# ISSUES IN INTERDISCIPLINARY STUDIES

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**Guest Editor: Tanya Augsburg**

# SPECIAL VOLUME: The Work of Julie Thompson Klein: Engaging, Extending, Reflecting

REFLECTING ON KLEIN'S WORK

# Guest Editor's Introduction

It is with both great delight and some trepidation that I introduce this special volume of *Issues in Interdisciplinary Studies* with its very fitting subtitle, *The Work of Julie Thompson Klein: Engaging, Extending, and Reflecting*. The volume has the distinction of being the first collection of articles addressing the work of Julie Thompson Klein. At least some of my delight stems from knowing that the arrival of such a volume is long overdue. After all, it goes without saying that the impact and influence of Klein's scholarship on interdisciplinarity have been far reaching, crossing many disciplinary and geographical divides. While Klein herself remains a bit of an enigma (she makes it no secret that she prefers not to be the center of attention), I do know from my interactions with her over the years that as a scholar she is a stickler for accuracy. To say that I have stayed up some nights worrying that I would overlook some typo or factual error in the production of this volume would be an understatement – hence my bit of trepidation.

When the Association for Interdisciplinary Studies Executive Board considered a proposal to dedicate a special volume of *Issue*s to Klein's work during its annual meeting in October 2016, its members immediately approved the idea and were cautiously optimistic that Klein would not object. When I emailed Klein about the project, her response was swift and to the point – she would reject and not support any possibility of a mere celebration of her work. She did mention that she might be interested in seeing how other scholars would engage and possibly extend her ideas – a hint of an alternative that quickly developed into the special volume's organizational principles. She insisted that she would not get involved in any way with the editorial process – with the sole exception of her being available to answer questions regarding matters of accuracy. However, she brainstormed with me as I conceptualized the special volume's call for articles, and gave me valuable feedback once it was done. She also reviewed my initial list of potential contributors and made some additional suggestions. But after that initial brief period of exchange, I was on my on own.

Well, not exactly. *Issues* co-editors Gretchen Schulz and Sven Arvidson had my back throughout the entire publication process. I steadfastly (stubbornly?) insisted that all the articles in this volume were to address Klein's work in substantive ways. I made some tough editorial decisions while adhering to that agenda, which both Schulz and Arvidson supported. They kept me on track, and helped tremendously with handling all the final bits and pieces to ensure that the volume would come out on time. I am greatly indebted to them both.

To be clear: this special volume is a critical examination of the work of Julie Thompson Klein. Eight out of the following nine articles were written specifically for this volume. They address many aspects of Klein's work, including all of the following: interdisciplinarity, interdisciplinary education, theories of integration, boundary work, typology, digital humanities, team science, collaboration, and transdisciplinarity. This special volume has no pretense to be comprehensive as time and length limitations prevented additional considerations of significant areas of Klein's research, but those that are addressed certainly deserve the attention they receive.

The special volume begins with two introductory articles. In addition to the usual "Editor's Introduction," it includes the written version of Daniel Stokols' presentation honoring Klein on the occasion of her receiving the 2016 Science of Team Science (SciTS) award in Phoenix, Arizona. Stokols, who is Chancellor Professor Emeritus at University of California, Irvine, invoked the well-known baseball metaphor of the "Five Tools Player" to introduce Klein (a great baseball fan) as a "Six Tools Player" in the interdisciplinary field of Team Science. Stokols added a sixth "Tool" in order to underscore one of Klein's rarefied talents: "She makes her colleagues and students better in their own right." Stokols' valuable insights about Klein and her achievements spotlight what it takes to be an exemplary interdisciplinarian. He places special emphasis on her quality of resilience, while mentioning additional qualities such as endurance and stamina that scholars who are interested in capacities that enable interdisciplinary work may wish to examine further.

The rest of the volume features the tripartite thematic structure of "engaging, extending, and reflecting" in the critical examination of Klein's work. Although the verb "to engage" has many meanings (indeed, the *Oxford English Dictionary* lists 19 definitions), I understand that "to engage" in this case means (to borrow from the OED's 13th definition) "to entangle" with Klein's work, certainly, but also to "involve and commit" to her work, and perhaps to question if not challenge that work…or, as the OED puts it, to "mix up (in an undertaking, quarrel, etc.)."

Karri Holley, who is a professor of higher education at the University of Alabama, starts off the "Engaging" section with her article, "Learning from Klein: Examining Current Interdisciplinary Practices within U.S. Higher Education." Holley draws from Klein's longstanding commitment to mapping American interdisciplinary higher education while offering a comprehensive overview of contemporary interdisciplinary education in the United States. Holley builds upon Klein's previous writings by asking questions: "Who engages in interdisciplinary work?" "How is interdisciplinary work supported?" "How is interdisciplinary work organized?" She then addresses

the question of "What's next?" by examining issues of access and new delivery modalities. In so doing Holley follows Klein's footsteps (and encourages other scholars to do so) insofar as she is interested in considering how emergent trends can be opportunities for supporting and advancing interdisciplinarity.

In the second article in the "Engaging" section Bethany Laursen, a graduate student, and Michael O'Rourke, a professor of philosophy, both at Michigan State University, critically engage with Klein's writings on integration. They compare Klein's recent socio-linguistic model of integration (as developed from her earlier step-wise model) with what they call an IPO (input-process-output) model in their illuminating article, "Thinking with Klein about Integration." While they make the case that the IPO model is a more generally applicable framework than Klein's socio-linguistic model, they use an example of integrative argumentation from a Toolbox workshop to demonstrate the complementarity of the two models, concluding that "we can understand instances of cross-disciplinary integration better with both models than with only one or the other." And they note that this "theoretical stereoscope opens new avenues of research" in integrative work.

Can "engaging" be a synonym for "applying"? For the purposes of this special volume it can. In the third and final article in the "Engaging" section, Christian Pohl, of ETH Zurich, Dena Fam, of the University of Technology, Sydney, Australia, Sabine Hoffman, of the Swiss Federal Institute of Aquatic Science and Technology, and Cynthia Mitchell, also of the University of Technology, Sydney, call attention to Klein's recent focus on boundary work, which happens to be the subject of her highly anticipated forthcoming volume, *Beyond Interdisciplinarity: Boundary Work, Collaboration, and Communication in the 21st Century*. With Klein's permission, Pohl and his collaborators apply Klein's conceptual framework for boundary work in order to evaluate its effectiveness for actual transdisciplinary teamwork. Drawing on two case studies – one that involved the installation of a sanitation system in a campus building at the University of Technology Sydney, Australia, and the other that involved a sustainable urban water management project in Switzerland – Pohl and his co-authors "explore and assess the heuristic value of the framework" and suggest how it might benefit from some modification. They make a persuasive case for the versatility and adaptability of Klein's conceptual framework while ultimately making a case for its further elaboration.

The two articles in the next section of this special volume, "Extending," push Klein's ideas forward in ways that have yet to appear in print. Frédéric Darbellay, a professor at the Centre for Children's Rights Studies of the

University of Geneva, Switzerland, has shared Klein's longstanding interest in typology and definitions of varieties of interdisciplinarity. In his article, "From Interdisciplinarity to Postdisciplinarity: Extending Klein's Thinking into the Future of the University," Darbellay revisits Klein's influential definitions in light of new developments and critique, inviting "further reflection on more or less likely scenarios" in "university institutions, scenarios more or less transgressive of the disciplinary status quo." As the university's attachment to disciplinarity becomes increasingly challenged, radical visions of revision, activism, and revolution in the name of postdisciplinarity emerge, well worth pursuit by scholars in the field.

In his article, "Imagination and Actionability: Reflections on the Future of Interdisciplinarity, Inspired by Julie Thompson Klein," former AIS President Machiel Keestra, assistant professor at the Institute for Interdisciplinary Studies at the University of Amsterdam, credits Klein's work on interdisciplinarity's history as a catalyst for his considerations of its present practice and future possibilities. Keestra charts similarities between the aims of interdisciplinarity and transdisciplinarity and those of action research before turning his attention to the role the arts, creativity, and the imagination can and should play in establishing actionability as a criterion for the best work in the field. In proposing new directions for thinking about ID and TD both, Keestra, a philosopher of mind by training, not only extends Klein's work in new directions but extends his own, as well, and encourages all of us to follow suit.

After reading about possible futures for interdisciplinarity in several of the articles in the first two sections of this special volume (that by Holley as well as those by Darbellay and Keestra), readers may deem the placement of the three reflective pieces in the third and last section of the volume a bit odd, given that the act of reflection involves looking back at the past. However, while not concerned with imagining the future, reflection aims to learn from the past in order to move forward. And our reflectors all feel that they have learned much from their past engagement with the work of Julie Thompson Klein (and often with Klein herself) and expect to learn still more as their engagement (with the woman and her work) extends into the future. As I considered their contributions to this volume, I was interested in highlighting the uniqueness of their writing styles and forms, which challenge the conventional form and exacting writing style of the usual peer-reviewed academic article. I find their transgressions of "the scholarly" innovative and liberating. They unveil new understandings of Klein's contributions that perhaps could not have been conveyed otherwise.

In the first of these articles, Cathy Davidson, Founding Director of the

Futures Initiative in the Graduate Center at the City College of New York (CUNY), and her co-author, Bruce Janz, a professor of philosophy at the University of Central Florida, break with strict expository writing rules in their article, "Theory into Practice: Julie Thompson Klein's Boundary Work and Institutional Change." Their first sentence, which conflates the literal with the metaphoric, simultaneously summarizes Klein's life and work: "Julie Thompson Klein lives at the border." Davidson, as many *Issues* readers will know, is no stranger to border work in interdisciplinary education herself, having served as the first Vice-Provost of Interdisciplinarity so-designated in the United States at Duke University prior to accepting her current position as a Distinguished Professor at CUNY. Davidson and Janz, recount Klein's vital role in the creation and continuation of HASTAC, the Humanities, Arts, Science, and Technology Alliance and Collaboratory, which they see as exemplary of the boundary-breaking efforts that Klein not only theorizes but also enacts, enabling others to do the same.

Gabriele Bammer, the founder of Integration and Implementation Sciences (i2S) and a professor at The Australian National University, gathered reflections of nine of her Australian colleagues and one New Zealander – in addition to writing her own – to offer what the title of their intriguing article denotes: "A Rich Mosaic of Impact: Julie Thompson Klein's Scholarly Influence in Australia and New Zealand." Bammer and her co-authors make explicit what should be quite evident in this special volume's Table of Contents: Klein is to be acknowledged and credited not just for advancing the discourse of interdisciplinarity, but also for connecting scholars interested in interdisciplinarity all around the globe. Their article also "demonstrates the value of reflective narratives in providing a more rounded and richer picture of an academic's influence than traditional metrics" do.

The third article in the "Reflecting" section and the final article of this special volume, "The Impact of Julie Thompson Klein's Interdisciplinarity: An Ethnographic Journey" by Gaetano Lotrecchiano, of George Washington University, and Andi Hess, of Arizona State University, is a special treat as it is chock-full of Klein's *own* reflections about her work and career. Lotrecchiano interviewed Klein via teleconferencing and email exchanges, and in processing the results of the extended dialogue, he and Hess focus on three major aspects of her work: "interdisciplinary educational activities, contributions to the professionalizing of interdisciplinarity, and discourse on teams." Accompanying Lotrecchiano and Hess on this "ethnographic journey" towards understanding how [Klein] herself views her scholarly evolution over the last five decades" is nothing short of revelatory.

Lotrecchiano and Hess's respective biographical notes are also uncon-

ventional for *Issues* in terms of both length and content. It's not often that biographical information proves to be deeply moving. While they each express how Klein's work has impacted their own work and their academic trajectories, they also take care to emphasize how personal interactions with Klein have impacted their very lives. It was a bit of a surprise to learn that someone whom I consider a personal mentor has been a mentor for so many others as well. But then again, my feelings about guest editing this special volume are similar to Lotrecchiano's feelings about preparing his article for this special volume. He describes the effort as "a labor of love and dedication to the kindness, encouragement, and trust afforded me by Julie." I would describe my own efforts in the same way.

In closing, I need to reiterate that this volume is not a mere celebration of Klein's work. It truly does engage, extend, and reflect on that work and, in so doing, should be inspiring of further work in its testimony to Klein's ongoing influence and impact, the results of her scholarship, her teaching, her collaboration, her networking, her mentoring, her consulting, and – dare I say it – her friendships. The Association of Interdisciplinary Studies owes a great deal to its former president, Julie Thompson Klein, but, as the articles in this collection attest, so do people involved in the many varieties of interdisciplinary endeavor worldwide. It is no wonder that the AIS Board of Directors found it fitting to schedule the publication of this special volume in the same year as the first AIS conference in Europe (its second international conference, after that held in Canada at the University of Ottawa in 2016). On behalf of AIS and the *Issues* co-editors, Gretchen Schulz and Sven Arvidson, I wish to thank our decidedly international roster of contributors for their work inspired by the work of Julie Thompson Klein. Without exception, they assert that they are immensely appreciative of and grateful for all she has done to advance the understanding – as well as the application – of interdisciplinarity. And so say we all.

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# An Interdisciplinary "Six Tools Player"

by

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***Editor's Note**:* The following biographical text by Daniel Stokols has been edited for this special volume. It was originally written as a presentation on the occasion of Julie Thompson Klein's 2016 Science of Team Science (SciTS) Recognition Award to honor her for her important and sustained contributions to the Science of Team Science field. Stokols presented Klein with the award on May 18, 2016, in Phoenix, Arizona.

***Keywords:*** 2016 SciTS Recognition Award, five-tools player, Julie Thompson Klein, six-tools scholar

Julie is Professor Emerita of Humanities at Wayne State University, where she taught from 1970 to 2016. She earned her PhD in English from the University of Oregon. She served as President of the Association for Interdisciplinary Studies (AIS) in 1987-1988 and received AIS's Kenneth Boulding Award for Outstanding Scholarship on Interdisciplinarity in 2003. Julie is the 2016 recipient of the Science of Team Science (SciTS) Recognition Award.

Before I say more about Julie's scholarly and professional achievements, I want to take a moment to mention some of her passions outside of academia. First, as many of you may know, Julie loves a variety of musical and artistic genres, from blues, New Orleans jazz and zydeco, to modern dance, burlesque, drama, and film. Also, Julie is an ardent baseball fan, especially of the Detroit Tigers and beyond the Tigers, Julie and her husband, George, are very knowledgeable about baseball history and lore.

Actually, baseball offers some very apt analogies for describing just why Julie is so highly esteemed by her colleagues and students. I don't profess to have a lot of expertise about baseball, but I did do some little league coaching back in the day and when I was around other coaches, I'd hear them

encourage their team members to become "Five Tools Players." I wondered what the heck a "Five Tools Player" is, but I soon learned that it is someone who:

1. *Hits for Average* – like Ichiro Suzuki of the Mariners, who knows how to hit behind the runner and get on base consistently;
2. *Hits for Power* – like Cecil Fielder, Albert Pujols, Mickey Mantle, Babe Ruth, and fellow home run sluggers;
3. *Has Great Throwing Ability* – like outfielders Mike Trout and Kirby Puckett;
4. *Has Excellent Fielding Ability* – like shortstop Ozzie Smith of the Cardinals;
5. *Has Outstanding Running Speed and Endurance* – like the speedy, base-stealing Ricky Henderson or always-in-the-lineup Cal Ripken, Jr.;

There's also a *sixth tool* not often mentioned in baseball, although the data crunchers who come up with *Moneyball* algorithms know of its importance.

6. This sixth tool is suggested by Anita Woolley's research on collective intelligence namely, *the team member who makes fellow players collectively better at what they do* – the utility player whom you can put anywhere on the field and their presence always enhances team performance.

For my purposes here, I will refer to the "Six Tools Player" instead of "Five." It's clear to me that as a metaphor, the six tools of baseball are very apropos Julie's scholarly and professional achievements.

Consider for example *Hitting for Average*: Julie has been a prolific contributor of high quality scholarship on interdisciplinary and transdisciplinary team science over several decades. One needs only to look at her CV to realize just how productive Julie has been and continues to be. Julie epitomizes the capacity for *consistent and sustained productivity*.

What about *Hitting for Power*? Julie indeed has hit *a lot* of home runs throughout her career. Her high-impact journal articles, chapters, and books have advanced our understanding of interdisciplinarity, transdisciplinarity, team science, convergence science, and the digital humanities. Her books *Interdisciplinarity: History, Theory, and Practice* (1990) and *Crossing Boundaries: Knowledge, Disciplinarities, and Interdisciplinarities* (1996) gave form to the field of Interdisciplinary Studies. Her books *Humanities, Culture, and Interdisciplinarity: The Changing American Academy* (2005) and *Creating Interdisciplinary Campus Cultures* (2010) traced the history and rise of interdisciplinarity in institutions of higher learning. She is Co-Editor of the *Oxford Handbook on Interdisciplinarity*, first published in 2010, followed by

the second edition in 2017. She also published her pioneering book, *Interdisciplining Digital Humanities,* in 2015.[1]

As further evidence of Julie's ability to hit for power, she has garnered many academic distinctions and awards, including (among others), her

- *Fulbright Professorship in Nepal (1987);*
- *Mellon Fellowship in Digital Humanitie*s at the University of Michigan (2008);
- *Kenneth Boulding Award for Outstanding Scholarship on Interdisciplinarity (2003);*
- and at Wayne State University, the *President's Award for Excellence in Teaching* (1985), the *Graduate Mentor Award*, and the *Board of Governors' Distinguished Faculty Recognition Award (1991)*.

And then there's Julie's *Throwing Ability*. Just as baseball players must feed the ball consistently to fellow teammates, academics must feed ideas to others. Julie is a well-spring of creative ideas that she generously shares, all of which help to enhance the scholarly efforts of her colleagues and students. Julie also generates collegial synergy at professional levels through her numerous advisory board memberships and contributions.

As for the fourth tool, *Fielding Ability*, Julie covers the field of team science (and the other arenas in which she plays) as well as anyone. In baseball, there's the relay person, who receives the outfielder's throw and fires the ball to the catcher at home plate, who tags out the base runner trying to score. Julie is a *boundary spanner* (her neologism) and bridge builder *par excellence,* comparable to the baseball player who relays an outfielder's throw to the catcher, especially reflected in her ability to connect team science scholars from around the globe. Examples of Julie's international bridge-building efforts include her visiting appointments and lectureships in Nepal, Japan, New Zealand, Mexico, Brazil, Uruguay, Australia, Russia, and Ireland, as well as Julie's

- service as a consultant to the Swiss National Science Foundation on transdisciplinarity;
- membership in the Academy of Finland's Integrative Research Team;
- service as advisor to the Royal Netherlands Academy of Arts and Sciences on evaluation of inter- and transdisciplinary research;
- and closer to home, professional contributions as President of the Association for Interdisciplinary Studies (1987-88);
- service as Founder and Director of the Digital Humanities Collabo-

[1] Editor's Note: In 2019 Klein is working on another book project titled *Beyond Interdisciplinarity: Boundary Work, Communication, and Collaboration in the 21st Century*.

ratory at Wayne State University;
- and service as an Advisory Board member for several organizations including HASTAC, InSciTS, the NCI Team Science Toolkit, and many others.

Turning to the fifth tool, *Running Speed and Endurance*, Julie personifies *resilience* and *endurance*. She became Professor "Emerita" in 2016 but has not slowed down one iota in scholarly productivity and professional engagement. Julie has tremendous stamina. Whenever Julie has been thrown a nasty curveball, or has been brushed back or even knocked down by a tight inside fastball, she's always gotten right back up with her indomitable courage and will power, reaching out to and caring for others as well, all the while remaining as vibrantly creative and professionally engaged as ever.

Julie is truly an academic superstar who possesses the aforementioned five tools as a scholar, mentor, and colleague. But she also possesses that sixth tool I mentioned earlier: *She makes her colleagues and students better in their own right* through the tremendous energy and supportiveness she invests in her collaborations with others. She has the special distinction of being both a highly prized superstar and a utility player. So, Julie genuinely possesses all the exceptional qualities of a "Six Tools Player"!

And I should add, Julie is a very modest person. When she was informed that she had been selected to receive the SciTS Recognition award in 2016, she expressed her embarrassment and even suggested that she should decline the award so that another deserving colleague could receive it.

Julie, for all of these reasons, we are fortunate to have you as our colleague and role model, and we treasure your contributions to the advancement of multiple interdisciplinary studies fields. Thank you for all you've done!

***Biographical Note:*** Daniel Stokols is Chancellor's Professor Emeritus at the University of California, Irvine and served as founding dean of UCI's School of Social Ecology. His research spans the fields of social ecology, environmental and ecological psychology, public health, and transdisciplinary team science. He is co-author of *Social Ecology in the Digital Age* (2018) and the National Academy of Sciences report on *Enhancing the Effectiveness of Team Science* (2015). He may be reached at dstokols@uci.edu.

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# Learning from Klein: Examining Current Interdisciplinary Practices within U.S. Higher Education

by

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***Abstract:*** In this article, I consider Klein's scholarship as a foundation to examine the realities of interdisciplinary practice in higher education institutions, including questions of who engages in interdisciplinary work, how interdisciplinary work is supported, and how interdisciplinary work is organized. In discussing each of these issues, I underscore elements of the higher education context, including funding, enrollment, and staffing. I identify areas that require future research regarding higher education and interdisciplinarity, specifically research engaging questions of inequality in access and outcomes and research examining educational delivery modalities such as hybrid and online learning and the effectiveness of interdisciplinary curricula and pedagogies in these environments.

***Keywords:*** higher education, interdisciplinarity, institutionalization, Julie Thompson Klein, online learning

I first encountered the work of Julie Thompson Klein when I was a doctoral student at the University of Southern California in the mid-2000s. My own field of expertise, higher education studies, is not a stranger to the concept of interdisciplinarity. In the prior decades, the topic had occupied what many higher education scholars might consider to be niche specialty areas, such as undergraduate teaching, student learning, and curriculum development. Evidence was emerging of the "interdisciplinary arms race" in higher education (Rhoten & Pfirman, 2007), a race that continues, with multiple and overlapping concerns about how interdisciplinary teaching, research, and practice might shape the way institutions behave. My engagement with Klein's work expanded my understanding of interdisciplinarity beyond the foci of my academic field; her work was an integral element of my doctoral dissertation, which examined the experiences of doctoral students enrolled

in an interdisciplinary neuroscience program (Holley, 2006; 2009).

When asked to reflect on Klein's scholarship in ways that might extend future research in interdisciplinary studies, I first considered the historical origins of interdisciplinary practices in higher education. While the so-called "arms race" of the 21st century is related to issues of funding, outcomes, and assessment, interdisciplinary activities among colleges and universities are evident throughout their history. A historical analysis reveals endeavors that mirror those of other social institutions – organizing and regulating the knowledge-producing activities of people in ways that promote legitimacy and longevity. Colleges and universities exist for many reasons, but one reason is to educate and graduate students with skills, knowledge, and degrees that translate into individual and social benefits. Yet contemporary rhetoric positions interdisciplinarity and its associated outcomes in near revolutionary terms: as a way to advance human understanding, move disciplines forward by transcending disciplinary knowledge, and better the human condition. Shared among these terms is the belief that interdisciplinarity holds a potential that cannot be reached by traditional, disciplinary ways of knowing. More muted among the same terms are the social, cultural, economic, and political realities in which higher education institutions exist, with the result that interdisciplinarity seems an ideal that all too frequently feels unattainable. Klein (2010) has acknowledged this paradox, noting that "promotional rhetoric and the promises of strategic plans ring hollow when interdisciplinary work is routinely impeded and discounted.…despite all the talk about interdisciplinarity, universities are failing to walk the walk" (p. 4).

Reflecting on Klein's writings as well as the current status of higher education in the United States conveys uncomfortable facts. These facts include declining public support of and trust in higher education; escalating tuition costs and skyrocketing student debt; emerging educational pathways to student learning and skill development, such as vocational, short-term, and credential-based programs; and devaluing of the professoriate in ways that make hiring and retaining future faculty uncertain: all trends that potentially influence the future of interdisciplinary education. Added to these facts are questions and concerns related to nationalism, globalization, and internationalization as well as shifting narratives on definitions of truth and expertise. Colleges and universities are being forced to re-examine their most core task, the production and dissemination of knowledge, in ways that involve consideration of interdisciplinary work. Advocates for interdisciplinarity frequently suggest that educational institutions need to do more to promote the new approaches needed to unravel complex problems and develop sustainable, ethical solutions to those problems; higher education institutions as a whole

face the need to understand and respond to such advocacy.

It is with the belief that higher education institutions serve as a mirror to larger society, reflecting our best and worst tendencies, that I write this article employing Klein's scholarship as a foundation to examine the realities of interdisciplinary practice in higher education institutions, including questions of who engages in interdisciplinary work, how interdisciplinary work is supported, and how interdisciplinary work is organized. In discussing each of these issues, I underscore elements of the higher education context, including funding, enrollment, and staffing. I identify areas that require future research regarding higher education and interdisciplinarity, specifically research engaging questions of inequality in access and outcomes and research examining educational delivery modalities such as hybrid and online learning and the effectiveness of interdisciplinary curricula and pedagogies in these environments.

**Who Engages in Interdisciplinary Work?**

Understanding the scale and scope of current interdisciplinary efforts in higher education gives important initial insight into what future research related to the topic might entail. Implicit across Klein's scholarship, and indeed that of other researchers who write about and study interdisciplinarity, is the lived experience of people – to understand "interdisciplinarity in higher education" is to understand how students, faculty, and other stakeholders experience interdisciplinary efforts. Students frequently experience these efforts in pursuit of a credential or degree. In 2016, postsecondary institutions in the United States awarded 2.9 million two- and four-year degrees; of these, 30,500 associate degrees and 49,000 bachelor degrees (slightly less than three percent of the total) were labeled as "interdisciplinary studies." These figures do not account for the thousands of degrees in fields such as biomedical sciences or disability studies that likely have curricula that cross disciplinary boundaries (NCES, 2018). Consistent with trends in higher education, the profile of students receiving interdisciplinary studies degrees is highly gendered – females earned 58 percent of the associate's degrees in interdisciplinary studies and 67 percent of the bachelor's degrees in interdisciplinary studies in 2016 (NCES, 2018). Overall, the number of students majoring in interdisciplinary fields has increased in the past decade (NCES, 2018), illustrating a sustained student interest in interdisciplinary learning (Brint, Turk-Bicakci, Proctor, & Murphy, 2009).

Quantifying the number of postsecondary faculty who engage in interdisciplinary work or who reside within interdisciplinary programs is a more

difficult task. While 1.5 million faculty work in postsecondary institutions (NCES, 2018), three-quarters of faculty positions are off the tenure track, typically in contingent, adjunct, postdoctoral, or lecturer roles (Harmon, Hopkins, Kelchen, Persky, & Roy, 2018). Looking across the various types of institutions that employ faculty (two-year, four-year, public, private, not-for-profit, and so on) reveals that only a little over half of all postsecondary institutions in the United States have tenure systems; tenure is no longer the *de facto* reality for most faculty. A widening gap exists between traditional faculty roles and the realities of higher education. At a time when the number of students receiving doctorates and potentially pursuing faculty careers has increased, and student demographics have become more diverse, the desirability of available jobs and the securities offered through the tenure system have weakened.

Examining interdisciplinary studies programs at U.S. institutions reveals how interdisciplinary studies programs are frequently led by contingent, adjunct, or lecturer faculty, or involve only a small number of faculty of whatever sort in relation to student enrollment. As an example, a review of the IPEDS (Integrated Postsecondary Education Data System) database and institutional websites shows six full-time faculty (only one of whom is tenured or tenure-earning) as part of the Interdisciplinary Studies Program at University of Maryland, Baltimore County and 183 students across all degree fields. In the University of Oklahoma Interdisciplinary Studies program, 115 students are enrolled across all degree fields, led by a team of four faculty (IPEDS, 2019). While some interdisciplinary studies programs may have a higher number of faculty per student, or make up deficiencies by drawing on faculty resources from other parts of campus, the student/faculty ratio is at present often too high to be optimal for the student experience. This ratio also suggests a deficiency not just in the number of faculty (including contingent, non-tenure-track, and lecturers) who serve as advisors and mentors, but also in the financial resources and support allocated by the university to the program. The frequently inadequate number of interdisciplinary studies faculty operating without sustained and abundant support is especially significant, given Klein's reminder that the interdisciplinary curriculum is invented by faculty. "Interdisciplinary study is creative and constructed rather than imitative and formulaic," she writes, and this construction requires the attention of empowered faculty (Klein, 1999, p. 17).

On the one hand then, as noted, an increasing number of students are interested in interdisciplinary learning. On the other hand, as also noted, faculty engaged in interdisciplinary work are more likely to be in insecure professional positions and lack access to support such as professional development opportunities when compared to those in more secure positions,

leaving questions about the ability of such faculty to structure and guide student engagement in interdisciplinary work (Augsburg, 2006). In the coming years higher education institutions will likely face continued demands from students to offer interdisciplinary learning opportunities that respond to learning trajectories that do not fit within the traditional four-year undergraduate scheme, that align with real-world challenges, and/or that suit emerging employment prospects. Successfully meeting these demands will require an interdisciplinary faculty community more empowered to create and offer programming than many are now. "Teaching by highly educated individuals engaged in ongoing learning of their own produces a valuable opportunity for students to learn essential knowledge and skills that will prepare them for life and career," conclude Condon, Iverson, Manduca, Rutz, and Willett (2016, p. 1). When faculty lack access to secure employment positions and the power of governance within those positions, not to mention professional development enabling ongoing learning, their capacity to design and deliver interdisciplinary curricula is questionable.

For interdisciplinarians who do assume a faculty position, even a relatively secure tenure-track position, the institutional challenge of working across interdisciplinary boundaries may still be significant. Klein (2013) acknowledges this challenge, noting that often "the rhetoric of transformation and powerful precedents [of such work being well done] are checked by the local political economy of institutionalization" (p. 73). The local political economy may negatively impact the assessment of faculty work and, in turn, the renewal of faculty contracts. Faculty who have secured positions in interdisciplinary programs and who develop and teach interdisciplinary curricula may find that policies and practices guiding their work are unclear. Pfirman and Martin (2010) offer examples of important policies and practices for those engaged in interdisciplinary teaching: "the need for course releases to develop intrapersonal expertise, co-teaching credit for the interpersonal approach, departmental buy-in for the interfield class, and adjunct support for practitioners when external stakeholders are involved" (p. 388). However, such support for interdisciplinary teaching may not be available. And when it comes to interdisciplinary research, Klein and Falk-Krzesinski (2017) suggest that "individuals face a double handicap. Their work is judged typically by discipline-based standards, and their contributions to collaborative research are under-valued if they are not first author on publications or principal investigator on a grant" (p. 1055). Even when institutions do offer policies and practices supportive of faculty working in interdisciplinary areas, these policies and practices usually exist within institutional cultures that have continually demonstrated their resistance to change. As Klein has

often observed throughout her work, this resistance is embedded in the deep roots that the academic disciplines have in the modern higher education system. While these roots ground the system (for example, routing students in a relatively straightforward pathway from entry to graduation through the academic major), they also constrain change. A troubling conclusion is that academia has been and may well continue to be reluctant to pursue the sorts of change necessary to support and further interdisciplinary work, thereby neglecting the increasing student interest in such work and the increasing societal demands for people who can do work of this kind.

**How Is Interdisciplinary Work Supported?**

Of course, knowledge production activities within the university come at a cost that goes well beyond the cost of a few faculty lines. However, regardless of the metric used, the costs of interdisciplinary programs must be balanced with those of other institutional priorities. As once reliable funding streams for colleges and universities have diminished, including state funding for public institutions and federal aid for students, institutional choices are increasingly made with regard to what value a program or activity provides, and whether this value is consistent with the associated cost. Only uncertain evidence is available as to whether or not interdisciplinary programs are more expensive overall compared to traditional disciplinary programs – hugely variable factors such as institutional context, faculty staffing, and number of students all influence estimates of program costs. A 2013 report from the Delta Cost Project at the American Institutes for Research ranked disciplines by cost per degree; interdisciplinary studies programs were just below the average, but cost more than such majors as mathematics, English, philosophy, and human sciences. Of course, the validity of figures of this sort depends on answers to many questions. What is the nature of faculty appointments in an interdisciplinary program? Does the program have tenure-earning or tenured faculty? Is the interdisciplinary academic program comprised of faculty with dual appointments, and if so, how do the academic departments support these positions? Does tuition generated by the students in the program remain within the program, or is it allocated across academic departments/colleges? Similar questions exist for interdisciplinary research centers, including questions about staffing, structure, and organization. Klein and others have reflected on the tendency to fund interdisciplinary programs through seed grants, venture capital, or related start-up funds with the expectation for future self-support. However, they also have noted it is important for such programs to have “a stream of funding that resists

budget cutting and other pressures" (Klein, 2010, p. 93). Without such a stream flowing when start-up funds give out, future self-support may be very difficult. Over the last two decades, institutions have increasingly expected all academic programs to produce enough revenue to maintain future program efforts. We should expect this trend to continue, and interdisciplinary programs may have a particularly hard time with this expectation.

Another trend that can make the investments to build and sustain interdisciplinary programs seem too costly: the straitened financial realities of higher education in general. Almost every state in the U.S. is spending less on public higher education now compared to 2007 (Mitchell, Leachman, & Masterson, 2016). Over half of the states have moved towards a performance-based funding model, where state-funded academic institutions are "rewarded" based on such criteria as the number of degrees completed annually, the average time to a degree, and/or the employment status and salary of graduates. These criteria fall outside those identified by Klein and colleagues as best criteria for assessment of interdisciplinary programs (Rhoten, Boix Mansilla, Chun, & Klein, 2006), including the ability of students to define an interdisciplinary topic, work with ideas from different disciplines, and be part of an interdisciplinary team. Measuring the productivity of an interdisciplinary degree program by pre-determined criteria designed for traditional academic degree programs has proven challenging (Feller, 2002). Academic institutions understandably shy away from perceived high-risk degree programs that fall outside of traditional boundaries, especially if questions exist related to externally defined performance criteria such as graduates' employability and salary.

Alternatively, interdisciplinary academic programs have been seen as cost-cutting or money-saving endeavors. Consider those institutions that merge several programs underneath a vague interdisciplinary label as a way to cut administrative or staffing expenses. Of course, colleges and universities can use merging and other structural changes to achieve two goals simultaneously, fostering a robust interdisciplinary academic culture while also reducing institutional expense. However, when the primary motivation for such structural changes is upping degree production (increasing the number of graduates under a specific disciplinary or interdisciplinary label as a way to satisfy external criteria) or addressing budget gaps (reducing staff or faculty by consolidating workloads and class responsibilities in response to fiscal shortfalls), the potential for real interdisciplinary learning has usually been usurped for other ends (Augsburg & Henry, 2009). Examples abound of once robust interdisciplinary studies programs that have been diminished or eliminated through administrative decisions related to budget, staffing, or student enrollment. The programs

at Wayne State University and Miami University are two of the most prominent examples (Augsburg & Henry, 2009).

Interdisciplinary research programs (as opposed to interdisciplinary teaching programs) have seen sustained interest from federal, state, industry, and not-for-profit funders. However, the influence of funders thus far has not been benign. Relying on external partners to motivate, fund, or promote interdisciplinary outcomes can reduce the ability of higher education institutions to make decisions based on student and/or academic interests. True, we have had statements from the National Science Foundation, the National Endowment for the Humanities, and other federal agencies in the United States that recognize and prioritize interdisciplinary research funding for at least the past three decades – as, for example, in the National Research Council's *Facilitating Interdisciplinary Research* (2004). However, now multiple decades into this push for interdisciplinary work, we have seen the potential detriment of this push through institutions "simply adopting interdisciplinary labels without adapting their disciplinary structures and artifacts" (Klein, 2010, p. 4). Newly formed interdisciplinary projects still building important bonds of trust and productivity among members can be harmed when academic institutions approach interdisciplinary funding with the same administrative approach as they use for disciplinary funding (e.g., the return of indirect costs to only one academic college or department).

**How Is Interdisciplinary Work Organized?**

Across much of her scholarship on interdisciplinarity, Klein reflects on the numerous variables that shape how institutions pursue interdisciplinary programming. These variables include the size and mission of the institution, the institutional culture, the financial capacity for this sort of programming, and the depth of the interdisciplinary effort (Klein, 1996, 2010). Colleges and universities may desire to become more responsive to student and faculty (and stakeholder) demands for alternative curricula that promote interdisciplinary work; however, even if they seek out best practices to do so, effective practices vary based on unique institutional characteristics. Klein (2013) writes, "We must test the appropriateness of best practices in the particularities of context" (p. 73). What works on one campus, at one specific point in time, may not work for another at a different time.

The organization of interdisciplinary teaching and interdisciplinary research commonly relies on using familiar building blocks (faculty, credit hours, centers and institutes, etc.) in novel ways. A lingering question is whether novel outcomes such as we expect from interdisciplinary work

can be anticipated from this approach. Writing with William Newell, Klein (1997) has critiqued the adoption of disciplinary practices for interdisciplinary ends, suggesting that managing the complex system necessary for interdisciplinary work "requires recognizing the coexistence of multiple activities and their essential heterogeneity" (p. 8). Moreover, this recognition necessitates changing not just institutional structures, but also institutional culture. The research center, for instance, holds promise as a unit capable of crossing boundaries (Klein, 1996) while responding quickly to external stimuli and maintaining engagement and status within the institution. However, while such centers may be promising vehicles for the promotion of interdisciplinary research, Biancani, Dahlander, McFarland, and Smith (2018) accentuate how such centers may be excessively vulnerable to administrative influences. Where such centers are concerned, "the administration likely has more leeway to change course or to scale the enterprises up or down," the authors conclude, employing "a strategy through which upper administration can exercise a great deal of discretion in steering the university with little opportunity for faculty resistance" (p. 557).

Interdisciplinary degree programs may find their capacity to be responsive to demands for education of this kind hindered by the old thinking that dominates our institutions, too. The "otherness" of these programs can leave them staffed with faculty who lack secure professional status within the institution (a problem noted above). They might also be ill-defined and, at times, unprotected from unfriendly administrative interference. Without adequate resources for the advising they need or other faculty support, students in such programs might be forced to select from a smorgasbord of courses that check boxes towards degree completion rather than encouraged to develop a rigorous interdisciplinary learning experience. This check-the-boxes approach negates the potential of interdisciplinary education to develop relational learning such as "the abilities, commitments, and knowledge [students] need to move among subjects and fields, individuals, communities, cultures, and nations" (Klein, 1999, p. 16). Curricula must be responsive to local contexts, but they must also serve as vehicles for robust learning opportunities. Accordingly, issues such as course sequence and integration across disciplinary bodies of knowledge require empowered faculty action and consistent faculty monitoring if such learning is to take place. And, whatever else happens, the organization of interdisciplinary learning is poised to change rapidly with the growth of online, hybrid, and other emerging delivery models for education.

Speaking of change, contemporary conversation about the organization of higher education reflects on the idea of "the university of the future." What

will the university be like for our next generation, and the ones after that? Among the commonly discussed features are an emphasis on lifelong learning, flexible learning experiences, and responsive financial models. Universities of the future are also presumed likely to advance digital and other alternative learning models and foster knowledge-generating partnerships with non-academic institutions – in sum, meeting students where they are in terms of their learning and desired outcomes, perhaps even anticipating where students will be, and providing training and credentials that are reflective of the needs of a changing economy. As one example, Georgia Institute of Technology (Georgia Tech), with its Commission on Creating the Next in Education (CNE), suggests the need "to imagine a future in which the artificial barriers found throughout higher education disappear" (2018, p. 60). In the Commission's final report, the idea of "interdisciplinarity" is mentioned only briefly, in reference to dissolving disciplinary silos and encouraging collaborative learning across academic departments. Yet the report in its entirety speaks to the sort of educational future where innovation and flexibility (hallmarks of interdisciplinarity) shape the university, as opposed to rigid structures and slow-moving change. Another example of future-think can be found in the so-called New American University at Arizona State University. Lamenting what he called the "fundamental design limitations" of the academic institution (Crow & Dabars, 2015, p. viii), President Michael Crow has spent the past decade re-imagining the possibilities of higher education. The ASU approach differs from Georgia Tech's in that academic programs and colleges are empowered to act based on the interests of students and faculty. By devolving responsibility to the level of the academic unit, ASU encourages students and faculty to seek collaborative learning not just within the institution, but with other entities outside of it.

For research universities of the future that prioritize interdisciplinarity, the organization of this work will no doubt begin with the acknowledgment of expense: Research universities are expensive organizations with a cost per student much higher than that of other institutional types, meaning that dedicated revenue streams and a consistent budget will be key elements of any organizational initiative. While this fact does not necessarily mean that interdisciplinary units must be entirely self-sufficient, the issue of cost will continue to be a paramount reality for institutional administrators and faculty. Furthermore, the master's and bachelor-level institutions (those outside of the Carnegie Classification doctoral-level range) that serve a significant and increasing percentage of students in American higher education have and will continue to have fewer financial resources to devote to innovative or experiential programming. In the future, as now, these institutions are less likely to have a robust endowment as a cushion for financial risk-taking.

Regardless of external pressures for interdisciplinary initiatives across the whole range of postsecondary institutions, then, unless these initiatives are connected to a steady and reliable revenue source, the chances of their widespread adoption across a significant percentage of such institutions are low.

## Future Research Related to Interdisciplinarity and Higher Education

I now turn to the question of "What's next?" When we reflect on the scholarship related to interdisciplinarity produced by Klein and her contemporaries, we should do so with a keen eye towards understanding the current and future state of higher education. Answering the question will require consideration of relevance. What is the relevance of interdisciplinarity not just to academic institutions, but also to the multiple stakeholders invested in their work, such as government and industry funders, employers, and policymakers? What is relevant across the range of the more than 4,000 academic institutions in the U.S. that work with a diverse array of students and curricula? What is relevant to bettering the core functions of the academic enterprise (teaching, research, and service) in ways that promote synergy and sustainability?

While the community of scholars who study interdisciplinary education have fashioned a robust research base, led by the work of Klein and others, it is important that we anticipate changes ahead for higher education. This anticipation requires connecting issues of interdisciplinary practice more closely to the higher education system. I believe we have more work to do here, especially considering the rapid pace of change in higher education and the diverse array of institutional types in the U.S. New studies are sorely needed to address interdisciplinary practice.

Drawing on the work of higher education scholar Burton Clark, Klein outlines the delicate balance academic institutions must achieve to negotiate "the gap between older, simple expectations and the complex reality that outruns those expectations" (2010, p. 6). Reflecting on this delicate balance, I examine two potential areas for future research on interdisciplinary studies in higher education: inequality in access and outcomes and delivery modalities of interdisciplinary curricula.

## Inequality in Access and Outcomes

Scholars should research which institutions offer interdisciplinary programs, what students have access to these programs, and what outcomes exist for the institutions, faculty, and students affiliated with these programs. Doing so most effectively requires consideration of what we mean by the

term "outcomes." Klein (2005) offers examples of important student learning outcomes, including the ability to ask meaningful questions about complex topics and the ability to understand multiple sources of knowledge relevant to those topics. In an era of heightened assessment and accountability, I suggest furthering our definition of outcomes to more strongly focus on career tracks and professional trajectories experienced by interdisciplinary graduates. For example, at two-year colleges, do graduates with associate's degrees in interdisciplinary studies transfer to four-year institutions at the same rate as graduates from other programs? What factors explain any differences between the groups? Do students who seek short-term certificates or job credentials in interdisciplinary programs secure employment? How well does their training serve them in professional roles? At the level of four-year institutions, comparative analyses of learning experiences and professional experiences of graduates with interdisciplinary degrees compared to their peers will be valuable. A longitudinal analysis of non-traditional graduates who arrive at the institution with credits already earned and assemble those credits towards an interdisciplinary degree would give insight into important issues such as prior learning assessment and college credit earned through workforce training, military training, or industry certification.

Demonstrating the outcomes of interdisciplinary degree attainment, in terms of individual student development as well as career advancement, is important to understanding the value-added nature of interdisciplinary education. For example, educational researchers have documented the influence of the college major on professional trajectories and earnings after graduation (Altonji, Arcidiacono, & Maurel, 2016). Unemployment rates for students aged 25-29 years old who completed an interdisciplinary studies bachelor's degree were four percent in 2016, roughly the same as those of graduates in English language, criminal justice, and mathematics (NCES, 2018). Examining how employment rates for graduates with interdisciplinary studies degrees change over time and what professions these graduates pursue will remain important. Amid institutional conversations regarding performance-based funding, information on employment rates and professional trajectories for interdisciplinary studies graduates can help inform administrative decision-making.

**Delivery Modalities and Interdisciplinary Curricula**

The realities of higher education in the years ahead will include a continued increase in online learning, a trend that runs counter to the downward trend of student enrollment overall. In the future as now these enrollments

will include fully online courses, in which all of the content is delivered virtually and students do not meet in a face-to-face environment, and blended or hybrid courses, in which a portion of the coursework is delivered virtually and a number of face-to-face meetings are required. Learning formats that include gaming or interactive virtual reality as well as MOOCs (massive open online courses) show the continued growth in educational environments and pedagogies beyond those of the traditional classroom. In 2014, 2.8 million students in higher education took coursework solely online, and that represents approximately one in seven learners (Allen & Seaman, 2016); again, this number is expected to increase for future generations of learners.

Despite its increasing popularity among students, online education still faces numerous institutional barriers. Faculty can be reluctant to develop online courses and engage in an online learning environment; only about one-third of chief academic officers at four-year institutions in the United States say that their faculty are supportive of online education (Allen & Seaman, 2016). Further, not all academic institutions have support systems or processes in place that enable faculty to participate in online course development and delivery. A close examination of online education reveals that the divide between institutions along such lines as prestige, resources, access to technology, and ability to move innovations forward quickly results in uneven program development and student outcomes.

The nuances of online education and related rapid change of technology bring additional complexities to questions of interdisciplinary programming. Patrick, Wicks, and Powell (2014) observe, "There is great diversity in the effectiveness of courses and content….increasing access alone [to online programs] will not lead to better outcomes for students" (p. 88). We lack an effective blueprint to support the features of impactful interdisciplinary learning such as learning communities, faculty networks, fluid disciplinary curricula, and subdisciplinary boundary crossing (Klein, 2010) when we project those features across a virtual environment and not solely across the physical map of a campus. However, interesting examples of possible templates for interdisciplinary engagement in an online environment do exist. One example involves new interdisciplinary fields that span multiple academic disciplines and encompass the online realm, such as the games studies and e-sports program under development at The Ohio State University, which will span five OSU colleges and eventually include undergraduate and graduate degrees, online certificates, and a range of virtual reality and computer gaming experiences. Another involves the growth of fully online graduate degrees in a variety of interdisciplinary academic fields, especially those that integrate theory and practice, such as social work and computer science.

