Pluralistic Collaboration in Science and Technology: Reviewing Knowledge Systems, Culture, Norms, and Work Styles

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Abstract:

This paper challenges the language of "interdisciplinarity", suggesting the notion of "pluralistic collaboration" as a better alternative. Interdisciplinarity, team science, and transdisciplinarity frame academic and problem-focused collaborations narrowly, overemphasizing epistemology, downplaying extra-disciplinary divides and non-academic collaborators, and either ignoring or psychologizing individual-level phenomena. We first paint a picture of the tensions and divides that exist in pluralistic collaborations, in three dimensions – epistemic, cultural, and normative – using a series of literature reviews to simultaneously map and extend these dimensions. We then introduce and explore a fourth dimension – academic work styles. Individual level considerations of collaboration in the literature generally rely on psychological types. We explore what a more sociologically oriented approach to individual dynamics within collaborations would look like, by identifying and exploring 4 general academic work styles: isolationist, imperialist, pragmatist, and pluralist. We conclude by emphasizing and reflecting on pluralistic collaboration. Pluralism exists along a range of dimensions and pluralizing or homogenizing different dimensions (pluralizing pluralism) can produce diverse effects on the outcome of interdisciplinary collaboration. While we thus advocate for pluralism along a greater range of dimensions when addressing complex problems, we suggest that over-pluralization can be a problem.

1 INTRODUCTION

Increasingly, academic scholarship is expected to be collaborative, interdisciplinary, and problem-focused, resulting in disparate scholars seeking to work productively together (Cook 2015; Becher and Trowler 2001). While there is a scholarly literature on the nature and practices associated with such collaborative work, it spans a range of fields including STS, interdisciplinary studies, group dynamics, social psychology, management, and related fields (Shockley et al 2016; Klein 1996; Becher 1994). And beyond this, much relevant literature is discipline or issue-area specific and highly localized (e.g. Spreng 2014; Falk-Krzeskinski 2010; Aboelela 2007). Thus, the existing literature is quite eclectic, spanning work on collaboration, interdisciplinarity, transdisciplinarity, team-science, system science, and a host of other terms used in both general and field-specific publications (Cooke & Hilton 2015; Huggan 2002; Schommer-Aikins et al. 2003).

While each such term reveals aspects of collaborative academic practices, we introduce a term that better encompasses the range of elements explored within the literature, and that better situates discussion of academic collaboration within the range of practices and forms that have been documented for years by STS scholars (and beyond). We thus gather and review the existing literature within the notion of *pluralistic collaboration*. Broader than interdisciplinarity, which overemphasizes disciplines and hides most of the non-epistemological aspects of collaborative work, this term signals both the cooperative nature of such work and the diversity of represented actors and institutions, along multiple scales, while challenging dominant assumptions about academic collaborations. Pluralistic collaboration shifts the focus from mechanisms for bridging disciplines to the question of what sorts of differences might be bridged, and how, to foster problem-focused work in complex systems.

We also note that, while individual level factors are crucial for the functioning of collaborations, a disjuncture exists between structural discussions of "interdisciplinarity" and the primarily psychological literature on collaboration in management texts. We offer work styles as a more sociological frame for individual factors in collaborations. The paper's second primary contribution is thus to introduce a sociologically oriented approach to individual work styles, using this exploration to both foreground the role of individual agents in collaborative practices and to interrogate the strengths and limits of pluralism as a frame for such practice.

We thus explore interdisciplinary research and pluralistic collaboration along four dimensions, arguing that deeper pluralization is often a way to bridge knowledge systems, overcome barriers, and negotiate normative values. We also recognize that collaborations can be strengthened if pluralization is not introduced in all dimensions at once.

2 RESEARCH DESIGN AND APPROACH: THREE INTERDISCIPLINARY REVIEWS AND INDUCTIVE ITERATIVE ANALYSIS

This study combines an "umbrella review" and a "critical review" (Grant and Booth 2009). An umbrella review refers to the compiling of evidence from multiple disciplines or literature searches into one accessible and usable document, highlighting (at times) competing interpretations and uncertainties in the literature. A critical review requires both sufficient review of existing literature and a degree of analysis, interpretation, and conceptual innovation. The critical aspect of our review enables us to describe and interpret what is known, whereas the umbrella aspect of our review enables us to capture diverse interdisciplinary perspectives and also identify recommendations for research.

