PRICPS, P-Z

<i>Design Component</i>	Design Space			Concept Space		
	Predesign	Research	Insights	Concepts	Prototypes	Strategies
<i>Persona</i>		⊖	○	●		
<i>Personal inventory</i>		●				
<i>PRICPS</i>						●
<i>Primary observations</i>		●				
<i>Proof of concept prototype</i>					●	
<i>Research hypothesis</i>			●			
<i>Research through Design (RtD)</i>		●			●	
<i>Semantic differential</i>			●			
<i>Shadow study</i>		●				
<i>Should do, Can do, Can know</i>	●		●			
<i>Sketch</i>				●		
<i>Social value plan</i>						●
<i>Stakeholder diagram</i>			●			●
<i>Storyboard</i>				●		
<i>Survey study</i>		●				
<i>Technology development plan</i>						●
<i>Think aloud protocol</i>		●				
<i>Usability prototype</i>					●	
<i>Use case diagram</i>					●	●
<i>Vision statement</i>	●		●			
<i>What-if scenario</i>			●			
<i>Wizard of Oz prototype</i>					●	
<i>Working prototype</i>					●	

In the design-oriented HCI program, admissions represent more diverse backgrounds. More structure is needed. The projects need to be comprised of a collection of smaller projects. In some versions of this, I use a pedagogy called *design challenge based learning* (DCBL)²³. The idea is to break projects into weekly design challenges. Students present their project work each week in assembly. They receive feedback from each other and the instructors. They vote on which projects are best, and a nominal prize is awarded.

A very important aspect of my teaching involves visual literacy, especially in the form of photography and how photographs are used in design²⁴.

Qualities of Instructors

For the most part, design instructors should be themselves research active scholars. Most of the quality issues I have observed over years of teaching design arise from professors who are inactive as scholars or from adjunct faculty who do not read nor value scholarly work. It is helpful to have adjunct instructors with industry backgrounds as well. There needs to be balance.

An alternative to having adjunct staff from industry is to commission volunteers from industry to serve as practice clients for student projects. Oftentimes, program alumni can so serve. Here, there can be issues as well with misunderstandings about who owns the intellectual property of the students' work. Another possibility is service learning, which pairs student design teams with non-profit organizations as clients. The issue in service learning is that non-profits also need to see something of value emerge from their engagement with the students, as they often have fewer resources or even less time to commit to projects that may sometimes turn out to be of little practical value or are unfinished in terms of implementation.

The Role of Program Directors

The first question here is *who are the program directors?* In some programs, the directors are not tenured or tenure track faculty. In others, becoming a program director is a step after tenure. In American research universities, faculty governance means that directors can propose which faculty to assign to which class, but tenured and tenure track faculty are free to decide on the content of the courses they teach.

Program directors can help faculty coordinate their classes into a coherent program. They can do this by having faculty agree on what the specific focus of their respective classes will be. .

Possibly the most important way to support instructors is to be careful at admissions time. Doing so requires an enormous investment in time and resources.

Challenges

I think these are challenging times for everyone. Young people today face challenges that owe to global conditions that are not of their own making—climate change, global tensions,

²³ DCBL owes to Eli Blevis. "Design challenge-based learning (DCBL) and sustainable pedagogical practice." *Interactions* 17, 3 (New York: ACM, May 2010), 64-69.

²⁴ For additional detail, please see the collection of papers here: <https://eli.informatics.indiana.edu/indexfull.html#visual>

intrusive technologies, and so forth. The challenge is to understand the challenges that they face and will face in 2025 and beyond. These are in many ways more complex than the challenges now tenured professors faced when they were their age. Abstractly, the challenge is to maintain rigor, foster openness, and promote tolerance in a way that is mindful of these changing conditions.

2025 and Beyond

Writing in 2019, it's hard to commit to a prediction of what design education will be in the world of 2025 and beyond. Perhaps some of what I write here is enduring. Perhaps there will be fundamental disruptions between now and this future. Among the community of scholars I know who work in the area of sustainability and technology²⁵, there is more than typical awareness of just how dire the circumstances of climate change have become. One of these scholars suggested in our regular correspondences that the design of grief counseling may become our major concern. Young people entering our design programs have mostly never known a world without smartphones and social media. They also face a world with previously unimagined challenges. While the frameworks, methods, and content theory I describe here may continue to serve, I expect refinements will be needed. I predict that there are many changes ahead for design pedagogy.

²⁵ Hazas, Mike, and Lisa Nathan, eds. *Digital Technology and Sustainability: Engaging the Paradox*. (Routledge, 2017).



Figure 3. Dianya Mia Hua demonstrates her prototype of the MemoryPin system for connecting people at a distance²⁶.

²⁶ Dianya Mia Hua. MemoryPin. MDes Interaction Design Demonstration Project. (Hong Kong: School of Design, The Hong Kong Polytechnic University, 2017). Image courtesy The Hong Kong Polytechnic University School of Design.



Figure 4. Wagi Kulasumpankosol demonstrates her Sleep to Go system for helping people sleep without the distraction of their smartphones, motivated by the metaphor of travel²⁷.

²⁷ Wagi Kulasumpankosol. Sleep to go. MDes Interaction Design Demonstration Project. (Hong Kong: School of Design, The Hong Kong Polytechnic University, 2018). Image courtesy The Hong Kong Polytechnic University School of Design.

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