## Conclusion

In this article, I have built from the foundation provided by Klein's scholarship as a way to examine the contemporary reality of interdisciplinarity in higher education, particularly who engages in interdisciplinary work, how interdisciplinary work is supported, and how interdisciplinary work is organized. Interdisciplinarity in higher education remains an endeavor laden with problems, as Klein and others have repeatedly reminded us. Confronting these problems in the future is likely to have one of two possible outcomes. One would be that discussed by Bammer (2017): changing interdisciplinarity, or more specifically, "disciplining" interdisciplinarity. Compartmentalizing interdisciplinary work within a disciplinary structure (and presumably, a related departmental structure) would allow for collaboration, academic recognition, professional advancement, and professional networks such as those that define established academic fields of study. But what might be lost in this approach, in which we would turn to the same model that has categorized knowledge for over a century as a way to produce new forms of knowledge? Instead, we can continue to strive for institutional change moving forward. We can extend and expand upon the work of Klein, to research and document best practices across institutional contexts. We can advocate for changes that allow scholars engaged in interdisciplinary work to secure, retain, and advance in faculty positions defined differently than those in the traditional model. We can articulate and harness the developments ahead for higher education institutions in ways that will allow interdisciplinarity to thrive.

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## References:

Allen, I. E., & Seaman, J. (2016). *Online report card: Tracking online education in the United States*. Babson Park, MA: Babson Survey Research Group.

Altonji, J. G., Arcidiacono, P., & Maurel, A. (2016). The analysis of field choice in college and graduate school: Determinants and wage effects. In *Handbook*

*of the Economics of Education* (Vol. 5, pp. 305-396). New York, NY: Elsevier.

Augsburg, T. (2006). Uncertain paths for interdisciplinary studies programs and their faculties: Critical stakes to claim. *Issues in Integrative Studies, 24*, 150-158.

Augsburg, T., & Henry, S. (Eds.). (2009). *The politics of interdisciplinary studies: Essays on transformations in American undergraduate programs*. Jefferson, NC: McFarland.

Bammer, G. (2017). Should we discipline interdisciplinarity? *Palgrave Communications, 3*(1), 30.

Biancani, S., Dahlander, L., McFarland, D. A., & Smith, S. (2018). Superstars in the making? The broad effects of interdisciplinary centers. *Research Policy, 47*(3), 543-557.

Brint, S. G., Turk-Bicakci, L., Proctor, K., & Murphy, S. P. (2009). Expanding the social frame of knowledge: Interdisciplinary, degree-granting fields in American colleges and universities, 1975-2000. *The Review of Higher Education, 32*(2), 155-183.

Condon, W., Iverson, E. R., Manduca, C. A., Rutz, C., & Willett, G. (2016). *Faculty development and student learning: Assessing the connections.* Bloomington, IN: Indiana University Press.

Crow, M. M., & Dabars, W. B. (2015). *Designing the new American university.* Baltimore, MD: Johns Hopkins University Press.

Delta Cost Project (2013). *How much does it cost institutions to produce STEM degrees?* Retrieved December 15, 2018 from https://deltacostproject.org/sites/default/files/products/Cost%20to%20Institutions%20of%20STEM%20Degrees.pdf

Feller, I. (2002). New organizations, old cultures: Strategy and implementation of interdisciplinary programs. *Research Evaluation, 11*(2), 109-116.

Georgia Institute of Technology (2018). *Commission on creating the next in higher education: Deliberate innovation, lifetime education.* Retrieved December 15, 2018 from http://www.provost.gatech.edu/commission-creating-next-education

Harmon, O., Hopkins, B., Kelchen, R., Persky, J., & Roy, J. (2018). The annual report on the economic status of the profession, 2017-18. *Academe, 104*(2), 4-10.

Holley, K. A. (2006). *The cultural construction of interdisciplinarity: Doctoral student socialization in an interdisciplinary neuroscience program.* Unpublished doctoral dissertation. University of Southern California.

Holley, K.A. (2009). The challenge of an interdisciplinary curriculum: A cultural analysis of a doctoral-degree program in neuroscience. *Higher Education, 58*(2), 241-255.

Integrated Postsecondary Education Data System (2019). *College navigator*. Retrieved August 1, 2019 from https://nces.ed.gov/collegenavigator/

Klein, J. T. (1996). *Crossing boundaries: Knowledge, disciplinarities, and interdisciplinarities.* Charlottesville: University of Virginia Press.

Klein, J. T. (1999). *Mapping interdisciplinary studies: The academy in transition.*

Washington, DC: American Association of Colleges and Universities.
Klein, J. T. (2005). Integrative learning and interdisciplinary studies. *Peer Review, 7*(4), 8-10.
Klein, J. T. (2010). *Creating interdisciplinary campus cultures: A model for strength and sustainability.* San Francisco: John Wiley & Sons.
Klein, J. T. (2013). The state of the field: Institutionalization of interdisciplinarity. *Issues in Integrative Studies, 31*, 66-74.
Klein, J. T., & Falk-Krzesinski, H. J. (2017). Interdisciplinary and collaborative work: Framing promotion and tenure practices and policies. *Research Policy, 46*(6), 1055-1061.
Klein, J. T., & Newell, W. (1997). Advancing interdisciplinary studies. In J. Gaff and J. Ratcliff (Eds.), *Handbook of the undergraduate curriculum: A comprehensive guide to purposes, structures, policies, and change*. San Francisco: Jossey-Bass.
Mitchell, M., Leachman, M., & Masterson, K. (2016). *Funding down, tuition up: State cuts to higher education threaten quality and affordability at public colleges.* Washington, DC: Center on Budget and Policy Priorities.
National Center for Education Statistics (2018). *The condition of education 2018.* NCES #2018144. Washington, DC: Institute of Education Sciences, U.S. Department of Education.
National Research Council (2004). *Facilitating interdisciplinary research.* Washington, DC: National Academies Press.
Patrick, S., Wicks, M., & Powell, A. (2014). K-12 online learning. In K. Shattuck (Ed.), *Assuring quality in online education*. Sterling, VA: Stylus Publications.
Pfirman, S., & Martin, P. J. (2010). Facilitating interdisciplinary scholars. In R. Frodeman, J.T. Klein, & R. Pacheco (Eds.), *The Oxford handbook of interdisciplinarity* (pp. 387-403). Oxford: Oxford University Press.
Rhoten, D., Boix Mansilla, V., Chun, M., & Klein, J. T. (2006). *Interdisciplinary education at liberal arts institutions.* Teagle Foundation White Paper. New York, NY: Teagle Foundation.
Rhoten, D., & Pfirman, S. (2007). Women in interdisciplinary science: Exploring preferences and consequences. *Research Policy, 36*(1), 56-75.

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# Thinking with Klein about Integration

by

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***Abstract:*** Integration is crucial to interdisciplinary and transdisciplinary work and it therefore deserves perennial attention by scholars and practitioners of such work. Few have thought so carefully, deeply, and tenaciously about integration as Julie Thompson Klein. In this article, we recount the development of Klein's thinking on integration, from her early stepwise model in 1990 to her current socio-linguistic model. After summarizing Klein's views, we compare the socio-linguistic model to a more recent view of integration known as the IPO (input-process-output) model. We show how these two models of integration relate to one another, and then we demonstrate their complementarity using an example of integrative argumentation from a Toolbox workshop. We conclude that we can understand instances of cross-disciplinary integration better with both models than with only one or the other. This theoretical stereoscope opens new avenues of research about the types of integrative relations collaborators use, what is involved in social/rhetorical integration, and the extent to which it is feasible to specify all of the parameters in an instance of integration.

***Keywords*:** argumentation, integration theory, interdisciplinarity, Julie Thompson Klein, reasoning

*All interdisciplinary work will be improved by more self-conscious focus on the process of integration.* (Klein, 2001, p. 54)

There are few topics more near and dear to Julie Thompson Klein and to us than integration. The topic is both a personal and professional preoc-

cupation, shared, we know, by nearly all readers of this journal. Many of us have been thinking with Klein about integration for decades. In this article, we provide a scenic overview of our journey, looking intently at where Klein has been and where we might go henceforth together. We begin by reviewing two models of integration that can be recovered from Klein's work – a stepwise model from Klein (in 1990) and what we call the "socio-linguistic model" from her later work. After presenting a model that we favor, the IPO or input-process-output model, we compare it with Klein's socio-linguistic model. We conclude by discussing an example of integrative argumentation from a Toolbox workshop that demonstrates we can understand instances of cross-disciplinary integration better with both models than with only one or the other.

## The Development of Klein's Thinking about Cross-Disciplinary Integration

We begin with two snapshots of Klein's thinking about the concept of *integration*. The first is an early account of integration developed in Klein's 1990 book, *Interdisciplinarity: History, Theory, and Practice.* This early work conducts a wide-ranging survey of the literature then extant on interdisciplinarity. The stepwise model presented in this book represents integration as a roughly linear, algorithmic process, a way of thinking about integration that has had a significant influence on other theorists interested in interdisciplinary process (e.g., Newell, 2001; Repko, 2008). We then describe her more recent view, the "socio-linguistic model," which emerged in subsequent work (e.g., Klein, 2001, 2004a, 2004b; Bruun, Hukkinen, Huutoniemi, & Klein, 2005) and is most clearly and forcefully articulated in her chapter "Research Integration: A Comparative Knowledge Base" in *Case Studies in Interdisciplinary Research* (Klein, 2012).

## The Stepwise Model

We begin our discussion of Klein's view on integration with its early development in *Interdisciplinarity: History, Theory, and Practice* (Klein, 1990). In this seminal book, she provides one of the first systematic accounts of integration in interdisciplinary contexts and the first comprehensive examination of interdisciplinarity and its literature up to that time. Her synoptic take on interdisciplinarity addresses a number of themes that were taken up by others in later work, for example, fragmentation (cf. Bammer, 2013), metaphor (cf. Boix Mansilla, 2010), communication (cf. Thompson, 2009), collabora-

tion (cf. Stokols, Hall, Taylor, & Moser, 2008), and complexity (cf. Newell, 2001; Repko, 2008), to name just a few. Her mastery of the literature and attention to detail support a robust exposition of interdisciplinarity that is historically grounded and international in scope. As she traces themes through the literature, her own view of interdisciplinarity emerges as a function of what she foregrounds and what she backgrounds. Integration figures centrally in her discussions of interdisciplinary activity, and in this section of our article, we reconstruct an account of her thinking in 1990 that will serve as a baseline for understanding her more recent reflections on the topic.

In addition to the fact that the verb "to integrate" and its cognates are used frequently in the book, the preeminence of the noun *integration* in Klein (1990) is underscored by her indication early on that "in general practice" she uses the adjectives "interdisciplinary" and "integrative" "interchangeably" (p. 15). There are moments where she distinguishes the two terms, for example, when allowing that "integration" can be used more broadly to describe features of *multidisciplinary* work, but most of what she writes in the book reflects her views on *interdisciplinary* integration. This emphasis on interdisciplinary integration is reflected in her summary of the book's central argument: "Interdisciplinarity is a means of solving problems and answering questions that cannot be satisfactorily addressed using single methods or approaches" (Klein 1990, p. 196). Whether focused on teaching, research, or practice, interdisciplinary activity is integrative activity, that is, activity that combines methods and approaches in pursuit of a complex understanding that does justice to the complexity of the phenomena under study.

In the book, when Klein asks "What may be said about a concept that is so vast, so complex, and so various?" (Klein 1990, p. 182), she is speaking of *interdisciplinarity*, but given her "general practice," we believe that her question works equally well for *integration*. The complexity of interdisciplinary integration prompts her to examine it from a variety of different perspectives, for example, historic, conceptual, theoretical, contextual, and practical. In the process, she discusses interdisciplinarians' *ways of speaking* about integration, *ways of thinking* about it, and *ways of acting* in light of it.

*Ways of speaking* about integration and interdisciplinarity are an important point of emphasis in Klein (1990), and the book includes one chapter on the interdisciplinary lexicon and another on the rhetoric of interdisciplinarity. Her interest in how we speak about these topics is also reflected in numerous other parts of the book, such as discussions of Burke's (1966, pp. 45-46, 49) description of technical vocabulary as a "terministic screen" and dialogue as an integrating mechanism. Klein's consideration of the subject opens with a historical account of the "evolution" of interdisciplinarity (p.

19) as a look back on what people said about integration in the past. The "area" approach to interdisciplinarity that emerged in American universities in the late 1930s, exemplified by women's studies and American studies, supported a conception of *integration* as *unification* that belonged to a "higher and more powerful category than 'interdisciplinarity'" (p. 26). Similarly, earlier theoretical work in education associated *interdisciplinarity* with "linking existing disciplinary categories" and *integration* with the "transmutation" or "unification" of those categories (p. 27). These early distinctions gave way to the conceptual synthesis that supported the "interchangeable" use of these terms.

A second way of speaking about integration that receives attention in Klein (1990) involves the importance of metaphor to our understanding of the concept. "Bridge-building" and "restructuring" (pp. 27-28) join "fusion" (p. 43), "transmutation" (p. 79), "symbiosis" (p. 80), "borrowing" (p. 85), and many other terms invoking images of different ways things can be brought together. Metaphor is a useful mechanism for making connections across disparate domains; as Lakoff and Johnson (1980) put it, "The essence of metaphor is understanding and experiencing one kind of thing in terms of another" (p. 5). Metaphors are thus "evocative approximations of interdisciplinary cognition" (Boix Mansilla, 2010, p. 289), calling our attention to features of integration that should figure in a more abstract analysis of the concept.

The different *ways of thinking* about integration Klein found in the literature she reviewed for the book help us get beneath the surface of semantics, exposing the structures that justify the similarities expressed by the metaphors. For example, Klein (1990) emphasizes the conceptual connection between *integration* and *differentiation* – to integrate *A* and *B* presupposes that *A* and *B* are differentiated (p. 43), and conversely, "[e]very differentiation postulates the existence of integrated elements" (p. 53). This reinforces the idea that integration involves *putting things together*, which of course entails a starting point where the things in question are not joined or combined. She also recognizes integration as a core process within interdisciplinary activity, calling interdisciplinarity "a process for achieving an integrative synthesis…that usually begins with a problem, question, topic, or issue" (p. 188).

By 1990, analysis of interdisciplinary integration had yielded a variety of distinctions among kinds of integration, and Klein canvasses many of those in the book. For instance, she lists a variety of integrative modalities under four fundamental kinds of interdisciplinary interaction: "(1) borrowing, (2) solving problems, (3) increased consistency of subjects or methods, and (4)

the emergence of an interdiscipline" (Klein, 1990, p. 64). These modalities include *concept interdisciplinarity*, under (1), which involves use of a concept from one discipline to supplement a concept in another (p. 64); *border interdisciplinarity*, under (3), which signifies the creation of an intersection between two closely related disciplines (p. 65); and *structural interdisciplinarity*, under (4), which refers to the formation of the "basic structure" of a new discipline (p. 65). Each of these modalities corresponds to a way of inducing dependencies among different disciplinary inputs to support thinking of them together as one.

A full account of interdisciplinary integration must address how one enacts interdisciplinarity in the world. That is, it must account for the interdisciplinary ways in which educators, researchers, and practitioners operate when pursuing integrative objectives. In discussing integrative techniques, strategies, and frameworks, Klein (1990) provides a rich and nuanced accounting of the practical and conceptual technology that had by then been developed to facilitate integrative activity. Late in the book, she lists 25 integrative techniques for achieving integration, focusing on *iteration* and *role clarification* as two "especially useful" techniques for integrating across disciplines (pp. 189-190). Iteration supports reflective engagement with an ongoing project, where collaborators have the opportunity to take turns being teachers and students, performers and critics. Given such turn-taking, role clarification is crucial as a way of assessing what the collaborators need and expect from one another.

Klein also discusses a number of integrative strategies, which are broader plans of action that constrain decision making about specific steps. These include "devising a set of abstract hypotheses" that can support integration by serving as shared objects of evaluation from different disciplinary points of view (p. 117; cf. the Toolbox approach in O'Rourke & Crowley, 2013), constructing a project "metalanguage" that can be used to coordinate different disciplinary contributions (p. 117), and building a team that includes "system generalists and disciplinary specialists" to iteratively appraise and interpret project data (pp. 190-191).

Another key feature of Klein (1990) is its detailed consideration of several integrative frameworks that provide conceptual structure for thinking and talking about integration, as well as practicing it in particular instances. Some of these are informal (e.g., Sjölander's 1985 description of 10 developmental stages of an interdisciplinary project, pp. 71-73), others are idealized (e.g., deWachter's 1982 model based on the "temporary suspension of all known methods," pp. 192-195), and still others are limited in scope (e.g., the models of integrative organization and communication from Rossini and

colleagues, pp. 129-130; the "four major models of integrative education in the health sciences," p. 151).

The more formal, concrete, and generally applicable models of integrative process that Klein discusses include one from Hursh, Hass, and Moore (1983) and one of her own design. Her process specification for integration includes these 12 steps:

1a. *defining* the problem (question, topic, issue);
b. *determining* all knowledge needs, including appropriate disciplinary representatives and consultants, as well as relevant models, traditions, and literatures;
c. *developing* an integrative framework and appropriate questions to be investigated;
2a. *specifying* particular studies to be undertaken;
b. *engaging* in "role negotiation" (in teamwork);
c. *gathering* all current knowledge and *searching* for new information;
d. *resolving* disciplinary conflicts by working toward a common vocabulary (and focusing on reciprocal learning in teamwork);
e. *building and maintaining* communication through integrative techniques;
3a. *collating* all contributions and *evaluating* their adequacy, relevancy, and adaptability;
b. *integrating* the individual pieces to determine a pattern of mutual relatedness and relevancy;
c. *confirming or disconfirming* the proposed solution [to the problem defined at the start]; and
d. *deciding* about future management or disposition of the task/project/patient/curriculum. (Klein, 1990, pp. 188-189)

This is a stepwise framework for pursuing integrative responses to problems or questions that require them, where integration is understood primarily as a process. As such, the framework outlines a progression from the earliest stages in which the problem or question is defined to the late stages in which the response is confirmed or disconfirmed. In introducing this framework, Klein (1990) acknowledges that there is "no absolute linear progression" to integration (p. 188), which is consistent with her contention that iteration is an important integrative technique. Nevertheless, she defends a model of integration as a process that can be pursued in an algorithmic and orderly fashion.

It is worth lingering for a moment over these steps. Klein organizes them in an order that breaks down into three stages: an *orientation* stage that focuses on understanding the problem or question, a *preliminary* stage that

involves preparing both knowledge and social resources for the business of integration, and an *execution* stage during which the integration itself is effected. Not all of the steps are obviously integrative. Some are – 1c, 2b, 2d, 2e, and of course 3b – but the rest focus on meeting the material or structural preconditions that must be in place before integration can be pursued.

Of the integrative steps, the first four (i.e., 1c, 2b, 2d, and 2e) focus on creating the epistemic, social, and communicative infrastructure conducive to integrative success. Step 3b is really where the action is – that is where the integrative response is generated. Although the specification of 3b largely presents integration as a black box, it does give us an important clue about one condition necessary for the success of integration, namely, that there is "mutual relatedness and relevancy" among the inputs to the integrative process. That is, the process of integration makes process inputs depend on one another, with the integrated result being an assembly of mutually related and mutually relevant parts.

**The Socio-Linguistic Model**

As Klein developed her views, she recognized that her original attempt to describe integration in 1990 was too linear to model the cases of integration she had observed in the earlier history of interdisciplinary work and was observing in her own day. Her 1996 book, *Crossing Boundaries: Knowledge, Disciplinarities, and Interdisciplinarities*, blended her previous, stepwise model of integration with an iterative, dialogic understanding of integration (p. 223). By 2001, when Newell used her 1990 model as one starting point in his own theorizing (Newell 2001), Klein (2001) responded thus:

> Some time ago, I moved beyond this [1990] description….*The new model is a socio-linguistic conceptualization of managing complex problems*….The earlier descriptive steps reappear, but they are extended and recontextualized in an iterative model of communicative action in the dynamics of data, information, knowledge, intuition and insight, judgment, retrospection, and decision making. In a subsequent proposal for a generic model of integrative process, I retained the fundamental dialogical coexistence of differentiation and unity (Klein, 1996, pp. 222-224; 1990-1991). (p. 53, emphasis added)

Klein has continued developing this socio-linguistic model ever since, working to place interdisciplinary integration in its contexts. Together, her writings reveal a coherent view of integration as involving instances of socio-linguistic practice subject only to guiding principles, never mechanistic

rules. Figure 1 illustrates how this view hangs together as successively more specific (narrower) theories, and the next sections of this article describe the relationships between the levels.

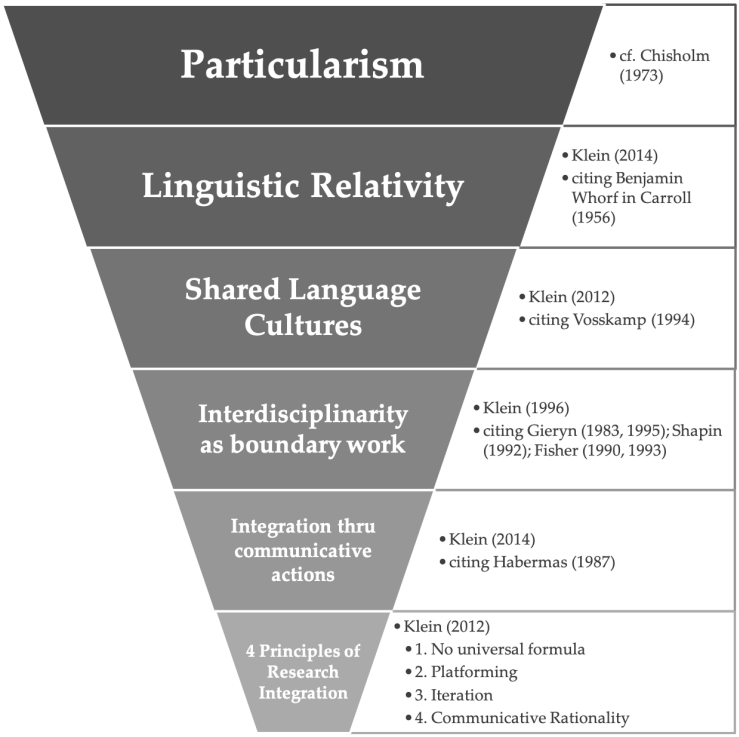


*Figure 1.* Klein's layered approach to understanding cross-disciplinary integration as a socio-linguistic phenomenon. Her approach proceeds from a more encompassing epistemology of particularism to a narrower theory of research integration. The citations for each level document the provenance of Klein's ideas as she cited them.

*Particularism*

Although she does not explicitly say so, Klein's fundamental approach to understanding integration is to study particular instances of it and then infer general principles from them. This bottom-up approach to defining a phenomenon, known as *particularism* (Chisholm, 1973), places more confidence in one's ability to recognize integration when one sees it than in

defining it without exemplars. This approach is why much of Klein's work involves intellectual history rather than, say, set theory. These recountings are not merely interesting; they are, in fact, the source of her insights.

*Linguistic Relativity*

From her observations, Klein – as a trained rhetorician and literature scholar – notices the importance of language in interdisciplinary practice. She finds this observation summarized profoundly in the concept of linguistic relativity. In Klein (2014), she explains,

> The concept of linguistic relativity is central to understanding interdisciplinary communication….The core premise is that language shapes the ways speakers conceptualize their worldviews, including the ways they think (cognition) and act (behavior). (p.15)

Linguistic relativity is an organizing concept that allows Klein to understand disciplines further as shared language cultures, not just worldviews or communities of practice.

*Shared Language Cultures*

If language shapes worldviews, and if worldviews go on to influence thoughts and actions, and if thoughts and actions are central parts of culture, then language is a key driver of a group's culture. It is, in addition, a key constituent of culture in its own right. In the language-as-culture view, disciplines are shared language cultures insofar as members understand each other through language. In fact, Klein (2012) claims, "The quality of [interdisciplinary] outcomes…cannot be separated from development and richness of a shared language culture" (p. 295). When people share a language culture, they can coordinate their insights and actions. This coordination enforces borders around the group that make interdisciplinary integration a matter of crossing the boundaries of disciplinary language cultures.

*Interdisciplinarity as Boundary Work*

Klein dedicated her entire 1996 book, *Crossing Boundaries: Knowledge, Disciplinarities, and Interdisciplinarities,* to explaining interdisciplinarity as boundary work. This article is too short to recount, indeed, even outline, all the insights the book contains, but we can summarize an important lesson thus: Just as there are many ways to interact across ethnic cultures, there are many ways to interact across disciplinary cultures, and all of these require

language in some way. Direct communication typically requires language, and so does coordinated action, such as deciding whom to ask for permission to use a lab's data by understanding what those researchers mean by terms like "principle investigator" and "data manager."

*Integration through Communicative Actions*

Because interdisciplinary work is intercultural language work, interdisciplinarity is a form of communicative action. In developing this thought, Klein draws on the work of Jürgen Habermas, who emphasizes that communication is neither rational nor productive when people do not share a language culture (Habermas, 1985, pp. 9-17, 86, 94-101). Habermas asserts that rational, productive communication must be "transsubjective" (Habermas, 1985, p. 9) or, alternatively, "intersubjective." Simply put, for integration to occur, people need to understand each other. Integration, in this view, consists of the many "trades" or communicative transactions in the trading zones (Galison, 1997) between disciplines. Because each disciplinary culture and each meeting of these cultures is different, the socio-linguistic model of integration, influenced by Klein's reading of Habermas, remains a high-level heuristic of interdisciplinary integration, and it emphasizes the actions of knowers rather than the products of knowledge they create. This cultural view of integration depends so much upon situation-specific interactions that it thwarts attempts to align it with Klein's 1990 stepwise model – even though that model was meant to be iterative and situation-specific. Instead of inviting a stepwise summary, Klein's more recent socio-linguistic model is best summarized as involving principles that act "more like guidelines than actual rules."[1]

*The Four Principles of Research Integration*

Klein (2012) summarizes the general characteristics of her socio-linguistic view of integration with the help of the following four principles:

1. "The Principle of Variance: No Universal Formula for Integration." (p. 293)
2. "The Principle of Platforming: Interaction Structure, Integration Potential, Fundament." (p. 294)
3. "The Principle of Iteration: Moving Back and Forth, Bootstrapping, Triangulation, Reflective Balance, and Weaving." (pp. 294-295)
4. "The Principle of Communicative Rationality: Shared Language

[1] To echo Blackbeard the Pirate, another famous thinker who operated at cultural boundaries (Bruckheimer & Verbinski, 2003).

> Culture, Social Learning, Translation-Negotiation-Mediation, Intersubjectivity." (p. 295)

Each principle derives from Klein's approach to interdisciplinary integration as illustrated in Figure 1 – from her particularism (Principle 1: Variance), to her view of integration as language cultures meeting in trading zones (Principle 2: Platforming), to her recognition of the messiness of intercultural boundary work (Principle 3: Iteration), to her commitment to intersubjectivity (Principle 4: Communicative Rationality). In what remains of this section of our article, we consider each of these principles in turn.

*The Principle of Variance*. Klein develops the Principle of Variance by observing that cross-disciplinary research projects vary along many dimensions, including context, focus, goals, participants, and scope. This variance implies that no universal formula of integration can account for all of the variables that figure into interdisciplinary and transdisciplinary research, and since such an accounting would be required of such a formula, no universal formula for integration can exist. We wonder, however, what she means when she denies the existence of a universal formula: Does she mean to deny possibility or just feasibility? The stronger version of the Principle of Variance would hold there is no *possible* universal formula for cross-disciplinary integration. A weaker version of this principle might be that there is no one *workable* or *tractable* formula, that is, no single formula that we could realistically and practically use to guide deliberation and action across the full range of interdisciplinary and transdisciplinary research projects. As we argue below, whether or not you agree with this principle may depend on the level at which you are conceiving of integration. We will argue below that there is a universal formula if you are conceiving of it at a very high, abstract level, but that this is not the case if you are conceiving of it at a lower, more concrete level.

*The Principle of Platforming*. This principle highlights the importance of "a set of actions aimed at building a foundation for integration"; for collaborative projects, this means "putting into place the antecedent conditions and contextual factors" required for epistemic and social integration (Klein, 2012, p. 294). Klein develops this principle by highlighting the structure of a project, both in terms of its timeline and its parts, including subprojects. This structure supports interaction among the parts of a project, including the people involved, as well.

This principle focuses on *project structure*, which we can take to be a systematic set of relationships among project elements. Within an interdisciplinary or transdisciplinary project, each element should be understood

partly in terms of its "integration potential" (Klein, 2012, p. 294), that is, its ability to contribute to the integration required for project success. Klein distinguishes those elements that are essentially integrative, for example, *bridge concepts* and *common foci*, from other elements (e.g., research questions, methods, disciplines represented) that may have more or less integrative potential, depending on the specific project context. Further, she introduces the notion of *interaction structure* to highlight that part of project structure that frames the contact among the different elements and creates the possibility of integration.

One important message entailed by this principle is that social and epistemic integration can happen at any time and any place in a project. That is, almost any location in a complex, cross-disciplinary project can be a site for integration. This widespread potential should not be surprising in light of the Principle of Variance. After all, if integration is sensitive to the great variability of interdisciplinary and transdisciplinary projects, this variability should include the various times and places integration might occur in a project.

*The Principle of Iteration*. The third principle emphasizes that the process of integration is not an uninterrupted, linear progression from unintegrated to integrated; rather, it can unfold in complex ways from more integrated to less integrated and back, or from interdisciplinary whole to disciplinary part and back. As Klein (2012) puts it, "These movements emphasize the importance of patterning and testing throughout the research process" (p. 295). Such "patterning" and "testing" are iterative reconsiderations that should track changes in understanding, objectives, and circumstances. This principle highlights the dynamic complexity of integration when it is a process platformed by certain elements in the project structure that vary along many dimensions. Following her own earlier work and that of Boix Mansilla (2010), Klein emphasizes *balance* in connection with this principle. That is, iteration keeps the many elements of the project in productive and not destructive tension.

*The Principle of Communicative Rationality.* The fourth principle articulates the importance of communication to integrative outcomes, especially when those are pursued by groups of collaborators. Klein (2012) illuminates how epistemic and social integration interact as collaborators communicate in moving toward intersubjectivity or "making sense together" (p. 295). Integrative communication requires "mediation" among different perspectives (p. 296). Mediating communication supports both reflexivity and perspective taking, creating the capacity for collaborators to achieve mutual understanding. Such communication encourages the progressive sharing of

"meanings, diagnoses, and objectives" (p. 296), and this progressive sharing is what creates intersubjectivity. Misunderstanding is always a risk in interdisciplinary contexts, but this can be mitigated by the creation and maintenance of a shared language culture that makes interdisciplinary dialogue possible. Although this principle acknowledges the roles of both epistemic and social elements in interdisciplinary integration, it foregrounds the social elements and reminds us how central communication is to integration.

In summary, the four principles bring out various aspects of integration as a process, highlighting among other things inputs (e.g., mediating communication) and outputs (e.g., mutual understanding) of the process. "The process," Klein (2012) tells us, "is not algorithmic. It is heuristic and constructivist at heart" (p. 296). The principles are also interrelated. For example, one might take the Principle of Variance to highlight the elements that figure into a specification of the process, the Principles of Platforming and Iteration the structural and functional aspects of the process, and the Principle of Communicative Rationality the role that people play in generating integrative outcomes.

## The IPO Model of Cross-Disciplinary Integration

If we as authors are to think with Klein about integration, it will help to be clear about our own way of thinking, which is the view of interdisciplinary integration developed in O'Rourke, Crowley, and Gonnerman (2016). This is an input-process-output (IPO) model that highlights the importance of integration as a *process* while still making room for understanding it as a *product* (i.e., as the *output* of the integrative process). In this section of our article we articulate this view, a view that has been influenced by Klein's work, especially Klein (1990) and Klein (2012). We describe the view in some detail here for purposes of comparing it with Klein's views, drawing out ways in which her ideas align with the IPO model and also ways in which the IPO model contrasts with her ideas.

O'Rourke et al. (2016) provide a theoretical account of what the authors call "cross-disciplinary integration," which is integration as it appears in the full range of complex activities that involve combination of disciplinary elements, e.g., multidisciplinarity, interdisciplinarity, and transdisciplinarity. To account for cross-disciplinary integration, they develop a model of integration in general. As they understand it, *integration* is a process that produces outputs that are typically different from and fewer in number than the inputs, where this reduction is a result of the process. This reduction is of course to be expected given that they take integration to be the combination

of elements into a whole (p. 67). Further, the processing involved typically puts the input elements into mutual dependence (cf. Andersen & Wagenknecht, 2013), where the contribution of a particular input to the output will depend in some (potentially complex) way upon its relationship with other inputs. (This typical impact of the process on the inputs rules out, by the way, the possibility of deleting one of the inputs as a means to integration.)

Three considerations serve as the basis for this account of integration. The first is the observation that people speak of "integration" in many different contexts even beyond cross-disciplinarity, such as art, politics, psychology, biology, and philosophy. Although in many of these contexts the term has a technical gloss, there is a core meaning that is part of common parlance. One aim of the IPO account of integration in O'Rourke et al. (2016) is to provide a *general* model of these different occurrences of the term and its cognates, subsuming them all under an abstract characterization of the concept. According to this approach, interdisciplinary integration is an instance, itself general, of a more general and widely-found process, where the specific properties of this instance are tied to the social and epistemic attributes of interdisciplinary activity. One important virtue of the general theoretical approach is that it supports the systematic transfer of insights about integration from one integrative context to another.

A conceptual model of the sort presented by O'Rourke and his colleagues (2016) could function simply to characterize logical connections at a general level, but the IPO model of integration is also intended to be specifiable so that it represents concrete integrative processes in specific contexts. As such, the IPO model is *schematic*, with abstract elements that are to be specified concretely when the model is applied in particular situations. These include the categories of *inputs*, *integrative relations,* and *outputs,* and parameters such as *commensurability, scale,* and *comprehensiveness*. In any particular instance, such as in a case of interdisciplinary integration, these categories and parameters will be specified in a way that renders the model more concrete. This rendering will involve quantitative aspects (e.g., the *number* of inputs) and qualitative aspects (e.g., the *types* of inputs).

The third consideration underlying the thinking of O'Rourke et al. (2016) concerns the role played by *integrative relations* in the model. Consistent with the idea that integration involves *combining* inputs into outputs, the IPO model of integration gives privilege of place to what it calls "integrative relations." So conceived, this can be understood as a *relational* model of integration, where the work of explaining integration involves identifying the characteristic features of integrative relations. Thus, the relational model aims to work out the details of step 3b in the Klein (1990) model, shining

light on the contents of the previously mentioned black box.

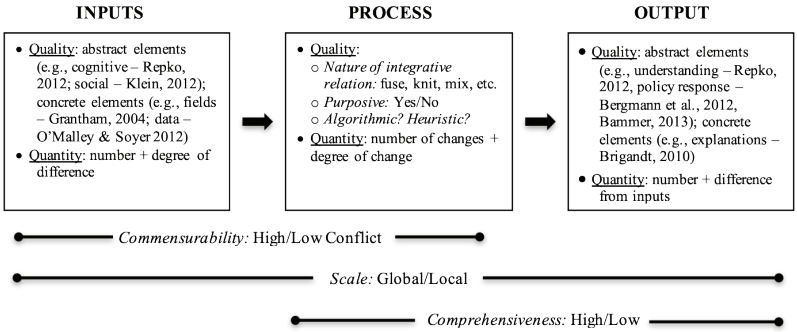


*Figure 2.* The specifiable but universal input-process-output (IPO) model of integration developed in O'Rourke et al. (2016) and pictured there on p. 69. The quality/quantity distinction classifies salient characteristics of inputs, processes, and outputs involved in episodes of integration.

The IPO model of integration is summarized in Figure 2, reprinted from O'Rourke et al. (2016). As noted above, it is an abstract, schematic model of integration that is intended to be rendered concrete through the specification of the variables that are built into the model. Using an IPO schema to model interdisciplinary integration requires identifying the inputs (e.g., a complex research question referencing multiple disciplines, researchers representing different disciplines if the project is collaborative), processes (e.g., collaboration, modeling), and outputs (e.g., published article with multiple authors, policy advice) that are relevant to the instance of integration under consideration.

The model is intended to represent integrative processes at different scales, and so in the interdisciplinary case it could represent integration that takes place over the lifecycle of a project as well as integration that takes place in a brief episode in which collaborators from different disciplines find a way to relate their alternative perspectives on a specific problem. The same model can be made to work at such different levels by specification of the values of the *scale* parameter – are we interested in integration at the more global, project-level scale or the more local, sense-making scale? The other parameters mentioned in Figure 2 also influence the nature of the integrative process: The *commensurability* parameter is set by the degree of difference that obtains

between inputs (e.g., low conflict between biochemistry and microbiology, high conflict between civil engineering and theater art), while the *comprehensibility* parameter corresponds to the extent to which the inputs are recoverable from the output (e.g., high comprehensiveness if input identity is lost in the integrative process, and low if input identity is retained).

The real action in this model takes place in the process box and involves the *integrative relations*. The integrating process puts inputs into these relations, thereby integrating them in generating the output. Not all relations are integrative. We can distinguish *integrative* relations from those that actively differentiate inputs – call these *disintegrative* relations – and those that leave inputs alone – call these *preservative* relations. Integrative relations change inputs by inducing dependencies among them, producing outputs that will typically (but not always) be fewer in number than the inputs. Disintegrative relations relate two things in a way that undermines existing dependencies, generating outputs that will typically be greater in number than the inputs. Preservative relations relate two things without changing them or inducing any dependencies that can reduce their number under the aspect of the output. Examples of integrative relations include blending (Nissani, 1995), extension (Newell, 2006), collaboration (Plutynski, 2013), and coupling (MacLeod & Nagatsu, 2016).

The IPO model of integration resembles other models that are available in the literature, for example, the idealized model of interdisciplinarity presented by deWachter (1982) and discussed in Klein (1990), and the model that is central to information integration theory, presented in detail in Anderson (1981).[2] Our interest in this article, though, is with the relationships between this model and Klein's views. While we will devote the next section to considering the relationship between the IPO model and the view developed in Klein (2012), we will close this section by considering its relationship with Klein (1990).

The stepwise model in Klein (1990) focuses on how one might engage in integrative activity from the initial phases to the final phase, providing

[2] DeWachter's (1982) model sets up interdisciplinarity as an IPO, with the process of integration black-boxed in the fifth stage, where in response to a global, interdisciplinary question, one "integrates all particular answers available" (p. 280). Anderson's (1981) account is more formal, detailed, and general. Information integration theory concerns how people combine information in making judgments, and Anderson's model of this type of integration is also an IPO model, with an emphasis on functional integration. Information integration theory depends on algebraic models, including "additive, averaging, and subtractive models" (Anderson, 1970, p. 156). In emphasizing relations, the IPO model in O'Rourke et al. (2016) is quite similar to Anderson's, but it is not limited to algebraic integration functions. This is not the place to develop a robust comparison of these two views, however.

people with guidance as they engage in interdisciplinary integration. In that sense, it is a *normative* model – it supplies a standard set of steps that, if executed, should result in integrative success. The IPO model, though, is descriptive, and is less focused on the full arc of an integrative activity than it is on the integrative episodes within that activity. Recall that the stepwise model in Klein (1990) includes a number of steps meant to ensure the preconditions for integration and the infrastructure necessary for integrative activity. The IPO model, by contrast, focuses on the moment when the inputs are brought together into integrated combination – the *process* box is the key location of this model. It seeks to show schematically (and, when specified, concretely and in detail) what must take place for integrative combination to occur.

**Comparing the IPO and Socio-Linguistic Models**

In this section, we compare the IPO model of integration developed in O'Rourke et al. (2016) and the socio-linguistic model of Klein, represented in summary by the four principles that conclude Klein (2012), discussed above. The IPO model is similar in a number of ways to the view that emerges from Klein (2012), in that both emphasize integration as a process that varies according to inputs, process characteristics, and outputs. In fact, Klein's socio-linguistic model served as an important influence on O'Rourke et al. (2016), as is explicitly acknowledged therein. Here we dive deeper into the similarities and differences among the two models so we can then show how they complement each other. (See Table 1 at the end of this section for a summary.)

In considering similarities and differences, we take Klein's four principles to be our guides. We begin with the Principle of Variance. One of the main motivations behind the IPO model in O'Rourke et al. (2016) is the variability of integrative processes, which range across a wide variety of phenomena and not just interdisciplinary or transdisciplinary activity. O'Rourke and his colleagues emphasize integration as a means to accommodate the manifold variability that Klein notes under this principle. The IPO model is intended to be universal in the sense that it applies across all contexts where one might find integration, although it is schematic and must be loaded contextually to model any specific instance. So, in a sense, O'Rourke and his colleagues both disagree and agree with Klein – there is a level of abstraction at which one can find a formula that subsumes all instances of integration, but also there is no maximally specific formula that applies to all particular instances of integration.

Klein's Principle of Platforming emphasizes the importance of thinking about integration at all points in an interdisciplinary or transdisciplinary project. The IPO model can represent integrative processes at various levels and temporal locations in interdisciplinary research. As those pursuing a project adjust the inputs involved, the various integrative relations that are a central part of the integrative process, and the scale parameter, which can be set globally or more locally, contextually loaded instances of the model can represent high-level integration (e.g., integration that results in the production of a new field, cf. Bechtel, 1993) or lower-level integration (e.g., at the level of data, cf. Leonelli, 2013).

The contextual flexibility of the IPO model also enables it to do justice to Klein's Principle of Iteration. There is nothing that keeps the IPO model from being instantiated in specific contexts that are brief and local, and there is no reason why it cannot be used in sequence to model a series of integrative episodes. Again, adjustments of variables and parameters make it possible to capture the iterative nature of project integration designed to strike a balance among different project elements.

Finally, the IPO model can be used to represent the processes of making sense together and building intersubjectivity and mutual understanding through both instrumental and relational communication (Hall & O'Rourke, 2014). These are social processes that involve epistemic elements in a central role, but the IPO model is designed to accommodate both epistemic and social integration, among other forms. Klein's development of the Principle of Communicative Rationality highlights the importance of a "shared language culture" to the mediation of information and relationships required to achieve integrative objectives in interdisciplinary and transdisciplinary projects. As introduced in O'Rourke et al. (2016), the IPO model would have difficulty representing this; however, there was no suggestion that the three parameters introduced in 2016 are the only relevant parameters. For instance, in accordance with Klein's argument concerning shared language cultures, the IPO model could include something like a *medium* parameter that concerns the medium in which communication takes place during collaborative instances of the use of the IPO model.

In sum, Klein's four principles either articulate aspects of integration that are important to the IPO model in O'Rourke et al. (2016) or phenomena that are critical to its implementation in a particular project. In our view, the IPO model and the socio-linguistic model are interrelated: On the one hand, something like the IPO model is presupposed by Klein's principles; on the other, Klein's principles and the socio-linguistic model they articulate are crucial to specifying the IPO model when it is used to describe cross-disci-

plinary integration. We exemplify this interdependence in the next section of this article by using both models to analyze a key form of cross-disciplinary integration – collaborative, interdisciplinary reasoning (Laursen, 2018a).

| Principle | Socio-Linguistic Model | IPO Model |
|---|---|---|
| 1. Variance | Particularism shows every trading zone between language cultures requires different boundary work. | There is a universal IPO formula at a high level of abstraction, but no universal formula at the level of particular instances of integration. |
| 2. Platforming | We need to be prepared to create these trading zones at any stage or level of an interdisciplinary project. | The IPO model can apply to integration at any stage or level in an interdisciplinary project. |
| 3. Iteration | The boundary work required for interdisciplinary balance is not typically one-and-done, but is rather iterative and complex. | The IPO model can represent iterations and the complex ways in which integration manifests in interdisciplinary projects. |
| 4. Communicative Rationality | Shared understanding through language is necessary. | Communicative integration can be represented by the IPO model, although it may need a new parameter to reflect shared language culture. |

*Table 1.* A summary of the relationships between Klein (2012)'s four principles of integration and the input-process-output (IPO) model of O'Rourke et al. (2016).

## Integrating the Models of Integration: A Worked Example

The IPO model aims to characterize integration in general, while Klein's socio-linguistic model describes cross-disciplinary integration. As described above, Klein's model presupposes something like the IPO model, and the two models are therefore compatible. In this section, we argue by example that the models are more than compatible – they are complementary. As such, they are more useful together than apart in describing instances of cross-disciplinary integration. Our example is a thread of collaborative, interdisciplinary reasoning excerpted from a Toolbox workshop transcript (cf. O'Rourke & Crowley, 2013). The Toolbox Dialogue Initiative hosts dia-

logue-based workshops for cross-disciplinary and cross-functional teams.[3] These dialogues are semi-structured by prompts that articulate assumptions that researchers and professionals usually leave implicit in their work but that would likely derail their team if left implicit because not everyone on the team holds those assumptions. The prompts invite each participant to respond on a Likert scale of "Strongly Disagree" to "Strongly Agree"; "Neither agree nor disagree," "I don't know," and "N/A" are also options. However, the prompts are worded with vague and sometimes extreme language that requires participants to define their terms or express qualifications in order to respond. These definitions and qualifications reveal hidden assumptions, making them available for discussion. Participants respond to all of the prompts first in writing on their own. Then, participants discuss their responses, and usually participants are invited to re-take the instrument to see if their views have changed.

We draw on Laursen (2018a) to show how instances of collaborative, interdisciplinary reasoning such as the Toolbox workshop below can be characterized as argumentation. This example will show that argumentation is one of the socio-linguistic routes to cross-disciplinary integration, and that it and similar routes stand to benefit from a dual application of the IPO and socio-linguistic models. This example also shows how the fields of argumentation and interdisciplinarity enlighten each other, as proposed in Laursen (2018b), published in this journal last year.