For our research design, we conducted three specific interdisciplinary desk-based literature reviews and document analyses. The first was of the broad literature on structures of academic research, with an emphasis on diverse knowledge systems, academic practices, and aspects of organizational structure within higher education. The second more targeted review sought studies examining collaboration and forms of pluralism, especially research on epistemic and cognitive dynamics, cultural dynamics, and normative dynamics. The third review focused explicitly on work styles and types of collaborators and academic scholars.

Rather than adhere dogmatically to any particular theory, we sought to remain "theoretically promiscuous" (Sovacool and Hess 2017) and avoid following any prescribed conceptual line of thinking. Our analysis is therefore grounded in the results of the literature reviews themselves, with core themes and findings emerging inductively. This makes our process inherently inductive (based on the evidence as we went) but also iterative and recursive. Our analytical development oscillated between reading and interpreting our evidence base from the literature and refining and augmenting our conceptual analysis, thus building the paper in a non-linear, reiterative process. This technique has at times been termed the SALSA approach to theory-building: Search, Appraisal, Synthesis and Analysis (Grant and Booth 2009). It also means our analysis includes both general descriptions of the literature gathered but also at times critical interrogation of analysis and resulting implications.

In addition to the literature searches, the authors draw on their combined experience of 40 years of having worked with both the theory and practice within the field of Science and Technology Studies, including work as authors and collaborators, grant managers, and peer reviewers and editors. We position ourselves as both producers of knowledge (via leading research and analytical outputs) but also consumers of it (via reading the literature and remaining engaged in

STS professional networks). Nevertheless, our goal is to produce insights that generally *do* apply to multiple bodies of literature (not just science and technology studies) that touch upon interdisciplinarity and collaboration. So, while our paper is indeed intended to inform readers of this journal, we also aim to offer insights, findings, constructs, and problematizations that contribute to the practice of social science and interdisciplinary team science broadly, and not just in a narrow disciplinary way.

We explore collaboration as requiring negotiation among four kinds of divides:

1. Epistemic practices
2. Institutional and cultural expectations, frames, and histories
3. Normative (ethical and political) commitments
4. Academic work styles

This last divide is mapped via a typology of isolationist, imperialist, pragmatist, and pluralist approaches to undertaking research, suggesting how this typology of academic work styles can help scholars to better envision pluralistic collaborations.

3 FROM INTERDISCIPLINARITY TO COLLABORATIVE PLURALISM

Much of the language of problem-based collaborations within academia is framed in terms of disciplinary divides. And, much of the language of disciplinary divides is framed in terms of epistemic divides. Thus, problems of interdisciplinarity are often conceived as problems of learning and communication.

Without denying the importance of epistemology, we use existing literature to broaden this framework, and thus challenge the tyranny of epistemology in collaborative thinking, by moving

in stages from interdisciplinarity to collaborative pluralism. We begin by challenging the reductive vision of disciplines upon which calls to interdisciplinarity are often built. We then review the literature on resolving and bridging knowledge system, cultural, and normative divides.

Kagan (2009) categorizes academic disciplines into distinct cultures: the natural sciences, the social sciences, and the humanities. We can also add the arts. Interdisciplinary research may involve different disciplines within a single academic culture, and it can also cross-cultural boundaries as in the study of humans and their environment.

As we might expect, such cross-cultural collaborations are particularly difficult. A systematic review of the literature on natural-social science collaboration (Fischer et al. 2011) found more mentions of barriers than of opportunities (72 and 46, respectively) among the nearly 100 papers in their analytic set. They identified four critical factors for success or failure in natural-social science collaboration: the paradigms or epistemologies in the current (mono-disciplinary) sciences, the skills and competences of the scientists involved, the institutional context of the research, and the organization of collaborations (Fischer et al. 2011). The so-called "paradigm war" between neopositivist versus constructivists within the social and behavioral sciences (Onwuegbuzie and Leech 2005) may complicate pragmatic collaboration further.