**Example**

In this example, a cross-disciplinary research group is mid-way through their 90-minute dialogue session. They've discussed several prompts already. Now they are discussing two prompts about reductionism vs. emergentism. First, they discuss Prompt 30: "The world under investigation is fully explicable as the assembly of its constituent parts." Participants 1 and 3 (P1 and P3) disagree with this statement, but P2 doesn't know because they can see it both ways:

[3] http://tdi.msu.edu

| Speaking Turn | Utterance |
|---|---|
| 203 | P2: I didn't know. I think when you talk about an assembly of things, yes they are constituent parts but they're assembled and so they're still connected. Sometimes you have to reduce it into smaller systems so you can comprehend and make quantitative answers and then you're always looking at, well I guess I never see it as one of these systems is totally independent from all of its connected parts. So this huge system and everything that we're looking at can always be taken into more systems or more parts and is always connected to other things. |

The group then turns to the next prompt, Prompt 31, which reads, "The world under investigation must be explained in terms of the emergent properties arising from the interactions of its individual components." After reporting their agree/disagree scores to each other, Participants 1 and 2 (P1 and P2) discover they both agree.

| Speaking Turn | Utterance |
|---|---|
| 210 | P1/P3: Woah! [laughter] |
| 211 | P1: We haven't agreed this whole time! I strongly agreed with that statement and I think it's my training and my background honestly that encourage me to say that because for example I remember from my introductory ecology class I took in college, the first day it was like the quote up on the PowerPoint slide was "the sum is more than all the parts" or whatever that statement is that says that essentially. |
| 212 | P2: I see how this is supposed to be kind of a converse of the previous statement but I interpreted it somewhat the same in terms of if you can't always understand the individual components it's kind of hard to explain the interactions as well but yeah I probably went a little farther than I would on [my own] on that one. I was thinking "fully" explained I guess, but that word wasn't in this one. |
| 213 | P3: Yeah I think to look at anything you have to simplify it somehow in your head so that you can understand it and then from the simplifications you then bring them back together. |

| | |
|---|---|
| 214 | P1: And things arise that you probably wouldn't have seen just by looking at the individual components. And that's how I interpret emergent properties anyways. |

In some respects, Prompts 30 and 31 are opposite and one would expect a participant who agrees with one to disagree with the other. However, P2 doesn't; while they are uncertain about reductionism they agree with emergentism. If we just looked at the scores, we might think P2 isn't reading the prompts carefully or lacks introspection skills. But the transcript tells a different story, showing that P2 holds a nuanced view that integrates aspects of both reductionism and emergentism, and this was hard to represent through responses to the prompts as written.

In the discussion, P2 explains how emergent explanations depend on identifying the parts in order to track the interactions between those parts. P2 indicates that they interpret Prompts 30 and 31 as "somewhat the same," which signals emphasis on the role played in both by the need to "understand the individual components" and on the fact that both prompts require the individual components to be related to one another – *assembled* in Prompt 30 and *interacting* in Prompt 31. Another way to look at this, articulated in ST 203 and reflected in ST 212, is that when it comes to complex systems, one needs to be willing to look at smaller and smaller parts in order to understand the whole, where this involves individual components at bottom. The difference in P2's reaction – scoring an "I don't know" to 30 and a "Strongly Agree" to 31 – is explained by the appearance of the word "fully" in 30 but not in 31. Collaborative reasoning with P2 moves P1 and P3 to acknowledge that it *is* important to pay attention to the parts of the world under investigation, including the individual components, even if one is a staunch emergentist.

It is clear this discussion thread contains some argumentation because claims and reasons are being exchanged, evaluated, and modified. In fact, the participants are eventually willing to entertain the nuanced position – championed by P2 – that reductionism and emergentism are not so obviously contradictory. The claimed similarity between the views is even clearer if we schematize the argument that emerges from P2's comments in standard form.

> *Premise 1.* According to reductionism, if one doesn't understand the parts of complex systems (e.g., subsystems, individual components), then one cannot explain assemblies of those parts. (ST 203)

*Premise 2*. According to emergentism, if one doesn't understand the parts of complex systems, one cannot explain interactions of those parts. (ST 212)
*Premise 3*. According to reductionism, if one explains the parts of a complex system in relation to one another, then one explains assemblies of parts. (Implicit)
*Premise 4*. According to emergentism, if one explains the parts of a complex system in relation to one another, then one explains interactions of parts. (Implicit)
*5*. According to both reductionism and emergentism, if one explains the parts of complex systems in relation to one another, then one must understand the parts. (From P1, P2, P3, P4)
*Premise 6*. If one fully explains a complex system, then one explains the parts of the complex system in relation to one another. (Implicit)

---

*Conclusion*. Reductionism and emergentism both require an understanding of the parts to explain a complex system. (5, P6)

Thus, P2 has integrated reductionism and emergentism by asserting that they share a commitment to understanding the parts of complex systems. Now we will show that if we analyze this integration episode with both Klein's socio-linguistic model and the IPO model, we can more fully explain the integration happening here than if we rely solely upon one model or the other.

**Analysis of the Example with Both Models**

With regard to Klein's model, the following things are important to note here. First, this is not the only way to synthesize reductionism and emergentism. According to Principle 1: Variance, we ought not to expect this team to synthesize other inputs in this way in other episodes. In fact, this same team might synthesize the same theories in a different way later in their project or even in this workshop itself. In addition, we should not expect other teams to synthesize these two explanatory theories in just this way either. Second, this synthesis relies upon a foundation laid by the structure of the Toolbox prompts themselves, which have asked participants to discuss their views on reductionism and emergentism. According to Principle 2: Platforming, "common foci" such as these prompts are a "fundament" or

"interaction structure" for integration, enabling collaborators to focus on the same[4] research object to begin integrating their insights about it. Third, this conversation highlights the "patterning and testing" that are crucial to Principle 3: Iteration. In this part of the dialogue, P2 stands out as someone with a different opinion, testing alternative ways of thinking about Prompts 30 and 31. By ST 214, the initial disagreement and difference among the collaborators give way to a kind of balance (cf. Boix Mansilla, 2010). Fourth, integration requires a language culture that is shared to some extent, and integration, in turn, enhances this shared language culture. In this case, the prompts have provided shared language, and the collaborators work through the episode to coordinate their understanding of these prompts and come around to a shared way of thinking about them. According to Principle 4: Communicative Rationality, integration both requires and builds a shared language culture because this is what enables collaborators to understand, evaluate, and respond to each others' proposals.

If we are to use the IPO model to explain the integration here, we must identify the inputs and outputs of this integrative episode, as well as the integrative relation(s) used to transform the inputs into the outputs. If we focus on the content of the dialogue, that is, the *argument*, as opposed to the arguers, then the standard form helps us locate inputs and outputs; specifically, the inputs consist of the premises and the integrated outputs are the conclusions (i.e., intermediate step 5 and final Conclusion). The argument establishes that reductionism and emergentism share an interest in the same thing: the parts of a complex system. In effect, then, the integration here is subsumption of two ostensibly inconsistent theoretical views under a single category (viz., theories interested in parts of complex systems). This subsumption under a common category explains why P2 believes that Prompt 30 and Prompt 31 are "somewhat the same" (ST 212).

From a rhetorical view, looking now at the *arguers*, we can take the inputs to be the social elements that are introduced into this exchange, such as the collaborators themselves, and take the outputs to include acknowledgement on the part of P1 and P3 that there is something to P2's complex view. The processes that transform these rhetorical inputs to outputs include social processes (e.g., trust-building through mutual enjoyment and use of the first-person pronoun, empathizing, acknowledgment) and cognitive processes (e.g., perspective-taking, explanation, illustration, collaborative reasoning). The integrative relations key to these processes from a social

[4] Here, "same" does not mean everyone must understand the research object the same way. In fact, if they did, this would be the opposite of a platform for integration as there would be nothing to integrate – only sameness. Rather, "same" means "shared" as with a boundary object or bridging concept (Klein, 2012).

perspective could include recognition, greater trust, and enhanced team cohesion. In both the argument case and the arguer case, the IPO model also asks us to be explicit about the commensurability of the inputs (high), scale of the integration (local), and comprehensiveness of the entire episode (low, in the sense that we can recover the inputs in both cases).

It is clear, then, that the socio-linguistic and IPO models of integration give different but compatible views of the same episode. But they are not merely compatible – they are complementary. Klein's socio-linguistic model identifies what types of inputs, processes, and outputs are possible by articulating what led up to and is likely to follow from the integrative episode, while the IPO model structures and parameterizes these components. In instances of collaborative, interdisciplinary reasoning such as our example above, Klein's socio-linguistic model tells us to look for shared standards of reasoning and both logical/epistemic and social/rhetorical argumentation moves. The IPO model asks us to get specific about which elements, standards, and moves are being used as the integrative inputs, processes, and outputs (not necessarily respectively). Perhaps most importantly, the IPO model spotlights the integrative relation(s) deployed in the argumentation.

## Conclusion

In conclusion, the IPO model is a general framework for integration intended to capture integration in any context, whereas Klein's socio-linguistic model is really focused on cross-disciplinary integration; as such, the latter could be used to help guide instantiation of the IPO model in particular cross-disciplinary cases. With such a stereoscopic view of collaborative, interdisciplinary reasoning, new explanations of integration become possible. For example, we can use argumentative examples like the Toolbox excerpt above to identify a range (and perhaps a typology or taxonomy) of integrative relations used by collaborators when speaking with one another or collectively to the outside world. We can also investigate the inputs, processes, and outputs that collaborators are using to integrate socially, such as using language to build team cohesion. Lastly, we can explore the feasibility of specifying the parameters in the universal IPO model into workable, situation-specific "formulas."

But, we hasten to conclude that in many respects, the foundation of an idea is more important than its future prospects since there can be no advancement without a beginning. Julie Thompson Klein's work on integration has been foundational for us. As we have shown, the IPO model, integrative relations, and integration through argumentation are all rooted in Klein's work

on interdisciplinary integration, and we expect many other contributors to the literature on integration will find her work to be fertile soil for their own work, as well.

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## References:

Andersen, H., & Wagenknecht, S. (2013). Epistemic dependence in interdisciplinary groups. *Synthese*, *190*(11), 1881-1898. http://doi.org/10.1007/s11229-012-0172-1

Anderson, N. H. (1970). Functional measurement and psychophysical judgment. *Psychological Review, 77*, 153-170.

Anderson, N. H. (1981). *Foundation of information integration theory*. New York: Academic Press.

Bammer, G. (2013). *Disciplining interdisciplinarity: Integration and implementation sciences for researching complex real-world problems*. Canberra: ANU E-Press.

Bechtel, W. (1993). Integrating sciences by creating new disciplines: The case of cell biology. *Biology and Philosophy, 8*, 277-299.

Bergmann, M., Jahn, T., Knobloch, T., Krohn, W., Pohl, C., & Schramm, E. (2012). *Methods for transdisciplinary research.* Frankfurt/New York: Campus Verlag.

Boix Mansilla, V. (2010). Learning to synthesize: The development of interdisci-

plinary understanding. In R. Frodeman, J. T. Klein, & C. Mitcham (Eds.), *The Oxford handbook of interdisciplinarity* (pp. 288-306). Oxford: Oxford University Press.

Brigandt, I. (2010). Beyond reduction and pluralism: Toward an epistemology of explanatory integration in biology. *Erkenntnis*, *73*, 295-311.

Bruckheimer, J. (Producer), & Verbinski, G. (Director). (2003). *Pirates of the Caribbean: The curse of the Black Pearl* [Motion Picture]. United States: Walt Disney Motion Studios.

Bruun, H., Hukkinen, J. I., Huutoniemi, K. I., & Klein, J. T. (2005). *Promoting interdisciplinary research: The case of the academy of Finland*. Helsinki: Academy of Finland.

Burke, K. (1966). *Language as symbolic action: Essays on life, literature, and method*. Berkeley: University of California Press.

Carroll, J. B. (Ed.). (1956). *Language, thought, and reality: Selected writings of Benjamin Lee Whorf*. Cambridge: MIT Press

Chisholm, R. (1973). *The problem of the criterion.* Marquette University Press: Milwaukee, WI.

de Wachter, M. A. (1982). Interdisciplinary bioethics: But where do we start? *Journal of Medicine and Philosophy, 7*, 275-287.

Fisher, D. (1990). Boundary work and science: The relation between power and knowledge. In S. Cozzens & T. Gieryn (Eds.), *Theories of science and society* (pp. 98-119). Bloomington, IN: Indiana University Press.

Fisher, D. (1993). *Fundamental development of the social sciences: Rockefeller philanthropy and the United States Social Science Research Council*. Ann Arbor: University of Michigan Press.

Galison P. (1997). *Image and logic.* Chicago, IL: University of Chicago Press.

Gieryn, T. (1983). Boundary work and the demarcation of science from non-science: Strains and interests in professional ideologies of scientists. *American Sociological Review*, *48*, 781-795.

Gieryn, T. (1995). Boundaries of science. In S. Jasanoff & Society for the Social Studies of Science (Eds.), *Handbook of science and technology studies* (pp. 383-443). Thousand Oaks, CA: Sage.

Grantham, T. (2004). Conceptualizing the (dis)unity of science. *Philosophy of Science*, *71*, 133-155.

Habermas, J. (1985). *The theory of communicative action: Reason and the rationalization of society* (Vol. 1)*,* (T. McCarthy, Trans.). Boston, MA: Beacon Press.

Habermas, J. (1987). *The theory of communicative action: Lifeworld and system: A critique of functionalist reason* (Vol. 2)*,* (T. McCarthy, Trans.). Boston, MA: Beacon.

Hall, T. E., & O'Rourke, M. (2014). Responding to communication challenges in transdisciplinary sustainability science. In K. Huutoniemi & P. Tapio (Eds.), *Heuristics for transdisciplinary sustainability studies: Solution-oriented approaches to complex problems* (pp. 119-139)*.* Oxford: Routledge.

Hursh, B., Hass, P., & Moore, M. (1983). An interdisciplinary model to implement general education. *Journal of Higher Education*, *54,* 42-59.

Klein, J. T. (1990). *Interdisciplinarity: History, theory, and practice*. Detroit: Wayne State University Press.

Klein, J. T. (1996). *Crossing boundaries: Knowledge, disciplinarities, and interdisciplinarities.* Charlottesville, VA: University of Virginia Press.

Klein, J. T. (2001). Interdisciplinarity and the prospect of complexity: The tests of theory. *Issues in Integrative Studies*, *19,* 43-57.

Klein, J. T. (2004a). Guiding questions for integration. *Integration Symposium 2004 – Proceedings*, CD-ROM, 5-8. Canberra: Land and Water Australia.

Klein, J. T. (2004b). Interdisciplinarity and complexity: An evolving relationship. *Eco*, *6*(1-2), 2-10.

Klein, J. T. (2012). Research integration: A comparative knowledge base. In A. F. Repko, W. Newell, & R. Szostak (Eds.), *Case studies in interdisciplinary research* (pp. 283–298). Thousand Oaks, CA: Sage.

Klein, J. T. (2014). Communication and collaboration in interdisciplinary research. In M. O'Rourke, S. Crowley, S. D. Eigenbrode, & J. D. Wulfhorst (Eds.), *Enhancing communication & collaboration in interdisciplinary research* (pp. 11-30). Thousand Oaks: Sage.

Lakoff, G., & Johnson, M. (1980). *Metaphors we live by.* Chicago, IL: University of Chicago Press.

Laursen, B. K. (2018a). What is collaborative, interdisciplinary reasoning? The heart of interdisciplinary team science. *Informing Science: The International Journal of an Emerging Transdiscipline, 21,* 75–106.

Laursen, B. K. (2018b). On the intersection of interdisciplinary studies and argumentation studies: The case of inference to the best explanation. *Issues in Interdisciplinary Studies, 36*(1), 93-108.

Leonelli, S. (2013). Integrating data to acquire new knowledge: Three modes of integration in plant science. *Studies in History and Philosophy of Biological and Biomedical Sciences, 44*, 503-514.

MacLeod, M., & Nagatsu, M. (2016). Model coupling in resource economics: Conditions for effective interdisciplinary collaboration. *Philosophy of Science, 83*(3), 412-433.

Newell, W. H. (2001). A theory of interdisciplinary studies. *Issues in Integrative Studies*, *19*, 1-25.

Newell, W. H. (2007). Decision-making in interdisciplinary studies. In G. Morçöl (Ed.), *Handbook of decision making* (pp. 245-264). Boca Raton, FL: CRC/ Taylor & Francis.

Nissani, M. (1995). Fruits, salads, and smoothies: A working definition of interdisciplinarity. *The Journal of Educational Thought, 2,* 121-128.

O'Malley, M. A., & Soyer, O. S. (2012). The roles of integration in molecular systems biology. *Studies in History and Philosophy of Biological and Biomedical Sciences*, *43*, 58-68.

O'Rourke, M., & Crowley, S. (2013). Philosophical intervention and cross-disciplinary science: The story of the Toolbox Project. *Synthese, 190,* 1937-1954.

O'Rourke, M., Crowley, S., & Gonnerman, C. (2016). On the nature of cross-disciplinary integration: A philosophical framework. *Studies in History and Philosophy of Biological and Biomedical Sciences, 56,* 62-70.

O'Rourke, M., Crowley, S., Laursen, B., Robinson, B., & Vasko, S. E. (2019). Dis-

ciplinary diversity in teams, integrative approaches from unidisciplinarity to transdisciplinarity. In K. L. Hall, A. L. Vogel, & R. T. Croyle (Eds.), *Advancing social and behavioral health research through cross-disciplinary team science: Principles for success* (pp. 19-44). Berlin/Heidelberg: Springer.

Plutynski, A. (2013). Cancer and the goals of integration. *Studies in History and Philosophy of Biological and Biomedical Sciences, 44*, 466-476.

Repko, A. F. (2008). *Interdisciplinary research: Process and theory*. Thousand Oaks, CA: Sage.

Repko, A. F. (2012). *Interdisciplinary research: Process and theory* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Rossini, F. A., & Porter, A. L. (1979). Frameworks for integrating interdisciplinary research. *Research Policy, 8*(1), 70-79.

Shapin, S. (1992). Discipline and bounding: The history and sociology of science as seen through the externalism-internalism debate. *History of Science*, *30*(4), 333-369.

Sjölander, Sverre. (1985). Long-term and short-term interdisciplinary work: Difficulties, pitfalls, and built-in failures. In L. Levin & I. Lind (Eds.), *Inter-disciplinarity revisited* (pp. 85-101). Stockholm: OECD, SNBUC, Linköping University.

Stokols, D., Hall, K. L., Taylor, B. K., & Moser, R. P. (2008). The science of team science: Overview of the field and introduction to the supplement. *American Journal of Preventive Medicine*, *35*(2S), S77–S89.

Thompson, J. L. (2009) Building collective communication competence in interdisciplinary research teams. *Journal of Applied Communication Research, 37*, 278-297.

Vosskamp, W. (1994). Crossing of boundaries: Interdisciplinarity as an opportunity for universities in the 1990s? *Issues in Integrative Studies*, *12*, 43-54.

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# Exploring Julie Thompson Klein's Framework for Analysis of Boundary Work

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***Abstract:*** Julie Thompson Klein's contributions to interdisciplinary and transdisciplinary research have enriched the way collaboration is discussed and handled by introducing concepts of boundary work and boundary crossing from the field of Science and Technology Studies. In recent years, she has been integrating those concepts into crossdisciplinarity, an effort culminating in the development of a framework for a forthcoming book (*Beyond Interdisciplinarity: Boundary Work, Collaboration, and Communication in the 21st Century*). With her permission, we have used an earlier version of her framework to analyze boundary work and boundary crossing in transdisciplinary sustainable water management projects in Australia and Switzerland. The aim of using the framework has been twofold: to explore and assess the

heuristic value of the framework, i.e. how it improves our conceptualization of boundary work in the two projects, and to examine the framework itself, i.e. whether some of the seven concepts involved are hard to work with or should be further developed.

***Keywords***: boundary crossing, boundary work, facilitating expertise, facilitating leadership, interdisciplinarity, Julie Thompson Klein, transdisciplinarity

## 1. Introduction

In her book *Crossing Boundaries. Knowledge, Disciplinarities, and Interdisciplinarities* (Klein, 1996), Julie Thompson Klein brought together concepts and theories from the field of interdisciplinarity and transdisciplinarity with concepts and theories of boundary work and boundary crossing from the field of Science and Technology Studies. Bridging these fields allowed new concepts to emerge for understanding and facilitating interdisciplinary and later also transdisciplinary collaborations. These new concepts enabled richer conceptualization of how boundaries between disciplines or between academia and society are constructed and maintained and of how boundary objects or interlanguages can help to bridge different subcultures and improve the way their members communicate. Since then, Klein has further elaborated the concepts of boundary work and boundary crossing, an effort culminating in the development of an analytical framework for a forthcoming book, *Beyond Interdisciplinarity: Boundary Work, Collaboration, and Communication in the 21st Century*. Klein developed an earlier version of the framework for analyzing boundary work for a joint paper with the lead author. That paper stayed a draft. However, in the following, with not only her permission but also her strong encouragement, we will present, report on the use of, and review this framework. In section two of this article, we introduce the framework, drawing mostly from the words of Klein taken from the draft paper. In section three we discuss our use of the conceptual framework to analyze two of our own projects. Both are from the field of sustainable water management, one from Australia and the other from Switzerland. The aim of using the framework is twofold: to explore and assess the heuristic value of the framework, that is, how it improves our conceptualization of boundary work in the two projects, and to examine the framework itself, i.e. whether some of the seven concepts involved in the framework are hard to work with or should be further developed. We address both those matters in section four.

## 2. Klein's Conceptual Framework for Analysis of Boundary Work

In the following we present Klein's conceptual framework for analysis of boundary work: a set of seven concepts expressed as questions in an analyti-

cal frame to explore boundary work of interdisciplinary and transdisciplinary teams. We introduce and explicate each concept, then reframe each concept as a question to guide reflection and analysis (see Table 1).

*Concept 1: Boundary Work*

Boundary work is the most generic concept in the framework. According to Klein, it is a composite label for the claims, activities, and structures by which boundaries are created, maintained, crossed, and reformulated between knowledge units. Knowledge units are built, for instance, by the members of a discipline (Fleck, 1986) or of a community of practice (Wenger, McDermott, & Snyder, 2002) that reaches beyond academia. Initial studies of boundary work focused on science and disciplinarity, though subsequently the concept was extended to studies of interdisciplinarity (Fisher, 1993, pp. 13-17; Gieryn, 1983; Klein, 1996, pp. 57-84). The concept adequately represents the complexity and multidimensionality of boundary crossing that occurs in many areas dubbed "interdisciplinary." Research and education on problems of Health and Wellness, for example, cross boundaries of expertise in academic disciplines as well as professions of medicine, social work, education, law, and other occupational groups. Hence, in this case the concept involves both interdisciplinarity and interprofessionalism (D'Amour & Oandasan, 2005). Interdisciplinary research also crosses boundaries of social sectors beyond the academy, leading Rustom Roy (2000) to propose the term "interactive research" to refer to alliances with governments and industry. Sustainability is another powerful example of an area involving much boundary crossing (Hirsch Hadorn, Bradley, Pohl, Rist, & Wiesmann, 2006; Jahn, Bergmann, & Keil, 2012). In both instances – Health and Wellness and Sustainability – different connotations of the terms "interdisciplinary" and "transdisciplinarity" appear, leading to several classifications of research and education being labeled with the terms (Huutoniemi, Klein, Bruun, & Hukkinen, 2010; Klein, 2010; Pohl & Hirsch Hadorn, 2007, pp. 69-95). For instance, "transdisciplinarity" might include trans-sector problem-oriented research that involves both academics and stakeholders in society (Hirsch Hadorn et al., 2008) and Patricia Rosenfield's (1992) notion of "transcendent interdisciplinary research" that creates new methodological and theoretical frameworks.

*The first question to consider in analyzing any particular case study, then, is the following: What forms of boundary work are evident, factoring in the range of interdisciplinary, interprofessional, interactive, and transdisciplinary approaches*?

*Concept 2: Subcultures*

A second concept involves academic tribes and cultures (Becher, 1989). Researchers collaborating in an interdisciplinary or transdisciplinary project can be seen as belonging to different academic tribes and cultures (i.e. disciplines or sub-disciplines), each of which inhabits, develops, and defends a particular territory of knowledge. Accordingly, in interdisciplinary and transdisciplinary collaborations members of different subcultures meet, exchange, and might argue about who has the final say on a particular topic. Depending on the project, further subcultures involved might represent the private sector, the public sector, or civil society.

*The second question in our framework follows: What are the different subcultures, their differences, and their basis for exchanges?*

*Concept 3: Expertise*

Gorman and colleagues (2002; 2010) speak of trading zones as a "space for exchange" where representatives of heterogenous disciplines are capable of producing a new homogeneous culture of "interactional expertise." Sociologists of science Collins and Evans (2002, p. 254) further distinguish between "interactional expertise" and "contributory expertise." "Interactional expertise" ("enough expertise to interact interestingly with participants and carry out a sociological analysis") refers to members of different subcultures who understand enough of the languages and norms of the other subcultures involved in a zone to have an interesting and stimulating exchange or to trade expertise. "Contributory expertise" ("enough expertise to contribute to the science of the field being analyzed") involves individuals who have learned enough about other disciplines to make original contributions. For Gorman (2002; 2010) the two kinds of expertise differ in intensity of collaboration: Interactional expertise is an exchange – or trading of expertise – on a more or less well defined boundary object (see below) not requiring a shared language or shared understanding. Contributory expertise, by contrast, would require an in-depth knowledge of the language and norms of other subcultures and of how representatives of each perceive the joint subject of research.

*The third question arises from this deepening of the concept of boundary work and asks: What forms of expertise exist in the team? How do they change in the process of participants' work with others?*

*Concept 4: Boundary Objects*

The next concept in the framework – boundary objects – plays a productive

role in mediating differences within trading zones without requiring a shared representation of the subject of research. Following Star and Griesmer's definition (1989), boundary objects are robust enough to maintain unity across practices but plastic enough to be delimited, manipulated, and bounded in individual practices and at local sites around a common interest but still retain separate interpretations. Particular technologies – for example, creation of the Mars Rover and development of Berkeley's Museum of Vertebrate Zoology – have been focal points for collective work among individuals from different subcultures. Exchange was possible because the objects were plastic enough to be adapted to local needs and constraints but still robust enough to maintain common identity. Other examples of boundary objects would be data (numbers) and data sources (rabbits) shared between labs and sometimes brought together for comparative analysis. Or molecules built by one research group and analyzed by another group, with both sides bringing insights to the final results. Or, for faculty from different disciplines in an interdisciplinary studies program, the boundary object could be the curriculum and the degree(s) to collectively work and agree upon. And, in the context of a large transdisciplinary research project on urban transportation in Germany, the concept of mobility operated as a boundary object that framed the process of identifying the main research question (Bergmann & Jahn, 2008).

*The fourth question in the framework follows in turn: What technologies, products, concepts, or ideas function as boundary objects, enabling members of a team to trade expertise on a common point of reference?*

*Concept 5: Interlanguages*

The concept of trading zones was borrowed from anthropology (Galison, 1997) but companion concepts of pidgin and creole are familiar in linguistics. The metaphor of bilingualism is a popular characterization of interdisciplinary work. However, it is not an accurate description of what happens in most projects. Interdisciplinary discussions, Gerhard Frey (1973) found, typically occur on a level similar to that of a popular scholarly presentation. They become more precise in phrasing as individuals acquire knowledge of other disciplines, combining everyday and specialist language. Disagreements in teamwork often boil down to disputes over language: people using the same words with different intended meanings. Interdisciplinary language typically evolves through development of an interlanguage. In accordance with the metaphor of trading zones, a pidgin language is an interim tongue devised to facilitate dialogue among subcultures. A creole is a new first language among members of a new social and cognitive community (Klein, 1996, p. 220).

Broadly speaking, the quality of outcomes in interdisciplinary projects, as Wilhelm Vosskamp (1994) observes, cannot be separated from the develop-

ment and richness of a shared language culture. Schmithals and Berkenhagen's notion of a "cooperation and communication culture" highlights the importance of paying attention to interfaces: to the points where the work of one participant is necessary for the work of another, and to the points where participants must coordinate effectively with one another (Schmithals & Berkenhagen, 2004). Shared language, Bruce Thiessen further urges, requires adaptive behavior to achieve common ground for establishing shared language and goal-directedness at both the group level and in individual capacity for collaboration (Thiessen, 1998, pp. 49-50).

*The fifth question of the framework, then, highlights the role of language: What kinds of interlanguage have developed over the course of a project, and did they evolve from a pidgin to a creole, and did a shared language culture emerge?*

*Concepts 6 and 7: Collaborative Learning and Leadership*

As Burtis and Turman observe in their book on the subject, all group communication engages in "boundary spanning" – that is, knowledge exchange between subcultures (Bednarek et al., 2018) – necessitating "boundary negotiations" in both internal and external communications (Burtis & Turman, 2006, pp. 53-54). Spanning and negotiation take on greater weight in interdisciplinary collaboration because worldviews must be bridged. There is no single unified model for interdisciplinary research (IDR) and transdisciplinary research (TDR) collaboration, but every project or program requires the creation of a platform of communication, creating a space and a network for developing shared goals, concrete ideas and measures, and assessment (Hindenlang, Heeb, & Roux, 2008, p. 243). On-going communication and interaction foster mutual learning among individuals as well as a sense of interdependence. The last key concept in the framework – single versus double loop learning – accentuates the difference between learning that issues in minimal change (single loop learning) versus learning that issues in fundamental change in the underlying assumptions of an organizational system (double loop learning). Double loop learning calls into question operant mental models, mindsets, and frames of reference. Goals and values are open to change, bringing the possibility of creative, innovative, emergent outcomes (Argyris, 1976).

*The penultimate question underscores the importance of learning: What activities have fostered collaborative learning and new hybrid expertise among the individuals and the entire team?*

*The final question follows the previous one by asking how and by whom the process of collaborative learning is organized: What leadership and management strategies have enhanced the prospect for communication and collaboration?*

Table 1
*Framework to analyze boundary work in interdisciplinary teams*

| | **Concept** | **Specific questions** |
|---|---|---|
| 1 | Boundary Work | What forms of boundary work are evident, factoring in the range of interdisciplinary, interprofessional, interactive, and transdisciplinary approaches? |
| 2 | Subcultures | What are the different subcultures, their differences, and their basis for exchanges? |
| 3 | Expertise | What forms of expertise exist in the team? How do they change in the process of participants' work with others? |
| 4 | Boundary Objects | What technologies, products, concepts, or ideas function as boundary objects, enabling members to work together on a common point of reference? |
| 5 | Interlanguages | What kinds of interlanguage have developed over the course of a project, and did they evolve from a pidgin to a creole, and did a shared language culture emerge? |
| 6 | Collaborative Learning | What activities have fostered collaborative learning and new hybrid expertise among the individuals and the entire team? |
| 7 | Leadership | What leadership and management strategies have enhanced the prospect for communication and collaboration? |

## 3. Analyzing Boundary Work in Two Sustainable Water Management Projects

Below we use Klein's conceptual framework (Table 1) to analyze two sustainable water management projects, one from Australia and one from Switzerland. We focus on sustainable water management because it is the field of expertise for three of the authors. For each analysis, we first briefly describe the project and then apply selected concepts of the framework, specifically those deemed most relevant for the project.

### *3a. The Australian Case*

The Australian case study analyzed for this article involved installing a novel system of sanitation – Urine Diversion (UD) – in a multi-story build-

UD systems aim to separate and collect urine from the wastewater stream for processing as an alternative fertilizer in agricultural production (Fam, Mitchell, Abeysuriya, & Meek, 2013). UD systems are a relatively novel technology within Australia with only four trial installations across Australia at the time of this project. Installing UD systems on the university campus at UTS required bridging multiple dimensions of UD to learn about the technological, social, and regulatory factors influencing the successful installation and management of UD systems. There was a lack of knowledge and expertise in installing, operating, and regulating UD systems by water utilities, councils, and regulators, making social learning and boundary work a critical and necessary process in the project (Fam, 2017). The overarching research frame of TDR was therefore informed by action research methodology (Dick, 2001).

Concept/Subcultures: What are the different subcultures, their differences, and their basis for exchanges?

The UD trial at UTS engaged a range of researchers, staff, and students (undergraduate and postgraduate) along with key industry and government stakeholders. This Community of Practice (CoP) (Wenger, 2004) provided cross-disciplinary expertise, drawing together 15 collaborators across six disciplinary faculties, five industry sectors, and three government departments (see Table 2 for further details).

Table 2
*Collaborators involved in the UTS trial across academia, industry, and government (Fam, 2017)*

| **Academia from three Universities** | **Industry** | **Government** |
|---|---|---|
| • Law<br>• Agriculture<br>• Design<br>• Engineering<br>• Sustainability Science<br>• Systems Thinking | • Toilet Manufacturer<br>• Horticulture Nursery and Garden Industry Association<br>• Water Utility<br>• Design and Construction<br>• Building Facilities Management | • Local Council<br>• Plumbing Industry Regulator<br>• Department of Health |

In terms of subcultures and their basis for exchanges, the academy can be contrasted with industry: In those two spheres there were distinct subcultures with differing agendas and interests in this project. For example, many of the disciplinary academics invited into the project brought with them a primary focus on disciplinary-oriented inquiry, which created barriers to active cross-disciplinary participation. Their lack of experience in inter- and transdisciplinary forms of research meant that their strong preference was to remain within their silos, conducting a solely legal or design or engineering inquiry. Embedded institutional structures and resource allocation also limited the collaboration among disciplinary departments and between universities, factors clearly noted by other scholars researching trans-, inter- and multidisciplinary collaboration (Stokols, 2006). In this case, as so often, academics were driven by the "politics of research" (Altman, 1995) and the need to publish research and fulfill expectations of their academic institutions. In the UTS case, the perceived incentives for academic collaboration (in lieu of financial payment) were intellectual outputs such as the development of conceptual frameworks, methodologies, empirical studies, and peer-reviewed publications satisfying institutional requirements to generate research outcomes (Fam, 2017). Some academics were disinclined to participate in this TDR project due to lack of institutional support. Overcoming this disincentive required renegotiating incentives for academics involved to meet institutional requirements. For example, we reviewed and revised the budget so that academics could be offered small financial incentives to support them in developing expected research outputs. Academics who were leading areas of research did so to meet individual goals as well as expectations of their associated institutions and were more likely to participate and lead research when there were opportunities to incorporate elements of the project's research into their teaching (e.g. student projects) and/or to publish research outcomes.

For those beyond the academy, the extent of partnering and engaging in the project varied significantly due to the diversity of industry and government members involved (see Table 2): Perceptions of benefits and the potential for direct gains differed greatly amongst these members. For example, the toilet manufacturer conducted tests of international products against Australian Standards, which provided an opportunity to examine other designs carefully. The design and construction company learned about what pitfalls to avoid in building successful urine diversion pipework in multistory buildings. The plumbing regulator recognized the need for change in the sector, so their contribution, or the form of their exchange, was to shepherd our project through strict regulatory approval processes, thereby

creating a path for potential innovation at scale, following our pilot project.

Concept/Expertise: What forms of expertise exist in the team? How do they change in the process of participants' work with others?

At the time of this project, the Project Director had approximately a decade of experience in leading TDR, firstly through pursuing projects with and for industry that sought to employ the scholarship of integration (Boyer, 1997), i.e. beyond "application," and secondly through creating enabling environments for TDR, especially through her leadership of a transdisciplinary doctoral research program that adopted elements of CoP in its orientation (Riedy, Fam, Ross, & Mitchell, 2018). Deep engagement over time with questions of what constitutes quality in TDR meant that the Project Director had developed a broad, pluralist stance in epistemological terms, and had by then much experience in helping disparate groups negotiate the epistemological chasms between disciplines. This expertise is neither interactional nor contributory in the sense Collins and Evans use the terms (2002, p. 254). It is not expertise in the content of a dialogue, but in making a dialogue happen, and we call it "facilitating expertise."

Facilitating expertise was important not only for the design of the project, but also for the implementation of the project. For example, industry partners in the project were familiar with research projects designed to follow a linear process, passing milestones and delivering a set of pre-determined outcomes. In this project, we aimed to take an emergent approach, leaving open the potential to change key elements and directions of the project as our exploration continued, integrating learning into the facilitation of the research. This approach to delivering the project was novel and initially confusing to our industry partners. However, our facilitating expertise meant we were able to carefully negotiate the process of the project in a way that enabled our industry partners to come to view emergence as a legitimate part of the research process. As one team member from industry recalled, "I think at the beginning I was very unclear of the scope of the project and then I realised the reason I'm unclear about the scope is because it is actually changing." Given that the drivers for innovation are much weaker in the water industry than elsewhere (Dolata, 2009; Mitchell, Abeysuriya, Willetts, & Fam, 2010), this acceptance of the new by industry partners was a significant result.

Concept/Boundary Objects: What technologies, products, concepts, or ideas function as boundary objects, enabling members to work together on a common point of reference?

The two main boundary objects were the evolving schematic of the conceptual approach (Figures 1 and 2) developed in the proposal stage and a systems diagram developed during the project (Figure 3). Together, TDR and action research provided a flexible and learning-focused approach to the project. In the project design, we sought to distinguish multiple distinct (but not disciplinary) strands of potential inquiry as well as to make explicit the need from a systems perspective to pay attention to integrating these separate strands. Each strand (Technology, Visual Communication, Stakeholder Engagement, Regulations/Institution, and Integration) is therefore depicted in Figure 1 as an ongoing line of activity throughout the life of the project. Our action research stance meant that we also designed in three cycles of research: (1) investigation; (2) design, contract, and commission urine diversion toilets; and (3) operate, monitor, evaluate, and decommission. The visual representation of the process that we developed both clarified our intent and captured the complexity of the concept in a way that could be readily shared with and readily comprehended by all the members of the team to ensure that everyone was clear about the conceptualization of the design and plans moving forward (see Figure 1).

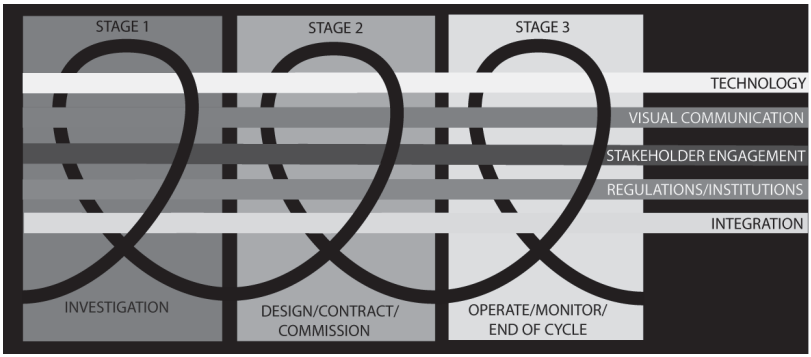


Figure 1. The first boundary object: a schematic of the conceptual approach for five strands of research spanning three action research cycles.

In line with Star's and Griesemer's (1989) concept of boundary objects, the schematic of the conceptual approach provided a rough structure for the research process that could be adapted to requirements as the project developed. We used the flexibility of the boundary object to create a space for learning. While we had clear and cogent plans on how we wanted the cycles of research to operate, we knew there were many, many unknowns.

In other words, we set out knowing and being explicit with all our team members about the fact that we would likely "skin our knees," so this colloquial terminology was part of the project's lexicon from the initial meeting that brought all the team members together. Rather than trying to obscure the high degree of change and emergence in the TD research process from our partners by attempting to make the process fit conventional expectations of research, we deliberately sought to construct an environment where our partners could experientially learn about the potential value of other ways of doing research. We were thus enabling our partners to expect and accept that emergent learnings could and should influence the direction of the project. In reality the project ran very differently from our plan: The small loops in Figure 2 each indicate a small cycle of initially unplanned action research that became necessary as the project progressed, and that changed the direction of our efforts (Dick, 2001).

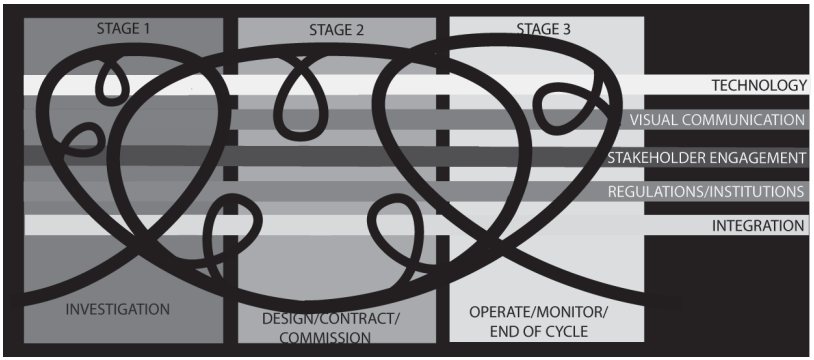


Figure 2. Schematic of the actual conceptual approach. The flexibility of the boundary object allowed us to adapt the representation of the methodological framework according to how the project unfolded in terms of action research cycles and subcycles (Mitchell, Fam, & Abeysuriya, 2013).

Another boundary object was an artefact that enabled the partners to position themselves in the process of the project (Figure 3). The systems diagram below brought together all the components of a new UD system as well as all the strands of research to help identify everyone's contribution and the connections between components of the system.

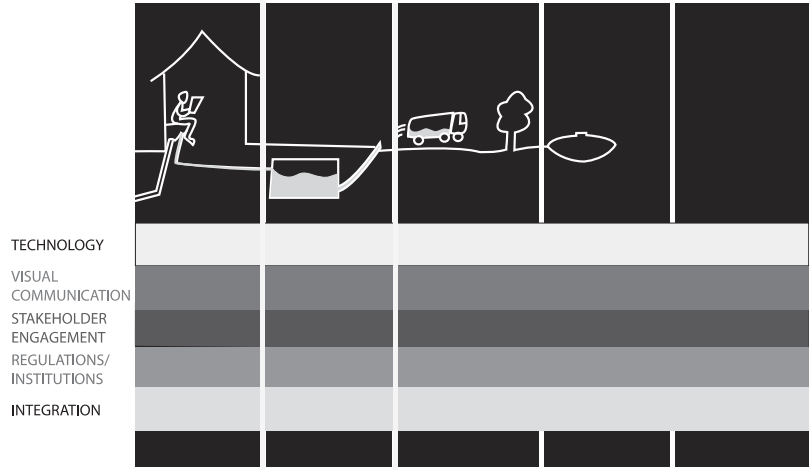


Figure 3. System diagram of the UD System (Mitchell et al., 2013).

Concept/Collaborative Learning: What activities have fostered collaborative learning and new hybrid expertise among the individuals and the entire team?

As elaborated above, the flexible methodological framework allowed creating a space for collaborative, or, as we framed it in our project, social learning from the beginning of the project. An unforeseen mode of interaction emerged in the form of writing as learning. Although its potential had not been recognized in the early stages of the project, collaborative writing proved to be important not only as a research contribution and an academic output but also as a mode of learning. Over the two years of the project, five academic conference papers were written across fields of systems thinking, design education, and transition management, and three academic journal papers were submitted in the areas of systems thinking, design studies, and transdisciplinary collaboration involving both industry and academic contributors. Cross-disciplinary coauthors commented on the process of writing as a mode of social learning with one industry partner highlighting that "in working with purely agricultural scientists… [writing together in the project] stretched my imagination a bit and made me think a little bit differently in how we approach the issue [of trialling a new system]." The opportunity to utilize academic writing as a means to the end of interdisciplinary learning was enhanced by the fact that half of the members of the project team

were academics from diverse disciplinary backgrounds. Industry partners also became productively involved in collaborative writing through interaction with academic partners.

Concept/Leadership: What leadership and management strategies have enhanced the prospect for communication and collaboration?

The UTS trial was designed to facilitate participatory leadership through actively engaging members of the project team in co-creating a community centered on the project. To deepen the engagement of, and therefore potential for meaning-making by, the team members, we created a largely horizontal structure of leadership, anchored in the experience and expertise of all the project participants. Although some leadership responsibilities did rest with individuals, as, for example, managing grant budgets and delivering grant outcomes, which were the responsibility of the Project Director, all participants were given the opportunity to make decisions about the direction of the project as well as develop and lead areas of research that were both important to individuals and beneficial to the project as a whole.

Empirical evidence from the UTS trial highlights the challenges and benefits of successfully implementing alternative models of leadership in practice. Supporting participants to take an active role in community-oriented leadership requires a facilitative rather than a directive approach. Facilitators are in effect serving a community at the same time as managing it. In community-oriented leadership, facilitators need to ensure that processes are in place to enable community members to improve their collective capability and contribute to learning in the process (Lank, Randell-Khan, Rosenbaum, & Tate, 2008). In the UTS trial, this involved designing strategies to engage and re-engage members in decision making and action, keeping the community energized, focused and interactive, and at times holding participants accountable. As a community is not a static entity, the facilitating role was dynamic, defined by the Project Director as "akin to herding" (Fam, 2017). It requires continually monitoring and evaluating the context in which members interact with each other and being respectfully responsive to challenges affecting members active in the project. In the UTS trial, this was achieved through the combination of weekly reflection on the project's development by core facilitating members, monthly meetings for those involved in each of the research strands, and whole group meetings every 4 to 6 months (Fam, 2017).

*3b. The Swiss Case*

The second project we analyzed for this article is called "Transdisciplinary Integration for Sustainable Urban Water Management in Switzerland." Urban water and wastewater management (hereafter called "water management") in Switzerland has gradually evolved over the last two centuries. Today, urban water management faces several challenges, including rehabilitation of aging infrastructure and adaptation to climate variability and demographic change. Meeting such challenges requires the transdisciplinary integration of disparate bodies of knowledge from both research and practice in order to understand the complexity, ambiguity, and uncertainty of such challenges and to develop and implement potential solutions. The synthesis project on Sustainable Urban Water Management in Switzerland (TS 3) aimed at meeting the challenges by integrating existing knowledge pertinent to urban water management in Switzerland. Funded by the Swiss National Science Foundation (SNSF), the project was carried out between 2012 and 2014 within the National Research Program on Sustainable Water Management (NRP 61). The project built on both knowledge delivered by seven (out of 16) individual NRP 61 projects (carried out between 2010 and 2013) and expertise provided by 36 key actors from both research and practice (see Table 3). Transdisciplinary integration within the synthesis project was systematically reflected in the associated NRP 61 research project headed by the leader of TS 3.

Concept/Boundary Work: What forms of boundary work are evident, factoring in the range of interdisciplinary, interprofessional, interactive, and transdisciplinary approaches?