Disciplines, and the divides that they represent, thus connote far more than just epistemologies. As Foucault suggests, a discipline is a more totalizing system of identity formation, hemming individuals in at every turn, to create powerful, authoritative subjectivities (Stuart 2005; Foucault 1977). The strength and vitality of these disciplines can suppress the emergence of new sub-disciplines or alternate ways of knowing (Lauter 1999). At a minimum, a discipline is constituted and characterized by the aspects shown in Table 1.

Table 1: A multitude of factors delineating academic disciplines

Aspect of Discipline	Description	Literature
Knowledge systems	what is known and knowable, ways of knowing, who counts as a knower, and what counts as evidence and argument.	Bauer 1990; Gieryn 1995; Fleck 1986
Practices	ways of working, a micro-physics of action, and valid methods	Anderson 1991; Knorr-Cetina & Cicourel 1981; Tobi & Kampen 2018
Language	a specific lexicon of professional and theory words, key concepts, preferred forms of expression, writing styles and structures of presentation.	Duszak 2011; Snow 2010; Snow and Uccelli 2009
Organizations and institutions	academic departments, professional societies, and accreditation boards.	Klein 2005; Klein 1996; Hunt 1994; Douglas 1986
Reward systems	systems of promotion and advancement, including acceptable and required forms of publication, grant expectations, hierarchies of journal legitimacy, an expected balance of professional activities, etc.	O'Meara 2005; O'Meara 2011
Educational systems	what, how, and where we learn, including the requirements and expectations of formal education	Archer 2013; Wilson et al. 2006
Justification and qualification systems	who counts as an expert and how expertise is validated, who is valued as a knower and contributor, what sorts of work is counted as knowledge and valued	Buehl & Alexander 2001; Schulz 2008
Normative and cultural structures	ways of being, ways of seeing the world, ideas of rightness and goodness. (Knowledge via logic versus analogy versus experiment, for example).	Whitley 2000
Social and professional networks	who knows who, and what counts as valuable relations.	Shapin & Shaffer 1985; Crane 1972; also Nicolaou & Birley 2003; Rappert et al. 1999
Publication and communication systems	how knowledge is disseminated, what sources are valued, who sees what.	Enders 2005; van Gelderen & Huij 2014

Systems of trust	when can we defer and when must we challenge, what people and institutions are worthy of trust, what mechanisms are relied upon to verify trustworthiness.	Wynne 1992; Stern & Coleman 2015; Hull et al 2018
Systems of docility or colonization	what actions are within bounds and what is unprofessional, what are valued or required forms of deference, what are the professional norms, what are acceptable and unacceptable ontologies?	Sayer 2000; Turner 2006; Balkin 1996; Foucault 1988
Political economy of the field	external and institutional forces that require certain practices, how the field is located in the broader world/economy, sources of power and weakness.	Becher & Trowler 2001
Ideals of Reflexivity and Anticipation	Normative and institutional pressure towards unreflectiveness (restricted and circumscribed analysis), reflection (deep serious consideration of the data), or reflexivity (recursive mutual conditioning of subjective representations and interventions so that multiple views are appreciated). Degree to which governance is accompanied by foresight, engagement, integration and ensemble in encouraging and supporting the reflection of scientists, engineers, policymakers, and other publics	Stirling 2006; Guston 2014

Many of these aspects of disciplinary power have been studied, in isolation, but the literature of interdisciplinarity and team science has not to date drawn on this full range of issues in thinking through what pluralistic collaboration requires. The focus on epistemology often overshadows these other features.

By simultaneously including a broader range of issues in interdisciplinary practice, and pushing beyond the constraints of the frame of interdisciplinarity itself to think about a broader practice of pluralistic collaboration, we can more fully specify tensions and divides that need to be overcome within collaborative work, and develop a typology of competencies for operating within such spaces.

We group these diverse factors into three broad categories of tensions in academic collaborations, each of which is essential to a pluralistic collaboration framework. Table 2

summarizes these three, loosely grouped around knowledge, expectations, and norms. The next section develops a complementary forth category of divergence.

Table 2: Three types of collaborative tensions/divides

Type	Emphasis	Description	Key concept(s)
Knowledge system divides	Diverse epistemologies, credentials, practices, and languages	Bridging distinct ways of knowing and working, and knowledge communities, to manage joint research	Trading zones, typologies of expertise, knowledge systems, professional networks, invisible colleges
Cultural divides	Organizational and cultural frames; managing expectations	Bridging cultural formations that emerge alongside and outside of disciplinary divides	Cultural misapprehension, cross-institutional collaboration, disciplinary cultures
Normative divides	Values and norms	Resolving diverse ethical and political commitments or values among a range of collaborators.	Identity politics, socially useful research

Source: Authors

3.1 BRIDGING KNOWLEDGE SYSTEMS IN COLLABORATION

As mentioned above, most analytic work on interdisciplinarity focuses on questions of knowledge systems, and particularly the problem of translating across or overcoming differences within languages, conceptual frames, and methods of meaning making. This literature is an important element of pluralistic collaboration, but if it is understood to reference only professional and disciplinary epistemologies, it risks hiding more than it reveals. This section thus uses the existing STS literature to push back on an overemphasis on knowledge itself in the literature on inter- and trans-disciplinarity by pointing out that more sophisticated approaches to epistemological divides implicitly or explicitly invoke knowledge systems – ways of knowing,

professional languages, practices, ideas of expertise – rather than narrower, relatively stable, bodies of knowledge.

The problem of communication across research communities has been recognized at least since Ludwig Fleck (1986/1927) explored his "thought collectives", and the problem of incommensurability that he raised was further extended by Kuhn (2012) and Feyerabend (1993).

Similarly, Derek De Sola Price (1963) identified "invisible colleges" as communication circuits through which groups of scientists working on similar questions interact and build community that expand and support communication within a field, but can also serve as barriers to interaction with other fields or groups. As Foucault articulates, such closely disciplined knowledge and practice provides powerful sources of legitimacy and expertise, but at the cost of flexibility and communicative opportunity (Foucault 1977).

Within the contemporary STS literature, Michael Gorman and his collaborators have perhaps done the most to draw together a range of authors thinking about epistemological bridges within collaborative practice. They yoke together theories about practice, language, and material interaction in developing the notion of collaboration interlanguage trading zones(Gorman 2002; Gorman 2010; Collins et al 2007). In developing a notion of interlanguage trading zones, Gorman and collaborators yoke together theories about practice, language, and material interaction in collaboration.

They build on Peter Galison's "trading zones", which directly addresses attempts to overcome the communicative difficulties of disciplinary divides. These unique spaces allow scientists to work together effectively when their theories are radically divergent and seemingly incommensurable by cobbling together shared material and linguistic practices (Galison 1997;

Gorman 2010; Balducci & Mäntysalo 2013). On the *material* side, Leigh Star (1988) identifies a specific mechanism by which communities collaborate across difference. Boundary objects (Star & Griesemer 1989, 393) allow actors to act "as if" they were talking about the same thing rather than requiring them to actually resolve fundamental differences of knowledge and practice (Halfon 2006). The "interactional expertise" of Collins and Evans (2007) is a largely *linguistic* practice designating the ability to converse as a native with members of a research or knowledge community, thus translating between communities that are not able to build towards the kind of shared languages or objects emphasized by Galison or Star. Gorman maps Collins and Evans' disparate forms of expertise in relation to different types of trading zones, but in all cases, this is about managing the epistemological aspects of interdisciplinary collaboration.

A very different literature emerging out of the small field of Interdisciplinary Studies draws on some of this same work. Julie Thompson Klein and her collaborators have been developing an approach to interdisciplinarity starting from the framework of boundary work (Klein 1996). The approach by Pohl et al (2019) is a framework for managing interdisciplinary collaborations, built around a series of analytic questions used to interrogate the dynamics of collaborations, addressing boundary work, subcultures, expertise, boundary objects, interlanguages, collaborative learning, and leadership. While this approach, and Klein's broader work, hints at a wider set of elements relevant to interdisciplinarity, it remains strongly focused on issues of epistemology. Lotrecchiano and Misra (2020) and Misra and Lotrecchiano (2018) focus explicitly on the problem of communication in team science, and develop specific techniques for training scientists and building effective communicative systems.