The synthesis project involved (a) a core team, responsible for leading transdisciplinary integration within TS 3 and authoring the final synthesis report (Hoffmann, Hunkeler, & Maurer, 2014), (b) a steering committee, (c) an advisory board, and (d) a management office set up by the NRP 61, as well as (e) scientific experts from within and/or outside NRP 61 and (f) practice experts from different sectors (water supply, wastewater treatment) and decision levels (federal, cantonal, municipal). Table 3 summarizes the composition of the different actor groups involved in TS 3 (Hoffmann, Pohl, & Hering, 2017a).

Table 3
*Actor groups involved in the Swiss project.*

| **Actor group** | **Involved disciplines or sectors, respectively** |
|---|---|
| Core team | 3 researchers in the fields of environmental science, environmental engineering, and hydrogeology |
| Steering committee | 6 internationally acknowledged experts in the fields of environmental engineering, aquatic ecology, environmental economics, hydrology, meteorology, and geophysics |
| Advisory board | 10 key stakeholders from the Swiss Water Sector representing the national council (2), the federal office for the environment (1), cantonal authorities (3), NGOs (1), and trade associations, including the Swiss Water Association (1), the Swiss Gas & Water Industry Association (1), and the Swiss Water Management Association (1) |
| Management office | 3 managers, including the SNSF program manager, the implementation officer, and the president of the steering committee |
| Research experts | 7 researchers in the fields of environmental sciences, decision analysis, hydrogeology, hydrology, water chemistry, and limnology |
| Practice experts | 7 key stakeholders representing the federal office for the environment (3), cantonal authorities (4), municipal authorities (1), consulting companies (1), water supply companies (2), the stakeholder network of Swiss Water Management (1), and trade associations, including the Swiss Water Association (1), the Swiss Gas & Water Industry Association (1), and Communal Infrastructure (1) |
| Total | 36 experts from both research and practice |

The boundaries that had to be worked on included

a) boundaries between different disciplines;
b) boundaries between those mandating, steering, advising on, and carrying out the research;
c) boundaries between different research projects;
d) boundaries between academics and stakeholders in society;
e) boundaries between different professions;
f) boundaries between different governmental levels.

Besides b) and c) these boundaries are all explicitly mentioned in the framework for analysis of boundary work. The boundaries listed as b) and c) point out further boundaries that necessitated work within the structure of the re-

search program NRP 61, be it between different research projects or different actor groups involved in mandating, steering, advising on, and carrying out research.

In order to work across boundaries, the core team worked together with the group of experts from research to define a number of key questions (Table 4) related to three types of knowledge relevant for urban water management in Switzerland (Hoffmann, 2016; Hoffmann, Pohl, & Hering, 2017b).

Table 4
*Questions used to work across boundaries.*

| **Knowledge type** | **Integrative questions** |
|---|---|
| Systems knowledge | What are current and future challenges to urban water management in Switzerland? What causal links underlie these challenges? |
| Target knowledge | What are social, ecological, and economic targets of sustainable urban water management in Switzerland? |
| Transformation knowledge | What are options for action toward sustainable urban water management? What are the consequences of these options for action? |

At the same time, the core team determined the need to develop a suitable method for integrating the different types of knowledge in a coherent and consistent way. Following Giupponi (2007), the team combined key elements of system analysis and multi-criteria decision analysis to structure and systematize the very heterogeneous research results provided by the seven individual research projects, ranging from the availability and quality of surface and groundwater resources *(systems knowledge)* to strategic planning of urban water infrastructure *(target knowledge)*. Based on the integrated results, the team generated new *transformation knowledge* targeted to the specific needs of federal, cantonal, and municipal authorities, water and wastewater companies, stakeholder networks, and trade associations (Hoffmann, 2016). Combining key elements of system analysis and multi-criteria decision analysis allowed for crossing the boundaries between different disciplines and projects; it also allowed for linking and relating the research results of such projects to the three types of knowledge and positioning them in the broader context of urban water management in Switzerland.

Concept/Leadership: What leadership and management strategies have enhanced the prospects for communication and collaboration?

The core team (see Table 3) took the lead in TS 3. The core team mainly employed two strategies to enable knowledge integration throughout the synthesis process to help all involved to cross the boundaries between different disciplines, projects, professions, and decision levels, and also between those mandating, steering, advising on, and carrying out research (Hoffmann et al., 2017b; Rossini & Porter, 1979). These two strategies were (a) common group learning, where integration of research results provided by the individual NRP 61 projects took place within the group of experts from research and/or practice working as a whole, and (b) integration by the core team, where integration of research results was handled by the core team, who interacted bilaterally with experts from research and practice to link and relate the results. Both integration strategies were employed iteratively with multiple loops within and between the involved disciplines, projects, and professions and across those mandating, steering, advising on, and carrying out research. The final results of this iterative integration were validated in consultation with the NRP 61 steering committee, the advisory board, and 25 experts to ensure not only their reliability and credibility, but also their relevance for research and practice (Hoffmann et al., 2017b).

By applying these strategies, the core team adopted two main roles throughout the synthesis process. In accordance with a typology introduced by Wieser, Brechelmacher, and Schendl (2014), in some stages the core team acted collectively as a facilitator fostering fruitful exchange with the NRP 61 steering committee, the advisory board, and the management team as well as with experts from both research and practice to, for instance, formulate sustainable targets for urban water and wastewater management, define potential options for actions, and assess the potential of such options to achieve those targets (Hoffmann et al., 2017b). In some stages, the core team shifted its role and acted collectively as a collaborator, engaging in bilateral discussions with experts from research and practice to, for instance, identify key challenges to urban water and wastewater management in Switzerland, analyze their causal relationships, and assess the impact of different options for actions on such challenges (Hoffmann et al., 2014).

Leading TS3 involved several challenges related to bridging the boundaries described above. Some challenges related to the synthesis process itself, for example, balancing competing demands of different actor groups (e.g. the steering committee, the advisory board, the management office, and experts from research and practice), as well as structuring, systematizing, prioritizing,

and synthesizing very heterogenous results from different research projects. Some other challenges related to the overall framework conditions of the synthesis process, including, for instance, the availability of research results and expert knowledge or the consolidation of final synthesis results (Hoffmann et al., 2017a). The various challenges triggered individual and collaborative learning processes as described below.

Concept/Collaborative Learning: What activities have fostered collaborative learning and new hybrid expertise among the individuals and the entire team?

Individual and collaborative learning was fostered by the associated research project on transdisciplinary integration. That research investigated transdisciplinary (knowledge) integration in TS 3, and also in three other synthesis projects carried out between 2012 and 2014 (TS 1, TS 2, and TS 4). The overlapping timeframes of the four synthesis projects together with the associated research conducted between 2013 and 2014 enabled a process of learning at different levels (see Hoffmann et al., 2017b):

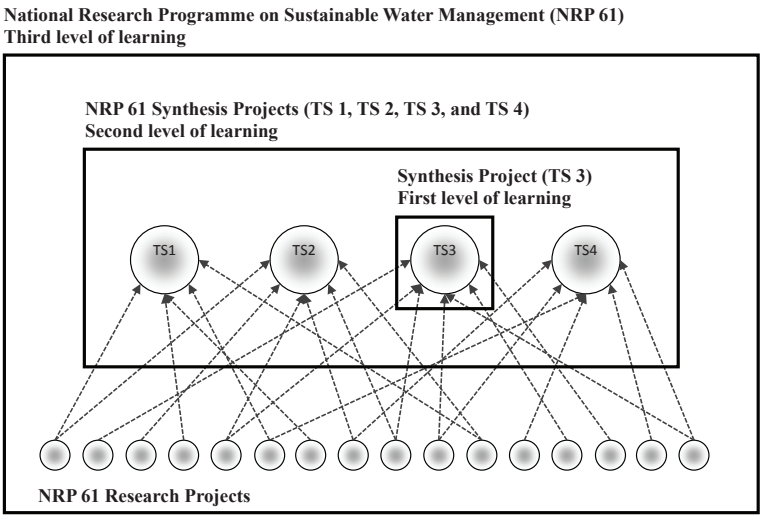


Figure 4 is a schematic illustration of the National Research Programme on Sustainable Water Management (NRP 61) carried out between 2010 and 2014, including 16 individual research projects (2010-2013) and 4 thematic synthesis projects (2012-2014), and the three levels at which learning occurred: at the level of the TS 3 synthesis project, at the level of all four synthesis projects (TS1, TS2, TS3, and TS4), and at the program level.

1. At the level of TS 3, the core team and the group of research experts started reflecting on the appropriate combination of methods and procedures for the integration of results from different disciplines and fields resulting in adaptations of methods and procedures in the course of the TS 3 synthesis process.
2. At the level of all four synthesis projects, a process of mutual learning started among the core teams of all the synthesis projects, (a) reflecting on the advantages and disadvantages of different approaches, (b) discussing challenges of transdisciplinary integration at different stages of the synthesis processes, and (c) formulating recommendations for future synthesis processes.
3. At the program level, the SNSF invited the leader of the TS 3 core team to present and discuss the results of the associated research on transdisciplinary integration at the annual conference of its Programme Division. The discussion led to the incorporation of the recommendations derived from that research into internal SNSF documents and guidelines supporting future synthesis processes in NRPs.

## 4. Discussion

Here we discuss our experiences with Klein's conceptual framework with two ends in mind: a) to explore and assess the heuristic value of the framework, that is, how it has improved our conceptualizations of boundary work in the two projects and b) to evaluate the framework itself, i.e. whether some of the seven concepts suggested in the framework are hard to work with as is and should be further developed.

Within the Australian project, the framework has provided a way to retrospectively reflect on the subcultures involved – which primarily involved industry and academic partners – and the unique expectations of academic involvement in TDR collaborations that needed to be addressed in providing incentives for academic partners. What has come to the fore in analyzing the case study against the framework is that the expertise of the team members significantly influenced the kinds of boundary objects produced. For example, the project manager's background as a visual communicator/designer meant that the technologies and products functioning as boundary objects were visually oriented (see Figures 1, 2, 3). The core project team did not explicitly set out to identify or manage boundaries – rather, our objective was to bring diverse interests together through generating shared visions and

intents, leading to mutually beneficial exchange between strands of research and teaching activities. Had the focus been on boundaries, we wonder what we would have done differently and whether the outcomes might have been richer (because we might have identified obstacles earlier in the project) or poorer (because we might have invested energy in what kept us separate, rather than in how we could better come together).

As regards the Swiss case, the framework allowed for reflecting *ex post* on the various boundaries that had to be worked on within the structure of NRP 61 (including boundaries between those mandating, steering, advising on, and carrying out research and between different research projects) to integrate knowledge and elaborate the final synthesis report. The framework was particularly helpful in analyzing different integration strategies that the TS3 core team employed to enhance communication and collaboration and in reflecting on individual and collaborative learning processes. It is a further merit of this framework that it allows those using it to explicitly address the issues of leadership and learning that are often neglected when analyzing boundary work and boundary crossing in interdisciplinary and transdisciplinary projects.

Looking at the framework in general and reviewing the experiences with both cases, we have concluded that the framework and the seven concepts involved are easy to understand and use. The only concept we did not use in either case analysis was *Interlanguages*. A reason might be that the project collaborations we analyzed were relatively short term, not allowing the time required for those engaged in a project to develop new social and cognitive communities with their own interlanguages. With regard to the other concepts (see Table 1), we gained the following insights:

- *Boundary Work*: For large collaborative projects, like NRP 61, the boundaries and the boundary work within the program structure have to be included in an analysis. These are boundaries between sub-projects as well as boundaries between those who mandate, steer, advise on, and carry out the research.
- *Subcultures*: Tables summarizing the subcultures involved are rather common in recent papers on interdisciplinary or transdisciplinary projects. What is less common is to elaborate their differences and their basis for exchanges, the latter being rather difficult to understand.
- *Expertise*: When Collins and Evans (2002) distinguished contributory from interactional expertise, they were not thinking of an expert facilitating such an exchange or trading of expertise. In our understanding, this role is key in order to further develop collab-

orative projects. In her conceptual framework, Klein mentions the "boundary spanner" under collaborative learning (concept 6). We would like to strengthen this idea by explicitly adding "facilitating expertise" as a further type of necessary expertise to concept 3.

- *Boundary Objects*: In the Australian project we found not one but several boundary objects, each being a useful bridge at a different stage of the project. Also, we found the transdisciplinary research approach itself to be an important boundary object, specifically early in the project. Furthermore, we learned that some of the boundary objects were very flexible and could be adapted, like the research approach (Figures 1 and 2), and others were rather stable, like the system diagram (Figure 3). This observation raises the question under what conditions stable boundary objects can be useful for collaboration, too.
- *Collaborative Learning*: We found three means that enable collaborative learning: a) a flexible methodological framework, b) joint writing, and c) an associated research project feeding back preliminary results.
- *Leadership*: We found that leadership might require that the same persons assume different roles at different moments of collaboration, acting, for example, as the facilitator (with facilitating expertise) as well as the collaborator (with contributory expertise) engaging in bilateral discussions with experts from research and practice. We assume further roles are needed if persons are to successfully lead and manage boundary work. The framework should therefore ask not only for leadership strategies, but also for clarification of roles and responsibilities among the participants.

## 5. Conclusion

What, then, have we learned from using Julie Thompson Klein's conceptual framework to analyze boundary work in two of our projects? First, we have learned how the concepts involved – like glasses – help (or force) the user to see and analyze interdisciplinary and transdisciplinary projects in a specific way. When analyzing projects using the concepts of boundary work and boundary crossing, we first looked for differences between groups, be it researchers from different disciplines or actors from different sectors of society. Only in a second step did we focus on boundary objects and on how

boundaries are crossed. For some of those working in interdisciplinary and transdisciplinary projects, this process might seem counterintuitive, because IDR and TDR are about integration and hence about what the participants share rather than about what makes them different. For others working in the field, looking for differences seems a logical way to begin any interdisciplinary or transdisciplinary project: to acknowledge differences in order to be able to build on them for collaboration. So, the framework sets a clear focus on boundaries, a focus that might not be appreciated by everyone.

Second, we learned that we did not find concepts we consider key in interdisciplinary and transdisciplinary projects mirrored in the concepts of boundary work and boundary spanning as currently expressed. Those key concepts are facilitating expertise and facilitating leadership. Whereas some scholars might look at interdisciplinary and transdisciplinary projects from an observer's position, seeing project participants interacting around a boundary object, we who have been participants in such projects realize we have often had to act to make this interaction happen. We consider that this role of the facilitator or boundary spanner who has relevant expertise is not yet included in the framework sufficiently. Some further conceptual work lies ahead of us.

Finally, we learned once again how fruitful and inspiring it can be to use concepts from other fields – well prepared and ready for use in the form of a conceptual framework – to reflect on interdisciplinary and transdisciplinary collaborations, regardless of whether the reflections evolved in the way originally intended by those who developed the concepts and organized them in a framework.

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**References**:

Altman, D. G. (1995). Sustaining interventions in community systems – on the relationship between researchers and communities. *Health Psychology, 14*(6), 526-536. doi:Doi 10.1037/0278-6133.14.6.526

Argyris, C. (1976). Single-loop and double-loop models in research on decision making. *Administrative Science Quarterly, 21*, 363-375.

Becher, T. (1989). *Academic tribes and territories – intellectual enquiry and the cultures of disciplines*. Stony Stratford/Milton Keynes: The Society for Research into Higher Education and Open University Press.

Bednarek, A. T., Wyborn, C., Cvitanovic, C., Meyer, R., Colvin, R. M., Addison, P. F. E., Close, S. L., Curran, K., Farooque, M., Goldman, E., Hart, D., Mannix, H., McGreavy, B., Parris, A., Posner, S., Robinson, C., Ryan, M., & Leith, P. (2018). Boundary spanning at the science-policy interface: The practitioners' perspectives. *Sustainability Science, 13*(4), 1175-1183. doi:10.1007/s11625-018-0550-9

Bergmann, M., & Jahn, T. (2008). City:Mobil: A model for integration in sustainability research. In G. Hirsch Hadorn, H. Hoffmann-Riem, S. Biber-Klemm, W. Grossenbacher-Mansuy, D. Joye, C. Pohl, U. Wiesmann, & E. Zemp (Eds.), *Handbook of transdisciplinary research* (pp. 89-102). Dordrecht: Springer.

Boyer, E. L. (1997). *Scholarship reconsidered: Priorities of the professoriate*. Princeton, N.J.: Carnegie Foundation for the Advancement of Teaching.

Burtis, J. O., & Turman, P. D. (2006). *Group communication pitfalls: Overcoming barriers to an effective group experience*. Thousand Oaks, Calif.; London: Sage.

Collins, H. M., & Evans, R. (2002). The third wave of science studies: Studies of expertise and experience. *Social Studies of Science, 32*(2), 235-296.

D'Amour, D., & Oandasan, I. (2005). Interprofessionality as the field of interprofessional practice and interprofessional education: An emerging concept. *Journal of interprofessional care, 19 Suppl 1*, 8-20. doi:10.1080/13561820500081604

Dick, B. (2001). *You want to do an action research thesis?: How to conduct and report action research (including a beginner's guide to the literature)*: [Boston Spa: The British Library, 2001].

Dolata, U. (2009). Technological innovations and sectoral change transformative capacity, adaptability, patterns of change: An analytical framework. *Research Policy, 38*(6), 1066-1076. doi:10.1016/j.respol.2009.03.006

Fam, D. (2017). Facilitating communities of practice as social learning systems: A case study of trialling sustainable sanitation at the University of Technology Sydney (UTS). *Knowledge Management Research & Practice, 15*(3), 391-399. doi:10.1057/s41275-017-0062-x

Fam, D., Mitchell, C., Abeysuriya, K., & Meek, T. (2013). Facilitating organisational learning to support decision making and planning for sustainability in the water sector. *Water Policy, 15*(6), 1094-1108. doi:10.2166/wp.2013.178

Fisher, D. (1993). *Fundamental development of the social sciences: Rockefeller philanthropy and the United States social science research council*. Ann Arbor: University of Michigan Press.

Fleck, L. (1986). The problem of epistemology. In R. S. Cohen & T. Schnelle (Eds.), *Cognition and facts: Materials on Ludwik Fleck* (pp. 79-112). Dordrecht/Boston/Lancaster/Tokyo: D. Reidel Publishing Company.

Frey, G. (1973). Methodological problems of interdisciplinary discussions. *RATIO, 15*(2), 161-182.

Galison, P. (1997). *Image and logic – a material culture of microphysics*. Chicago: The University of Chicago Press.

Gieryn, T. (1983). Boundary-work and the demarcation of science from non-science. Strains and interest in professional ideologies of scientists. *American Sociological Review, 48*, 781-795.

Giupponi, C. (2007). Decision support systems for implementing the European water framework directive: The MULINO approach. *Environmental Modelling & Software, 22*(2), 248-258. doi:10.1016/j.envsoft.2005.07.024

Gorman, M. E. (2002). Levels of expertise and trading zones: A framework for multidisciplinary collaboration. *Social Studies of Science, 32*(5-6), 933-938.

Gorman, M. E. (2010). *Trading zones and interactional expertise creating new kinds of collaboration*. Cambridge: The MIT Press.

Hindenlang, K. E., Heeb, J., & Roux, M. (2008). Sustainable coexistence of ungulates and trees: A stakeholder platform for resource use negotiations. In G. Hirsch Hadorn, H. Hoffmann-Riem, S. Biber-Klemm, W. Grossenbacher-Mansuy, D. Joye, C. Pohl, U. Wiesmann, & E. Zemp (Eds.), *Handbook of transdisciplinary research* (pp. 315-326). Dordrecht: Springer.

Hirsch Hadorn, G., Bradley, D., Pohl, C., Rist, S., & Wiesmann, U. (2006). Implications of transdisciplinarity for sustainability research. *Ecological Economics, 60*, 119-128.

Hirsch Hadorn, G., Hoffmann-Riem, H., Biber-Klemm, S., Grossenbacher-Mansuy, W., Joye, D., Pohl, C., Wiesmann, U., & Zemp, E. (Eds.). (2008). *Handbook of transdisciplinary research*. Dordrecht: Springer.

Hoffmann, S. (2016). Transdisciplinary knowledge integration within large research programs. *GAIA - Ecological Perspectives for Science and Society, 25*(3), 201-203. doi:10.14512/gaia.25.3.14

Hoffmann, S., Hunkeler, D., & Maurer, M. (2014). *Nachhaltige Wasserversorgung und Abwasserentsorgung in der Schweiz: Herausforderungen und Handlungsoptionen. Thematische Synthese 3 im Rahmen des Nationalen Forschungsprogramms NFP 61 Nachhaltige Wassernutzung.*Bern.

Hoffmann, S., Pohl, C., & Hering, J. G. (2017a). Exploring transdisciplinary integration within a large research program: Empirical lessons from four thematic synthesis processes. *Research Policy*. doi:http://dx.doi.org/10.1016/j.respol.2017.01.004

Hoffmann, S., Pohl, C., & Hering, J. G. (2017b). Methods and procedures of transdisciplinary knowledge integration: Empirical insights from four thematic synthesis processes. *Ecology and Society, 22*(1). doi:10.5751/ES-08955-220127

Huutoniemi, K., Klein, J. T., Bruun, H., & Hukkinen, J. (2010). Analyzing interdisciplinarity: Typology and indicators. *Research Policy, 39*(1), 79-88. doi:10.1016/j.respol.2009.09.011

Jahn, T., Bergmann, M., & Keil, F. (2012). Transdisciplinarity: Between mainstreaming and marginalization. *Ecological Economics, 79*, 1-10. doi:10.1016/j.ecolecon.2012.04.017

Klein, J. T. (1996). *Crossing boundaries. Knowledge, disciplinarities, and interdisciplinarities*. Charlottesville: University Press of Virginia.

Klein, J. T. (2010). A taxonomy of interdisciplinarity. In R. Frodeman, J. Thompson Klein, & C. Mitcham (Eds.), *The Oxford handbook of interdisciplinarity* (pp. 15-30). Oxford: Oxford University Press.

Lank, E., Randell-Khan, J., Rosenbaum, S., & Tate, O. (2008). Herding cats: Choosing a governance structure for your communities of practice. *Journal of Change Management, 8*(2), 101-109. doi:10.1080/14697010701838771

Mitchell, C., Abeysuriya, K., Willetts, J., & Fam, D. (2010). *Enabling decentralized urban sewage infrastructure by facilitating successful organisations to provide long-term management.* Paper presented at the Cities of the Future 2010 conference jointly hosted by Water Environment Federation and International Water Association, March 7-10, Boston.

Mitchell, C., Fam, D., & Abeysuriya, K. (2013). *Transitioning to sustainable sanitation: A transdisciplinary pilot project of urine diversion*. Institute for Sustainable Futures, UTS, Sydney.

Pohl, C., & Hirsch Hadorn, G. (2007). *Principles for designing transdisciplinary research - proposed by the Swiss academies of arts and sciences* (A. Zimmermann, Trans.). München: oekom Verlag.

Riedy, C., Fam, D., Ross, K., & Mitchell, C. (2018). Transdisciplinarity at the crossroads: Nurturing individual and collective learning. *Technology Innovation Management Review, 8*(8), 41-49. doi:10.22215/timreview/1177

Rosenfield, P. L. (1992). The potential of transdisciplinary research for sustaining and extending linkages between the health and social-sciences. *Social Science & Medicine, 35*(11), 1343-1357.

Rossini, F. A., & Porter, A. L. (1979). Frameworks for integrating disciplinary research. *Research Policy, 8*, 70-79.

Roy, R. (Ed.) (2000). *The interdisciplinary imperative: Interactive research and education, still an elusive goal in academia*. San Jose: Writers Club Press [imprint of iUniverse.com, Inc.].

Schmithals, J., & Berkenhagen, J. (2004). Beziehungen und motivation. In M. Schophaus, S. Schön, & H.-L. Dienel (Eds.), *Transdisziplinäres kooperationsmanagement* (pp. 69-102). München: ökom Verlag.

Star, S. L., & Griesemer, J. R. (1989). Institutional ecology, "translations" and boundary objects: Amateurs and professionals in Berkeley's museum of vertebrate zoology, 1907-39. *Social Studies of Science, 19*, 387-420.

Stokols, D. (2006). Toward a science of transdisciplinary action research. *American Journal of Community Psychology, 38*(1-2), 63-77.

Thiessen, B. L. (1998). Shedding the stagnant slough syndrome: Interdisciplinary integration. *Creativity Research Journal, 11*(1), 47-53. doi:DOI 10.1207/s15326934crj1101_6

Vosskamp, W. (1994). Crossing of boundaries: Interdisciplinarity as an opportunity for universities in the 1990s. *Issues in Integrative Studies, 12*, 43-54.

Wenger, E. (2004). *Communities of practice learning, meaning, and identity* (Repr. ed.). Cambridge: Cambridge University Press.

Wenger, E., McDermott, R., & Snyder, W. M. (2002). *Cultivating communities of practice - a guide to managing knowledge* Boston, MA: Harvard Business School Press.

Wieser, B., Brechelmacher, A., & Schendl, G. (2014). Identitäten und rollen in inter- und transdisziplinärer forschung und lehre finden In G. Dressel, W. Berger, & V. Winiwater (Eds.), *Interdisziplinär und transdisziplinär forschen praktiken und methoden* (pp. 151-166). Bielefeld: transcript.

ISSUES IN INTERDISCIPLINARY STUDIES
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# From Interdisciplinarity to Postdisciplinarity: Extending Klein's Thinking into the Future of the University

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***Abstract:*** Complexity is among the main drivers that justify and guide the genesis and establishment of multi-, inter- and transdisciplinary approaches to the production and application of knowledge. Complexity can be read in the relatively canonical taxonomy of these concepts that structure epistemological reflections on the dynamics of knowledge production lying between and beyond disciplinary boundaries, a taxonomy that Julie Thompson Klein and other leading interdisciplinarians have proposed. The introduction of the concept of postdisciplinarity into this conceptual evolution allows for further reflection on more or less likely scenarios for the development of university institutions, scenarios more or less transgressive of the disciplinary status quo. These possible epistemological and institutional mutations would require actors who are cognitively available and open to change, or even frankly "undisciplined," with the goal of transforming academic institutions into the university of the future by fostering breakthrough innovation.

***Keywords****:* complexity, interdisciplinarity, Julie Thompson Klein, postdisciplinarity, scenarios, transgression

> *We are not students of some subject matter, but students of problems. And problems can be cut right across the borders of any subject or discipline.*
>
> Karl Popper

> *We can't solve problems by using the same kind of thinking we used when we created them.*
>
> Albert Einstein

## 1. Introduction

Interdisciplinarity has become a concept that has the wind in its sails and that seems to promise a bright theoretical and practical future. It innervates institutional discourses that employ it as a slogan and/or more seriously as a strategic vision. The call for interdisciplinarity and/or transdisciplinarity is heard in higher education and research organizations at national, European, and international levels. Numerous academic policy reports in this area, succeeding each other, are relatively similar, offering more or less innovative reflections and recommendations. Research funding agencies also promote interdisciplinarity and/or transdisciplinarity, even making one or both a requirement in the submission of projects aimed not only at advancing basic research, but also at solving complex problems (environmental, social, political, technological, etc.). The implementation of interdisciplinarity has sometimes been crowned with success but not without provoking debates and encountering obstacles, evoking resistance or anxiety among people who have taken the risk of leaving their discipline to do interdisciplinary work. If interdisciplinarity is accepted as important, it should not (or no longer) be taken for granted and considered as a practice that does not require specific study. This would be to ignore the many scholarly works that do study the issues of interdisciplinarity in its institutional, epistemological, theoretical, methodological, and practical dimensions. Within this field of inter- and transdisciplinary studies, the expertise of Julie Thompson Klein is widely recognized by the interdisciplinary academic community. In this article, I will draw upon her expertise, not to reconstruct the origins, content, and trajectory of her pioneering, significant, inspiring, and promising work, nor to offer the long and hagiographic tribute of which she is so highly deserving, but to try to discern some reflections from her work that might help us envision the future of the university – perhaps a postdisciplinarity future.

In what follows, I discuss several lines of thought in a complementary way. Firstly, I return to the motivations and drivers of the genesis and progressive establishment of interdisciplinarity and transdisciplinarity as an apparently pre-eminent perspective in the production of knowledge in a complex and uncertain world. The central and powerful argument that complexity invigorates and justifies the discourse on inter- and transdisciplinarity is specifically highlighted. Secondly, I return to the relatively canonical definitions of the main concepts/approaches of multidisciplinarity, interdisciplinarity, and transdisciplinarity. From there, I attempt to discover whether such a taxonomy is likely to be able to take into account newly emerging trends, such as

postdisciplinary research. Can the concept of postdisciplinarity be simply integrated/assimilated into the existing taxonomy, or does it offer a radically different and unusual perspective, in the sense that it frees itself from any disciplinary reference? From that point, I outline possible development scenarios in universities wishing to promote interdisciplinarity, transdisciplinarity, and even postdisciplinarity, though they may remain epistemologically and institutionally programmed (disciplinarily organized) to resist this change. This discussion of openness to more or less likely academic futures in the short, medium, and long term finally raises the question of the identities and specific capacities of the actors (teachers, researchers, academic leaders, etc.) who wish to be agents of change in favor of inter- and transdisciplinarity, or even more radically, of postdisciplinarity, within a context of development, innovation, and discovery. To explore these lines of thought, I freely build upon Julie Thompson Klein's work in relation to these issues (see in particular Klein, 1983, 1990, 1996, 2004, 2010a, 2014), while linking them with references to other authors, as well.

## 2. Drivers of Interdisciplinarity: Complexity First

### *2.1. Convergent Drivers against Disciplinary Dominance*

The production of knowledge has always oscillated between centripetal cognitive, theoretical, and organizational forces that aim at disciplinarizing the study of restricted subjects and, inversely, centrifugal forces that promote interdisciplinary and transdisciplinary academic decentration. Historically (Klein, 1990), the discourse on interdisciplinarity that has fueled centrifugal forces pushing beyond disciplinary limitations has been characterized by the desire to study complex issues/problems and solve them by employing several disciplinary points of view, while exploring the relationships and convergences among insights derived from different disciplines and professions. Beyond local or national variances, and the many forms that interdisciplinary work can take, the call to interdisciplinarity has energized the fields of natural and life sciences and technologies, as well as the humanities, social sciences, arts, and culture. This call for interdisciplinarity is not just a rhetoric of promotion; it is motivated by some views widely shared across academic communities, professional and political organizations, university administrators, and research funding agencies (König & Gorman, 2017; Klein, 2018).

Among the many possible motivations for embarking on the interdisciplinary path, there is agreement that we should recognize four major driv-

ers for doing so, as formulated in the US-based National Research Council report (National Research Council, 2005). This report, often referenced in interdisciplinary literature, including Julie Thompson Klein's publications, identifies these drivers as follows: 1. The inherent complexity of nature and society; 2. The desire to explore issues not confined to a single discipline; 3. The need to solve societal problems; and 4. The need to produce revolutionary insights and generative technologies. The argumentative force of these four drivers lies in their interdependence and coherence. The endogenous complexity of problems of different types (scientific, environmental, social, political, cultural, etc.) – problems that are necessary or even urgent to solve – makes it impossible to apply a strictly unidisciplinary approach to solving them, and joins the desire to explore beyond arbitrary boundaries between disciplines with the need to do so. By responding to these drivers 1, 2 and 3 and relying on the accelerating and transformative power of new information and communication technologies, researchers are likely to produce revolutionary ideas for problem solving by transgressing existing disciplinary paradigms.

These convergent drivers pose a serious threat to the seemingly well-stabilized disciplinary university structure and challenge disciplinary hegemony (Henry, 2005). In response, the drivers of disciplinarity can be (and have been) inversely formulated as an anti-interdisciplinary force and promoted as the primary means of knowledge production. Proponents of disciplinarity do not consider (or are blind to) complexity, or deal with only one dimension of this complexity. They are driven by a desire to focus on a single issue, a problem or sub-issue clearly defined within a larger set. They also do not try to rethink their disciplinary practice to solve concrete problems outside the academic field. They act primarily to ensure reproduction and durability of their own disciplinary community. And they have been successful. In spite of the argumentative force of drivers in favor of interdisciplinarity and the many advances in this field, it must be acknowledged that the disciplinary model is still dominant, recognized and valued in universities. The obstacles repeatedly encountered in attempts to implement interdisciplinarity are a testament to this persistence of disciplinary hegemony: the prevalence of the disciplinary organization/institutionalization of knowledge, the priority and symbolic power attributed to the disciplinary career, and the disciplinary bias in evaluating interdisciplinary research and publications, etc.

### *2.2. Complexity and Interdisciplinarity*

The notion of complexity as the first driver or trigger of interdisciplinar-

ity is of central importance as a founding prolegomenon of interdisciplinary thought. If complexity is properly regarded as a preliminary concept that motivates and justifies the use of interdisciplinarity, it is then likely to lead to a redefinition of the nature of knowledge as going beyond the partitions between disciplines. To think in a complex way is to change one's way of thinking in terms and disciplines and to realize that complexity is at work in multiple bio-psycho-social systems, crossing the boundaries between disciplines. Although their historical affiliations are relatively different, the concepts of interdisciplinarity and complexity converge at many points (Jantsch 1972; Klein, 1990-91, 1999, 2004; Klein & Newell, 1998; Newell, 2001; Repko, 2008). They come together in their epistemological positioning against the atomization or, conversely, the unification of knowledge; they are on the contrary in favor of the reorganization of the diversity of knowledge in ways that supersede the disciplinary and institutional frameworks that insist on divisions between the natural sciences, social sciences, and humanities. Interdisciplinarity and complexity are powerful antidotes to both reductionism that disjoins interdependent elements and holism that merges them without considering their productive diversity (Le Moigne, 2008). Both promote articulation of what is separate and connection of what is disjointed by means of cognitive and practical integration devices. Faced with the discrepancy among the elements of a complex system, as well as among the disciplines that study it, it is necessary to favor the "reliance" (Morin, 1996, 2005) that, instead of disjoining, reducing, and unidimensionalizing, makes it possible to distinguish without disjoining, to associate without reducing. Any complex system can be conceived as *unitas multiplex* (unity/multiplicity in diversity and diversity in unity/multiplicity); such a system oscillates between a homogeneous tendency to organize its elements into a coherent whole and a heterogeneous tendency to highlight the specificity of each constituent element (Klein, 2001).

A system is a whole unit that emerges from the constant interaction among its constituent elements (Morin, 2005). This vision of complexity or systemic thought is inter- or transdisciplinary in the sense that it applies in many disciplines: From philosophy to physics, sociology, psychology, biology, environmental studies, etc., each system (cognitive, natural, social, biological, etc.) is defined as an assembly of heterogeneous elements irreducible to only one of them. To take note of this inherent complexity of any subject, object, or problem, and to make it a principle of epistemological vigilance, is to guard against any anti-interdisciplinary attempt to ignore the elephant in the room. The strictly disciplinary (and seriously limited) vision considers more or less consciously only a sub-part of a complex thing by artificially

isolating it from everything to which it is nevertheless directly related. This epistemological stance, often propounded as academically correct, amounts to refusing to admit the obviousness of complexity; to move from the pachydermic metaphor to another, it makes complexity a taboo subject by urging one to bury one's head in the sand and ignoring the need for more systemic and interdisciplinary thinking.

Interdisciplinarity and complexity are, then, two intertwined notions: Taking into account the complexity of an object of study requires an interdisciplinary approach and, inversely and in a complementary way, any interdisciplinary approach conceives its object of study as complex. This fundamental epistemological lesson in the relationship between a multidimensional observant subject and a multidimensional observed object involves rethinking a series of tenacious dualisms: between unity and diversity, homogeneity and heterogeneity, whole and parts, order and disorder, etc. This dialectical tension between seemingly opposing terms (and referents) crosses rhetorical discourses on the complexity of knowledge (Klein, 2004). By going beyond this contradiction/tension between opposing and yet inseparable notions, the *dialogical principle* (Morin & Le Moigne, 1999) makes it possible to join these antagonistic notions and use them to think about the complex process of knowledge production. It is a question of discarding the strictly monological, analytical, and Cartesian perspective that tends to mutilate the inherent complexity of scientific, social, environmental, political, and cultural issues. In the same dynamic, the *principle of recursion*, according to which the object of knowledge produces the subject who produces it through a series of positive feedback loops, reinforces the idea of an epistemological coherence between the posture of the observant subject and the complex nature of the observed object. Finally, a *hologrammatic principle* posits that the part is in the whole and the whole is in the part (for example, the individual is in the society and the society is in the individual): The whole and the parts of a complex system are not opposed; they are interdependent and co-produce each other. The full awareness of these three convergent principles makes it possible to resituate the idea of disciplinarization, which often – under the pretext of scientificity and objectivity – omits complexity. However, it is by understanding and accepting the principles of complex thinking that disciplinarity can be located and rethought in its relationship to interdisciplinarity (and transdisciplinarity), and even more so in relation to the newer concept of postdisciplinarity.

## 3. What Place for Postdisciplinarity?

### *3.1. Disciplines et cetera*

Interdisciplinarity does not seem to be defined or definable outside the basic idea of disciplinarity, the historical and semantic foundation from which it takes meaning through continuity and differentiation. The fundamental link between disciplinarity and interdisciplinarity lies at the heart of the definitions of these concepts, definitions that reflect the range of their complementary and antagonistic relationships, a range encompassing inclusion, attraction, repulsion, association, dissociation, integration, and disintegration. The dense semantic network of concepts that reflect disciplinary decompartmentalization includes: monodisciplinarity, multidisciplinarity, alterdisciplinarity, intradisciplinarity, paradisciplinarity, supradisciplinarity, metadisciplinarity, transdisciplinarity, etc. Scholarly literature on interdisciplinarity is full of concepts with more or less attractive sounding names, and lexical creativity in this area is not lacking, although these terms do share the central notion of a disciplinarity that an open series of prefixes modulates/transforms on a case-by-case basis. In spite of debates that have engaged a whole community of researchers, a few of these concepts have come to be broadly accepted in synthesis work on interdisciplinarity: multidisciplinarity, interdisciplinarity and transdisciplinarity.

This terminological triad represents the main taxonomy for thinking about the degree of interaction and integration among disciplines in a collaborative dynamic (Klein, 2010a). Although it is now commonplace, a topos widely disseminated in interdisciplinary studies, it is also important not to stop there but to consider this taxonomy from an evolutionary perspective. Like any taxonomic approach (Klein, 2010a), its purpose is to identify and describe the organization of knowledge at a given moment, to name and group its constituents under a set of provisional definitions. The emergence of new knowledge production practices, methods, theories, or academic fields is likely to raise questions about the accepted terminological classification, and extend or even transform it. We shall see below how considering the concept of postdisciplinarity is likely to bring about a change in the taxonomy most interdisciplinarians have been using for many years now.

It should be noted at this stage of the reflection that the concept of disciplinarity itself is surprisingly often ignored, as if its definition is self-evident as the obvious (and unquestioned?) foundation of university organization and of knowledge itself. However, I think it appropriate to define it initially and then to fix, through successive differentiations, the triad of related concepts involving versions of interdisciplinarity identified above, in preparation for

final consideration of the concept of postdisciplinarity, gateway to a possible future of transformation in the academy and the wider world, as well. This definitional section of the article, essential to properly situating the concept of postdisciplinarity, is obviously inspired by the typological work of Julie Klein (2010a) and directly echoes my own work, too (see in particular Darbellay, 2005, 2015, 2016) and that of many others (see Jantsch, 1972; Piaget, 1972; Huutoniemi, Thompson Klein, Bruunc & Hukkinena, 2010; Rosenfield, 1992; Stokols, Hall, Taylor & Moser, 2008). It is not a question here of formulating a new typology, but simply of proposing a clear and articulated definition of the key concepts.

The terms of disciplinarity, multidisciplinarity, interdisciplinarity and transdisciplinarity can be defined as follows:

- *Disciplinarity*: In a classical perspective, any discipline is the result of a process of institutionalization/standardization of research and teaching practices specific to an academic community, socially and historically situated and governed by a paradigm that defines the hypotheses, objectives, theories, and methods from which scholars build knowledge. Disciplinarizing therefore involves the institutional juxtaposition of several communities of specialists, divided into faculties, departments, and autonomous laboratories. The specialization of knowledge, through the many attendant approaches, epistemological postures, languages, and disciplinary methods, fragments the objects of study into disjoint parts. These communities of specialists are plunged into academic isolation, blocking any possibility of interdisciplinary dialogue.
- *Multidisciplinarity*: In multidisciplinary work, an object of study, a theoretical subject or a practical problem to be solved, is approached from the perspective of at least two disciplines. This practice has the advantage of plurality, but nevertheless organizes the different disciplinary approaches in an additive logic of succession that generates a juxtaposition of disconnected points of view without integration among them. There is an openness to epistemological pluralism, but nevertheless the practice fits into the continuum being discussed close to disciplinarity insofar as it confirms institutional compartmentalization in disciplinary communities that remain governed by their own academic paradigms, theories, and internal methods.
- *Interdisciplinarity*: This approach mobilizes at least two disciplines by articulating them dynamically; it entails describing, analyzing, and understanding the complexity of an object of theoretical or practical study irreducible to a monodisciplinary approach. Inter-

disciplinarity, which goes beyond the multidisciplinary juxtaposition of different disciplinary points of view, involves a collaborative and integrative endeavor associating insights from two or more disciplines around a jointly defined object. Collaborative interaction and integration among disciplines can occur in different ways, for example, through transfer or borrowing of concepts or methods, through crossing or hybridization mechanisms, or even through creating new areas of research by combining two or more disciplines. As indicated by the prefix *inter-*, the production of knowledge is played out among the disciplines, in what circulates among them, at the interface, in their interstices. The result is not the mere juxtaposition of disciplinary insights that multidisciplinarity provides, fragmenting complexity by disjunction, but instead a new conjunction of cognitive, conceptual, theoretical, and methodological fragments in a coherent and intelligible whole. Collaborative and integrative endeavor are most often institutionalized through the establishment of interdisciplinary structures at the interface of several faculties in the university system. These structures (interdisciplinary centers, platforms, etc.) offer space-time dedicated to interdisciplinary work.

- *Transdisciplinarity*: The concept of transdisciplinarity covers different and complementary orientations. In a first orientation, transdisciplinarity refers to a process of knowledge production that goes beyond disciplines, or transcends disciplinary boundaries, involving a reconfiguration of those boundaries in a systemic, global, and integrated perspective (transdisciplinarity as "discourse of transcendence," as described by Klein, 2014). In a second orientation, a more pragmatic, participatory, and applied approach, transdisciplinarity can be considered as a research method bringing together political, social, and economic actors as well as ordinary citizens in the research process itself, in a dynamic of problem solving (transdisciplinarity as "discourse of problem-solving," cf. Klein, 2014; Klein et al., 2001). Platforms for exchange and dialogue between academia and society make it possible to establish this bridge between researchers and citizens, using transdisciplinary methods. In a third orientation, transdisciplinarity also applies to the exploration of complex relationships woven into the transcultural dialogue between academic cultures from the technical, life and natural sciences, social sciences, and humanities. Projects, structures, and devices at the interface of these cultures allow mutual learning be-

tween researchers with different epistemological horizons. Klein (2014) also considers a fourth trend of transdisciplinarity (the "discourse of transgression") that is more critical of the existing system of knowledge organization and educational stakes that underlie it. I return below to this idea of transgression in that, beyond the fact that it can characterize one of the orientations of transdisciplinarity, it carries with it a transformative potential relevant to a possible postdisciplinary path.

The clarification of these four concepts inherent to the discourse on interdisciplinarity shows the progression of and interconnections between the complexity levels of the links between the academic disciplines involved in an interdisciplinary endeavor. From multidisciplinarity to interdisciplinarity and transdisciplinarity, there is an epistemological dynamic that roots these different but complementary approaches in a disciplinary base from which a network of relations grows that is increasingly dense, interactive, and integrative. Disciplinarity remains the epistemic foundation on and from which multi-, inter- and transdisciplinary approaches to problem solving are built to stand at varying distances from the idea of disciplinary dominance.

### *3.2. Postdisciplinarity: Future Scenarios*

The term "postdisciplinarity" is less common in the field of interdisciplinary studies than the terms defined above, and is perhaps less widely accepted and disseminated because it carries a transformative claim on the organization of disciplinary knowledge, its institutionalization, and the concomitant hierarchical relationships that structure academic institutions. This much less accepted stance towards the disciplinary status quo – unlike the multi-inter-transdisciplinarity that is based on the idea of disciplinarity – gives rise to some fear, or at least caution, on the part of interdisciplinary actors who do not wish to confront the dominant disciplinary scenario. Postdisciplinarity opts for a more militant critical discourse against disciplinary rigidities, and calls for a redefinition of the partitions between the disciplines, and even the very notion of disciplines (Klein, 2005, pp. 60-62). As noted earlier, in the terms "multi-," "inter-," and "transdisciplinarity," the prefixes all designate a relationship with the disciplinarity foundational to them. In a more provocative way, the prefix "post-*"* in "postdisciplinarity" opens a horizon of knowledge that comes after the disciplines. The prefix "post-" expresses a state of posterity whose interest lies precisely in how it has shaken definitional taxonomy with regard to the relationship between disciplinarity and non-disciplinarity or even anti-disciplinarity (Darbellay, 2015, 2016), calling for epistemic disobedience versus acceptance of established knowledge (Ings, 2016).

Of course, the discourse of transgression, as identified by Klein (2014) in discussing transdisciplinarity, is also characterized by the desire to question the simple reproduction of dominant practices and to reinvent the ways of thinking and doing research. And, in this case, the prefix "trans-," like the prefix "post-," is also used to designate so-called "post-normal science" (Funtowicz & Ravetz, 1993). The arguments underlying this kind of transdisciplinarity (involving interdependence and intersectoriality of social problems, complex relations, non-reductionism, irreducibility to a single discipline, etc.) are very close to those guiding the discourse of problem solving, and they similarly question the limits of disciplinary approaches. But they don't make people as nervous, perhaps because they don't seem sufficient to radically challenge the disciplinary foundations of knowledge production processes. In the same vein, the useful and beneficial distinction that can be made between two kinds of knowledge, mode 1 (hierarchical, homogeneous, disciplinary, "reliable scientific knowledge") and mode 2 (contextualized, complex, non-linear, heterogeneous, transdisciplinary, "socially robust knowledge") (Gibbons et al., 1994; Nowotny, Scott, & Gibbons, 2001), invokes dichotomies to transgress boundaries and foster new partnerships between academia and society. But does it go further and transform thinking on the dichotomy between disciplinarity and inter- and transdisciplinarity in ways that can be seen as transgressive?