Another literature focusing on the significance of knowledge in collaboration reverses the problematic – not asking how emerging cultural practice can bridge epistemological divides, but

rather how shared epistemologies can bridge institutional divides and lead to cultural isomorphism. Peter Haas articulates epistemic communities as loosely coordinated groups of experts and policymakers who share common understandings of and approaches to specific issues (Haas 1992). While this literature pertains to a quite different realm of concern (international political confluence/cooperation) and has been criticized in its conceptual details, the overall lesson is useful in thinking about collaborative practice.

It is important to recognize that all of the above cited literature focuses on professional practices and epistemologies. The expansion from disciplinary to pluralistic knowledge systems, however, opens this frame to non-professional and non-disciplinary epistemologies.

While it is not clear that practices for bridging professional versus non-professional epistemologies is necessarily different (although see Verran 2002), explicit attention to non-professional epistemology does two things:

1. It invokes a different literature highlighting a range of alternative collaborative mechanisms that are relevant to but less well considered when discussing professional practice. These include activities such as Participatory Action Research (Reardon 1993; Forester 1999), performance (Halfon et al 2020), and citizen science (Allen 2018; Ottinger 2010), as well as the general literature on transdisciplinarity (Max-Neef 2005; Spreng 2014).
2. It more clearly articulates issues of power and authority present in all collaborations, particularly around authorized and unauthorized epistemologies (Haraway 1988, Harding 1993). The literature on elite mobilization provides a specific approach to this issue (Bonds 2011; Sovacool & Brisbois 2019), as does the longer history of science-based social movements (Epstein 1998).

3.2 COLLABORATION THROUGH MANAGING INSTITUTIONAL AND CULTURAL BARRIERS

Collaboration relies on not just overcoming divides in knowledge systems, but also a wider set of institutional and cultural barriers. These barriers can be internal to disciplines, but can also supersede them, and collaborations require a range of cultural bridges. Below we explore a small sub-set of such cultural struggles within collaborative spaces, as represented in the literature.

This, and the subsequent sections, continue to perform a double move beyond the interdisciplinary literature: Firstly, we extend the analysis beyond epistemology by accounting for non-epistemic dimensions of interdisciplinarity; and secondly, we again extend the discussion of collaboration beyond interdisciplinarity by accounting for nonacademic actors and institutions.

Cultural misapprehension: Thomas Grammig (2001) explores failed attempts to collaborate in technical development projects. He provides a compelling story of how two different projects fell apart because of cultural misunderstanding and distrust. He makes the important point that the various collaborators shared quite a bit at the beginning, including both goals and epistemological models, and they established various forward-looking mechanisms to facilitate collaboration. Nevertheless, distrust built over time due to mutual misunderstandings of actions, expectations, and language. "Notions of authority and otherness, rather than technical knowledge and disciplinary language, turn out to be the most important elements of this interface in Grammig's two cases" (Halfon 2003). This analysis points to a broader issue, addressed within the diversity management literature, on appropriate types and levels of diversity for both justice and work-flow, and how to organize teams to successfully account for such diversity (for a positive review of this literature, see Kearney & Voelpel 2012; for a more critical assessment, see Gotsis & Kortezi 2015).

Cross-institutional collaboration: We might expect difficulties in managing meaningful Academic-industry-government collaborations, and other collaborations across organizational divides. A large literature focuses in particular on the difficulties and possibilities of managing University-industry collaboration (e.g. Bloedon 1994; Bouty 2000; Gassol 2007). Cultural differences and differing institutional logics (Friedland & Alford 1991; Thornton 2008) can pose deep barriers to both knowledge transfer and successful institutional relations, although Bjerragaard (2010) suggests that institutional barriers may not be as large as expected because of institutional co-production across assumed divides. Davenport et al (1998) point to the importance of building trust relations across cultural difference, a point that is mirrored by Weber & Khademian (2008) in their exploration of public management. Again, even if two organizations can articulate a common set of goals (which is, itself, quite difficult), all of the micro-physics of work practices, hierarchies, and norms can very easily get in the way of meaningful and productive collaboration.