Granted, the idea of transdisciplinarity has been seen as transgressive insofar as it promotes critical approaches to knowledge production and problem solving that question the limits of a one-dimensional vision (Klein, 2014). Cultural, postcolonial, and gender studies have challenged notions of class, gender, race, ethnicity, and identity, highlighting the complexity of these issues and arguing for transcendence of disciplinary boundaries in dealing with them. This questioning of disciplinary conventions and the institutional straitjacket they entail has been accompanied by strong insistence on the principle of responsibility from a human rights perspective, recognition of the value of secular and not just academic knowledge, and increased democratic participation in solving social, political, and environmental problems (Klein, 2014). The discourse of transgression clearly highlights the inability of an imperialist monodisciplinary vision to address such concerns and rightly criticizes the institutionalization of disciplinarity and hierarchies among disciplines, involving relations of power or prestige among them. But is this critical form of interdisciplinarity capable of radically altering the persistent tension between disciplinary restraints and inter- and transdisciplinary openness?

The notion of postdisciplinarity offers some usefulness in this discussion, if it is not thought of as merely (or nearly) synonymous with inter- or transdisciplinarity. We would argue that "postdisciplinarity" is not simply another term to be added to the conceptual taxonomy discussed above in a logic of progressive de-and-re-construction of the disciplinary conventions, but is, on the contrary, a term that reverses perspective by radically challenging the need for a disciplinary foundation in the process of producing knowledge. This vision of a strong postdisciplinarity would not preserve the identity of the disciplines and the disciplinary organization of knowledge. In this respect, it would distinguish itself from the milder and more moderate accepted forms of multi-, inter- and transdisciplinary practices. Transgression is understood here to involve a truly transgressive lack of respect for the disciplines and the institutional logics that legitimize and protect them, as well as the obligation to assign to others or to oneself a fixed disciplinary identity.

In a forward-looking and intuitive approach, we can attempt here to open a field of reflection on the current reality and possible future of a more or less truly transgressive postdisciplinary approach, given the disciplinary organization of academic institutions that for now retains its dominance and its prevalence. By considering postdisciplinarity as a form of knowledge production that potentially differs the most from those based within and on disciplines, one can dialectically relate postdisciplinarity to disciplinarity. Figure 1 below describes a variably strong postdisciplinarity (i.e. a variably marked degree of rupture with respect to disciplinarity) and, conversely, a variably strong disciplinarity, ranging from one firmly maintaining disciplines to one allowing their progressive decompartmentalization or even their disappearance. To each level of disciplinary organization corresponds a postdisciplinarity that is more or less capable of subverting or even transforming the disciplinary principle. Deriving from this differential coupling between seemingly antagonistic perspectives, four heuristic scenarios can be briefly identified. For a more detailed presentation and discussion of these scenarios, I refer readers to my contribution (Darbellay, 2019) to the collaborative work *Postdisciplinary Knowledge* (Pernecky, 2019) that presents philosophical, theoretical, and methodological perspectives on postdisciplinarity in research.

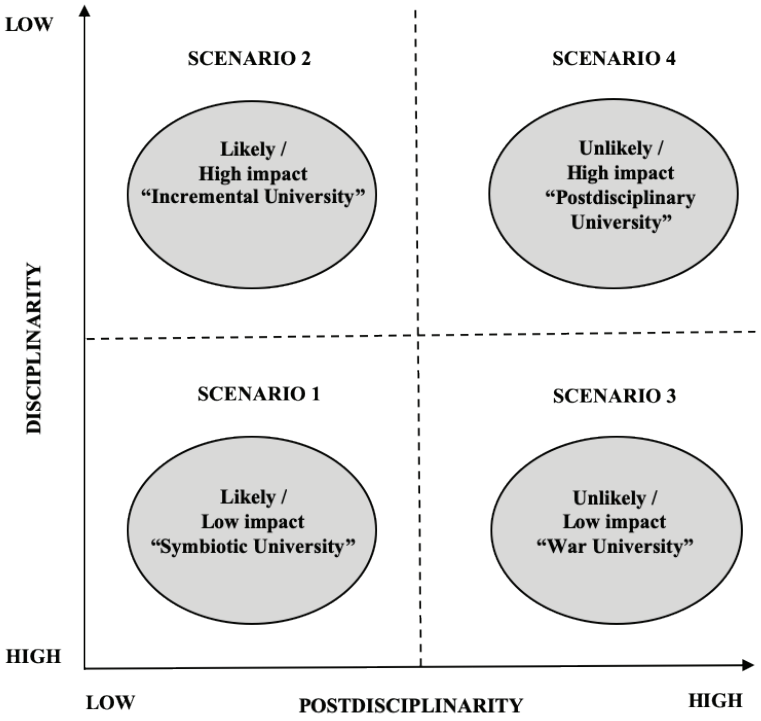


Figure 1. Scenarios

Scenario 1 (very likely, even current, and with very low transformational impact on the disciplinary system) involves a high level of the disciplinarization of knowledge characterizing academic institutions, with a weak form of postdisciplinarity. The disciplines represent the basic building blocks from which new approaches are built: Postdisciplinarity here corresponds to the multi-, inter- and transdisciplinary approaches that yield academic advances, but do not imperil the disciplinary model on which they rely. There is coexistence – without mutual exclusion – between disciplinary approaches and multi-, inter- and transdisciplinary approaches, resulting in a "symbiotic" relationship (Walklate & Richards, 2012; Repko, Szostak & Buchberger, 2017) that is neither transformational nor critical.

Scenario 2 (likely and ongoing with a possible gradual impact on discipli-

narization) continues the logic of scenario 1: The decompartmentalization of disciplinary boundaries, characteristic of a gradual weakening of the level of disciplinarity, triggers a process of incremental change that progressively transforms disciplinary configurations, without disrupting the disciplinary model. The disciplines' progressive transformation improves the system of knowledge production but without carrying out a radical questioning of its foundations. Disciplinary conservatism remains, but innovations within and among disciplines are possible, allowing evolution through contact and circulation of ideas, theories, and methods. In such a scenario, any discipline is likely to change through inter- and transdisciplinary dialogue; it is itself a heterogeneous construct subject to a greater or lesser variation under the impulsion of exogenous forces or forces of internal diffraction due to the diversity of schools of thought that constitute it. This dynamic tension involving disciplinary openness and possible change due to diversity of subdisciplines and contact with other disciplines is reflected in particular in hybridization processes that create new approaches to knowledge production – and even new disciplines, as well (Klein, 1983).

Scenario 3 opens up a different path and a much less peaceable one insofar as its postdisciplinarity is displayed in a demand for an in-depth redefinition of the disciplinary system or even its substitution by an alternative system yet to be defined, a demand that risks open conflict with the persistence/resilience of a high level of disciplinarization. In response, disciplinary conservatism is then expressed in the corporatism of "academic tribes" (Becher & Trowler, 1989) who withdraw themselves, refuse any constructive dialogue, and "declare war" on any initiative that might call into question the primacy of the disciplinary principle and the authority of the bodies that institutionalize it. Planned incommunicability, deaf dialogue, and epistemological and institutional blockages outweigh the dynamics of change. Discourses against inter- and transdisciplinary initiatives are customary, reflecting these anxiogenic and warlike attitudes. Although this warrior scenario is persistent, it is probably not sustainable, as it presents in the medium and long term little of value for those in the opposing camps.

In a spirit of openness, cooperation, and co-production, based on a low level of disciplinarity, scenario 4 represents an alternative marked by a strong postdisciplinary vision in a context that favors change that might be of value to all. This "anti-" or "adisciplinary" epistemological stance calls for radical innovation strategies, disrupting disciplinary logic by transgression and, indeed, revolution. This pathway, promising a strong transformative impact on the disciplinary system, may not take us far in the medium term, given the slow rate at which academic institutions evolve, but it lets us

contemplate a possible epistemic horizon, helping us to imagine the future and push towards it. In this scenario, the notions of disciplines, boundaries, etc. would no longer make sense, and we would have to invent new ways of thinking both individually and collectively. While pursuing the development and deepening of interdisciplinary and transdisciplinary approaches, we would also be acting to eventually enable the more disruptive models of an utterly altered academic system that the DNA of the current system seems to forbid.

As you will have understood, this brief outline of scenarios proposes more or less compatible visions of a redefinition of the disciplinary model with which most can align themselves, envisioning what is current and likely or possible in the short, medium, and long term. It allows us to consider past and present situations in which interdisciplinary studies have developed along with successes, limits, and resistances, but also to imagine possible alternatives to the persistent status quo, or even to think the unthinkable. Although scenario 1 now seems to dominate in the university context, the sequence of different scenarios can certainly be thought of as linear in progressing from scenario 1 to 2, then 4, avoiding scenario 3 if possible. But we can also imagine, for example, a switch from scenario 1 to 3 or even a revolutionary transition from 1 to 4 in a short time. In a context of uncertainty, we cannot predetermine the evolutions and possible transformations by continuity, rupture, or reversibility.

Of course, behind what is thought or imagined, there are the thinking subjects: the actors in research and teaching who are more or less in phase with the scenarios mentioned, as they would be with others as yet unformulated. The views of these actors in regard to the disciplinary status quo, and to more or less disruptive change, are as numerous and diverse as the disciplines that constitute academic structures and cultures. One could say that the realization of scenario 1 would involve actors (teachers, researchers, academic leaders, etc.) who are conservators who favor maintaining the predominance of disciplinary organization. They might tolerate inter- and transdisciplinary approaches, as long as they do not affect the disciplinary organization. The implementation of scenario 2 would require reformers or transformative critics who are willing to engage in the gradual modification/adaptation of the disciplinary organization through the integration of new approaches found among and beyond disciplinary boundaries. In the case of incommunicability between disciplinarians and reformers, the characteristic negotiated approach of scenario 2 can potentially slip into scenario 3, a tribal academic war situation that is uncomfortable and uncertain in its outcome. It is here that the figure of the warrior (whether disciplinary or

postdisciplinary) would be activated, preferring paralyzing disagreement to constructive dialogue. By trying to avoid the status quo of scenario 1 and the unproductivity of scenario 3 while going further and accomplishing more than is possible in scenario 2, scenario 4 is based on the figure of the revolutionary who aims for radical change, namely, re-founding the disciplinary organization of knowledge and, in the process, imagining and creating a postdisciplinary university operating under a new epistemological and institutional regime of knowledge production. As suggested in Klein's reflections on the conditions conducive to interdisciplinarity (Klein, 2010b), it would be a question of creating a postdisciplinary campus culture that modulates or removes the barriers and disincentives to interdisciplinary work at many different levels and in many different forms: the organizational structure in disciplinary silos and rigid university policies regarding procedures and resources and infrastructures and regarding recognition, reward, and incentives. The challenge is very ambitious – perhaps utopian – insofar as new strategic visions and facilitating mechanisms for the development of a very different campus culture would be necessary for actors to carve a postdisciplinary path through unknown territory.

It goes without saying that any imagining of actors with these different profiles into reality should be done with nuance and flexibility. Any actor, any researcher, teacher, etc., may embody one or other of these profiles more or less sustainably, being a conservator, a reformer, a warrior, or a revolutionary at intervals or all throughout his academic career, or may evolve and transform himself by passing from one profile to another. A conservator might evolve towards a more reforming logic through his openness to inter- and transdisciplinary dialogue, or on the contrary become radicalized in his fierce opposition to this kind of destabilizing approach; an academic warrior might return to a more moderate position, or become open to transformative practices; a reformer might push the logic of rupture further and become revolutionary, etc. In short, many (poly-)identitary configurations are possible, given academic trajectories that may involve evolutions, transfers, or reversals. The reformer profile (scenario 2), even that of the revolutionary (scenario 4), presents characteristics in phase with those identified as typical for interdisciplinarians. Both echo the main features and skills of inter- and transdisciplinary individuals (Klein, 1990; Augsburg, 2005, 2014; Repko, 2008): reliability, flexibility, patience, resilience, risk-taking, altruism, preference for diversity, tolerance of ambiguity, openness to complexity, ability to think dialectically, etc. People with profiles reflecting such features and skills may well struggle to express themselves in universities still dominated by those with disciplinary profiles pursuing academic careers that glorify

the sacrosanct disciplinary principle. However, those with these inter- and transdisciplinary profiles are perhaps the seeds of the postdisciplinarity of tomorrow, willing to challenge those whose belief in disciplinarity hinders the full expression of their transgressive impulses. Such seeds may grow.

## 4. Conclusion

Among the various drivers that might steer commitment towards the path of inter- and transdisciplinarity, and even more postdisciplinarity, the reasoned consideration of the complexity of research objects and real-world situations justifies dialogical thought that exposes the limits of disciplinary insights, even radically questioning their value, so as to advance more innovative approaches to problem solving. The concept of postdisciplinarity can be located in relation to the canonical taxonomy of interdisciplinary studies that defines the concepts of multi-, inter - and transdisciplinarity. This article has done that. And the attendant conceptual and epistemological exploration has made it possible to sketch out current, probable, and possible scenarios in the medium or long-term future of the academy by putting into dialectical tension the tendency towards disciplinarization and that which turns towards postdisciplinarity. Thus envisioning possible futures is not a matter of acting as an academic Nostradamus, soothsayer, or utopian. It is more about recognizing the distance that separates interdisciplinarity and transdisciplinarity, and even more postdisciplinarity, from disciplinarity – and then recognizing how one might move along that path.

To do so, though, would-be agents of change must achieve legitimization of their transgressive, non-conformist, and ultimately "undisciplined" attitudes. On this point, universities and, more broadly, all the actors in the education system, still have a ways to go: to become fully aware of the changes under way, and of the expectations and aspirations of interdisciplinarians who would be change agents, making them a place inside or outside the dominant system, as self-critique might prompt them to do, and accepting (and even promoting) the cognitive and institutional mutations of the disciplinary status quo that are likely to come.

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**References:**


Augsburg, T. (2005). *Becoming interdisciplinary: An introduction to interdisciplinary studies*. New York: Kendall/Hunt.

Augsburg, T. (2014). Becoming transdisciplinary: The emergence of the transdisciplinary individual. *World Futures*, *70*, 233-247.

Becher, T., & Trowler, P. (1989). *Academic tribes and territories: Intellectual enquiry and the cultures of disciplines*. Philadelphia, PA: Open University Press.

Darbellay, F. (2005). *Interdisciplinarité et transdisciplinarité en analyse des discours. Complexité des textes, intertextualité et transtextualité*. Genève: Éditions Slatkine.

Darbellay, F. (2015). Rethinking inter- and transdisciplinarity: Undisciplined knowledge and the emergence of a new thought style. *Advances in transdisciplinarity* 2004-2014, *Futures*, *65*, 163-174.

Darbellay, F. (2016). From disciplinarity to postdisciplinarity: Tourism studies dedisciplined. *Tourism Analysis*, *21*(4), 363-372.

Darbellay, F. (2019). Postdisciplinarity: Imagine the future, think the unthinkable. In T. Pernecky (Ed.), *Postdisciplinary knowledge*. Routledge.

Funtowicz, S., & Ravetz, J. (1993). Science for the post-normal age. *Futures*, *25*(7), 739-755.

Gibbons, M., Limoges, C., Nowothy, H., Schwartzman, S., Scott, P., & Trow, M. (Eds.) (1994). *The new production of knowledge: The dynamics of science and research in contemporary societies*. London: Sage.

Henry, S. (2005). Disciplinary hegemony meets interdisciplinary ascendancy: Can interdisciplinary/integrative studies survive, and if so, how? *Issues in Integrative Studies*, *23*, 1-37.

Huutoniemi, K., Thompson Klein, J., Bruunc, H. & Hukkinena, J. (2010). Analyzing interdisciplinarity: Typology and indicators. *Research Policy*, *39*(1), 79-88.

Ings, W. (2017*). Disobedient teaching: Surviving and creating change in education.* New Zealand: Otago University Press.

Jantsch, E. (1972). Towards interdisciplinarity and transdisciplinarity in education and innovation. In *Interdisciplinarity: Problems of teaching and research in universities* (pp. 97-121). Paris: Organization for Economic Cooperation and Development.

Klein, J. T. (1983). The dialectic and rhetoric of disciplinarity and interdisciplinarity. *Issues in Integrative Studies*, *2*, 35-74.

Klein, J. T. (1990). *Interdisciplinarity: History, theory, and practice*. Detroit: Wayne State University.

Klein, J. T. (1990-91). Applying interdisciplinary models to design, planning, and policy making. *Knowledge and Policy*, *3*(4), 29-55.

Klein, J. T. (1996). *Crossing boundaries: Knowledge, disciplinarities, and interdisciplinarities*. Charlottesville: University Press of Virginia.

Klein, J. T. (1999). *Mapping interdisciplinary studies*. Washington, D.C.: Association of American Colleges and Universities.

Klein, J. T. (2001). Interdisciplinarity and the prospect of complexity: The tests of theory. *Issues in Integrative Studies*, *19*, 43-57.

Klein, J. T. (2004). Interdisciplinarity and complexity: An evolving relationship. *Emergence: Complexity and* Organization, *6*(1-2), 2-10.
Klein, J. T. (2005). *Humanities, culture, and interdisciplinarity: The changing American academy*. Albany: State University of New York Press.
Klein, J. T. (2010a). A taxonomy of interdisciplinarity. In R. Frodeman, J.T. Klein & C. Mitcham, *The Oxford handbook of interdisciplinarity* (pp. 15-30). Oxford: Oxford University Press.
Klein, J. T. (2010b). *Creating interdisciplinary campus cultures: A model for strength and sustainability*. San Francisco: John Wiley & Sons.
Klein, J. T. (2014). Discourses of transdisciplinarity: Looking back to the future. *Futures*, *63*, 68-74.
Klein, J. T. (2018). Current drivers of interdisciplinarity: The what and the why. In M. Nasser Al-Suqri, A. Khamis Al-Kindi, S. Said AlKindi, & N. Eid Saleem (Eds.), *Promoting interdisciplinarity in knowledge generation and problem solving* (pp. 14-28). Hershey PA, USA: IGI Global.
Klein, J. T., & Newell, W. H. (1998). Advancing interdisciplinary studies. In W. Newell (Ed.), *Interdisciplinarity: Essays from the literature* (pp. 3-22). New York: College Board.
Klein, J. T., Grossenbacher-Mansuy, W., Haberli, R., Bill, A., Scholz, R.W., & Welti, M. (Eds.) (2001). *Transdisciplinarity: Joint problem solving among science, technology, and society: An effective way for managing complexity*. Basel: Birkhäuser Verlag.
König, T., & Gorman, M. T. (2017). The challenge of funding interdisciplinary research: A look inside public research funding agencies. In R. Frodeman, J.T. Klein, & R. Pacheco (Eds.), *The Oxford handbook of interdisciplinarity* (pp. 513–524). Oxford: Oxford University Press.
Le Moigne, J.-L. (2008). Edgar Morin, le génie de la reliance. *Synergies Monde*, *4*, 177-184.
Morin, E. (1996). Vers une théorie de la reliance généralisée. In M. Bolle De Bal, *Voyage au cœur des sciences humaines, De la reliance*, Tome 1 (pp. 315-326). Paris: L'Harmattan.
Morin, E. (2005). *Introduction à la pensée complexe*. Paris: Éditions du Seuil, 2005.
Morin, E., & Le Moigne, J.-L. (1999). *L'intelligence de la complexité*. Paris: L'Harmattan.
National Research Council, Committee on Facilitating Interdisciplinary Research (2005). *Facilitating interdisciplinary research*. Washington, DC: National Academies Press.
Newell, W. H. (2001). A theory of interdisciplinary studies. *Issues in Integrative Studies*, *19*, 1-25.
Nowotny, H., Scott, P., & Gibbons, M. (2001). *Re-thinking science: Knowledge and the public in an age of uncertainty*. Cambridge, UK: Polity Press.
Pernecky, T. (Ed.) (2019). *Postdisciplinary knowledge*. Routledge.
Piaget, J. (1972). Épistémologie des relations interdisciplinaires. In L. Apostel, G. Berger, Briggs, & G. Michaud (Eds.), *L'interdisciplinarité: Problèmes d'enseignement et de recherche dans les universités* (pp. 131-144). Paris, France: OCDE.

Popper, K.R. (1963). *Conjectures and refutations: The growth of scientific knowledge*. New York: Routledge and Kegan Paul.

Repko, A. F. (2008). *Interdisciplinary research.* Thousand Oaks, CA: Sage.

Repko, A., Szostak, R., & Buchberger, M. (2017). *Introduction to interdisciplinary studies*. Thousand Oaks, CA: Sage.

Rosenfield, P.L. (1992). The potential of transdisciplinary research for sustaining and extending linkages between the health and social sciences. *Social Science & Medicine*, *35*(11), 1343-1357.

Stokols, D., Hall, K. L., Taylor, B. K., & Moser, R. P. (2008). The science of team science: Overview of the field and introduction to the supplement. *American Journal of Preventive Medicine, 35*(2), 77-89.

Walklate, J. & Richards, A. (2012). The symbiotic academy: On specialisation and interdisciplinarity. *Science Progress, 95*(4), 447-465.

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# Imagination and Actionability: Reflections on the Future of Interdisciplinarity, Inspired by Julie Thompson Klein

by

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***Abstract:*** When introduced around 1925, interdisciplinarity, grounded in the notion of the unity of knowledge, was meant to reconnect the fragmented and specialized disciplines of academia. However, interdisciplinary research became more and more challenging as the plurality and heterogeneity of disciplinary perspectives and insights increased. Insisting on this divergence and diversity, Julie Thompson Klein has nevertheless contributed in important ways to convergence in interdisciplinarity with her work on the process of integration as interdisciplinarity's defining feature. Of course Klein is aware that the increasing inclusion of extra-academic stakeholders in *trans*disciplinary research constitutes a fundamental challenge to integrative interdisciplinarity. Along with academic contributions, experiential knowledge, interests, and norms must be recognized as valuable to the process, and stakeholder expectations of applicable results must be met. Exploring the future by extending this crucial development further, this article focuses on the actionability of knowledge as an additional criterion for effective interdisciplinarity and transdisciplinarity, as it is in Action Research. With action options for stakeholders being an important goal for such research, it is argued that joint deliberation about these options must be part of the process, aiming for reflective equilibrium. At the same time, an important role for imagination is defended, enabling adequate consideration of action options with their ramifications and implications. The future of interdisciplinarity, it is concluded, will entail an important role for the actionability criterion and for the related role of imagination of potential outcomes, much greater roles than these now have.

***Keywords:*** action research, actionability, imagination, interdisciplinarity, Julie Thompson Klein, reflective equilibrium, transdisciplinarity

## Introduction: Interdisciplinarity's Convergence and Divergence as It Approaches Its Centennial

Almost a century ago, around 1925, the concept of "the interdisciplinary" was introduced in connection with a new funding scheme by the Social Science Research Council aimed at fostering collaborations between researchers from its constituent societies. Specialization and fragmentation among academic disciplines had affected the practice of modern social scientists in such a way that it was no longer natural or attractive for them to work together with peers with a background in another social science than their own. The initiative was well received, and within 25 years' time, interdisciplinarity had been embraced widely within the social sciences, increasing the coherence between the (sub) disciplines represented in the SSRC (Frank, 1988).[1]

Nor were the social sciences the only disciplines seeking a strategy to mitigate the fracturing process in their midst. Considering the problems fragmentation presented to teaching and research in the universities another (near) quarter of a century later, the influential 1972 OECD report on interdisciplinarity presented several explanations of how interdisciplinarity could help respond to those problems, apparent in many disciplines beyond the social sciences alone, with one author emphasizing interdisciplinarity's capability to decrease the mismatch between academic disciplines (and sub-disciplines) and the vocational practices pertaining to their fields (Heckhausen, 1972). Another author urged the embrace of interdisciplinarity as a way of bringing together the different components of the education/innovation system such that the system would be better able to respond to current challenges (Jantsch, 1972).

By 1990, looking back at 65 years of interdisciplinarity, Julie Thompson Klein concluded that, in all that time, the ambition to employ interdisciplinarity as a means to bridge differences between disciplines and fields had remained consequential together with the confidence that it could actually fulfill this role. She noted that this ambition was not just driven by an organizational impulse but was also supported by a particular concept of knowledge, an epistemology that enables linkages between different forms and domains of knowledge. In the words of her groundbreaking 1990 book, *Interdisciplinarity: History, Theory, and Practice*, "[s]till, all interdisciplinary activities are rooted in the ideas of unity and synthesis, evoking a common epistemology of convergence" (Klein, 1990, p. 11).[2]

[1] The SSRC was established in 1923 as an "intrinsically interdisciplinary operation" (Worcester & Sibley, 2001, p. 31). Although the term "interdisciplinary" may have appeared elsewhere before, the SSRC has been a key promotor and facilitator of explicit interdisciplinary projects (Abbott, 2001).

[2] Interestingly, writing in 1992 about the Swiss or continental situation, Mudroch observes that this unifying ideal is no longer embraced widely: "Unifying or radically reforming disciplines so as to attain even a limited unity of science as was proposed in the 1970s is presently not regarded as a realistic goal of interdisciplinarity" (Mudroch, 1992, p. 46).

Klein has not only observed such fundamental consensus among early theorizers and practitioners of interdisciplinarity; she has also contributed herself to the coherence of the field in several influential ways, as with the co-development of a definition of interdisciplinarity that has found wide acceptance, in part because it avoids defining interdisciplinarity in a substance- or content-based way. Instead, the Klein-Newell definition focuses on the process of integration of disciplinary insights that characterizes interdisciplinarity, describing it as a means to reach a more comprehensive insight into a complex problem (Klein & Newell, 1997). An earlier version of this process-oriented definition was already included in Klein's 1990 book, where it was presented along with a description of the interdisciplinary research process.

Characteristic of this description are the articulation of the various steps of the interdisciplinary research process and its explanation of the features distinguishing it from a disciplinary research process, like the two-step determination of the interdisciplinary research problem and the fact that several steps are re-iterated (Klein, 1990, p. 193). The influence of this process description is visible in that, since its first appearance, many major authors in our field have published modified versions of this interdisciplinary research model that are being used widely in higher education and elsewhere, manifesting once more convergence and consensus among interdisciplinarians (for example Menken & Keestra, 2016; Newell, 2001; Repko & Szostak, 2017).

However, in parallel with these and other important contributions to consensus and coherence within the field of interdisciplinary studies, Klein has also insisted on the field's increasing plurality and heterogeneity. Although interdisciplinarity by its very nature has always involved some form of boundary crossing, making connections between disciplines or knowledge domains, that process was for a long time a relatively simple endeavor that did not affect the traditional disciplinary organization of knowledge nor that of the academy itself (Klein, 1996). Yet, as Klein and Newell point out in the 1997 book in which they presented their co-developed definition of interdisciplinarity and its integrative process, this traditional, rather simple and discipline-oriented system (that allowed a subsidiary role for interdisciplinarity) was already changing into a complex, non-hierarchical system, determined by complex networks of scholars and students, cross-disciplinary centers and institutions, novel forms of collaboration, and other innovative features, all of which have been making the field of interdisciplinary studies increasingly pluralist and diverse.

Creating pluralism and diversity in the field more than any other change listed by Klein and Newell in 1997 has probably been the inclusion of extra-academic participants in problem-solving projects, as this affects interdisciplinarity more fundamentally than other changes do. Indeed, the label "transdisciplinary" is being increasingly used to distinguish these projects from interdisciplinary ones that only involve scholars (Klein, 2013).[3] More than merely adding another group with its discipline-specific expertise to an already diverse mix of people with disciplinary expertises, this crossing beyond the boundary of academic disciplines has proven to have far-reaching consequences. Having extra-academic stakeholders on board requires that their experiential knowledge must be taken into account along with the interests and values that they embody. Including a wider participation of stakeholders together with a more ecumenical attitude regarding the forms of insights they bring to the table has an impact upon all stages and elements of the research process. And of course it has an impact on the product of the process, as well, for such projects commonly yield more adequate responses to life-world problems than interdisciplinary projects do that are not performed in collaboration with extra-academic stakeholders (Hirsch Hadorn et al., 2008; Klein, 2004, 2019).

According to Klein, this shift towards transdisciplinary collaborations further entails an impressive list of other non-trivial changes:

- from segmentation to boundary crossing and blurring;
- from fragmentation to relationality;
- from unity to integrative process;
- from homogeneity to heterogeneity and hybridity;
- from isolation to collaboration and cooperation;
- from simplicity to complexity;
- from linearity to non-linearity;
- from universality to situated practices. (Klein, 2003 §1)

As we can learn from this list, transdisciplinarity affects not just the nature and process of interdisciplinary research, but also the relation of the research to its context and practices.

[3] As much as Klein has helped to establish the field of interdisciplinary studies, she has also played an important role in this crucial and challenging expansion of it towards transdisciplinarity, even though she modestly contrasts her own "descriptive approach" with "prescriptive" approaches in an interview in this journal (Lotrecchiano & Hess, 2019). Yet she has obviously done more than just describing the boundary crossing involved in transdisciplinarity's emergence, according to the introduction of the first journal issue completely devoted to it, where she is named among "those who have largely contributed in diffusing and refining this concept [of transdisciplinarity] in recent decades" (Lawrence & Després, 2004, p. 398).

Offering an analysis of the state of the field of interdisciplinarity in the 2013 volume of *Issues in Interdisciplinary Studies*, Newell comes to a similar conclusion regarding the crucial role of transdisciplinarity for the field. He spells out how transdisciplinarity challenges interdisciplinarity to reposition itself:

> Specifically, transdisciplinarity pushes us to rethink the exclusive reliance of interdisciplinarity on disciplines, the focus of interdisciplinarity on understanding over application, the locus of interdisciplinary activity in the academy instead of the real world, and the conception of interdisciplinarity as intellectual inquiry rather than political or social activity. (Newell, 2013, p. 36)

Given Klein and Newell's agreement that the inclusion of extra-academic stakeholders in otherwise interdisciplinary projects is having such a fundamental impact upon many features of interdisciplinarity, it is probable that the implications for interdisciplinarity of this form of boundary crossing have not yet fully come to the fore.[4] Hence my attempt below to reflect upon what those implications could be, inspired by the insights above and by a more philosophical take on the challenge of considering the future of a phenomenon as a way of considering its nature and potentiality.

## Considering Interdisciplinarity's Future

Authors as diverse as Aristotle, Hegel, Marx, and Nietzsche have insisted that we come to know a phenomenon's nature most comprehensively when it has developed itself fully. Whether a seed, baby, or revolution, its potential is only visible once it has grown, matured, or institutionalized. This implies, though, that the future might confront us with an unexpected and surprising actuality of a phenomenon, as when the seed grows into another plant than expected, the child demonstrates surprising talents, and terror comes to dominate the aftermath of a revolution, for example.

More radical than such observations, though, is the reflection on the disciplinary future of philosophy offered by Martin Heidegger in his lecture

[4] In his introduction to the *Oxford Handbook of Interdisciplinarity* Frodeman raises and answers the question: "What, then, is the problem that interdisciplinarity seeks to solve? I suggest it is one of politics, democracy, and technocracy. Interdisciplinarity is the bridge between academic sophists and the rest of society" (Frodeman, 2017, p. 7). Avoiding the term "transdisciplinary" here creates the risk that the reader overlooks the fundamental implications that bridging to the "rest of society" can have, for example when extra-academic participants are involved in problem solving projects. Such an implication could be that knowledge is no longer produced for its own sake but only for the sake of a sustainable future, as Frodeman argues elsewhere (Frodeman, 2014).

on "Das Ende der Philosophie und die Aufgabe des Denkens" – on the end of philosophy and the task of thinking. According to him, philosophy has completed its flawed course by accommodating itself to and positioning itself within the sciences, exhausting the limited possibilities stemming from the way it was conceived in Greek antiquity. Claiming that we are now observing the end of philosophy, understood as a form of "technical-scientific rationalization," he suggests that we must reconceive the task of thinking in a fundamental way (Heidegger, 2007 [1964]). Employing the joint exercise of analysis and critique, Heidegger's arguments serve to demonstrate that, contrary to the belief of many that modern philosophy has fully developed its potential from its ancient beginnings, we should recognize that philosophy has in fact failed to realize its most important task. When we return to philosophy's pre-Socratic beginning, he argues, we can uncover ways of accounting for reality and truth that are fundamentally different from those with which later philosophers have performed this task. Indeed, radically different forms of thought emerge from such considerations, forcing us to reconsider our current understanding of philosophy as a discipline.[5]

Would a return to interdisciplinarity's supposed origins be as fruitful as such an endeavor is claimed to be for philosophy? A reconsideration of its aforementioned origins at the SSRC headquarters around 1925 in an attempt to reconnect increasingly specialized social scientific disciplines will hardly lead to a fundamental rethinking of interdisciplinarity because such thinking will then remain focused on disciplines and their boundaries. So how about alternative means to the end of the adaptation or rejuvenation of interdisciplinarity? Reflecting upon interdisciplinarity's approaching century mark and its future, Klein explores three different trajectories for "(re)situating interdisciplinarity." The first entails a "universal radical transformation" of higher education as a whole, foregrounding cross-disciplinary research around problems and topics. The second provides room for an increasing plurality of kinds of interdisciplinary activity on the one hand while emphasizing the need for consistency and criteria for the quality and reliability of

[5] Proponents of a "critical interdisciplinarity" have argued in a similar way for a reconsideration of the knowledge system, as Klein points out: "Over time, critical interdisciplinarities have influenced the way that research and teaching [are] conducted in established disciplines, older interdisciplinary fields, and general education" (Klein, 2005, p. 58). In so doing, they fulfilled the potential of interdisciplinarity, as it can imply "a more radical questioning of the nature of knowledge itself and our attempts to organize and communicate it" (Moran, 2002, p. 15). As soon as interdisciplinarity crosses over into transdisciplinarity, such radical questions and reconsiderations will inevitably present themselves because of the impact of extra-academic insights and norms.

interdisciplinary education and research on the other. Finally, "institutionalization and self-definition" are a third option for resituating interdisciplinarity within its largely disciplinary context, with such strategic repositioning being necessary for its survival (Klein, 2010a, pp. 158-160).

Irrespective of their differences, these three trajectories all involve interdisciplinarity's institutional future. Although institutionalization is probably an important precondition for interdisciplinarity's continuing presence as a force in the world, I think that, as far as its future is concerned, it is equally important to explore what ramifications the relatively recent boundary crossing involved in transdisciplinarity have for interdisciplinarity. Indeed, with extra-academic stakeholders co-determining all phases of transdisciplinary work, both the process and the product of that work are bound to be fundamentally different from those of work done by academics alone, with the aim of the work reaching beyond the production of new knowledge and its evaluation influenced by the expectations of those stakeholders. As Klein has observed of the transdisciplinarity that has now "become an essential mode of thought and action," stakeholders are expecting not just academic insights into but also practical solutions to the problems at stake, not just thought, but action (Klein, 2004, p. 524).

In what follows I will further consider what the transdisciplinary development of interdisciplinarity that includes extra-academic stakeholders and their experiential knowledge, interests, and values and their practice-oriented expectations might hold for the future of interdisciplinarity. I believe that this development will force us to fundamentally reposition interdisciplinarity. And I believe this repositioning must occur in relation to two human faculties that are now not typically considered to be at the center of interdisciplinary projects: action and imagination. I am claiming that the future of interdisciplinarity will in large part depend upon how successfully it will connect to these faculties. In the next sections I will elaborate my views on the roles for action and imagination within interdisciplinary and transdisciplinary work – and especially within a version of the latter called "action research."

## Actionability as a Criterion for Interdisciplinary Knowledge

One of the changes in interdisciplinarity brought about by the inclusion of extra-academic stakeholders among the changes mentioned by Klein above is the shift from a quest for universally valid knowledge to interest in "situated practices" (Klein, 2003, §1). Articulating this development in the context of a more recent reflection on transdisciplinarity's promising future, she

observes "a clear historical shift from traditional epistemology to problem solving, from the pre-given to the emergent, and from universality to contextuality and subjectivity" (Klein, 2014, p. 74). With the problem setting, methodology for solving the problem, and implementation of results being co-determined by all collaborators, and hence reflecting the subjectivity and positionality of the extra-academic stakeholders, a transdisciplinary project yields a context-specific solution. Transdisciplinarity delivers not just generally valid knowledge as interdisciplinary research does, but also socially robust knowledge that retains its relevance and value in the real-world contexts of its application (Klein, 2010b; Nowotny, Scott, & Gibbons, 2001).

It is important to acknowledge that calls for a more societally relevant form of knowledge production were voiced several decades before the word "transdisciplinarity" in the current sense began to be used.[6] Particularly in the context of development activities in the global South, critique was leveled against traditional knowledge production that often occurred purely for its own sake. However, critique was also directed at the production of knowledge for instrumental purposes when those purposes were not sufficiently co-determined by the joint deliberation about insights, interests, and values by all stakeholders in a project and not just the academic ones (Klein, 2001).

In Latin America in the 1970s, so-called "action research" emerged from these debates, partly motivated by epistemological considerations but even more by societal expectations and needs. Fals Borda, a pioneer in this movement, writes that he and his colleagues were increasingly aware of the impossibility of objectivity and neutrality in social scientific research. They were eager to avoid the risk of exploiting subjects or communities for academic purposes. And they committed to the request of their communities that researchers produce "actionable" knowledge that would serve those communities. Taking these motivations seriously, researchers began to initiate their own "insertion into the social process," insisting that knowledge being actionable should become an important research goal (Fals Borda, 1979).

Actionability of knowledge implies not only that the knowledge is valid from different perspectives (as is required in interdisciplinarity) and maintains its relevance when applied in a social context (as in transdisciplinar-

[6] The term "transdisciplinarity" is being used and interpreted in several ways. For example, the influential OECD report on interdisciplinarity also contains references to transdisciplinary theories like systems thinking or mathematics, which potentially cover different domains of reality (Apostel, Berger, Briggs, & Machaud, 1972). "Transdisciplinarity," as understood here, referring to the inclusion of extra-academic stakeholders in interdisciplinary work, was developed in Europe (Balsiger, 2004) and this use of the term is now gaining more currency internationally.

ity). Actionability also implies that the knowledge responds to the needs and desires of the stakeholders involved in the interdisciplinary process. Indeed, applied as an additional criterion, actionability enables the distinction "between people knowing about something and their being able to produce that which they desire by using their knowledge" (Bradbury-Huang, 2008, p. 6). With this actionability criterion, action research goes another step beyond both interdisciplinary and transdisciplinary research: It not only includes stakeholder perspectives in its engagement with real-world problems but also subscribes to certain research goals that include "emancipation, empowerment, participatory democracy, and the illumination of social problems" (Grant, Nelson, & Mitchell, 2008, p. 589).

Clearly, by participating in a social process and aiming to produce actionable knowledge, action researchers assume roles and perform activities that are in many ways different from those of other inter- and transdisciplinarians. More explicitly aiming for social change and doing so with equal participation of extra-academic stakeholders, action researchers "do not define themselves as (or strive to be) impartial observers, but use their knowledge to help bring about change" (Smith, 2007, p. 162). Actionability understood in this way can only be fulfilled if researchers not only bring along a comprehensive set of research, social, and communicative skills but also are prepared to commit themselves to long-term projects unlike those common in academic research, even in transdisciplinary research. In the case of the development of a regional integrated health network, for example, action researchers participated for the entire period of its construction as partners in the project, being well aware that their role had a political dimension, as well. They have described how they used their theoretical and empirical expertise while contributing to the process in various ways:

> Our role as researchers entailed partly identifying the types of development situations, partly contributing with strategies and methods for organizing the development processes, to systematize the participants' and the researchers' reflections over practice and in that way contribute to knowledge creation and development. This was a complex development task that reflected the challenges and complexities constituting a world full of ambiguity, multiple identities and conflicting interests. (Huzzard, Ahlberg, & Ekman, 2010, p. 310)

The authors suggest that action researchers in such cases function as "boundary subjects," as experts who mediate between different organizational and professional perspectives while working towards the changes to which all involved in the project are committed (Huzzard et al., 2010).

Another action research project that serves as a case in point entailed the development of a participatory budget in Brazil. To pursue that end, citizens, researchers, and government officials together constructed an innovative democratic process. The process allowed the researchers involved to avoid the risk of "methodologization" or the belief that optimal solutions can be found given a sufficient methodological research design. Instead, as one of the researchers explains, all involved worked jointly to gradually identify the relevant questions as well as the evaluation criteria for the answers to those questions, including the actionability of the knowledge the process would yield. In the case of developing this participatory budget, for example, researchers contributed knowledge and analysis in multiple platforms during the process, aiming for research results for which rigor went well beyond adequate control of variables and instruments. Aiming for a middle ground between research in a theoretical vacuum on the one hand, and research as activism on the other, they defined rigor as "among other things, knowing how to move among the different types of knowledge and ways of knowing in order to help a given community or group to develop their strategies for organization, and to find means that enable them in the struggle for a better living together" (Streck, 2007, p. 123).[7]

In our report on the 2017 international transdisciplinarity conference, well aware of action research being different from inter- and transdisciplinary research, Julie Thompson Klein, Rick Szostak, and I drew attention to its emphasis on actionability of knowledge, pointing out that according to this criterion, "researchers are responsible for producing knowledge that potentiates social transformation, making 'practicability of knowledge' a criterion of validity" (Klein, Keestra, & Szostak, 2018, p. 1). Now, in 2019, this explicit devotion of researchers to helping extra-academic stakeholders in their pursuit of a better life still appears to be specific to action research and unusual in the context of inter- and transdisciplinary research.[8] Nonetheless, I contend, inter- and transdisciplinarity's futures may well move towards ever-increasing actionability since, as Fals Borda has argued, most inter- and transdisciplinary researchers *are* aware of us facing a global "challenge

[7] Comparing action research with transdisciplinary research, Streck points out several distinct characteristics of action research: It entails collective (self-)reflection involving diversity of experts and stakeholders; practicability of knowledge as an additional validity criterion; strategies to potentiate action for social transformation; democratization of knowledge; and intercultural dialogue (Streck, 2017).

[8] In addition, action research has been hailed as forming a barrier against the complete neoliberal management of the university since action research is not aimed at financial gains but instead "[at strengthening] remaining pro-social and pro-democracy forces within higher education and links these to the wants and needs of a broad social spectrum of non-university stakeholders" (Levin & Greenwood, 2008, p. 224).

to create a new science, responsible, democratic and participatory, to bring order to a world that is overexploited and in crisis, with threats of breakdown from the heavens to the caverns" (Fals Borda, 2013, p. 166).

With this plea for and promise of increasing pursuit of actionable knowledge, though, a new difficulty presents itself, for that pursuit involves challenges in addition to those posed by the fact the knowledge that is produced must be produced under the auspices of all stakeholders. In the next section I will consider how actionable knowledge cannot be produced unless all stakeholders decide upon a certain action after jointly imagining potential action options while taking into account the plurality of ideas and positions in their midst. The future of inter- and transdisciplinarity, according to this line of reasoning, must contain a prominent role for the imagination needed to create adequate options for action.

**The Role of Imagination in Knowledge-Based Action**

As we observed above, inter- and transdisciplinary research projects involve the crossing of multiple borders and the integration of a plurality of perspectives and insights. We noted, too, that Klein's analysis of integrative process acknowledges that the "principle of variance" reigns in that process. In other words, there is "no universal formula for integration" of pertinent perspectives and insights (Klein, 2011, p. 293). In agreement with that observation, this section draws attention to the fact that the process is further complicated when actionability is embraced as an additional outcome criterion. Actionability or the "extent to which the project provides new ideas that guide action in response to need" (Bradbury-Huang, 2010, p. 103) implies that normative and pragmatic dimensions are important in the integrative process and in its future-oriented outcome. It is not surprising that in most cases a plurality of options for integration is available, none of which mutually exclude each other and all of which are at least partially unpredictable when it comes to their implementation. Choosing among them requires a process of deliberation among project participants as they consider possibilities, all having their own preferences. One participant may propose to respond to a given interdisciplinary health or sustainability problem by an adjusted prevention policy, for example, while another may prefer a new intervention, with a third suggesting further exploration with a computer simulation under certain limiting conditions, perhaps in combination with other approaches and actions. Individually and together, participants need to balance the positives and negatives that each solution to a problem might bring against those of others, involving costs and benefits, values, interests,

and priorities (Boix Mansilla, 2006; Hirsch & Brosius, 2013).

Navigating such a plurality of options without there being an obviously optimal outcome requires stakeholders to engage in another form of process than integration, a process that allows them to strike a balance or trade-off between different options for action. Interestingly, the process, called "reflective equilibrium," was developed in political philosophy and ethics as a way of weighing options for action given norms and accepted background theories, allowing participants in a deliberation to gradually reach maximum coherence and agreement (Daniels, 1979; Rawls, 1974). Given the plurality of perspectives involved in interdisciplinary problem solving, reflective equilibrium can help such participants to reach a consensus, too (Boix Mansilla, 2010; Klein, 2019; O'Rourke, 2013). They would also be required to metacognize and reflect upon their own normative and epistemological assumptions as a precondition to further pursuit of the process, because only then could they adequately deliberate about available options with others, eventually reaching the desired equilibrium (Keestra, 2017).

As if such reflection and subsequent deliberation are not yet formidable tasks enough, participants must also employ another faculty when they have to choose between action options in light of available actionable knowledge. Given the plurality and openness pertaining to such options mentioned earlier, details and ramifications of each action option need to be specified before adequate deliberation is even possible. For this, participants in action research – as to a lesser extent also those in any interdisciplinary and transdisciplinary research – must apply "the dramatic rehearsal (in imagination) of various competing possible lines of action" (Bratman, 2007, p. 150). Such imagination of action options is often accomplished in the form of narratives that allow participants to configure and reconfigure the options in many more or less detailed ways, while envisioning those options as integrated into their own biographies and life-worlds (Keestra, 2014). Of course, instead of narrative imagination other forms can be employed for this task, as well.

One might expect people to understand that imagination thus plays an important role in interdisciplinary and transdisciplinary research projects, especially those involving action research. Unfortunately, though, imagination and the arts generally speaking are often contrasted with rationality and science, as Klein notes in a chapter on interdisciplinary arts and music research. In that context she rejects the "false dichotomy that posits rationality (cognitivity) as the realm of science and irrationality (imagination) as the realm of arts," suggesting that there is value in the joint application of these faculties (Klein & Parncutt, 2010, p. 135). I would reject that false dichotomy, too.