Public Participation: We cannot here begin to summarize the ever-growing literature on public participation and engagement, but implicit in much of this, in both discussions of "upstream engagement" and action research, is the problem of production and enrolment of relevant publics. That is, social organization and cultural identities rarely map neatly onto researchers' concerns, and social identities rarely map neatly onto existing academic forms of expertise and experience (Bogner 2012; Krzywoszynska et al. 2018). Building public engagements with science and technology thus requires extensive social formation (Chilvers & Kearns 2020).

3.3 COLLABORATION THROUGH NEGOTIATING NORMATIVE VALUES

Disparate normative commitments matter deeply in science, despite rhetorics of objectivity and disinterestedness, particularly in problem-based research (Haraway 1988; McComas 2002).

Tensions between such commitments are perhaps most striking in collaborations between humanities scholars and scientists, but they are present in every form of collaboration. Recognizing that collaborations around public issues require partnering with communities further expands the normative pluralism of any such project.

Sometimes such commitments are explicit, particularly in "politicized" arenas of science, such as ecology or global climate science. But often, they emerge in subtle ways. This is particularly true when the commitments pertain not to the content of the research, but to the goals of the research, the kind of research, or the way that the research is conducted. For example, Habermas (1971) identifies three broad knowledge interests: technical control for problem-solving, increasing human understanding, and emancipation from social domination. While often overlapping, they can also be deeply at odds with each other.

Sovacool et al's (2018) typology of social science research contributions (below) provides a starting point for exploring this issue, as it raises the question of what scientific research is for and what it is supposed to be doing: solving problems or providing basic knowledge; interpreting knowledge through a lens or just laying bare the facts? These are reflective of normative commitments – to an idea of science, to an idea of science in the world, to an idea of who a scientist is.

[Figure 1: **A typology of energy social science research contributions.** (*Note*: Research in the top right-hand quadrant is the most impactful, but also rare). Source: Sovacool et al. (2018), creative commons license.]

Beyond this general framework, we can see the problems of differential norms in a range of collaborative projects. Without trying to be comprehensive, we offer a few examples to display a variety of such conflicts.

Saul Halfon, et al, (2020) detail complex negotiations over normative commitments in an STS-performance collaboration, focusing on Darwin. Arts and STS collaborators struggled over the appropriate stance towards, respectively, Darwin – as the intellectually and aesthetically brilliant father of modern biology – and Darwinism – as a hegemonic naturalization of race, class, and gender hierarchies. Retaining both sensibilities, in tension, provided a way forward and a richer engagement with the subject matter and with the audience than convergence around one reading could have.

Frances Moore (2012) discusses conflict over norms in the context of climate science (specifically, Adaptation Cost Estimates), noting the importance of both negotiated scientific and justice norms in determining the legitimacy and relevance of specific claims. Prior to the establishment of such norms within the broader community of scientists, specific technical claims were difficult to stabilize.

Once we move beyond purely academic collaborations, the range of values and norms at stake expands quickly. These norms pertain not only to the purposes of academic pursuit, but also to broader social goals and worldviews.

The ongoing conflict over the Flint water crisis entered a new phase when the collaborators themselves began fighting over goals and aims. Mark Edwards and his colleagues initially teamed up with local activists in Flint to highlight high lead levels and the failures of State

regulators. But once the state switched Flint's water source, and lead levels began to return to normal values, the collaboration began to fall apart – first through disagreement over tests and other scientific matters, and then over trustworthiness and personal interests and bias. This increasingly public fight spilled over into the courts through a defamation suit. While we might see this set of disputes as strictly personal (perhaps even a dispute of professional work styles), we might also read it as a good example of conflicting commitments in a collaboration, particularly between narrow scientific truth-telling and broader support for local voices, or racial equality as a cultural movement versus environmental justice as a technical matter, leading to a collapse of that collaboration. (Roy 2017; Roy & Edwards 2019; Donnelly 2019; Kalmbacher 2019).

Steven Epstein's (1995; 1998) classic work on AIDS activists working in collaboration with medical research scientists to change the research protocols around AIDS drug trials provides a case in which different normative commitments were overcome through what Epstein calls the "credibility tactics" of activists. Initially, the scientists held a commitment to fastidious trials, as a long-term ethical commitment to better treatments overrode short term ethical commitments to individual patient health. Activists confronted this set of commitments by labelling them as both unethical and ineffective, and pushing for a replacement with a messier approach based on the present needs of the community. Epstein thus provides a clear example of how negotiating normative commitments can lead to successful collaboration. More recently, Nukaga (2016) explores the collaborative production of ethical frameworks in biomedical research, as a way to stabilize ethical research across the community.