When imagination has been fostered in inter- and transdisciplinary collaborations, this has often occurred by integrating the arts and "exploring the interconnected creation of worlds" in that way (Gabrys & Yusoff, 2012, p. 19). Less formal creative and imaginative explorations invite participants to engage in "artful doing," building upon acquired knowledge. Dieleman appreciates that exercising creativity and imagination also provides room for participants' affective and embodied being (Dieleman, 2017). Imaginative explorations help to develop representations of potential complex futures in the form of narratives or animations, for example, providing participants with experiences that are sufficiently rich and vivid to enable them to sense and understand them, share them, and deliberate about them.[9] Indeed, artistic imagination can be invoked as a genuine form of experimentation useful in inter- and transdisciplinary work, especially when that work can be characterized as action research: Instead of (or in addition to) using scientific experimentation as a way to test novel insights, participants in ID, TD, and AR, using proper "imaginaries," can experiment with potential futures and generate new questions and answers about those insights (Born & Barry, 2010).[10]

Urban planning projects, an example that Klein uses in discussing this matter, require not only input from academics representing various disciplines but also the full employment of the faculties of all those involved in the projects, including creativity and imagination. Before adequate deliberation about options is possible, the engagement of these faculties is important:

> [N]ew objects come into view, practices come into new configurations, theory and learning are contextualized and resituated, and awareness of hybridization heightened when incorporating once excluded forms of knowledge, including the understandings of lay people. (Klein, 2019)

In this way, it is feasible for both experts and lay people alike to have a relatively rich, embodied, and affective experience of future options, enabling all to weigh the options against each other and deliberate about them. Obviously, the merely disciplinary processing of information and knowledge is

[9] In our research group "Neurocultures" at the University of Amsterdam artists participate on equal footing with scholars and scientists. Artists can be involved in arts-science collaborations, for example, helping to explore neurodiversity as contributions to our 2016 conference demonstrated (Besser et al., 2016). Film director Nevejan presented her documentary about epileptic absences, integrating in them artistic imaginaries co-produced with patients, enabling them to convey their first-person experiences of absences and hallucinations to others (Nevejan, 2019).

[10] In their contribution on the ethics of interdisciplinarity, Balsamo and Mitcham draw attention to "technological imagination" as it entails the "performativity and improvisation" necessary for reflecting upon our interactions with technologies (Balsamo & Mitcham, 2010).

incapable of accomplishing this. Even interdisciplinary or transdisciplinary research does not generally encourage participants to engage their imaginations to such ends, yet our exploration of the future of interdisciplinarity suggests we should do so. In action research, imagination often already plays such an important role that a particular method has been developed to enable that role. This research method is called "appreciative inquiry," which is "a form of action research in pursuit of knowledge creation for social innovation [that] invites us to be daring in our explorations and articulations of alternative possibilities for our shared and organized existence" (Zandee & Cooperrider, 2008, p. 190). In other words: Actionable knowledge requires imagination for its realization in potential solutions to real-world problems.

Imagination and the arts are playing a more important role in action research than they do (or are acknowledged to do) in interdisciplinarity and transdisciplinarity, as the literature shows.[11] Yet by exploring the actual and potential boundary crossings at work in interdisciplinary and transdisciplinary research, Klein has fathomed the implications of widening the circle of participants in research collaborations, of extending the set of evaluation criteria for their integrative results, and of expanding the set of options for future action to be considered in the integrative process. All of these evolutions in ID and TD work involve a more prominent role for interdisciplinary imagination and will benefit if that role is acknowledged and deliberately enhanced, especially as AR or the actionability of the work becomes more important.

## Actionability and Imagination in the Future of Interdisciplinarity

As noted at the start of this article, then, interdisciplinary activities initially were motivated by ideas of unity and synthesis, a point Klein made in her 1990 book on interdisciplinarity. Since earlier days, though, as Klein has also observed, interdisciplinarity and transdisciplinarity have come to be

[11] A crude indicator of the differential importance of imagination and arts in interdisciplinary, transdisciplinary, and action research might be how often they figure in prominent handbooks. Imagination occurs not even once in the index and only a few times in the *Oxford Handbook of Interdisciplinarity* (Frodeman, Klein, Mitcham, & Holbrook, 2010), not at all in the *Handbook of Transdisciplinary Research* (Hirsch Hadorn et al., 2008), and as "social imagination" and conjugated forms in the index of the *Handbook for Action Research* and at least 20 times in its chapters (Reason & Bradbury, 2008). However, Augsburg notes that inter- and transdisciplinary arts are thriving even though this is not represented in the literature (Augsburg, 2017). It is not implausible that the action research literature is similarly not sufficiently covering the – still larger – role of the arts in action research.

increasingly characterized by the plurality, heterogeneity, and hybridity of their communities, practices, methods, and results (Klein, 1996, 2010a). In her description of these fields and their developments, she uses the metaphor of boundary crossing to capture both the relevant dynamics and the permeability of the boundaries involved (Klein, 1996, 2019). With the inclusion of extra-academic stakeholders in transdisciplinary research projects, new forms of engagement and new criteria for success have been introduced, along with new kinds of boundary crossing, which do have fundamental implications for interdisciplinarity according to Klein.

Taking this change in ID work another step further, I have here focused on a mode of research that has been little mentioned thus far in the literature on inter- and transdisciplinarity, to wit, action research. With actionability as an aim and criterion, action research presents several important challenges in addition to those already prevalent in interdisciplinary and transdisciplinary research.

Notwithstanding the plurality and hybridity involved in all ID and TD work, AR requires that we select one option for acting over others. This situation requires, so I have argued, that participants engage in a complex process that consists of two elements: deliberation in order to reach a reflective equilibrium enabling an adequate choice between future action options and imagination to bolster adequate consideration of those options. Extending and transforming some elements of Klein's important contributions, I hope to have made plausible that actionability and imagination should and will become prominent features of interdisciplinary work of all kinds in the future, and that there is actually an urgent need for this to happen and for interdisciplinarians to address how it might be made to do so.

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**References**:


Abbott, A. (2001). *Chaos of disciplines*. Chicago: University of Chicago Press.

Apostel, L., Berger, G., Briggs, A., & Machaud, G. (Eds.). (1972). *Interdisciplinarity: Problems of teaching and research at universities*. Paris: Organization for Economic Cooperation and Development.

Augsburg, T. (2017). Interdisciplinary arts. In R. Frodeman, J. T. Klein, & R. C. Dos Santos Pacheco (Eds.), *The Oxford handbook of interdisciplinarity*, 2nd ed. (pp. 131-143) Oxford: Oxford University Press.

Balsamo, A., & Mitcham, C. (2010). Interdisciplinarity in ethics and the ethics of interdisciplinarity. In R. Frodeman, J. T. Klein, & C. Mitcham (Eds.), *The Oxford handbook of interdisciplinarity* (pp. 259-272*)*. Oxford: Oxford University Press.

Balsiger, P. W. (2004). Supradisciplinary research practices: History, objectives and rationale. *Futures, 36*(4), 407-421.

Besser, S., Keestra, M., Kiverstein, J., Lysen, F., Pisters, P., & Hoogland, T. (2016). *Worlding the brain: Patterns, rhythms, narratives in neuroscience and the humanities.* Program booklet of the conference "Worlding the Brain: Patterns, Rhythms, Narratives in Neuroscience and the Humanities," March 17-19, 2016, Amsterdam.

Boix Mansilla, V. (2006). Assessing expert interdisciplinary work at the frontier: An empirical exploration. *Research Evaluation, 15*, 17-29.

Boix Mansilla, V. (2010). Learning to synthesize: The development of interdisciplinary understanding. In R. Frodeman, J. T. Klein, & C. Mitcham (Eds.), *The Oxford handbook of interdisciplinarity* (pp. 288-306). Oxford: Oxford University Press.

Born, G., & Barry, A. (2010). Art-science. *Journal of Cultural Economy, 3*(1), 103-119.

Bradbury-Huang, H. (2008). Quality and "actionability": What action researchers offer from the tradition of pragmatism. In A. B. Shani, S. Albers Mohrman, W. A. Pasmore, B. Stymne, & N. Adler (Eds.), *Handbook of collaborative management research* (pp. 583-600). London: Sage Publications.

Bradbury-Huang, H. (2010). What is good action research? Why the resurgent interest? *Action Research, 8*(1), 93-109.

Bratman, M. E. (2007). *Structures of agency: Essays*. New York: Oxford University Press.

Daniels, N. (1979). Wide reflective equilibrium and theory acceptance in ethics. *Journal of Philosophy, 76*(5), 256-282.

Dieleman, H. (2017). Transdisciplinarity as a cultural endeavor: Hermeneutics and team dialogue beyond mere analysis and logic, including subjective experience and imagination. *Issues in Interdisciplinary Studies, 35*, 170-199.

Fals Borda, O. (1979). Investigating reality in order to transform it: The Colombian experience. *Dialectical Anthropology, 4*(1), 33-55.

Fals Borda, O. (2013). Action research in the convergence of disciplines. *International Journal of Action Research, 9*(2), 155-167.

Frank, R. (1988). Interdisciplinary: The first half century. *Issues in Integrative Studies, 6*, 91-101.

Frodeman, R. (2014). *Sustainable knowledge: A theory of interdisciplinarity*. Basingstoke: Palgrave Macmillan.

Frodeman, R. (2017). The future of interdisciplinarity. An introduction to the 2nd edition. In R. Frodeman, J. T. Klein, & R. C. Dos Santos Pacheco (Eds.), *The Oxford handbook of interdisciplinarity*, 2nd ed. (pp. 3-8). Oxford: Oxford University Press.

Frodeman, R., Klein, J., Mitcham, C., & Holbrook, J. (Eds.). (2010). *The Oxford handbook of interdisciplinarity*. Oxford: Oxford University Press.

Gabrys, J., & Yusoff, K. (2012). Arts, sciences and climate change: Practices and politics at the threshold. *Science as Culture, 21*(1), 1-24.

Grant, J., Nelson, G., & Mitchell, T. (2008). Negotiating the challenges of participatory action research: Relationships, power, participation, change and credibility. In P. Reason & H. Bradbury (Eds.), *The SAGE handbook of action research* (pp. 589-601). London: Sage Publications.

Heckhausen, H. (1972). Discipline and interdisciplinarity. In L. Apostel, G. Berger, A. Briggs, & G. Michaud (Eds.), *Interdisciplinarity: Problems of teaching and research in universities* (pp. 83-89). Paris: Organization for Economic Cooperation and Development.

Heidegger, M. (2007 [1964]). Das Ende der Philosophie und die Aufgabe des Denkens. In F.-W. v. Herrmann (Ed.), *Zur Sache des Denkens*. Vol. 14. (pp. 67-90). Frankfurt: Klostermann.

Hirsch Hadorn, G., Hoffmann-Riem, H., Biber-Klemm, S., Grossenbacher-Mansuy, W., Joye, D., Pohl, C.,...Zemp, E. (Eds.). (2008). *Handbook of transdisciplinary research*. Dordrecht: Springer.

Hirsch, P. D., & Brosius, J. P. (2013). Navigating complex trade-offs in conservation and development: An integrative framework. *Issues in Interdisciplinary Studies, 31*, 99-122.

Huzzard, T., Ahlberg, B. M., & Ekman, M. (2010). Constructing interorganizational collaboration: The action researcher as boundary subject. *Action Research, 8*(3), 293-314.

Jantsch, E. (1972). Towards interdisciplinarity and transdisciplinarity in education and innovation. In L. Apostel, G. Berger, A. Briggs, & G. Michaud (Eds.), *Interdisciplinarity: Problems of teaching and research in universities* (pp. 97-121). Paris: Organization for Economic Cooperation and Development.

Keestra, M. (2014). *Sculpting the space of actions. Explaining human action by integrating intentions and mechanisms*. Amsterdam: Institute for Logic, Language and Computation.

Keestra, M. (2017). Meta-cognition and reflection by interdisciplinary experts: Insights from cognitive science and philosophy. *Issues in Interdisciplinary Studies, 35*, 121-169.

Klein, J. T. (1990). *Interdisciplinarity: History, theory, and practice*. Detroit, MI: Wayne State University Press.

Klein, J. T. (1996). *Crossing boundaries: Knowledge, disciplinarities, and interdisciplinarities*. Charlottesville, VA: University Press of Virginia.

Klein, J. T. (2001). The discourse of transdisciplinarity: An expanding global field. In J. T. Klein, W. Grossenbacher-Mansuy, R. Häberli, A. Bill, R. W. Scholz, & M. Welti (Eds.), *Transdisciplinarity: Joint problem solving among science, technology, and society: An effective way for managing complexity* (pp. 35-44). Basel: Birkhaeuser Verlag.

Klein, J. T. (2003). Unity of knowledge and transdisciplinarity: Contexts of definition, theory and the new discourse of problem solving. *URL: http://www. mines. edu/newdirections/essay2. htm (accessed February 2004)*. Retrieved from https://www.eolss.net/Sample-Chapters/C04/E6-49-01.pdf

Klein, J. T. (2004). Prospects for transdisciplinarity. *Futures, 36*(4), 515-526.

Klein, J. T. (2005). *Humanities, culture, and interdisciplinarity. The changing American academy*. Albany: State University of New York Press.

Klein, J. T. (2010a). *Creating interdisciplinary campus cultures: A model for strength and sustainability*. San Francisco, CA: Jossey-Bass.

Klein, J. T. (2010b). The transdisciplinary moment(um). *Integral Review, 9*(2), 189-199.

Klein, J. T. (2011). Research integration. A comparative knowledge base. In A. F. Repko, W. H. Newell, & R. Szostak (Eds.), *Case studies in interdisciplinary research* (pp. 283-298). Thousand Oaks, CA: Sage Publications.

Klein, J. T. (2013). The state of the field: Institutionalization of interdisciplinarity. *Issues in Interdisciplinary Studies, 31*, 66-74.

Klein, J. T. (2014). Discourses of transdisciplinarity: Looking back to the future. *Futures, 63*(0), 68-74.

Klein, J. T. (2019). *Beyond interdisciplinarity: Boundary work, collaboration, and communciation in the 21st century*. Manuscript in preparation.

Klein, J. T., Keestra, M., & Szostak, R. (2018). "Intercultural endeavors" explored at "td-net" conference. *Integrative Pathways, 40*(1), 1-5, 21, 24-25.

Klein, J. T., & Newell, W. H. (1997). Advancing interdisciplinary studies. In J. Gaff & J. Ratcliff (Eds.), *Handbook of the undergraduate curriculum: A comprehensive guide to purposes, structures, practices and change* (pp. 393-415). San Francisco, CA: Jossey-Bass.

Klein, J. T., & Parncutt, R. (2010). Art and music research. In R. Frodeman, J. T. Klein, & C. Mitcham (Eds.), *The Oxford handbook of interdisciplinarity* (pp. 133-146). Oxford: Oxford University Press.

Lawrence, R. J., & Després, C. (2004). Futures of transdisciplinarity. *Futures, 36*(4), 397-405.

Levin, M., & Greenwood, D. J. (2008). The future of universities: Action research and the transformation of higher education. In P. Reason & H. Bradbury (Eds.), *The SAGE handbook of action research* (2nd ed.). London: Sage Publications.

Lotrecchiano, G., & Hess, A. (2019). The impact of Julie Thompson Klein's interdisciplinarity: An ethnographic journey. *Issues in Interdisciplinary Studies*, *37*(2), pp. 169-192.

Menken, S., & Keestra, M. (Eds.). (2016). *An introduction to interdisciplinary research. Theory and practice*. Amsterdam: Amsterdam University Press.

Moran, J. (2002). *Interdisciplinarity*. London: Routledge.

Mudroch, V. (1992). The future of interdisciplinarity: The case of Swiss universities. *Studies in Higher Education, 17*(1), 43-54.

Nevejan, M. (2019). If you are not there, where are you? Amsterdam: Ceruitti Film. https://areyouthere.nl

Newell, W. H. (2001). A theory of interdisciplinary studies. *Issues in Integrative Studies, 19*, 1-25.

Newell, W. H. (2013). The state of the field: Interdisciplinary theory. *Issues in Interdisciplinary Studies, 31*, 22-43.

Nowotny, H., Scott, P., & Gibbons, M. (2001). *Re-thinking science: Knowledge and the public in an age of uncertainty*: Cambridge: Polity Press.

O'Rourke, M. (2013). Philosophy as a theoretical foundation for I2S. In G. Bammer (Ed.), *Disciplining interdisciplinarity: Integration and implementation sciences for researching complex real-world problems.* Vol. 47 (pp. 407-415). Canberra: ANU E Press.

Rawls, J. (1974). The independence of moral theory. *Proceedings and Addresses of the American Philosophical Association, 48*, 5-22.

Reason, P., & Bradbury, H. (Eds.). (2008). *The SAGE handbook of action research*. London: Sage Publications.

Repko, A. F., & Szostak, R. (2017). *Interdisciplinary research: Process and theory*. Thousand Oaks, CA: Sage Publications.

Smith, P. M. (2007). A transdisciplinary approach to research on work and health: What is it, what could it contribute, and what are the challenges? *Critical Public Health, 17*(2), 159-169.

Streck, D. (2017). What can action research and transdisciplinarity learn from each other? In G. Bammer (Ed.), *Integration and Implementation Insights*. Retrieved from https:// https://i2insights.org/2017/08/29/action-research-and-transdisciplinarity/ on July 4, 2019.

Streck, D. R. (2007). Research and social transformation: Notes about method and methodology in participatory research. *International journal of action research, 3*(1+ 2), 112-130.

Worcester, K., & Sibley, E. (2001). *Social Science Research Council, 1923-1998; Reprinting Social Science Research Council: The first fifty years*. New York: Social Science Research Council.

Zandee, D. P., & Cooperrider, D. L. (2008). Appreciable worlds, inspired inquiry. In P. Reason & H. Bradbury (Eds.), *The SAGE handbook of action research* (pp. 190-198). London: Sage Publications.

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# Theory into Practice: Julie Thompson Klein's Boundary Work and Institutional Change

by

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***Abstract:*** In this article, we seek to apply Julie Thompson Klein's supple understanding of typology as both category-making and category-defying to one aspect of her own body of work: her participation in a range of organizations with permeable boundaries. Specifically, we review her contributions to theories of boundary work in interdisciplinary studies and then her applications of those theories to building new academic institutions and networks that mirror and support related goals. We concentrate on Klein's work as a proponent of Digital Humanities (DH) and, in particular, on Klein as a founding member and leader of a boundary-breaking, cross-institutional, and cross-disciplinary alliance, HASTAC (Humanities, Arts, Science, and Technology Alliance and Collaboratory: HASTAC.org), the world's first and oldest academic social network, a participatory, constantly evolving, user-driven online community that has grown to more than 17,000 network members.

***Keywords*:** boundary work, institutional change, interdisciplinarity, networks, participation

Julie Thompson Klein lives at the border. Perhaps it is because she can almost see Canada from where she lives that she always is concerned about what happens when different regimes of knowledge, different political systems, different cultures, and different kinds of practice meet. Perhaps it is because she spent much of her career teaching at Wayne State University, a

great public university nourishing, and nourished by, a city ever on the brink of insolvency and bankruptcy. Whatever the origins of her boundary work, she is keenly aware that borders can be fertile places but can be also sites of enforcement, containment, and constraint. Borders can be places of flow or they can maintain implicit and explicit power relations. Klein's life on the border has never been that of a colonialist, assuming that one dominant system will inevitably overtake and subsume another. She is, rather, interested in the interface as a conducive membrane between two things. For her, a border is a liminal space that, in its ideal form, can foster exchange and creation. To that end, she has spent a career actively working to ensure that institutional structures support boundary fluidity, even against more normative institutional imperatives towards guarding turf and minding gates.

While others in this volume will address various theoretical and intellectual contributions Klein has made throughout her career, we are focusing on what happens when a deep thinker about boundaries has a formative role in helping to create a new kind of collaborative, community-based, cross-disciplinary organization and publishing platform in which boundary work is an integral part of its design and its activist aims. That organization? The Humanities, Arts, Science, and Technology Alliance and Collaboratory (HASTAC). Certainly, her unique insights on crossing boundaries have been echoed in her work with other organizations, such as the Association for Interdisciplinary Studies (AIS), of which she was an early president, and the Science of Team Science (SciTS) organization, which presented her with their 2016 Recognition Award for her work on interdisciplinarity and team science. However, we will focus on how she has worked to design structures that support interdisciplinarity rather than constrain it within the realm of Digital Humanities (DH), and, more specifically, within HASTAC, where her work both extends and is an extension of her work in DH.

**From Scholarship to Practice**

In her important article "Typologies of Interdisciplinarity: The Boundary Work of Definition," a chapter in the volume for which she serves as co-editor, the *Oxford Handbook of Interdisciplinarity*, Klein (2017) argues that

> typologies are neither neutral nor static. They reflect political choices of representation by virtue of what is included or excluded, which activities are grouped within a particular category, and how narrow or wide the field of vision is in a spectrum ranging from small academic projects to society at large. (p. 22)

The passage exemplifies Klein's encouragement of activism through scholar-

ship. One of her goals as a scholarly activist has been to think (and invite others to think) through ways to *institutionalize* the permeability of such boundaries as typologies create, a seeming oxymoron that she has turned into a praxis supportive of interdisciplinary endeavor. In the same article, Klein lists multiple terms associated with interdisciplinary endeavor and, by association, border work. For multidisciplinarity, there are juxtaposing, sequencing, and coordinating. For interdisciplinarity, there are interacting, integrating, focusing, blending, and linking. Finally, for transdisciplinarity, there are transcending, transgressing, and transforming. What is characteristic about her scholarly stance is that, rather than favor one term and approach over another, Klein generously shows how each term and approach contributes a different and needed nuance, emphasis, or mission to the goal of crossing intellectual borders.

How does one translate scholarship supportive of border crossing and boundary work into institutional design? Klein consistently throughout her long career has championed organizational reforms designed to move institutions toward openness and away from the many tendencies to guard turf, protect territory, and exclude all who do not meet the narrowest definitions of who belongs. Over the course of her career, Klein has envisioned and supported fluid institutional interfaces as complex as Mobius strips with membranes permeable from multiple directions. Through her scholarly research and publications, which have both informed and been informed by her leadership in professional organizations and funding agencies, she has worked to build interdisciplinary institutions that facilitate participation and contribution. Most impressively, she has done this not simply as a theorist but also as one who puts theory into practice by designing, implementing, and supervising an array of complex professional organizations and systems in a way that supports the border work they do.

**Experience in Boundary Crossing and Institution Building**

As president of AIS and editor of its journal, *Issues in Integrative Studies* (now *Issues in Interdisciplinary Studies*), Klein championed interdisciplinary studies and interdisciplinarity. And in her continuing efforts on behalf of AIS in this, its fourth decade, she still does. Beyond her work for AIS, she has served on more committees and programs and think tanks and task forces on interdisciplinarity than would fill up the vitas of a dozen full professors. She can claim such notable achievements as membership on the National Academies of Science task force on modernizing the National Science Foundation's taxonomy of research categories and the National Academies

of Science task force on Convergence of Life Sciences, Physical Sciences and Engineering and the programming committee of the national Science of Team Science network. And of course she can also claim voluminous publications on interdisciplinarity and transdisciplinarity across many disparate academic fields ranging from the humanities to the hard sciences, in addition serving as co-editor of the University of Michigan Press series Digital Humanities@digitalculturebooks. Her leadership has been well recognized by an array of international awards including the Eesteren-Fluck Van Lohuizen Foundation international competition award for new research models, the Kenneth Boulding Award for outstanding scholarship on interdisciplinarity, the Ramamoorthy & Yeh Distinguished Transdisciplinary Achievement Award, and the Joseph Katz Award for Distinguished Contributions to the Practice and Discourse of General and Liberal Education. Hers is a distinguished career of professional boundary crossing and institution building.

For those who are familiar with Klein's achievements, the awards and other recognition underscore the success of her boundary work, often happening at a level barely perceptible to the rest of the world, but nonetheless making borders productive spaces. She is a tireless networker who often makes introductions between individuals, encouraging them to cross borders, too. For example, one of us (Janz) organized conferences in Canada through a now-defunct center called the Centre for Interdisciplinary Research in the Liberal Arts (CIRLA), based at what was Augustana University College (now the Augustana Faculty of the University of Alberta). Klein was a keynote speaker at the 1998 conference, and she helped bring the discussion of the liberal arts in the contemporary university down from the romantic heights of rhetoric to real questions about their place among applied science, technology, and professional programs. Instead of arguing that the liberal arts are the bulwark against the erosion of the classical university, Klein helped everyone in the conference see potential for their own research, amplified in boundary work across all the disciplines of the existing academy. Klein motivated conference participants not only in her keynote lecture but also in conversations at breaks where she connected people across different disciplines and countries by helping them to rethink their approach to collaboration and encouraging them to ask questions at the borders of the safe spaces of their disciplinary methodologies. Boundaries, for Klein, are always creative spaces, offering opportunities for practicing generosity, optimism, and openness to change.

## HASTAC and Klein's Visionary Influence

Among her many other achievements, Julie Thompson Klein has had a visionary and sustaining influence on the shaping of what has been called the world's first and oldest academic social network, Humanities, Arts, Science, and Technology Alliance and Collaboratory (HASTAC, pronounced "haystack" by its members). Founded in 2002, this innovative online academic community now numbers over 17,000 network members. It combines a vital and remarkably active online presence with annual onsite conferences hosted by volunteer institutions or consortiums of institutions in a given region or area, including three past international conferences (Toronto in 2013, Peru in 2014, Vancouver in 2019).

HASTAC has, from its beginning, existed with a permeable interface allowing any registered user to contribute. It was designed to be structurally dynamic and responsive, on the level of code (a free, open-source content-management system) and on the level of content (any network member can contribute public content to the HASTAC.org site *without prior approval or permission from its leaders*), thus ensuring its permeability. HASTAC not only promotes "dynamic cross-fertilizations" among its members with its permeability but also, as an open and dynamic social platform, allows its users a means by which to work out the ever-changing nature of those cross-fertilizations. Online, HASTAC's social network is built on a Drupal platform, the aforementioned free, open-source content-management system. Drupal, written in PHP (Hypertext Preprocessor) scripting language by the Drupal software developer community, is offered to users at no cost. Similarly, membership in the HASTAC network is free. Once registered to the HASTAC site, one not only becomes a member but also can contribute as long as the content is relevant to the organization's general mission and the user is respectful of community standards. HASTAC's mission is exemplified by two expansive mottos: "Changing the Way We Teach and Learn" and "Difference Is Our Operating System." As both mottos testify, boundary work – testing and redefining – is intrinsic to the mission and structure of the organization.

Older than either Facebook or MySpace, HASTAC was co-founded by Cathy N. Davidson and David Theo Goldberg, Director of the University of California Humanities Research Institute. Meetings of scholars across interdisciplinary fields (before HASTAC had a name) were hosted at UCHRI in 2001. Led by UCHRI's Kevin Franklin, the group conceptualized the design of a new kind of online tool developed specifically to promote inclusion, participation, and constant change and innovation. A new book by wiki

inventor Ward Cunningham and Bo Leuf, *The Wiki Way: Quick Collaboration on the Web* (2001), helped the group to think about how to translate a theory of inclusive scholarly community with permeable institutional and disciplinary boundaries into an online platform that facilitated this model of networked community. No other organization at that time had such an online site. (As a point of historical reference, it might be noted that Wikipedia launched in 2001.) Originally housed at Stanford University, HASTAC.org was developed by a distributed leadership team across many other institutions. Julie Thompson Klein was among the scholars who, early on, helped all involved to think about how emergent digital forms could be used to translate a theoretical commitment to boundary crossing into an online space for work of that sort.

From its inception, HASTAC has been supported by academic institutions in the form of grants, dedicated administrative time, and paid student internships. It also has won support from institutions like the National Science Foundation and private philanthropic organizations. It is costly and labor intensive to maintain and operate the technologically complex Drupal platform and to administer so large and complex an organization, but this support has made that possible. It is important to know that, throughout its existence, HASTAC has never sold user content or information to help defray costs.

In 2005, the HASTAC website moved to Duke University. From 2005 to 2014, HASTAC co-founders Davidson and Goldberg co-directed the Digital Media and Learning (DML) Competitions supported by the John D. and Catherine T. MacArthur Foundation, with HASTAC.org serving as a networking site for the competition and its winners. This grant funding from the DML Competitions helped HASTAC to continue its online innovation. In 2014, HASTAC's administrative homes were Duke and the Graduate Center, City University of New York (CUNY), where Davidson took a new academic position. In 2017, after an open call for a new institutional partner, leadership was shared across the Graduate Center, CUNY and Arizona State University (ASU) with Jacqueline Wernimont becoming HASTAC's co-director. In 2018, HASTAC added a third, jointly-held administrative home at Dartmouth College and, as of 2019, HASTAC is now supported primarily by two institutions, the Graduate Center, CUNY and Dartmouth.

While material support from an array of institutions has thus been crucial to HASTAC's founding and continuing existence, voluntary participation by a constantly evolving cadre of intellectual leaders has been equally important. HASTAC is the rare organization that has been maintained by volunteer leadership that is shared, nonhierarchical, cooperative, and collabora-

tive. Within this loose and voluntary structure, it is impossible to exaggerate the tireless contribution of Julie Thompson Klein. She has been a dynamic, thoughtful force, constantly working with others in the HASTAC community, especially graduate students and junior scholars, to think through and enable the structures a network needs to support true boundary work, not only intellectually but also institutionally.

One example of Klein's innovative thinking is apparent in the 2006 creation of the HASTAC Scholars Program. By then, it was clear that it was time to find a way to share support of HASTAC beyond just one or two institutions, so the leadership began to discuss ways that institutions could support HASTAC without conventional dues collection. Klein was among a group of leaders who brainstormed a way that institutions could support the next generation of scholars dedicated to HASTAC's mission by offering them modest funding, as graduates or undergraduates, to become HASTAC Scholars. Instead of paying institutional dues to HASTAC, institutions would pledge to support undergraduate and graduate HASTAC Scholars through small stipends. These stipends might be used to pay for travel to the HASTAC conference or another conference or workshop. The HASTAC Scholars would become network members who contribute their own ideas to the network and publicize their own research on the website (and gain professional recognition for doing so). The HASTAC Scholars would form collaborative communities across disciplines and institutions and find support, via the HASTAC network, that is sometimes lacking in their own more traditional institutional homes. The plan, which Klein helped to initiate and implement, has worked well. To date, over 1,425 graduate and undergraduate students from more than 400 institutions have been named HASTAC Scholars.

And this is only one example of the many ways in which Klein has served the complex, amorphous, permeable, and seemingly utopic network of HASTAC, working at the forefront of the senior scholars who are changing structures and mentoring younger colleagues, meeting virtually, as the system allows, and at physical HASTAC conferences and other conferences to support the mission of the organization that is so boundary-crossing in content, method, field, and even technology. As noted earlier, Klein served on the first Steering Committee of the organization, and she continues to serve on that committee in the present. She was co-director of the 5th International HASTAC Conference, "Digital Scholarly Communications," held at the University of Michigan in December of 2011. She has also been a tireless consultant to all conference organizers in every imaginable capacity. She has reviewed proposals for every HASTAC conference, from the beginning

to the present; has helped craft the organization's constantly (and intentionally) malleable bylaws; and has served on numerous nominating committees to choose new Steering Committee members. Any number of HASTAC projects have benefitted from her constant, consistent, passionate counsel.

Not only has Klein supported HASTAC with her substantial volunteer service from its founding, but her evolving theories of boundary work have also contributed to this dynamic social network's ongoing development, raising and suggesting answers to important questions. Klein (2017) argues, "ultimately, the question of knowledge cannot be separated from how we talk about it" (p. 32). And the HASTAC system Klein helped to create has helped connect the "what" and the "how," the content (the information being shared) and the platform (the means of sharing that information). From the start, the system has allowed all involved to deal with the most basic questions of all: How does one work with a collective to turn an idea into a complex social organization sustained by a remarkably complex technological system? How does one create and sustain such an organization based on the lofty ambition to help build and not simply reify reputations as traditional academic publishing tends to do? As we know, the *modus operandi* of much academic publication is based on peer review in which standards for reliability are institutionally self-referential: Those who have attained the status of experts serve as peer reviewers for others seeking to publish their work in a given journal. But what might happen if familiar intellectual boundaries were not reinforced with peer review (as in a conventional scholarly journal), but could be breached by anyone who has chosen to become a member of a community of more open-minded scholars? What might happen if the purpose of publication were not to reify reputation – solidify the grounding of the past that brings scholars to the present – but to support, inspire, and propel a new generation of scholars to thrive, to begin the process of learning together, of, eventually, building their own reputations while supporting and being supported by a community of their peers?

In a 2018 interview with HASTAC Scholar Molly Mann, Klein notes how concepts foundational to HASTAC (reflected in the answers to the questions of the previous paragraph) exemplify boundary work of the sort that allows spaces for change within otherwise seemingly intransigent institutions. She notes, "two concepts – 'mobilizing networks' and 'spatializing practices' – illustrate how HASTAC has been fostering positive change" (Mann, 2018). She alludes here to a definition proposed by HASTAC co-founders Davidson and Goldberg in *The Future of Learning Institutions in a Digital Age*: "institutions are mobilizing networks" (Davidson & Goldberg, 2009, p. 4). Klein builds on the idea that members of a community can be freer of

boundaries than the institutions in which they reside. She notes that, within and across academic institutions, there are constantly changing patterns of contact by individuals that result in "horizontal structures that flatten expert authority" and culminate in "a shift from predetermined expert authority to collective credibility, decentering pedagogy, networked learning through social engagement and cooperation, and a conception of learning based on connectivity and interactivity" (Mann, 2018). Klein also connects flattened hierarchy to a second concept, that of "spatializing practices," advanced by HASTAC co-founder Anne Balsamo (2011), a concept related to "Michel de Certeau's distinction between 'place' [and] 'space.' A place such as a university or school has stable boundaries and a fixed location. Space is 'a practiced place' created by actions" (Mann, 2018). In her role as one of HASTAC's leaders, Klein has helped to enable its online academic network as a "practiced place created by actions" (Mann, 2018).

**Klein's Boundary Thinking and Digital Humanities**

Klein's ongoing work with HASTAC is an extension of her work in the field of Digital Humanities (DH). In a 2012 interview with Conor Shaw-Draves, Klein noted that, even before she became a HASTAC leader, she began "making use of digital technologies and new media in [her] classrooms, initially in the Interdisciplinary Studies Program at Wayne State" (Shaw-Draves, 2011). Since becoming a HASTAC leader, Klein has contributed specific DH themes and ideas to HASTAC. In 2006-2007, for example, Klein hosted a local event in the year-long, multi-site international HASTAC In/Formation Year, with a symposium on "Digital Partnerships in Humanities," featuring the Wayne State University Libraries' Digital Collections and innovative work in the English Department.

In her recent book *Interdisciplining Digital Humanities*, Klein (2015) notes that her goal is to test the widespread claim that DH is interdisciplinary by examining the boundary work of establishing, expanding, and sustaining a new field (p. 5). She writes about the early computational linguistics in the mid-twentieth century and charts the "sea change" that occurred in DH with the advent of the Internet. Klein notes that, now, DH "is encompassing new digital-born objects, forms of scholarship and publication, new areas such as gaming studies, [and] critique of the impact of the computer on behavior and culture" (Mann, 2018). These are major accomplishments yet, Klein notes (2015), DH still has to overcome infrastructural challenges as well as problems of sustainability given the difficulty of needing to preserve digital content on constantly changing platforms (p. 4). These challenges are

exacerbated by "the weakened funding climate in humanities, conservative policies for publication as well as tenure and promotion, lack of common standards and evaluation criteria, resistance to interdisciplinary innovation, and uneven development across disciplines, fields, and institutions" (Klein, 2015, p. 4). Insistence on stable infrastructure, Klein notes, can be at odds with the "permeability" of intellectual structures key to creative, disruptive, cross-boundary thinking like that represented by DH. DH today, at its best, can exemplify the crossing of many boundaries, including those long thought to divide academe from sectors of the public sphere such as government and industry. Klein points out that, even as the regulatory and bureaucratic structures of the university construct more elaborate systems designed to satisfy the public's desire to get value for their dollar, DH offers opportunities to look beyond those structures to new kinds of partners doing new kinds of valuable work.

**Activating Boundary Space**

Klein's advocacy for boundary work is exemplified, as we have seen, both in her ongoing contributions to HASTAC and in her participation in DH. In these overlapping contexts, she has not merely imagined institutional structures that serve as clearinghouses for information from multiple sources or meeting-places where people can pool resources or exchange ideas, but has also advocated for and actually helped to build spaces that allow for change and creation. In her boundary lands, concepts travel, as do people moving into different disciplinary areas (Bal, 2002; Klein, 2015, pp. 29-30). The boundary work may be between disciplines, but it may also be between regimes of knowledge and practice anywhere they are found. And work at the boundaries does not foreground disciplinary (or interdisciplinary) production at the expense of that which is examined. The work is done in spaces of encounter in which everyone is learning. No longer is the specialist or the expert the only active knowledge-producer. The inflexible boundaries between junior and senior scholar, or student and teacher, give way to collaborative possibilities in which anyone might learn from the knowledge of anyone else. Similarly, the static boundary between the academy and the public also shifts. No longer is the academic the inquirer and the community merely the place under study that yields its secrets more or less willingly. "In-reach" becomes as important as "outreach" and community contributes to as well as benefits from academic knowledge. Finally, no longer is there a firm line between theory and practice, between the "academic" and the "real world."

In Klein's understanding, a boundary is an interface – a space where faces

face each other, an "inter-face" of whole human beings, a space of affect as well as intellect. People sometimes mistake the best computer interface for the one that is invisible and seamless, but that erases the boundary space and discourages the work that can happen there. Klein's boundary spaces look like feedback loops, relationships of reciprocity and synergy, busy with the autopoietic emergence of new structures, new tools, and new communities. In the boundary spaces she promotes, there is no invisibility, but there is permeability, and opportunity for experiment, trial, failure and success, revision and repetition.

HASTAC and other new academic organizations Klein has worked on have in common the preference for creativity over productivity and the preference for asking new questions rather than just extending or refining old ones. Those involved share her commitment to boundary work allowing surprise and play, meant to do much more than simply meet metrics and targets as one might in an intellectual factory. Activating a boundary space for what might come next, but cannot be programmed or predicted, is different from building an intellectual factory. On the other hand, HASTAC and other structures Klein has been influential in creating are still structures. We suggest that, for Klein, boundary work is no Hegelian *Aufhebung*, no rising to a new level of consciousness or thought after the exhaustion of tensions or contradictions between systems of knowledge. Instead, it is work that builds the new upon the old, transcending but not demolishing the old in the pursuit of something grander, more encompassing, more real or true. In this way, she points us to the creation of new structures that will prepare both existing and future academics, and society, to deal with the world to come.

## Conclusion

As Julie Thompson Klein argues in her publications and presentations (and conversations) and demonstrates in her practice, boundary work gives us alternative paradigms and structures. Such work is often easier recommended than done, however, and Klein also has been tireless in addressing the forms of institution-building required to scaffold such work and the new forms of knowledge it can produce. As a nonhierarchical network and boundary-crossing organization, HASTAC has grown through the efforts of many people, and continues to draw new people, particularly students and early career academics with innovative ideas who enjoy working in the collaborative space HASTAC provides to discover curricular ideas, pedagogical tools, and technological possibilities, along with other education innovations, and opportunities in the digital humanities. For a scholar of Klein's

stature to dedicate herself to an organization such as HASTAC, even without the potential for professional reward and recognition, is not only laudable, but almost singular. She embodies a better alternative for a productive career trajectory than that offered more conventional academics by the neoliberal corporatized university. By her work and by her personal and professional example, Klein has inspired countless scholars, senior and junior, and helped to create and sustain spaces – *boundary spaces* – where they can collaborate to make innovation happen and, through that innovation, benefit us all.

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## References:

Balsamo, A. (2011). *Designing culture: The technological imagination at work*. Durham, NC: Duke University Press.

Bal, M. (2002). *Travelling concepts in the humanities: A rough guide*. Toronto: University of Toronto Press.

Davidson, C. N., & Goldberg, D. T. (2009). *The future of learning institutions in a digital age.* Cambridge, MA: MIT Press.

Jones, Z. M. (Ed.). (2012). Digital scholarly communication: Conference proceedings from HASTAC 2011. Retrieved from https://www.hastac.org/hastac-conferences/digital-scholarly-communication-conference-proceedings-hastac-2011

Klein, J. T. (2015). *Interdisciplining digital humanities: Boundary work in an emerging field*. Ann Arbor, MI: University of Michigan Press.

Klein, J. T. (2017a). A taxonomy of interdisciplinarity. In R. Frodeman, J. T. Klein, & R. C. Dos Santos Pacheco (Eds.), *The Oxford handbook of interdisciplinarity* (2nd ed.) (pp. 15-30). New York, NY: Oxford University Press.

Klein, J. T. (2017b). Transdisciplinarity and sustainability: Patterns of definition. In D. Fam, J. Palmer, C. Riedy & C. Mitchell (Eds.), *Transdisciplinary research and practice for sustainability outcomes* (pp. 7-19). New York, NY: Routledge.

Klein, J. T., Grossenbacher-Mansuy, W., Haberli, R., Bill, A., Scholz, R. W. & Welti, M. (Eds.). (2001). *Transdisciplinarity: Joint problem solving among science, technology, and society*. Basel: Springer AG.

Leuf, B., & Cunningham, W. *The wiki way: A quick collaboration on the web.* Boston: Addison-Wesley, 2001.

Mann, M. (2018, January 5). Boundary work and the digital humanities: An interview with Julie Thompson Klein. Retrieved from https://www.hastac.org/blogs/molly-mann/2018/01/05/boundary-work-and-digital-humanities-interview-julie-thompson-klein

Shaws-Draves, C. (2012, February 14). Interdisciplinarity and the digital humanities: Profiling Julie Thompson Klein. Retrieved from https://www.HASTAC.org/blogs/cshawdraves/2012/02/14/interdisciplinarity-and-digital-humanities-profiling-julie-thompson

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# A Rich Mosaic of Impact: Julie Thompson Klein's Scholarly Influence in Australia and New Zealand

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***Abstract:*** Ten Australians and one New Zealander provide reflections on the influence of Julie Thompson Klein's work on and in inter- and trans- disciplinarity. Even taking into account that this article is based on a small number of contributions from only one corner of the world, the reflections demonstrate the influence of a diverse array of Klein's academic work, the ground-breaking nature of her book *Interdisciplinarity: History, Theory, and Practice,* the meticulousness of her scholarship that makes her voice authoritative, and the added benefits of personal connections. The contributions also demonstrate the value of reflective narratives in providing a more rounded and richer picture of an academic's influence than traditional metrics, including – in Julie Thompson Klein's case – non-citable enhancement of thinking and orientation, catalytic effects when her ideas are combined with others, and practical value in making sense of events and circumstances. Most importantly, assembling reflective narratives provides a window onto the unique attributes and contributions of individual researchers, educators and practitioners, illustrating and affirming the richness of differences and the importance of valuing and capitalising on them. Recognition of such diversity is not only essential to help individuals identify the strongest contributions they can make, but also critical for good inter- and trans- disciplinary research, education and practice.

***Keywords:*** diversity, interdisciplinarity, Julie Thompson Klein, reflective narratives, research impact, transdisciplinarity

**Introduction**

There is growing demand on the academic community to demonstrate that its work has impact. In addition to citations of publications, academics are increasingly required to show that specific projects and programs have made a difference: enhancing public debate, changing government policy, improving professional practice, producing new commercial products and so on. Here we approach the assessment of impact in a different way, by reflecting on how we and – through us – research, education and practice have been (and continue to be) influenced by the academic work of Julie Thompson Klein.

Our focus is especially, but not exclusively, on her impact in Australia and New Zealand. Klein has only visited this part of the world twice. In 1995 she was a Foundation Visitor at the University of Auckland in New Zealand, combining that with a tourist trip to Australia. In 2004 she was a keynote speaker at the Australian Academy of Science Fenner Conference on "Bridging Disciplinary Divides: Understanding the Population/Environmental Debate" (Klein, personal communication, May 2018).

The ten reflections in this article all demonstrate the influence of her writing. Some reflections also reveal impacts resulting from personal connections made on Klein's 2004 Australian trip as well as at meetings in other parts of the world. The reflections establish the power not only of her own ideas, but also of the ideas of others that she has promoted. The diversity of Klein's impact is striking. A major advantage of the process we have used is that it allows this diversity to be made evident and captured. As we show, she has influenced interdisciplinarity and transdisciplinarity in research, education and evaluation, and she has also helped make sense of institutional responses to these research approaches.

Our reflections are couched in the syntax, spelling and grammar used in Australia and New Zealand to highlight the special flavour of Klein's impact in our part of the world. The collection is structured as follows:

- One reflection on how Klein's work fostered a deeper understanding of the challenges of interdisciplinarity, as well as ways of accepting them (Lorrae van Kerkhoff).
- Three reflections that draw on the link between interdisciplinarity and complexity, first articulated by Klein in 1990: 1) how one of her articles joining these two ideas helped a doctorate make a difference (Wendy Elford), 2) how her work impacted on a teaching

program (Chris Browne and Louise Blessington) and 3) how her views had a permeating influence on university-based research and government work (Virginia Kaufman Hall).
- Two reflections on Klein's thinking about how organisations have approached transdisciplinarity: 1) one on how it provided the justification for the focus at a self-funded university institute (Cynthia Mitchell) and 2) one on how it influenced evaluation at a New Zealand Crown Research Institute (Bruce Small).
- One reflection on making sense of a negative university response to interdisciplinarity and transdisciplinarity, using ideas of others promoted by Klein as well as her own work. This contribution could be subtitled *Singing Old Songs, Tussock Jumping and the Glass Bead Game: Environmental Transdisciplinary Practice at the Australian National University* (David Dumaresq).
- One reflection on how Klein influenced the choices made during an intentionally integrative career, which involved unearthing layers of memory as well as correspondence with other authors of this article (Stefan Kaufman).
- Two reflections on the importance of personal interactions with Klein: 1) one addressing her tact and strategic sense (Valerie Brown) and 2) one dealing with her intellectual generosity (Gabriele Bammer).

**Lorrae van Kerkhoff, Fenner School of Environment and Society, The Australian National University**

*For many scholars working in problem-oriented fields such as sustainability, environmental management, public health, and social policy in Australia, the idea of interdisciplinarity is something of a no-brainer. "Of course" academic disciplines are artificial constructs of limited use in tackling complex problems; "of course" disciplinary understandings are partial and insufficient to really understand and effectively intervene in those problems. But (at least in the late 1990s when I became interested in such things) beyond the seemingly obvious shortcomings of disciplines, there seemed to sit a large void. If not disciplines, then what?*

*Klein's work shone a light into this void in ways that allowed us to start to see some shape and contours there, and to develop some orientation. I have framed my reflection of her influence in terms of both understanding and accepting the interdisciplinary challenges that are presented to scholars, researchers, educators and practitioners. Have we conquered these chal-*

*lenges? No. But Klein's contributions to defining interdisciplinary work as a field of scholarship in its own right have done much to enable us to recognise these challenges, see them in a broader context, and deal with them.*

*Understanding academic work beyond disciplines is a minefield of tricky definitions, long-winded debates, and often tedious contestation. While it was tempting as a younger scholar to simply dismiss versions of these definitions that I did not subscribe to, Klein offered a subtler approach. Impatiently seeking a quick, 25-words-or-less definition of interdisciplinarity that I could brandish in triumph over other, less well-read conversation partners, I turned to Klein's 1990 work,* Interdisciplinarity: History, Theory, and Practice*. Instead of finding my verbal weapon of choice, I found a rich and nuanced discussion over several chapters that outlined the various, diverse and situated understandings of interdisciplinarity. I learnt that while some definitions may be more suited to particular contexts than others, there are no universally applicable right or wrong ways to think about interdisciplinary work.*

*With hindsight perhaps the multiplicity of possible definitions is obvious, and as Klein and others have observed, it should be expected that an interdisciplinary field would maintain a range of interpretations (Huutoniemi, Klein, Bruun, & Hukkinen, 2010). Ontological and epistemological differences in philosophical frames are apparent not only in the diverse content, theoretical perspectives or methods attached to each discipline that might be involved in an interdisciplinary enterprise; they are also manifested in how people see interdisciplinarity itself. Granted the Australian appetite for interdisciplinary work during the 1990s was largely (not exclusively) driven by practical concerns: How can we become more effective at solving complex problems? Klein's research and writing challenged me, and I believe assisted others around me, to understand the philosophical dimensions of crossing disciplinary boundaries and how doing so might have practical implications. Such understanding establishes a more robust foundation from which to explore similarity and difference, and the strengths and limitations unique to each disciplinary perspective. Without being able to delve into the depths of underlying thought and find common ground enough to enable agreement and action, interdisciplinary conversations can become circular and repetitive, reinventing the same misinterpretations and repeating them over and over.*

*The second part of my reflection focuses on not just understanding, but also accepting – by which I mean taking on – the challenge(s) of interdisciplinarity. Importantly, Klein's work pointed to the institutional dimensions of this challenge, reminding us that disciplines are not only cognitive, but*

*also organisational, and structure much formal recognition and esteem in universities (Klein, 2010; Klein & Falk-Krzesinski, 2017a). Consequently the challenges include recognising and preparing for the institutional difficulties faced by those involved in interdisciplinary endeavour in a university context, such as often being the first whose programs are cut when financial or socio-political forces push "back to basics" (Klein & Newell, 1996). In discussing institutional context and outlining its features, Klein not only reminded interdisciplinary scholars that these challenges exist, but also created a sense of solidarity, that we are not alone in confronting institutional barriers. Klein was also intent on celebrating the successes amongst the challenges; successes such as women's studies, environmental and urban studies and integrative and innovative curriculum, highlighting the benefits that can come from questioning and crossing disciplinary boundaries, taking complexity seriously, and experimenting with alternative ways of understanding and dealing with complexity (Klein, 2010). While Australian academic institutions have not, generally speaking, followed the U.S. path of liberal education that encourages interdisciplinarity, we have developed strong academic programs in interdisciplinary areas, and supported substantial and long-term collaborative funding models to take a problem-focused approach to complex issues. Klein's contribution to the debates about and evolution of interdisciplinarity in this part of the world has been to underpin the arguments of those advocating for interdisciplinary and transdisciplinary work, to ensure we don't lose sight of the deeper philosophical dimensions of this endeavour while we pursue its practical benefits, and to inspire innovation and bravery in the face of conservative institutions that deny those benefits.*

**Wendy Elford, Now to Next Pty Ltd.**

*To reflect on Julie Thompson Klein's work is to acknowledge the power of a single article, one that acts as a type of punctuation mark in the deep thinking that is required for a doctorate. For me, such an article has driven the transition from being a professional feeling stuck dealing with an intractable problem to an international collaborator shaping the changing setting in which the problem occurs. I am a human factors and ergonomics professional. I use narrative – the stories and reflections that people share about their day to day experiences – as data to improve the design of work systems and workplaces. I apply knowledge gained from physiotherapy, psychology, neuroscience, architecture, organisational design and more. My interpretations and interventions place my practice between, within and across mul-*

*tiple professions and disciplines, which makes it complex; adding the human element to any problem almost always adds complexity. I always pick the most complex of problems to deal with and expect to make a difference in people's wellbeing and safety, in their ability to work effectively and to lead productive and satisfying lives.*

*The article concerned was entitled "Interdisciplinarity and Complexity: An Evolving Relationship" (Klein, 2004a). Armed with Klein's words and analysis, I finally felt I had the permission needed to think, write and work well outside of my professional box and in the end, my personal comfort zone. As a doctoral student, I had naïvely started off wanting "the answer" to a problem and all the facts to go with that quest. Perhaps receiving a diagnosis of Asberger's Syndrome a decade or more later would partly explain my desire for certainty; discovering Klein's work marked a useful early turning point towards a new way of thinking that could accommodate the power of ignorance; accepting your ignorance is humbling. This opened up a new way to resolve the differences I experienced between disciplines as a child growing up, between my mother the artist and my father the engineer, and as an academic later on. Reflecting on this now, I can see the links Klein made between interdisciplinarity and complexity were what I needed to respond to my instinctual and growing discomfort with the challenge of forcing the evolution of my career to match the evolution of my thinking, for one to keep pace with the other.*

*On an academic note and as a writer and student, I was also grateful for Klein's article as an exemplar of how to combine excellent use of sources with quotable thinking on a challenging topic. Beginning doctoral students need such articles to inspire them to reach beyond their current professional boundaries. These articles are written by academics with great courage and expertise. Klein has both qualities, yet she is not alone; the compliment to her can be extended to others who have provided a solid argument by bringing two big ideas together. Such articles give less experienced academics, researchers and thinkers a way to move quickly forward to their own new ground. For me, Klein's article on interdisciplinarity and complexity acted like a bridge; it helped me feel safe as I considered the landscape of ideas from a new position. Klein reminds us that "A significant number of new specialities have a hybrid character. They constitute a second form of specialization focused on areas missed or only partially examined by traditional disciplinary specialities" (Klein, 2004a, p. 3). Through Klein's work, I discovered how one article can forever change the academic landscape by creating a new structure for thinking based on what has been left out of the discussion. One article can act as scaffolding for new concepts and new*

*specialties to come.*

*Finally, Klein's article finishes with a cloaked warning. Academia is not immune to the same complexity it references and explores. Klein names some of the ways in which past ways of thinking still influence innovators who think deeply for a living: "Contests of legitimacy over jurisdiction, systems of demarcation, and regulative and sanctioning mechanisms continue, and perceptions of academic reality are still shaped by older forms and images" (Klein, 2004a, p. 10). My conclusion is that my identity as a professional, whether as a solo researcher or as part of collaborative praxis within an interdisciplinary endeavour (Elford, 2011; Elford, 2012), must become even more fluid if I am to become increasingly useful in dealing with complexity. Working out how to "know fallibly" yet be effective in continuing partnership with others is an essential part of knowing anything at all.*

**Chris Browne, Science Teaching and Learning Centre, and Louise Blessington, Fenner School of Environment and Society, The Australian National University**

*The most significant influence that Julie Thompson Klein has had on what has become our shared teaching practice came through her argument that engaging meaningfully in interdisciplinary studies requires a different set of classroom metaphors (Klein, 1999). This realisation early in our teaching careers gave us "permission" to develop and align our philosophy of teaching and learning in an interdisciplinary context to focus on process through the journey metaphor.*

*We guide, probably more from behind than in front, students through an interdisciplinary capstone course "Unravelling Complexity," where students are challenged to become "bold in unravelling" (Boulton & Lucas, 2008, p. 9) complexity. They learn to become comfortable in navigating the uncertainty of complex problems rather than becoming paralysed by complexity itself or – worse – remaining ignorant of it. We focus our practice in the 12-week journey through a range of perspectives, with the goal of helping students to realise for themselves how to see the world anew through an interdisciplinary lens.*

*The link between learning about the nature of complexity and the need for an appreciation of interdisciplinarity is clear. Complex problems are characterised by deep uncertainty and multiple, conflicting world views (Head & Alford, 2008). Through a series of course seminars, a range of invited academics provide their opinions on how their discipline handles the nature of complexity and complex problems. Our role on this journey is to help stu-*

*dents to integrate these ideas, so that they can make sense of these perspectives through later discussion and reflection.*

*The intellectual journey of the course moves through three phases. The first is a collated "primer" on complexity, where each student reviews relevant articles on a concept related to complexity from outside their discipline and writes a 500-word piece for their peers explaining their articles' take on the topic. Students prepare a draft for peer review, before submitting a final for collation into the primer. The resulting artefact becomes a resource for students to share disciplinary perspectives that allows students to, as Klein describes, "cross the boundaries" of inquiry (Klein, 1999, p. 3).*

*The second phase of our journey promotes integration of disciplines around complex problems. Invited experts delve deep into "grand challenges," such as migration, energy security, food production, gender inequality, truth and justice, and the fourth industrial revolution. Groups of students take turns each week to plan and lead a discussion on their assigned topic after the presentation and develop a co-authored proposal on how they might address the challenge described by the invited expert. These activities highlight the great complexity of such topics and the need for the integration of insights drawn from the perspectives of many disciplines to deal with those complexities.*

*The third phase of our journey involves the composition of an individual portfolio. Students unravel a complex problem of their choosing, typically arising from their discipline, through drawing connections to insights from other disciplines. Students create "a critical or creative piece that can be consumed in 10 minutes" and are encouraged and supported to present their work in any medium they wish. During this phase, our guidance helps students tether their exploration to the course themes of complexity.*

*The portfolio encourages students to synthesise the knowledge they have gained during the course in a process that, for many students, is a transformative experience. Submissions span many themes and media; recent examples include a sculpture of Aphrodite commenting on gender equity, embroidery embodying human-nature relationships, an essay on sexual assault law reform, a slam poem on emergence, a board game about climate change, and a podcast on the nature of complexity itself.*

*What these diverse artefacts have in common is an understanding of the "evolving relationship" between complexity and interdisciplinarity that Klein (2004a) addresses in her work. Shaping our course to elicit this understanding shows how we have been influenced by, and responded to, Klein's work, by working to integrate these ideas within tertiary-level education.*

**Virginia Kaufman Hall, Retired**

*I appreciate Klein's articulation of the usefulness of interdisciplinarity. Upon reflection upon my working life in academia, government, education and community development, I realise how much I enjoyed discovering through my doctorate studies (including exposure to Klein's work) that theory is useful not only in unpacking multiple influences within a complex situation, but also in offering multiple "tools" to apply. For example, in my Australian government work facilitating ongoing and participatory research and evaluation of indigenous programs, I analysed wicked problems in attempts to shape policy. I was strengthened and informed by an integrative pragmatism that, for me, traces back to Klein.*

**Cynthia Mitchell, Institute for Sustainable Futures, University of Technology Sydney**

*For me, transdisciplinarity is a means to the end of improving planetary outcomes in ecological, social, and economic terms. My engagement with the concept has therefore always been from a practitioner standpoint, initially as an engineering educator in the 1990s, and since 2001 as a researcher at a self-funding institute whose mission is to create change towards sustainable futures. For us as researchers with a normative stance, the relevance of our work was always clear. My enduring interest was and remains in ensuring that the quality of our research (doctoral theses plus reports for government and industry) is equally clear. Boyer's scholarship model served me well in this regard for many years (Glassick, Huber, & Maeroff, 1997), including our translation of his assessment criteria into a transdisciplinary realm, but in thinking about quality criteria for transdisciplinary theses, more richness and nuance were needed. This was the context for my first encounters with Klein's superlative capacity for search and synthesis. My national teaching and learning fellowship in 2006 concerning quality criteria for transdisciplinary doctorates set out from the platform created by her closing reflections in special journal editions on transdisciplinarity in both* Futures *(Klein, 2004b) and* Research Evaluation *(Klein, 2006).*

*Firstly, in Klein's work, I found what felt like a rare space of resonance with our strong praxis orientation. For example, the richness of her conceptualisation of transdisciplinarity, in her piece in* Futures*, integrating as it did across the many "schools" of transdisciplinarity, provided multiple touchstones for our institute's work. Furthermore, her statement that "transdisciplinarity is simultaneously an attitude and a form of action" (p. 521) helped legitimise our normative stance. Her comments were significant be-*

*cause at the time, our change creation orientation had a powerful marginalising effect in academia.*

*Secondly, in Klein's (2006) work I found guideposts for how to strengthen our praxis. Here again, the strength for me lay in Klein's breadth of coverage and sharpness of synthesis, with themes like "the expanded meaning of quality," "the centrality of integration," "the interaction of social and cognitive factors," and the "the need for change in peer review." These themes spurred me on to collaboratively explore, define (Mitchell & Willetts, 2009), and recently revise (Willetts & Mitchell, 2017) new criteria and processes for the evaluation of transdisciplinary doctorates.*

*Our institute is now 21 years old, with more than a hundred staff and research students, and is globally sought after for its practice orientation to transdisciplinarity. We cemented that position in 2017 with a Routledge publication entitled* Transdisciplinary Research and Practice for Sustainability Outcomes*, in which, most appropriately, Klein sets the scene (Klein, 2017).*

**Bruce Small, AgResearch**

*Crown Research Institutes (CRIs) are major suppliers of research to the New Zealand Government. Much of the research conducted by CRIs focuses on applied, real world research problems. Frequently these problems are urgent, and have elements of scientific uncertainty, and both the problem issues and potential solutions impact various stakeholders in different ways (with potential winners and losers). Additionally, impacted stakeholders may have different values and legitimate end-goals with respect to the problem and solutions. These types of research problems are sometimes called "wicked problems," and for both ethical and pragmatic reasons, transdisciplinary research processes are currently viewed as the most appropriate approach for creating long-term desired societal impact (increasingly a requirement demanded by the government research funders).*

*One New Zealand CRI, AgResearch, has embraced the concept of transdisciplinary research through its Adoption and Practice Change programme (A&PC). The programme has much benefitted from comments Klein offered in 2008, in her article "Evaluation of Interdisciplinary and Transdisciplinary Research: A Literature Review." Her discussion about evaluation as being one of the least understood aspects of transdisciplinary research resonated with those involved in the AgResearch's A&PC programme, and also with the government funders, keen to be able to demonstrate the societal impact of the research they fund. Consequently, the A&PC programme has focused on creating, and adapting existing, tools and other resources*

*that are enabling AgResearch to develop evaluation capacity for reviewing transdisciplinary research programmes. These tools and other resources are currently being introduced to AgResearch scientists, so that they may be utilised at all research phases from planning to review. Currently, this is being done through a website called "Beyond Results" (http://www.beyondresults.co.nz/). AgResearch and other New Zealand CRIs have been in discussion about how an "evaluative culture" and "evaluative capacity" can be built into the CRIs with respect to transdisciplinary research.*

**David Dumaresq, Fenner School of Environment and Society, The Australian National University**

*I first read Julie Thompson Klein's* Interdisciplinarity: History, Theory, and Practice *(Klein, 1990) sometime in the mid-1990s. I was immediately struck as to how useful Chapter 3, "An Interdisciplinary Lexicon," could be in dealing with two concerns (among many others) within the Australian National University (ANU) in its long and convoluted path towards establishing a multidisciplinary (even interdisciplinary, and potentially transdisciplinary), robust, coherent, and rigorous academic entity dedicated to detailing the problems of, and pursuing solutions for, environmental literacy and social and ecological sustainability. Firstly, Klein's work could help describe to ourselves, our immediate colleagues and the wider university what it was we were trying to do, and secondly, it would help reveal why there had been and would be so many missteps along the way.*

*In particular Klein's typification of "the kinds of interaction that have constituted 'interdisciplinary' interaction in actual practice" provides an excellent and revealing starting point for addressing these concerns. These four basic kinds of interaction are "(1) borrowing, (2) solving problems, (3) increased consistency of subjects or methods, and (4) the emergence of an interdiscipline" (Klein, 1990, p. 64).*

*These interactions provide a neat summary of the safe ground that many if not most disciplinary based researchers use to extend their own field and engage with the "other." Interactions within the ANU up until the mid-1980s could best be described in this way, even if some wished to push much further. What happens when we push further into the "gaps" and on into the transdisciplinary?*

*Again, Klein provides a useful succinct map. Here Klein borrowed from a Scandinavian colleague adapting Sverre Sjölander's ten stages of development in interdisciplinary activity. Although the original stages were developed for group work, Klein points out that they work just as well for the*

*individual and individual interactions with others. These ten stages are:*

*1. Singing the old songs;*
*2. Everyone on the other side is an idiot;*
*3. Retreating into abstractions;*
*4. The definition sickness;*
*5. Jumping the tussocks;*
*6. The glass bead game;*
*7. The great failure;*
*8. What's happening to me?;*
*9. Getting to know the enemy;*
*10. The real beginning. (for details see Klein 1990, pp. 71-73)*

*So how have these ten stages played out at the ANU across the years from the 1970s to the early 2000s and what can their application to actions at the ANU tell us? In the 1970s the ANU created two small units to focus on transdisciplinary academic activities in teaching and research designed to bridge the social and biophysical sciences centred around the problematique of environment and sustainability. The Human Sciences Program was established in 1974 to bridge the Arts–Science "gap" in undergraduate teaching, and the Centre for Resource and Environmental Studies (CRES) in 1975 to carry out research and provide postgraduate studies. Both entities were multidisciplinary in the staff they engaged and did not operate within the traditions of disciplinary based academic departments. Among other objectives, they were founded with the imperative to "get to know the enemy" in Klein's terms. Both units constantly struggled to gain legitimacy among the strongly disciplinary based departments and schools of the wider university.*

*In 1987 the university declared a "great failure" and disbanded the Human Sciences Program against the strong opposition of students and staff. In defiance of this higher edict, most of the academic and intellectual activity and purpose was retained and further developed in a renamed Human Ecology Program housed within a strongly single discipline teaching department along with some of the original program staff. This "housing" was intended as an interim step pending the creation of a range of larger academic multidisciplinary entities. A School of Resource and Environmental Management (SREM) was proposed but was stillborn in 1990 with those disciplinary voices still "singing the old songs" being the loudest. Even so a virtual SREM existed across the relevant disciplinary based departments for the next ten years with much jostling among staff across Klein's first four stages, with "the definition sickness" taking hold.*

*Multiple pressures from budgetary constraints, rising managerialism, and administrative consolidation for institutional survival in the early 2000s*

*gave rise among several disciplinary departments for the need to re-engage in creating an interdisciplinary school concerned with society and environment. Very quickly the strategy of "tussock jumping," moving fast from one known and agreed on position to the next, emerged allowing for the formation of a School of Resources, Environment and Society (SRES) in 2001.*

*Within SRES, the "glass bead games" rapidly developed, each with its own rules, arenas, officials and participants including their own Joseph Knechts (Hesse, 1943, 2000). "Glass bead games" are opaque to outsiders, the rules are vague, undefined, even unknowable except to a few adepts, entry is limited to a chosen few, and years may be spent learning the game and gaining entry. Those who wish further familiarity with the "glass bead game" are referred to Hesse's book. Interestingly at this time of the early 2000s, many "glass bead games" concerning society, environment and sustainability sprang up across the whole university, not just within SRES.*

*Perhaps in order to avoid another Stage 7, "a great failure," SRES engaged in a rather bewildered "What's happening to me?" Stage 8 with the research entity CRES to form the Fenner School of Environment and Society (FSES) in 2007. FSES's creation and early activities re-engaged with the ANU's 1970s Stage 9 vision of "getting to know the enemy." Despite this, many old and new "glass bead games" remain being played and interactions between these games within FSES seem reduced to "tussock jumping" at best. A fully developed Stage 10 of "getting a new beginning" remains in the future.*

*Klein's work provides a many layered, nuanced approach to understanding where we stand as individuals, as research groups, or as more formal institutions in our engagement with inter-, multi-, and trans- disciplinary activities. The above brief account of one strand of such activity at the ANU gives us an insight into just how difficult extended and re-iterative working outside accepted intellectual disciplines can be.*

**Stefan Kaufman, BehaviourWorks Australia, Monash Sustainable Development Institute, Monash University**

*I was both pleased and a little bit disconcerted when I first received Gabriele Bammer's request for contributions to this article for the special issue celebrating the work of Julie Thompson Klein. I certainly remembered who Klein is, and felt familiar with some of her perspectives. In particular, and in my own scholarship and practice, I identify with her recognition of, and sense-making of, the impacts of complexity, hybridity, non-linearity, and the subsequent necessity of embracing heterogeneity (Klein, 1998). I can lay*

*some reasonable claim to be working in a transdisciplinary way throughout a chequered but entertaining (thus far) career bridging disciplines and contexts in academia, policy and practice. I think that this is, at least partly, because of insights from her work. But I was in an initial panic at the thought of trying to identify exactly where, how and when I first encountered it, which seemed to me a necessary step in tracking her influence in my context. Nevertheless, I wrote back to Gabriele saying "Funny, it's been so much of the water I've been swimming in I think it will take some reflection and rereading, but I like the idea of participating."*

*Further investigation revealed two illuminating perspectives. One was the refreshingly acerbic and astute recollection of David Dumaresq when I asked him about Klein's influence in my education and research training. David was the convenor of the Human Ecology Program throughout my own 1997-2000 undergraduate studies and was the supervisor of my honours (1st class). He was also the convenor of the Human Ecology Seminar series I participated in from 2001-2007 and the PhD program I started in 2004 and submitted in 2009, after leaving the campus to work in government in 2007 (I'm now back in the university sector). My primary supervisor for the PhD, Valerie Brown, is also contributing to this article. David wrote:*

> *I would be interested in your recollection in this period Stefan, because to the best of my knowledge (and for the record), the program never explicitly used JTK's work in any of its formal teaching activities.... This is of itself remarkable.*

*He said he believed he would have referred to her work in passing in lectures, tutorials and workshops.*

> *Human Ecology forum discussions and presentations certainly referred explicitly to JTK around 2003-4 when Jacqui Russell and I were writing a piece on the philosophical and methodological basis for transdisciplinary human ecology and a program based within it for the 2004 Society of Human Ecology Conference in Utah.*

*He also wrote that he would expand on this in his own contribution to this article:*

> *What I explicitly used JTK's work for was to help me situate and defend Human Ecology's place in ANU as a transdisciplinary teaching and research program that bridged the social and the biophysical sciences, focused around the problematique of environment and sustainability.*

*Intrigued now, I had to dig deeper to find the aforementioned second perspective, because I definitely recalled talking and thinking about Klein's*

*ideas during my undergraduate studies and honours year (1997-2002). Despite that, as David reminded me, Human Ecology Program colleagues only began sharing work influenced by Klein's thinking from 2003-4. So I asked my mum if she remembered anything about Klein's work. Dr Virginia Kaufman Hall was the first PhD graduate of the University of Western Sydney's Social Ecology Program, under Professor Stuart Hill, in 1996. Her research explored the transformational impacts on organisations of women joining the workforce. Both my father, Byron Kaufman, a US advertiser expatriate from Boston, Massachusetts, and my mother (Australian born) had two simple but non-negotiable pieces of "advice" for my undergraduate course choices: 1) don't study anything you are not interested in just to get a job and 2) follow your interests and passion. A third element that Byron in particular was adamant about was that, regardless of what I studied, I understand the value of having qualifications from a respected university, an a-disciplinary pragmatism and reflexivity of knowledge in context that I suspect Klein would appreciate. Their advice aligned well with that of Professor Stephen Boyden (a seminal contributor to Human Ecology at ANU and globally). His advice to Human Ecology honours students, via Louis Pasteur, was "chance favours the prepared mind."*

*But back to Klein. Virginia commented:*

> *What I love about Klein's work and what I wanted you to be exposed to at the time of your studies in the early 2000s is that we were living through a fundamental change in the ways that knowledge was becoming more accessible through the Internet and changes in education.*

*She saw an opportunity in Klein's recognition of a new definition of interdisciplinarity for her doctorate studies and teaching in social ecology, saying "Klein offered a way to reframe problem contexts and bring in opportunistic approaches, to shift the old stuck thinking."*

> *Problem contexts are transient and problem solvers mobile. Emerging out of wider societal and cognitive pressures, knowledge is dynamic. It is stimulated by continuous linking and relinking of influences across a dense communication network with feedback loops. As a result, new configurations are continuously generated. (Klein, 1998. p. 26)*

*Virginia noted that:*

> *Klein's thinking, research and development activities were to me social ecology in action. I was excited that you leant towards the disciplines within Human Ecology and could learn in action with people like Val Brown et al.*

*So in an important sense, via my teachers and mentors, Klein was there at key points in my undergraduate studies, honours year, work for the ANU's cross-institute environment institute (Dyball, Beavis & Kaufman, 2005), establishment of "GreenSteps" at ANU (Kaufman, Symons & Bachar, 2006), PhD research, and later knowledge broker role in state government environmental protection (Curtis et al., 2017; Faulkner & Kaufman, 2017; Kaufman, 2010).*

*Thanks in part to Klein's influence, I have always sought to locate myself at intersecting boundaries, with a prepared, open, but critical mind. And her influence is there not least now, when I'm working to bridge sectors and disciplines in a multi-agency collaboration on behaviour change campaigns in waste and the circular economy, towards sustainability transitions, back home in Australia and, at the time of writing, undertaking a fellowship at the Institute of Advanced Sustainability Studies, Potsdam, Germany, exploring the potential of "rigorous storytelling" and extended peer review for evaluating the societal impact of transitions research (Davies & Dart, 2005; Funtowicz, 2001). Now, too, I find her work a useful guide (Klein, 2008).*

*In summary, although diffuse and multi-threaded, I can identify at least some exposure to and engagement with Klein's ideas in this personal history of choices in study, research and work. Through my account of this experience, I offer evidence of some of her contribution to transdisciplinary scholarship and practice in Australia in at least three university programs, as well as government policy and practice.*

*Klein's primary contribution for me personally is the attitude that pervades her writing: a calm, constructive certainty that, to the careful (and prepared) participant's mind, underneath the prickly edges of disciplinary and sectoral boundaries and barriers to entry, emergent order and structure are potentially discernible, if always evolving. For those of us compelled to work across and around boundaries, she offers the faith that transdisciplinary sense-making is possible and desirable. Despite substantial challenges to traditional knowledge generating (and using) institutions in adapting to transdisciplinarity, she offers good reason to believe that we can transcend and synthesise situated perspectives in order to tackle complex, pressing problems. And that we can, and must, do so without being trapped in any one perspective on these complex, unfolding situations we create, exist in and navigate.*

**Valerie Brown, Fenner School of Environment and Society, The Aus-**

**tralian National University**

*I have met Julie Thompson Klein three times while I have read her articles often. The first time we met, Julie was on the planning committee for a multi-disciplinary conference on integrated approaches to environmental issues. Other members of the committee were mono-disciplinary researchers. With great tact, Julie managed to convince the committee that integrated approaches might need more than a short summing up of individual papers. The second time we met was at the end of the conference where our job was to sum up the conference for the participants. Here Julie's strategic sense again came into play. She summed up the presentations perfectly, with due recognition of their contributions to integration, and with a twist that recognised the (large) number of times a paper was a specialised piece of work with a preliminary bow to the ideal of integration.*

*Our third meeting was by a video-link in which Julie made an appearance for an Integration and Implementation Sciences (i2S) conference. Julie, as so often in her publications, gave us all a clear understanding of the uses of inter-, multi- and trans- disciplinarity in research and practice (*https://www.youtube.com/watch?v=pKTi3ZPHEE0*). The clarity of her review was a joy to hear. It has been the touchstone for my own work in the transdisciplinary field of practice ever since.*

**Gabriele Bammer, Research School of Population Health, The Australian National University**

*Validation of budding ideas about interdisciplinarity was one of Julie Thompson Klein's earliest and greatest contributions to my work. I remember the excitement with which I discovered her book* Interdisciplinarity: History, Theory, and Practice *(Klein, 1990) and the legitimacy it gave to my thinking. My copy of her book still bears post-it flags from my first reading, marking key ideas including:*

- *the tension between interdisciplinarity as a "philosophically conceived synopsis" and as a practical concept (p. 42);*
- *the four kinds of interaction that constitute interdisciplinarity (p. 64);*
- *the importance of defining disciplines as well as interdisciplinarity (p. 104);*
- *thoughts on interdisciplinary teams (especially pp. 127 and 129).*

*These are all ideas that informed the development of Integration and Implementation Sciences (i2S; Bammer, 2013), although this was not always a*

*conscious process.*

*A second influence is intellectual generosity and is a key quality that I associate with Julie Thompson Klein. She is a strong advocate of the work of others and her writing and presentations are densely infused with the breadth of scholarship on inter- and trans- disciplinarity. (She quite rightly admonishes – mostly gently, but not always – those who are ignorant of the wheels they are reinventing.) Further, she seems tireless in responding to invitations to contribute to books, papers and conferences. I have valued her intellectual generosity in helping inform others of my work, as well as in contributing to writing projects and conferences that I have led. Her invited commentary on i2S (Klein, 2013) provided both an affirmation and a critique of the i2S ideas and extended them in a helpful way by introducing the notion of "the network as platform" (p. 429).*

*Third, Julie Thompson Klein does not just write about the network as platform, but is a strong supporter of, and participant in, initiatives that strengthen links among interdisciplinarity, transdisciplinarity and team science. In 2013 she provided an online opening keynote for the First Global Conference on Research Integration and Implementation, which is preserved on Youtube (*https://www.youtube.com/watch?v=pKTi3ZPHEE0*), and is also referred to in Valerie Brown's contribution above. Klein has also been a leading player in the development of various communities of practice, including the International Network of the Science of Team Science (INSciTS) and, most recently, the Inter- and Trans- disciplinary Alliance (ITD-Alliance). Further, she has provided valuable and well-cited blog posts (Klein 2016a, 2016b; Klein and Falk-Krzesinski, 2017b) for the Integration and Implementation Insights blog (http://i2Insights.org), which aims to connect a wide range of communities of practice. The reach of Klein's contributions in supporting INSciTS, ITD-Alliance and i2S is international rather than regionally confined. This automatically benefits researchers and educators in Australia and New Zealand who generally take a strong international perspective.*

## Conclusions

Two major conclusions can be drawn from the reflections presented above. The first is the striking diversity of Klein's influence on our work. The second is the value of the open qualitative process we have used to assess any researcher's (not just Klein's) impact.

Four key observations can be made about Julie Thompson Klein's contributions, even from such a small number of reflections. First, the breadth of

Klein's work that has been influential is noteworthy, with only a few overlaps cited among the different contributors to this article. Second, one overlap in particular warrants discussion, namely the common lessons drawn from Klein's ground-breaking 1990 book, *Interdisciplinarity: History, Theory, and Practice.* All three contributors who cited this work were struck by the richness of her depiction of interdisciplinarity and found this a useful platform for their own thinking.

Third, Klein's voice is authoritative because of her meticulous inclusion of the wide range of work on inter- and trans- disciplinarity and her ability to weave it into coherent narratives suitable for different audiences and contexts. This depth of scholarship provides comfort and legitimacy, especially to neophytes in search of a lexicon and scaffolding for bridging disciplinary divides. Finally, personal connection is not critical for Klein's influence to be felt but adds to it.

Regarding the second conclusion about the value of reflective narratives, they provide a rich picture of influence that cannot be gained from calculation of H factors and journal article citations. Allowing those reflecting to focus as they see fit on a particular person's contributions can uncover dimensions of influence that might otherwise remain hidden. In Julie Thompson Klein's case, the reflections demonstrate an influence on thinking and orientation that has been fundamental, but not easily citable, as shown in the contributions of Lorrae van Kerkhoff, Virginia Kaufman Hall, Cynthia Mitchell, Bruce Small, Stefan Kaufman and Gabriele Bammer. The reflections illustrate catalytic effects when Klein's ideas are combined with the ideas of others in particular educational and research settings, as described by Wendy Elford, as well as Chris Browne and Louise Blessington. They also show the practical value of her ideas in making sense of and/or shaping events and circumstances, highlighted by David Dumaresq and Valerie Brown.

It is also useful to see our reflections as recollections of particular learning moments prompted and/or supported by Klein's scholarship and practice. These learning moments can be linked to Bawden's (2000) three levels of critical learning systems that have the capacity to be self-reflective and adaptive: 1) learning about the situation at hand, 2) learning about how to learn, and 3) learning about the paradigmatic and worldview assumptions that frame the previous two levels, and exploring our own responses to these. We can see all three at play in our reflections: 1) using Klein's definitions and descriptions to learn about the situation at hand (van Kerkoff, Kaufman Hall, Small, Dumaresq, Kaufman and Bammer), 2) using Klein's scholarship on crossing boundaries, integration, and synthesis to provide prompts

and guidance (van Kerkhoff, Browne and Blessington, Mitchell, Dumaresq and Bammer) and 3) using Klein's work as permission to transcend one's own paradigms, as with van Kerkhoff's strategies for making sense of and responding to institutional challenges, Elford becoming "fluid," Browne and Blessington seeking to enable transformation in their students, and Kaufman adopting Klein's models to open the door to transformation.

As a group of authors we were surprised – pleasantly so – by the greater whole that emerged from the sum of our individual written parts, especially as some of us were not sure we had anything worthwhile to contribute when agreeing to participate. The result reminded us of assembling shards of glazed pottery into a mosaic.

Reflective narratives, of course, also have shortcomings, with biases resulting from the selection of contributors and the vagaries of memory being two that are immediately obvious. A few words about the selection of contributors to this article may be in order. There is no organised inter- or trans- disciplinary community in Australia or New Zealand and no one employed in Australia or New Zealand is currently a member of the Association for Interdisciplinary Studies (James Welch, personal communication, July 2018). The Australian Academy of Science was unable to provide a list of attendees at the 2004 Fenner Conference, at which Julie Thompson Klein was a keynote speaker. Instead two other participant lists were used: the participants at a 2004 Integration Symposium hosted by the now-defunct Land & Water Australia and the Australian and New Zealand participants at the 2013 First Global Conference on Research Integration and Implementation. Personal connections were a third source of invitees. The second list and personal connections yielded contributors. Of those approached, some did not respond, some said they did not know who Julie Thompson Klein is (with many adding that they would now look up her work), some could not identify strong influences based on her work and some were not able to contribute in the time available. In terms of a selection process for contributors of reflective narratives, this illustrates the challenges of attempting to draw a representative sample. But perhaps ensuring that the sample is representative is less important than ensuring that there are enough pieces to assemble a mosaic, recognising that such a mosaic is not only a product of the individuals involved, but also of the moment of writing. The same person writing at a different time, in a different context, may well contribute different shards to the mosaic.

As an aside, noting the non-respondents who were not aware of Klein's research led us to conclude that there is work to be done in strengthening inter- and trans- disciplinary scholarship in Australia and New Zealand.

Further the challenge of identifying likely contributors to reflect on Klein's influence demonstrates that the community of researchers and educators in inter- and trans- disciplinarity needs to be organised through a professional association or network. These were unexpected lessons from reflecting on Klein's contributions in Australia and New Zealand.

Additional lessons stem from the reflective narratives. Despite their limitations, reflective narratives provide an important complement to metrics measuring influence. Simple comparators based on limited dimensions (such as the number of publications in high impact factor journals) do not illustrate the unique strengths that each academic can contribute based on their specific attributes or the value of that diversity among researchers, educators and practitioners. Each of us brings a different set of knowledge, skills and personal qualities to our academic work. For some it is deep knowledge about particular methods, for others the focus is on concepts, still others can extrapolate from myriad cases, and so on. Some are qualitatively skilled, others are outstanding wordsmiths, others are expert at project design and more. Some are skilled in nurturing up-and-coming talent, others in working with senior leaders; some are good at starting projects, others at finishing them; some bring creative thinking, others attention to detail; and the list could go on. Metrics tend to focus on targets to reach or exceed, rather than affirming, valuing and capitalising on the wide range of individual differences that exist. And it is differences that are critical for good inter- and trans- disciplinary research, education and practice. It is combining differences that makes for richer understandings of problems and that yields new, creative insights for tackling them. This is the most important lesson that we have drawn from reflecting on Julie Thompson Klein's unique contributions.

***Biographical Notes:*** Gabriele Bammer is the founder of Integration and implementation Sciences (i2S), which aims to link researchers tackling complex societal and environmental problems. She curates the popular Integration and Implementation Insights blog (http://i2Insights.org). She is also a professor in the Research School of Population Health at The Australian National University. She can be reached at Gabriele.Bammer@anu.edu.au.

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**References:**

Bammer, G. (2013). *Disciplining interdisciplinarity: Integration and implementation sciences for researching complex real-world problems*. Canberra: ANU Press. http://dx.doi.org/10.22459/DI.01.2013

Bawden, R. (2000) Valuing the epistemic in the search for betterment: The nature and role of critical learning systems. *Cybernetics and Human Knowing, 7*(4), 5-25.

Boulton, G., & Lucas, C. (2008), *What are universities for?* Belgium: League of European Research Universities.

Curtis, J., Graham, A., Ghafoori, E., Pyke, S., Kaufman, S., & Boulet, M. (2017). Facilitating adaptive management in a government program: A household energy efficiency case study. *Journal of Environmental Management, 187*(February), 89-95. https://doi.org/10.1016/j.jenvman.2016.11.033

Davies, R., & Dart, J. (2005). *The "most significant change" (MSC) technique: A guide to its use*. Retrieved from *https://mande.co.uk/wp-content/uploads/2018/01/MSCGuide.pdf*

Dyball, R., Beavis, S., & Kaufman, S. (2005). Complex adaptive systems: Constructing mental models. In M. Keen, V.A. Brown, & R. Dyball (Eds.), *Social learning in environmental management: Towards a sustainable future* (pp. 41-59). Sterling, VA: Earthscan.

Elford, W. (2011). *Using narrative in ergonomics research and practice.* Paper presented at the HFESA 47th Annual Conference, Sydney. http://www.ergonomics.org.au/downloads/EA_Journals/2011_Conference_Edition/Elford_W.pdf

Elford, W. (2012). A multi-ontology view of ergonomics: Applying the Cynefin framework to improve theory and practice. *Work*, *41*(Supplement 1), 812-817. https://doi.org/10.3233/WOR-2012-0246-812.

Faulkner, N., & Kaufman, S. (2017). Avoiding theoretical stagnation: A systematic review and framework for measuring public value: Measuring public value. *Australian Journal of Public Administration.* May. https://doi.org/10.1111/1467-8500.12251

Funtowicz, S. (2001). Peer review and quality control. In *International encyclopaedia of the social and behavioural sciences* (pp. 11179-11183). Retrieved from http://www.andreasaltelli.eu/file/repository/PeerRevieQualityControl_1.pdf

Glassick, C. E., Huber, M. T., & Maeroff, G. I. (1997). *Scholarship assessed: Evaluation of the professoriate*. San Francisco: Jossey-Bass.

Head, B., & Alford, J. (2008). *Wicked problems: The implications for public management.* International Research Society for Public Management 12th Annual Conference.

Hesse, H. (1943, 2000) *The glass bead game.* (R. & C. Winston, Trans.). Vintage Books.

Huutoniemi, K., Klein, J. T., Bruun, H., & Hukkinen, J. (2010). Analyzing interdisciplinarity: Typology and indicators. *Research Policy*, *39*(1), 79-88. https://doi.org/10.1016/j.respol.2009.09.011

Kaufman, S. (2010). Rising above hot air: A method for exploring attitudes towards zero-carbon lifestyles. In I. Jubb, P. Holper, & W. Cai (Eds.), *Managing climate change: Papers from the Greenhouse 2009 Conference* (pp. 223-236). Collingwood, Vic.: CSIRO http://site.ebrary.com/id/10620347

Kaufman, S., Symons, W., & Bachar, Z. (2006). The green steps program: Fostering environmental change agents. In W.L. Filho (Ed.), *Sustainability in the Australasian university context* (pp. 91-106). Frankfurt am Main: Lang.

Klein, J. T. (1990). *Interdisciplinarity: History, theory, and practice*. Detroit: Wayne State University Press.

Klein, J. T. (1998). Notes toward a social epistemology of transdisciplinarity. *Interactive Bulletin of the International Center for Transdisciplinary Research and Studies*, no. 12. http://ciret-transdisciplinarity.org/bulletin/b12c2.php.

Klein, J. T. (1999). *Mapping interdisciplinary studies: The academy in transition*. Washington D.C.: Association of American Colleges and Universities.

Klein, J. T. (2004a). Interdisciplinarity and complexity: An evolving relationship. *Emergence: Complexity & Organization*, *6*(1-2), 2-10. doi: 10.emerg/10.17357.5b032d0fdc094281a75e3ff2f998d161

Klein, J. T. (2004b). Prospects for transdisciplinarity. *Futures*, *36*(4), 515-526.

Klein, J. T. (2006) Afterword: The emergent literature on interdisciplinary and transdisciplinary research evaluation. *Research Evaluation, 15*(1), 75-80.

Klein, J. T. (2008). Evaluation of interdisciplinary and transdisciplinary research: A literature review. *American Journal of Preventative Medicine*, *35*(2S), S116-S123.

Klein, J. T. (2010). *Creating interdisciplinary campus cultures: A model for strength and sustainability.* San Francisco: Wiley & Sons.

Klein, J. T. (2013). When the network becomes the platform. Commentary in G. Bammer (Author). *Disciplining interdisciplinarity: Integration and implementation sciences for researching complex real-world problems* (pp. 427-430). Canberra: ANU Press. http://dx.doi.org/10.22459/DI.01.2013

Klein, J. T. (2016a). Integration, part 1: The "what" [Blog post]. Retrieved from https://i2insights.org/2016/08/30/what-is-integration/

Klein, J. T. (2016b). Integration, part 2: The "how" [Blog post]. Retrieved from https://i2insights.org/2016/09/06/how-to-do-integration/

Klein J. T. (2017) Transdisciplinarity and sustainability: Patterns of definition. In D. Fam, J. Palmer, C. Riedy & C. Mitchell (Eds.), *Transdisciplinary research and practice for sustainability outcomes* (pp. 7-21). London: Routledge.

Klein, J. T., & Falk-Krzesinski, H. J. (2017a). Interdisciplinary and collaborative

work: Framing promotion and tenure practices and policies. *Research Policy*, *46*(6), 1055–1061. https://doi.org/10.1016/j.respol.2017.03.001

Klein, J. T., & Falk-Krzesinski, H. J. (2017b). Promotion and tenure policies for interdisciplinary and collaborative research [Blog post]. Retrieved from https://i2insights.org/2017/10/10/interdisciplinarity-promotion-and-tenure-policies/

Klein, J. T., & Newell, W. H. (1996). Advancing interdisciplinary studies. In J. G. Gaff, J. L. Ratcliff, & Associates (Eds.), *Handbook of the undergraduate curriculum. A comprehensive guide to purposes, structures, practices, and change* (pp. 393-415). San Francisco, CA: Jossey- Bass.

Mitchell, C. A., & Willetts, J. (2009). *Quality criteria for inter- and trans-disciplinary doctoral research outcomes*. Sydney, Australia: UTS, Institute for Sustainable Futures.

Willetts, J. R., & Mitchell, C. (2017). Assessing transdisciplinary doctoral research: Quality criteria and implications for the examination process. In D. Fam, J. Palmer, C. Riedy, & C. Mitchell (Eds.), *Transdisciplinary research and practice for sustainability outcomes* (pp. 122-136). London: Routledge.

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# The Impact of Julie Thompson Klein's Interdisciplinarity: An Ethnographic Journey

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***Abstract:*** Throughout 2018 we had the privilege of engaging with Julie Thompson Klein using an ethnographic approach combining interviews via teleconferencing and email exchanges to discuss many aspects of her work with the goal of understanding how she herself views her scholarly evolution over the past five decades. Discussions about Klein's life quickly became intertwined with stories about her work, and the process of capturing details of her intellectual journey resulted in a collection of commentaries in which biography could not be easily separated from review of her scholarly output. In this article, we decided to foreground the richness of the dialogue we have so enjoyed in which there has been a fusion of the two kinds of content, incorporating Klein's reflections to illuminate some of the central themes of her entwined personal and academic trajectories. We have chosen to organize the material into three categories that we see as primary areas of focus for her and her work over the years: interdisciplinary educational activities, contributions to the professionalizing of interdisciplinarity, and discourse on teams. Whenever possible, we quote Klein directly in her own words (printed in italics) to facilitate our overview of these areas.

***Keywords:*** collaborative work, digital humanities, interdisciplinarity, Julie Thompson Klein, team science, transdisciplinarity

## Introduction

Throughout 2018 we had the privilege of engaging with Julie Thompson Klein through interviews, casual conversations, and emails to discuss many aspects of her work with the goal of understanding how she herself views her scholarly evolution over the past five decades. We took a standard ethnographic interviewing approach, attempting to capture both artifacts and meaning embedded in the evolution of Julie's nearly 50-year career (Creswell, 2007; Spradley, 2016). Interviews were conducted via teleconferencing through Zoom (www.zoom.com) using a LiveScribe 3 Pen that captures voice recordings and pairs them with handwritten notes (www.livescribe.com). The digital audio recordings were transcribed using www.Rev.com and then used to reconstruct conversations, capture quotes, and analyze for themes embedded in the data (Maxwell, 2005). In addition, email exchanges were utilized so that Klein could provide written responses to various questions. The line of questioning was semi-structured and partly co-developed through casual conversations about main areas of interest that would later be organized into the written presentation of the data. Member-checking of data was exercised throughout the process and the presentation of data in this article is the result of verification from the participant for inclusion and accuracy (Miles & Huberman, 1994).

Upon the onset of this project, discussions about Klein's life quickly became intertwined with stories about her work, and the process of capturing details of her intellectual journey resulted in a collection of commentaries in which biography could not be easily separated from review of her scholarly output. In this article, we decided to foreground the richness of the dialogue we have so enjoyed in which there has been a fusion of the two kinds of content, incorporating Klein's reflections to illuminate some of the central themes of her entwined personal and academic trajectories. We have chosen to organize the material into three categories that we see as primary areas of focus for her and her work over the years: interdisciplinary educational activities, contributions to the professionalizing of interdisciplinarity, and discourse on teams. Whenever possible, we quote Klein directly in her own words (printed in italics) to facilitate our overview of these areas.

## Interdisciplinary Educational Activities

The 1970s and 80s were a time in Klein's life when she explored the boundaries of her own disciplinary experiences in English studies. This era of experimentation propelled her work into the realm of interdisciplinarity,

the sphere central to the whole body of work for which we have come to recognize her today. In the late 1970s, she was a Visiting Foreign Professor at Shimane University in Matsue, Japan. She stated that this appointment was a *one-year leave from [her] standing appointment at the English Department at Wayne State.* Klein recalls this year fondly, as it *spoke [to her] professed sense of adventure.* Her Fulbright a decade later, at the Tribhuvan University in Nepal, along with her assignment as an Academic Specialist for the U.S. Information Agency in Kathmandu, is another example of experience that appealed to her adventurous spirit. Klein reflects,

> *My Fulbright was in an English Department, so it was based strongly in language and literature. My colleagues were interested in developing American studies, including a master's degree, but resources were short and teacher preparedness another problem. The traditional curriculum was longer on rote learning than innovation.*

Her desire for adventure was not limited to world travel. She began to travel into uncharted territories on the home front, as well. The most significant activity from this era and the one that most clearly affected Klein's scholarly trajectory was the launch of the Wayne State University (WSU) Interdisciplinary Studies Program (ISP) (first known as the University Studies/Weekend College Program or USWCP). It was an outlet that allowed Klein to break free from some of the less experimental curricular trends of the time, thus enabling her to dedicate her time to more innovative endeavors. Klein's work on this program, beginning in the mid 70s, launched one of the main themes of her career: designing interdisciplinary education. The program served a population of adult learners with an undergraduate curriculum modeled on curricula for interdisciplinary general education and liberal arts programming that had begun to be offered by some other institutions, with courses drawn from humanities, social sciences, and science and technology, followed by a senior capstone year. This curriculum reflected some of the trends that were apparent in new interdisciplinary fields such as "black, women's, ethnic, environment, urban, science, technology, and cultural studies" (Furtado et al., 2009, p. 69). These developments foreshadowed a growing interest in interdisciplinarity as a means of grappling with societal and cultural issues of the day, an interest Klein soon came to share.

In the wake of the university's termination of the Monteith College program, established in 1959 and closed in 1973, the innovative USWCP program was designed for working adults in the Detroit metro area. The program utilized an almost exclusively open enrollment policy, and those initially enrolled were predominantly African American. It continued the mission of the Monteith program by offering

> alternative, interdisciplinary, humanistic curriculum-centered undergraduate degree programs [like those usually offered to] traditional college-aged students…to a self-selected group of [non-traditional] students ideally suited to a challenging interdisciplinary curriculum that [focused] on historical to contemporary issues, problems and topics. (Furtado et al., 2009, pp. 68-69)

Later, the faculty also developed a master's program modeled on other programs offering interdisciplinary liberal education to post-graduates. Eventually, to reflect greater recognition by the university, the program dropped the "Weekend College" label, was renamed the Interdisciplinary Studies Program (ISP), and gained department designation.

Over the course of these early years in Klein's career, despite continuing questions about the place of interdisciplinarity in undergraduate degree programs and the value of the contributions of faculty who dedicated time to interdisciplinary studies, Klein and others were dedicated to advancing integrative approaces to fulfill the "urban mission" of the university. As the status of other university priorities increased, however, that of its "urban mission" began to wane. Interdisciplinary studies programs and faculty members, at this point in time, at Wayne State and even on liberal arts campuses, did not escape intense scrutiny and skeptical critique, according to Klein:

> *The USWCP and its faculty were disrespected because of the near open-enrollment status, bias against interdisciplinary general/liberal education, and, many faculty believed, its dominant African-American population despite institutional lip service to an "urban mission." Our prioritizing of teaching also paled in comparison to tenure and promotion policies favoring research and publication in a R1 research university.*

Despite the scrutiny and negative attitudes, Klein believes the interdisciplinarity of the ISP had an impact not only in the application of interdisciplinary studies to real-world local problem solving, but also in re-characterizing the relationship between instructors and students. The program made the educational experience more student-centered, emphasizing collaborative course design, active learning, and learning based on multicul-

turalism (Furtado et al., 2009). Such contextual learning, based in the real experiences of adults and their local community involvement, became a hallmark of the program and relationships were forged with labor unions, public works, private industry, government agencies, community service organizations, and in particular the State Prison of Michigan in Jackson, MI. This synergy among interdisciplinary thought, curriculum development, and application of learning in community settings was an important factor in shaping Klein's subsequent thinking about the confluence of academic and community perspectives for understanding complex social problems. It was a vehicle to continue to create and promote interdisciplinarity in the context of active learning course design. These developments, though not always appreciated by all, were how innovative thought became the impetus for innovative education:

> *Since we created the curriculum from the ground up our work was heavy on curriculum development and teaching, in a research university that did not value that kind of work for tenure and promotion. Over time we developed a roster of courses but also kept designing new ones for approval in the university's revised general education program and the new ISP master's degree. The era of curricular reform was an initial "wind at our backs" but so, more profoundly, was a university president's introduction of a new College of Lifelong Learning that would serve "adults" in the student population and offer courses in locations throughout the Detroit Metro area (and even in Jackson prison). The majority of early students were also veterans who had educational benefits at the time, resulting in a high number of students but uncontrolled growth at times…[Subsequently], there was a heightened focus on instrumental interdisciplinary problem solving in research. Wayne State's later priorities are no surprise given national trends. There was never a focused commitment to a research agenda. The interest in interdisciplinary problem solving was centered on study of societal problems, especially in the social science division.*

The program and the work conducted at the ISP were a result of the reform era of educational experimentation during the 1960s and 1970s that bolstered interest in the usefulness of interdisciplinarity as a means of solving problems although, Klein notes, the Wayne State program *did not engage to any significant degree in the kind of hands-on problem solving [that characterizes some] curricula today*. After enjoying a rich tenure of 34 years dedicated to interdisciplinary education, the department was dismantled in 2007. The program itself continued briefly; however, despite its long history

of high local impact and relevance, it was also eventually discontinued:

> *Departmental status was demoted to program status prior to termination by Wayne State University at a time when the university was courting a "better quality" of students. Colleagues and I [Furtado et al., 2009] joined in publishing an analysis of the program's history and reason for termination.*

As Klein and her colleagues explained in their analysis, several factors beyond the financial constraints the university was struggling with contributed to the downfall of the ISP. There were new cuts in veterans' educational benefits that had supported many of the local enrollees. The program experienced reduced enrollment over the 80s and 90s. Moreover, though no a cause of the downfall, there was a shift in composition of the student population from blue-collar working adults to more white-collar management personnel from key industries, such as telecommunications, the insurance industry, and the public sector.

**Contributions to the Professionalizing of Interdisciplinarity**

Klein has stated that her scholarly interest in interdisciplinarity arose from teaching in the Wayne State interdisciplinary program, experience that served as a foundation for ongoing critical analysis of the role of interdisciplinary and, later, transdisciplinary studies in higher education. Intellectual questions surrounding the nature of interdisciplinarity piqued her curiosity and led to her decades-long program of research. Her efforts developing educational frameworks that incorporated interdisciplinarity resulted in a series of seminal publications that aimed to encourage change in the structuring of modern university programming.

In *Interdisciplinarity: History, Theory, and Practice,* published in 1990, Klein explored the broad background of the concept of interdisciplinarity and its application. Klein (1990) emphasized the importance of definition and the description of practices and ultimately, the relationship of interdisciplinarity to disciplinarity as it had come to be understood in the latter 20th century.

In her 1996 book, *Crossing Boundaries: Knowledge, Disciplinarities, and Interdisciplinarities,* Klein developed her early thoughts about boundary work, the differing claims on the definition and value of interdisciplinarity, and a conceptual framework for understanding, studying, and supporting interdisciplinary practices. Klein (1996) also presented a comprehensive account of developments in two major areas: "Critical Interdisciplinarity," which interrogates the existing structures of knowledge and education with

the aim of transforming them, and "Instrumental Interdisciplinarity," which typically focuses on pragmatic problems that need solving. She also explained the increasing complexity and dynamism of interdisciplinary and disciplinary relationships while presenting updated case studies of interdisciplinary fields, interdisciplinary genealogy in literature studies, and growing related movements in science and technology, including biomedicine and engineering (Klein, 1996). Now, in 2019, Klein notes that the field has evolved to such an extent that

> *[the term "interdisciplinarity"] is no longer adequate to describe the plurality and complexity of crossing boundaries today. Even though the term continues to be an umbrella label, research and education are crossing divisions of not only disciplines but also interdisciplinary fields, and sectors of society including government, industry, and local communities. "Boundary work" is a composite label for claims, activities, and structures by which individuals and groups work directly and through institutions to create, maintain, break down, and reformulate between knowledge units [Klein, 2019].*

Her 2005 book, *Humanities, Culture, and Interdisciplinarity: The Changing American Academy,* examined historical contexts and perspectives on interdisciplinary theory and practice (including formation of the generalist model and new interdisciplinary conceptions, changing internal academic and external influences, and the expanded presence of interdisciplinarity as a field of study). It included case studies (with an updated account of literary studies plus studies of visual and aural domains typically included in literary analyses), and it discussed the interdisciplining of the study of America (in fields of American, black, and women's studies with a comparison to Canadian studies) (Klein, 2005).

With regard to these books, Klein states,

> *The methodology of [the] three books is itself interdisciplinary, combining historical, rhetorical, and sociological analysis. Historiographical analysis uncovers genealogies of origin, benchmark events, periodization, and tensions between continuity and change. Sociological analysis examines how knowledge is codified in conditions of group membership and sanctioned practices. Rhetorical analysis dissects the claims by which people construct a field, patterns of consensus and difference, and the ways keywords and taxonomies structure hierarchies of value. These methods are not isolated. In the manner of Michel Foucault's [1969] genealogical studies of knowledge, historiography considers how discursive objects, concepts, and strategies produce regularities, rules, and*

> *unities that are challenged by ruptures, re-figurations, and transformations. In the manner of Pierre Bourdieu's [1993] studies of the academic sphere, questions about power, conflict, and change arise in tracking the production, circulation, and institutionalization of knowledge. And, in the manner of Tony Becher's [2001] studies of disciplinarity, tracing historical and rhetorical patterns also entails an anthropological interest in how influential figures, artifacts, and literature establish cognitive authority, reputational systems, cultural identity, and symbolism.*

We asked Klein to elaborate on how the works of Foucault (1969), Bourdieu (1993), and Becher (2001) influenced her research and the development of her theoretical constructions, particularly in her later writings:

> *Great question. My colleagues in humanities were shocked as I moved more toward social sciences to explain questions of power in institutionalizing interdisciplinary practices. Foucault helped me explain the politics of disciplinarity, Bourdieu patterns of power in the academy, and Becher a more heterogeneous understanding of disciplinary formations. This… reminds me of a conversation I had with Joseph Kockelmans once. He commented [that] the figures I cited were not the same as he would have chosen to frame interdisciplinarity, given his background as a philosopher who grounded thinking about interdisciplinarity in the work of philosophers. I reached more broadly across other theories and practices. To cite another example [of what others have done], the Association for Integrative [and, latterly, Interdisciplinary] Studies (AIS) has continued to prioritize the thinking behind Allen Repko's [Repko & Szostak, 2016] textbook for [those undertaking] individual student projects, which frames [a] definition of interdisciplinarity grounded in the concept of common ground emanating from interdisciplinary teaching and curriculum development. I reached more widely into research and team-based collaboration. Doing so expanded my purview to include the European-based notion of trans-sector transdisciplinarity and the U.S.-based notion of team science, here again underscoring the heterogeneity of interdisciplinarity while distinguishing my descriptive approach from prescriptive ones. I would not point to [Foucault, Bourdieu, and Becher] specifically as much as I would monitoring growing priorities of what I have defined as "Critical Interdisciplinarity" versus "Instrumental Interdisciplinarity": pitting critique and problem solving against each other as motivations. I carried earlier questions of power*

> *and definitions of disciplinarity into expanding arenas of inter- and trans-disciplinary discourse.*
>
> *I have written about "Critical Interdisciplinarity" in books that post-date the 1990 initial study, including pertinent sections. . .of* Crossing Boundaries: Knowledge, Disciplinarities, and Interdisciplinarities *[1996] and* Interdisciplinarity: Interdisciplining Digital Humanities; Boundary Work in an Emerging Field *[2015]*, *and my chapter in the 2017* Oxford Handbook of Interdisciplinarity [2017]. *It is also a major thread in my forthcoming book on boundary work [2019]*.

So, for Klein, what is the unfinished agenda of the discourse on higher education and interdisciplinarity? The agenda is not so much "unfinished" as it is "evolving," an argument Klein presented in Paris in 2018 in a keynote address on "Beyond Interdisciplinarity: Changing Scales and Spaces," at a conference on "Politiques et pratiques de L'interdisciplinarité"*:*

> *I ground [the agenda] in linguistic understanding of the changing semantics of meaning in use of words. I am working right now with a number of calls for future scholarly focus that might be worth embellishing. They reinforce the current heterogeneity, relationality, and intersectionality of the core concept. This expanded thinking is at the heart of my new book on boundary work [2019], where I emphasize understanding the nature of cross-disciplinary work by "listening" to the heterogeneity of practices and interests. There are cross-sections but also significant differences such as the imperative of pragmatic problem solving versus critique and versus epistemology. Heterogeneity challenges universalist theories that posit a "true" or "genuine" meaning of interdisciplinarity in favor of a spectrum. Relationality and intersectionality call attention to shared imperatives and alliances across fields, for example, problem solving in health and in environmental research as well as shared cultural agendas of cultural studies, women's studies, postcolonial studies, and other such fields. Intersectionality also recognizes that the academy is not the sole space of cross-disciplinary work. It intersects with interests in government, business, and the public sphere [2018a]*.

For more than five decades, Klein has been particularly committed to connecting and disseminating the diversity of ideas around interdisciplinarity. Consequently, she has been a key voice in shaping and linking many communities of practice that have emerged around interdisciplinarity. As she

developed her expertise in interdisciplinary pedagogy in the 70s and 80s and beyond, a multitude of such communities were working to establish norms for interdisciplinary studies as a focused area of study and not just a philosophical method in designing education. Klein's publications, even those that preceded the big book in 1990, provided much guidance in this area, helping to establish best practices for interdisciplinary work in teaching and research. Klein also devoted countless hours to networking and interfacing with scholars and practitioners dedicated to the philosophy of interdisciplinarity and the development, administration, and evaluation of interdisciplinary programs in higher education (Doty & Klein, 1994; Klein, 1999, 2002; Lenoir & Klein, 2010).

Klein's early work in the field came at a time when the inklings of the scholarly field of interdisciplinarity were being pulled together. AIS (the Association for Integrative Studies as it was then) began to form as the 80s approached, and by 1979 an initial cast of characters had created the association, built around sharing best practices for interdisciplinary pedagogy. In 1983, Klein joined the association. In one of its initial editions, the journal of the association (*Issues in Integrative Studies* as it was then) served as an outlet to disseminate an important piece by Klein titled "The Dialectic and Rhetoric of Disciplinarity and Interdisciplinarity" (Klein, 1983). Reflecting on that first piece she wrote for *Issues*, Klein says,

> *You could call it [my] first publication within a dedicated community of practice. To recall, I started writing about theory and practice of interdisciplinarity because I was curious about their legitimacy, from both intellectual and political standpoints. Being in a disrespected ID program for adult learners, with a strong teaching mission and majority African-American population, was certainly a prompt in a research university. We were regarded as pariahs at the time, all the more striking given interdisciplinarity became a valued priority decades later (and I more valued as a result because of my expertise).*

By 1984, Klein was involved in the leadership of AIS as an at-large member of the board of directors. In succeeding years, she served as vice president, president-elect, and president in 1987-88. Of Klein's role in the early association (as in the many years since), her long-time colleague at Wayne State and in AIS, Roz Schindler, has commented,

> Her networking, initiating, consulting, editing, and supporting of interdisciplinarians and interdisciplinary programs have been just as important as her research, even though they often take place out of the limelight….A major aspect of her contribution to AIS has been networking with other associations, organizations, and

> groups, not just individual scholars. (Schindler, 2014)

Of course, Schindler did also comment on the importance of Klein's networking with individual scholars, both inside AIS and out. There's no doubt that her overall approach to the formation of knowledge is highly collaborative, between individuals as well as groups, and across institutional types, national boundaries, and divergent perspectives, including fledgling academics as well as seasoned scholars. And the vast majority of these efforts have been highly individualized, involving face-to-face discussions, phone calls, or emails, and requiring an enormous amount of time and effort (Schindler, 2014). If the Association for Integrative Studies (which became the Association for Interdisciplinary Studies in 2013) has had a wide impact on the evolution of interdisciplinarity, helping to establish best practices for interdisciplinary pedagogy and curricular design in addition to establishing a community for sharing resources, in turn influencing a plethora of degree programs, Klein's efforts have had much to do with that impact. AIS has twice recognized the value of her work with its highest awards, the Boulding Award in 2003 for outstanding long-term contributions to interdisciplinary studies and the Newell Award in 2014 for exemplary service to the association.

It is perhaps because Klein is a true interdisciplinarian that her impact has been as broad-reaching as it has. She has brought people with varied expertise and interests together, and her service has spanned communities that might not have otherwise had much overlap. As Schindler has further explained,

> [H]er consulting on interdisciplinarity was not limited to the U.S. but was worldwide….Nor was her consulting focused solely on general education, or even on education as a whole; it also included interdisciplinary research and administration, and emerging interdisciplines as well. In these diverse consultations, she has drawn not only upon the work of AIS but also of GRIP – Group for Research into the Institutionalization and Professionalization of Literary Studies (focused on disciplinarity), HASTAC (focused on digital humanities), INTERSTUDY (focused on interdisciplinary research), Science of Team Science (focused on interdisciplinary team research), td-net (focused on transdisciplinary studies), and other professional groups in which she gained prominence over the last three decades. (Schindler, 2014)

In the 2000s, Klein's impact on interdisciplinary studies worldwide became increasingly visible in a variety of contexts. Klein's newer work was gaining influence in multiple fields and communities of practice. And along

with greater recognition of the value of her previous work, it generated national and international awards and accolades that highlighted her passion, commitment, and dedication. Besides the aforementioned top awards from AIS, these honors included her induction into the Wayne State Academy of Scholars; her receipt of the College of Urban, Labor, and Metropolitan Affairs Teaching Award; her receipt of an award recognizing her graduate mentoring; her receipt of the Joseph Katz Award for Distinguished Contributions to the Practice and Discourse of General and Liberal Education; and her visiting distinguished scholar appointment in the Centre de recherche sur l'intervention educative, Université de Sherbrooke, Quebec.

As a testament to the widespread influence of her ideas (the extension of her educational pioneering), Klein was invited to share her work with many different audiences across a variety of venues, including the Task Force on Accreditation (of AIS) and the National Task Force on Integrative Learning (of AAC&U). Speaking engagements around the world, as in Canada (Sherbrooke Institute), Switzerland (Mutual Learning Session on Theory and Method), and Mexico (Seminario Internacional: Diálogos Sobre la Interdisciplina Observatoire des Réformes Universitaires or ORUS) served as vehicles for her influence to reach an international audience. This period of Klein's life allowed her to further explore the potential of her scholarship, too, propelling the evolution of her own thoughts in which she continued to make novel connections:

> *I have learned from every experience, not just performing related duties but testing my evolving ideas with different audiences. The context at Sherbrooke, for example, included a didactic tradition of school education as well as medical practices. Later as a Visiting Fellow at University of Michigan Institute for the Humanities and as a Mellon Fellow and Visiting Professor of Digital Humanities my focus was on the emerging field of digital humanities. The keynotes [associated with these invitations] have also spanned facilitating institutional practices, designing and teaching education programs of varied types from general/liberal education to specific interdisciplinary fields, and supporting research agendas increasingly focused on societal problems.*

Klein's dedication to intertwining various perspectives became increasingly visible as the 2000s progressed and as her work progressed, continuing to impact key interdisciplinary fields beyond interdisciplinary studies, most notably digital humanities and the Science of Team Science (SciTS). In 2005, in the first full-length investigation of the triangulation of the three keywords found in the title of her book *Humanities, Culture, and Interdisci-*

*plinarity: The Changing American Academy* (Klein, 2005), Klein presented a "new interdisciplinarity" in humanities, as proposed by Kaplan and Levine (1997), a version of ID that questioned not only the canon and curriculum but also the larger organization of knowledge and hierarchies that govern both intellectual and political lives. When we asked her about the changing landscape of digital humanities and its connections with interdisciplinarity, a subject she addressed at length in her 2015 book, *Interdisciplining Digital Humanities: Boundary Work in an Emerging Field*, Klein responded,

> *My goal was to test the widespread claim that digital humanities is interdisciplinary by examining the boundary work of establishing, expanding, and sustaining a new field. [The] five years [between now and my research for my last book on the subject] is a short time to gauge change, despite the widespread rhetoric of "revolution" and "transformation." Yet, digital tools, concepts, and environments have continued to expand. Dating from computational linguistics, electronic text production, and digital collections in the mid-20th century, the field of digital humanities underwent a sea change with the advent of the Internet. It now encompasses new digital-born objects, forms of scholarship, and publication, new areas such as gaming studies, critique of the impact of the computer on behavior and culture, and a new rhetoric and epistemology of Making.*
>
> *Yet, challenges to sustainability, infrastructure, and preservation of digital content continue. They stem from the weakened funding climate in humanities, conservative policies for publication as well as tenure and promotion, lack of common standards and evaluation criteria, resistance to interdisciplinary innovation, and uneven development across disciplines, fields, and institutions. Differing priorities also occur across instrumental work focused on producing tools and critiques of digital media and culture. A large part of my research, then, tracked trajectories of different histories, methodologies, theoretical positions, schools of thought, and institutional locations. Keyword clusters were valuable means of defining both their particularities and their relationalities. I also examined the dynamics of integration and collaboration in trading zones of expertise and communities of practice. Finally, in answer to the question of whether digital humanities is an interdisciplinary field, I concluded a triple efficacy is unfolding across disciplines, interdisciplinary fields, and professions; within and across their*

> *institutional locations; and within and across all organizations and groups that are grappling with implications of digital technologies and new media.*

In further exchanges about interdisciplinary and digital work, we asked Klein questions about how the changing academic environment along with the unchanging inherent constraints in the American education system affects work in those areas and the need for "interdisciplinary spaces":

> *I like your use of the term "interdisciplinary spaces" since the contexts in which interdisciplinary and digital work occur are numerous. My 2010 book* Creating Interdisciplinary Campus Cultures: A Model for Strength and Sustainability *[Klein, 2010] explored many of the challenges scholars face and strategies for responding. More recently, Holly Falk-Krzesinski and I [Klein & Falk-Krzesinski, 2017] co-authored an article on framing promotion and tenure for interdisciplinary and collaborative work. We cite numerous studies and models including. . .the University of Southern California revised documents on counting digital scholarship as well as related policy statements of the Modern Language Association (MLA) and the American Psychological Association (APA).*

We should note that the 21st century has seen an acceleration of "interdisciplinary spaces" and education programs, especially in international, women's, ethnic, and biomedical and environmental studies, though we might also note that American cultural studies have lacked the same growth (Brint, Proctor, Murphy, Turk-Bicakci, & Hanneman, 2009).

Of course, broader questions exist about the future of interdisciplinarity in higher education. We asked Klein to address these questions, too, and she was quick to emphasize that, in spite of the challenges involved, such as those she explored in her 2010 book and has explored since, there are exciting new directions on the horizon and much hope for the future:

> *In her book* The New Education*, HASTAC co-founder Cathy Davidson [2017] highlights both the challenges facing higher education and strategies for responding. The challenges include adjunctification of teaching labor accompanied by deprofessionalization of the faculty, rising tuition costs and student debt, narrow prioritizing of STEM and reductive skills training, corporatization of the university, and extremes of technophobia and technophilia. Formidable though the challenges are, Davidson argues we are at a tipping point for change, supported by models and strategies in a variety of institutions. Their common denominator is moving beyond narrow skills training to help students navigate their futures*

> *by understanding the complexity of the world they live in, coping with change by learning how to learn, steering between technophilia and technophobia, and cultivating a new literacy grounded in skills of deep and critical thinking, communication and collaboration, [and] cross-cultural understanding. They are capable of having "palpable impact," though not by jettisoning everything but by keeping what works well while shedding inherited features and practices that make it difficult to prepare students for [the] future: "unbundling" and "rebundling" practices.*

Klein further notes,

> *Other HASTAC members have…fostered two powerful concepts that are exciting: "mobilizing networks" and "spatializing practices." In* The Future of Learning Institutions*, Davidson and David Theo Goldberg [Davidson & Goldberg, 2010] proposed a definition of institutions as "mobilizing networks," characterized by traits [Davidson] echoes in her new book: including horizontal structures that flatten expert authority, a shift from predetermined expert authority to collective credibility, decentering pedagogy, networked learning through social engagement and cooperation, and [a] conception of learning based on connectivity and interactivity. HASTAC colleague Anne Balsamo [Balsamo, 2011]…also echoed Michel de Certeau in distinguishing "place" from "space." A place such as a university or school has stable boundaries and a fixed location. Space [like the "interdisciplinary space" discussed above] is "a practiced place" created by actions Balsamo calls "spatializing practices."*

**Discourse on Teams**

Klein's contributions in both interdisciplinary education and cross-disciplinary theory and application, as well as her emphasis on communication, naturally have positioned her to become an important voice in the emerging field of team science. The Science of Team Science (SciTS) community is dedicated to thinking about how teams tackle complex and global problems using a variety of scholarly insights about team dynamics and functions. The field is grounded in psychology, organizational science, the humanities, social psychology, management, leadership, and philosophy, among other disciplines, grounding that makes it prime for applying the collaborative brand of interdisciplinarity that Klein advocates. She has consistently contributed to the SciTS discourse through keynote addresses, panel participation, pre-

sentations at SciTS conferences, and publications over the past decade. In addition, she joined the growing field of scholars instrumental in establishing the key clearinghouse for matters related to SciTS as a founding editorial board member of the virtual Team Science Tool Kit (www.teamscience5.cancer.gov) hosted and managed by the National Cancer Institute:

> *My involvement in the Team Science conferences dates from early meetings at Northwestern University (2010). Prior to that I was invited to the ground-breaking conference on Team Science in Bethesda (2006), which subsequently formed the basis of a special issue of the* American Journal of Preventive Medicine *containing my article on evaluation [Klein, 2008]. My membership on the planning committee dates from 2011, also the date of a co-authored article on mapping a research agenda for the field. [Falk-Krzesinski et al., 2011]. In addition I was also a founding member of the Toolkit Editorial Board (2012) and did a media review of www.Team Science.net for the* journal Clinical Anatomy *the same year [Klein, 2012]. More recently, I have a co-authored article on evaluating interdisciplinary and collaborative research in* Research Policy *[Klein & Falk-Krzesinski, 2017].*
>
> *This [subject] reminds me of how often I find myself cross-secting organizations and networks that invoke inter/transdisciplinarity but not in a fully informed matter. I'm thinking of someone who heard an address I gave at SciTS in Phoenix. The person had argued earlier [that] we do not need to spend any more time talking about transdisciplinarity, but acknowledged not knowing a lot of the historical relationship of inter/transdisciplinarity and collaboration. Sigh….*

Of course, and thankfully, many involved in *organizations and networks that invoke inter/transdisciplinarity* do know *a lot of the historical relationship of inter/transdisciplinarity and collaboration*. By the late 20th century interdisciplinary research and its impact on complex problem solving had become a stabilizing element that in turn informed the emerging field of team science as it expanded from the beginning of the 21st century. A transcendent transdisciplinarity became associated with the team science movement as new frameworks were developed for health and medical research, along with an emphasis on joint problem solving between academia and stakeholders in a number of other social sectors. An emphasis on engagement in problem solving, such as that popularized by Swiss and German environmental and sustainability scholars of the 80s and 90s, stressed the real

life problematizing and the co-production of knowledge between academics and social actors.

Klein describes this development:

> *The term ["transdisciplinary"] had limited circulation at first but proliferated in the late 20th century. It is now a descriptor of broad fields and synoptic disciplines, a team-based holistic approach to health care, integrated curriculum design, and a general ethos. At present three major discourses appear. The first discourse – Transcendence – has moved beyond the historical quest for unity of knowledge. Reviewing the history of transdisciplinary discourse, philosopher Joseph Kockelmans [1979] concluded it has tended to center on educational and philosophical dimensions of science. In contrast to the historical principle of unity, current discourse of transcendence accepts plurality and diversity, a value prominent in the Centre International de Recherches et Études Transdisciplinaire. It is advancing a new universality of thought and type of education replacing reduction with a principle of relativity that is transcultural and transnational. In addition, new synthetic paradigms have emerged, notable among them general systems theory, post/structuralism, neo-Marxist and feminist theories, cultural critique, and sustainability.*
>
> *In the late 20th century the discourse of Problem Solving became more prominent in two developments: a form of "transcendent interdisciplinary research" associated with the team science movement, fostering new methodological and conceptual frameworks in health and wellness, and joint research and problem solving with stakeholders in society. The latter was evident in a new connotation of TD evident in the late 1980s and early 1990s in German and Swiss contexts of environmental research. Problems of the "lifeworld" took center stage and were subsequently coupled with the idea of "co-production of knowledge" by academics and stakeholders in the private and public spheres. Gibbons, et al. [1994] called further attention to the discourse when they proposed [that] a new mode of knowledge production had emerged. An older Mode 1 form of knowledge production – characterized by hierarchical, homogeneous, and discipline-based work – is being supplanted by a newer Mode 2 – characterized by complexity, non-linearity, heterogeneity, and transdisciplinarity.*

> *[A] third discourse – Transgression – is a multi-layered critique that interrogates the existing system of knowledge and education. It is prominent in interdisciplinary humanities, critiques of disciplinarity, socio-political movements for change that catalyzed new interdisciplinary fields, and a widening discourse of human rights accountability. The three discourses are not airtight, however. The imperative of Transgression is also evident in problem solving, in the difference between solving problems for the purpose of product development and seeking democratic solutions to controversial problems such as risks of technological modernizations such as nuclear power plants. The latter moves beyond traditional "reliable scientific knowledge" to advance "socially robust knowledge" fostering new partnerships between the academy and society in the agora of public debate [Nowotny, Scott, & Gibbons, 2001]. This complexity implies not only changes in disciplinary knowledge production. It also promotes inclusion of Western science and traditional ecological knowledge in a cooperative and contextualized rather than hegemonic form of knowledge.*

As the field of team science coalesced during the first two decades of the 21st century, Klein's work tracing the evolution of interdisciplinary thought and her focus on collaborative knowledge creation, a key tenet of the Science of Team Science, has provided insights that have become important to the field. For her, SciTS has been a natural outlet that combines her previous experiences with and interests in mapping typologies of interdisciplinary research, collaborative problem solving, and the philosophical and applied reasoning of interdisciplinarity with the evidence-based study of science teams. Like the work of those involved in the Science of Team Science, Klein's theory building and its application to real world problem solving draws on often unrelated disciplines all of which strive to arrive at similar goals with differing methodological and epistemological approaches. When asked for her view of how she fits in the SciTS community and how her scholarship contributes to the goals of Team Science, Klein states,

> *My "fit" is three-fold. First, team science is not only collaborative but often interdisciplinary in nature. Since my expertise is inter/transdisciplinary research and education, I see my contribution as informing and enhancing thinking about those concepts in the network. Second, I work on an international scale and in fact organized the first panel on international perspective at a SciTS meeting in 2012. Third, I am a humanities professor, so am committed to enlarge the scope of methods and contexts for collaborative work*

*to be inclusive of humanities and arts.*

Klein's contributions do not always align with those of others in a field that is heavily populated by individual and social psychologists, management and leadership specialists, policy makers, and sociologists. Nor do all in the SciTS community agree that typology and definition are important aspects of the thinking she shares. Inter- and trans-disciplinary models for team science that Klein has propounded have received varying levels of support in the team science community. However, she continually strives to encourage connections between fields and advance the causes of team science. She says,

> *Inter/transdisciplinarity has been a natural alignment of interests [with Team Science], even though SciTS continues to adopt one definition [of the term and practice] without accounting for different connotations. [In particular] it also minimizes a connotation of collaboration prominent in the international Network for Transdisciplinary Research (known as td-net), engagement of stakeholders in society in the actual research process. Humanities has also traditionally been outside the purview of thinking about team "science," even though there is a new openness today to inclusion [of humanities disciplines] while still not appreciating collaboration is also an "art."*

When asked about the role the Science of Team Science has played in the development of her own personal research, Klein responded,

> *Team Science has not shaped my personal research as much as represented an opportunity to think more deeply about inter- and trans-disciplinary collaboration, leading to literature I had not read in the past but now reference when relevant. The most direct example [of the way this deeper thinking has enriched my own research and thence my work with others] was my work as Faculty Fellow for Interdisciplinary Development in the Division of Research at Wayne State University. The Division was prioritizing team science at the time, so my expertise in this area was of value in consultations with campus teams and professional development workshops.*

Klein is clearly committed to the establishment of team science as a professionally and academically recognized field. Her involvement as a director of the board of the International Network for the Science of Team Science (INSciTS) as of 2018 is a testament to her dedication to the field – and a testament to the extent to which most of those in the field do welcome her views. Klein believes that advancing team science is about establishing

strong core relationships and expanding the scope of science to include more than is commonly associated with SciTS, challenging scientists to incorporate multiple methods and approaches that reach beyond traditional STEM science to include humanistic and art forms in knowledge integration. Klein comments,

> *The greatest challenges [in establishing TS as a respected field] involve organizational strength and credibility in inter- and transdisciplinary communities of practice. Meeting the first challenge will require not only a strong INSciTS board and enlarged membership but also a concerted effort to enhance visibility and legitimacy in the crowded landscape of related interests. Extending from the last challenge, it is crucial to position the organization strategically in multiple communities that share related interests while bridging their discourse and that of team science, including organizations that posit criteria for status as an "interdiscipline." Continued use of the term "science of...science" will narrow perception of the value of our work further over time.*

In 2016, Klein was the recipient of the Science of Team Science Recognition Award for her distinguished contributions to the field of SciTS. On that occasion, longtime friend and colleague Dan Stokols, a past recipient, provided an overview of her long-standing impact in the field of SciTS and the many other fields she has impacted (Stokols, 2019). The carefully crafted depiction of Klein's stellar attributes describes her as a force within these multiple fields and provides a fitting synopsis of who she is as a model scholar and integrating force. [Note that readers of this journal will find Dan Stokols' remarks reprinted in this volume.]

## Conclusion

For five decades, Julie Thompson Klein has documented, interrogated, and pushed the boundaries of scholarship in higher education, interdisciplinarity, digital humanities, team science, and countless other fields. She has personally connected scholars across disciplines, across communities, and across the world. There is no doubt that her influence is wider than what we can describe in these pages or indeed what others can describe in this volume. Rather than attesting to that influence by merely summarizing her career, we have adopted an ethnographic approach, using interviews via teleconferencing and e-mail exchanges to weave just a few of its many historical threads with reflections from Klein herself on the motivations behind her work and the trajectory of her ideas over the many years of her career

thus far. Her motivations include a passionate dedication to changing and impacting the world. And her scholarly work has been not only intellectual but also deeply personal. As authors, we feel that we have not done justice to her total contribution to and impact on both theory and practice in interdisciplinary studies and the many other areas where she has made a difference. However, we trust that we have been clear about the admiration we have – and share with so many – for this generous colleague and friend.

***Biographical Notes:*** Gaetano R. Lotrecchiano, EdD, PhD, is President, International Network for the Science of Team Science. He reports the following. As doctoral students often do, I was waiting for that "grand" idea that would magically transform into a dissertation topic that would not only be novel but could also easily be completed within my already shortened academic career. As one who already had a PhD in Ethnomusicology under my belt, I knew enough to know that a dissertation was something one needs to start and more importantly *finish* within a reasonable amount of time. While I was working toward my EdD in Human and Organizational Learning, an instructor once asked a group of us "What really intriguing topical area do you plan to pair with a real problem worth researching?" The small group of students uttered some same-old-same-old topics like "resilience," "organizational silence," "executive training," and a number of others, all of which drew from our professor a less than excited stare. I, on the other hand, had just finished reading Nicolescu's *Transdisciplinary Manifesto* and Thomas Kuhn's *Structure of Scientific Revolutions* and was cautiously interested in this notion of "transdisciplinarity" (a topic I ardently blurted out). My professor, a disciple of Karl Weick, asserted "Now that's exciting" and he quickly sent me off to find everything I could on the subject. Needless to say, Klein's work made up a pretty substantial part of my late night reading. Soon after, I began trying to understand the connections between team science, Parsons, Giddens, Nicolescu, Kuhn, and now this new scholar's work that was invading my already crowded doctoral schedule. I happened to go to my first (the first) SciTS meeting in Chicago, and many of the new members of my community of scholars came to life. Of note was Julie Thompson Klein. However, I remember it was not until the second SciTS conference when I made a presentation under the direction of Stephen Fiore that I worked up the nerve to say hello. It was a cathartic experience. Why? Not because I learned anything more than what I had already extrapolated by reading her work (which was a lot by that point), but because I was able to begin to know the person behind the work. And amazingly, this humble, kind, electric, somewhat sassy, and always on point scholar made no bones about wanting to get to know me, what I was studying, and when the first chance we might do something together might be. This is the Julie Klein I most remember and to this day cherish as a colleague and friend. As I am now in the mid stages of my career, there are many lessons I am still learning from Julie as a collaborator, fellow IN-SciTS Board Member, and most importantly, friend. This project has been a labor of love and dedication to the kindness, encouragement, and trust afforded me by Julie. Gaetano Lotrecchiano may be reached at glotrecc@gwu.edu.

Andi Hess, MSTech, is Vice-President, International Network for the Science of Team Science. She reports the following. As an undergraduate, I would find myself taking many courses and getting interested in a variety of topics. Each time, I'd get halfway through the material or the course, and I would feel like I couldn't possibly understand that topic without understanding a similar or related topic from a different perspective. Thus, my interests would coalesce around one discipline and then quickly shift to another as I decided I couldn't understand particular time periods without studying history, art, *and* anthropology. Then I would decide that I couldn't understand human movement without anthropology, geography, *and* psychology. Those that teach in interdisciplinary programs will recognize that my experience was not unique among the students that find themselves in our programs. As I struggled to create a triple major, involving subjects none of which I felt allowed for a complete understanding of whatever I was interested in, I happened to stumble upon a relatively new program that Arizona State University was offering in IDS. I remember taking the first course, using Allen Repko's textbook [Repko & Szostak, 2016], and finally feeling like I was in the right place. The theorists I studied (mostly Julie Thompson Klein and Bill Newell) finally provided some evidence that my instincts were well founded and that there were a plethora of connections to be made between the disciplinary perspectives I was learning. Most importantly, the IDS curriculum I studied validated that "every perspective owned a kernel of the truth" and that one was not necessarily more correct than another. It wasn't until years later when I was teaching in the same IDS program that I would come to see myself not as simultaneously an anthropologist *and* a geographer (neither of which quite fit), but instead as an interdisciplinarian. When I first attended an AIS conference, I was thrilled to put names to faces and meet those whom I had studied about, but as it happened Julie could not attend that year. However, I was fortunate enough to meet her at the SciTS conference in 2016. I recall summoning all of my nerve to sit down next to her and introduce myself at a lunch break, simply intending to thank her for the contribution that her ideas had made to my studies and for ensuring that there exists a field to which I can contribute my own work. In the intervening years, a friendship has developed that I value deeply as well as an ongoing dialogue that has continued to inspire my own work in interdisciplinarity and team science. I know there would not be a place in the academy for those of us who work specifically on the theory and practice of connecting areas of knowledge if it weren't for Julie's pioneering contributions to these fields. Personally, Julie's ongoing kindness, support, and encouragement have been invaluable, and for these and many more reasons, I am grateful for the chance to contribute to this project. I sincerely hope that she finds that we have done her work as much justice as is possible in such a short piece. Andi Hess can be reached at andihess@asu.edu.

## References:

Balsamo, A. (2011). *Designing culture: The technological imagination at work*. Durham, N.C.: Duke University Press.

Becher, T., & Trowler, P. (2001). *Academic tribes and territories: Intellectual enquiry and the cultures of disciplines* (2nd ed.). Buckingham: Open University

Press/SRHE.
Bourdieu, P. (1993). *The field of cultural production:* Essays on art and literature. New York: Columbia University Press.
Brint, S., Proctor, K., Murphy, P., Turk-Bicakci, L., & Hanneman, R. (2009). General education models: Continuity and change in the U.S. undergraduate curriculum, 1975-2000. *The Journal of Higher Education*, *80*(6), 605-642.
Creswell, J. W. (2007). *Qualitative inquiry and research design*. Thousand Oaks, CA: Sage.
Davidson, C. (2017). *The new education: How to revolutionize the university to prepare students for a world in flux*. New York, NY: Basic Books.
Davidson, C., & Goldberg, D. (2010). *The future of thinking: Learning institutions in a digital age*. Cambridge, MA: The MIT Press.
Doty, W., & Klein, J. (Eds.). (1994). *Interdisciplinary studies today*. San Francisco, CA: Jossey-Bass.
Falk-Krzesinski, H. J., Contractor, N., Fiore, S. M., Hall, K. L., Kane, C., Keyton, J., . . . & Trochim, W. (2011). Mapping a research agenda for the science of team science. *Research Evaluation*. 20(2), 145-158.
Foucault, M. (1969). *L'Archéologie du savoir.* Paris: Gallimard.
Frodeman, R., Klein, J., & Pacheco, R. (Eds.) (2017). *The Oxford handbook of interdisciplinarity* (2nd ed.). Oxford: Oxford University Press.
Furtado, A., Hulbert, L., Klein, J., Maruca, L., Maun, C., Ntiri, D., & Schindler, R. (2009). To educate the people: The department of interdisciplinary studies at Wayne State University. In T. Augsburg & S. Henry (Eds.), *The politics of interdisciplinary studies* (pp. 66-84). Jefferson, NC: McFarland and Company.
Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., & Trow, M. (1994). *The new production of knowledge: The dynamics of science and research in contemporary societies*. London: Sage.
Kaplan, E., & Levine, G. (Eds.). (1997). *The politics of research*. New Brunswick, N.J: Rutgers University Press
Klein, J. T. (1983). The dialectic and rhetoric of disciplinarity and interdisciplinarity. *Issues in Integrative Studies*, *2*, 35-74.
Klein, J. T. (1990). *Interdisciplinarity: History, theory, and practice*. Detroit: Wayne State University Press.
Klein, J. T. (1996). *Crossing boundaries: Knowledge, disciplinarities, and interdisciplinarities*. Charlottesville, VA: University Press of Virginia.
Klein, J. T. (1999). *Mapping interdisciplinary studies*. Washington, D.C.: Association of American Colleges and Universities.
Klein, J. T. (2005). *Humanities, culture, and interdisciplinarity: The changing American academy*. Albany: State University of New York Press.
Klein, J. T. (2008). Evaluation of interdisciplinary and transdiciplinary research: A literature review. *American Journal of Preventive Medicine, 35*(2S), S116-123.
Klein, J. T. (2010). *Creating interdisciplinary campus cultures: A model for strength and sustainability*. San Francisco: John Wiley & Sons.
Klein, J. T. (2012). COALESCE (CTSA Online Assistance for Leveraging the Science of Collaborative Effect. *Clinical Anatomy, 25*(5), 670-672.

Klein, J. T. (2014). Discourses of transdisciplinarity: Looking back to the future. *Futures*, *63*, 68-74.

Klein, J. T. (2018a). Beyond interdisciplinarity: Changing scales and spaces. Keynote: Colloque international – Politiques et pratiques de l'interdisciplinarite. March 15-16. Paris.

Klein, J. T. (2018b). Current drivers of interdisciplinarity: The what and the why. In M. Nasser Al-Suqri, A. Khamis Al-Kindi, S. Said AlKindi, & N. Eid Saleem (Eds.), *Promoting interdisciplinarity in knowledge generation and problem solving* (pp. 14-28). Hershey PA, USA: IGI Global.

Klein, J. T. (2019). *Beyond interdisciplinarity: Boundary work, collaboration, and communciation in the 21st century*. Manuscript in preparation.

Klein, J. T., & Falk-Krzesinski, H. (2017). Interdisciplinary and collaborative work: Framing promotion and tenure practices and policies. *Research Policy, 46*(6), 1055-1061.

Klein, J. T., & Newell, W. H. (1997). Advancing interdisciplinary studies. In J. Gaff & J. Ratcliff (Eds.), *Handbook of the undergraduate curriculum: A comprehensive guide to purposes, structures, practices and change* (pp. 393-415). San Francisco, CA: Jossey-Bass.

Kockelmans, J. J. (1979). Why interdisciplinarity? In J. J. Kockelmans (Ed.), *Interdisciplinarity and higher education* (pp. 123-160). University Park, PA: Pennsylvania State University Press.

Lenoir, Y., & Klein, J. (2010). Interdisciplinarity in schools: A comparative view of national perspectives. *Issues in Integrative Studies*, *28*, i-xxiii.

Maxwell, J. A. (2005). *Qualitative research design*. Thousand Oaks, CA: Sage.

Miles, M. B., & Huberman, A. M. (Eds.). (1994). *Qualitative data analysis*. Thousand Oaks, CA: Sage.

Nowotny, H., Scott, P., & Gibbons, M. (2001). *Re-thinking science: Knowledge and the public in an age of uncertainty*. London: Polity Press.

Repko, A., & Szostak, R. (2016). *Interdisciplinary research: Process and theory (3rd ed.)*. Thousand Oaks, CA: Sage Publications.

Schindler, R. (2014). *The Newell award*. Association of Interdisciplinary Studies. http://wwwp.oakland.edu/ais/about/awards/

Spradley, J. (2016). *The ethnographic interview*. Long Grove, IL: Waveland Press.

Stokols, D. (2019). An interdisciplinary "six tools player." *Issues in Interdisciplinary Studies*, *37*(2) 13-16.

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