4 BUILDING COLLABORATIONS AROUND ACADEMIC WORK STYLES

While the previous three aspects of academic collaboration have been well developed in the literature, the fourth has not. This section, then, develops a typology of academic work styles based on earlier work by Jackson (1987), Flood (1989), and Gregory (1996). Work styles are individual orientations towards research, knowledge, and collaboration, rooted in social practices. The typology we develop contributes to the question of pluralistic collaboration.

Work styles connect to the three divides discussed above, but provide a different orientation towards collaborative work. Unlike personality types (such as the Myers-Briggs test) which are based in psychology, we conceive of these work styles as institutionally located, strategic orientations towards diverse practices and forms of knowledge. Institutions (including disciplines) shape, value and reward certain work styles over others, thus producing dominant orientations. However, institutional orientations are not totalizing, as longer life histories and personal dispositions are ever present, and we can thus find the full range of work styles within any particular organizational context.

A work-style approach to collaboration serves as an adjunct to bridging knowledge system, cultural, and normative divides. As with these previous divides, an exploration of work styles takes account of both interdisciplinary collaborations and those that reach beyond a disciplinary frame. Such an approach also allows those managing collaborations to both identify individuals who can best work together and to establish systems that promote styles of work that better facilitate collaboration across otherwise difficult divides. Such individualized approaches to collaborative management have been emphasized in certain business, collaboration, and team science literature (e.g., Epstein 2019, Fiore 2008, and Bennett & Gadlin 2012). The typology we

offer here thus builds on such efforts, but also works to move from a psychological to a sociological approach.

We want to leave a space here for individual predispositions, but whether these predispositions are psychological, psycho-social, cultural, historical, institutional, or some combination of these, we will leave open for further study. Our own dispositions are towards the cultural and social, but working that out is beyond this particular paper. Nevertheless, which of these is applicable is significant in thinking about how to seek out compatible or productive collaborators – if the predispositions are psychological, recruitment and screening might be preferred, and if learned, then education may be the best approach (Hull et al 2018), but if they are cultural and institutional, then it may be more important to establish appropriate cultural and institutional systems.

4.1 Existing Collaborator Typologies, Styles, and Roles

A range of individualist typologies exist in literature on team building and group management. Most of these are oriented towards psychological types (Myers-Briggs, Big Five, etc), but some provide pedagogical lessons for improving management practice (Hull et al 2018). A small number of these focus specifically on Academic workers, and are thus directly applicable to questions of interdisciplinarity and team science.

For example, Alvesson et al. (2017), in their book about increasing the value and impact of social science research, characterize nine academic types which cut across the dimensions of religiosity, narcissism, cynicism, and instrumentalism shown in Figure 2. A *scientific ritualist* believes they belong to a pure and noble profession of uncovering the truth by being as rigorous and dispassionate as possible. An *incrementalist* believes individual contributions become

significant only when combined with the output of others. An *esotericist* values dense, elite, and inaccessible scholarship. A *discursivist* obsesses over the value and use of language and words. An *egocentrist* pursues research for self-actualization and personal advancement. A *hedonist* pursues research that they enjoy, no matter how trivial. The *self-denigrator* is always deconstructing and critiquing their own work to the point of paralysis. The *careerist* pursues research as a way to climb the professional ladder. The *radical despairists* are hyper critical not of themselves but others as well as the entire academic system.

[Figure 2: Individual Academic Work Styles across the dimensions of religiosity, narcissism, cynicism, and instrumentalism. Source: Alvesson et al. 2017. Permission to copy granted.]

Colquitt and Zapata-Phelan's (2007) typology of articles or academic contributions, can also be read to reflect different kinds of scholars: those who build new theories, those who expand/elaborate theories (using empirical data or new concepts), those who test or qualify theories (using wider/different empirical data or methodological considerations); etc. (see Figure 3). While these taxonomies are useful for thinking about the approach of individual collaborators, they do not reflect on an orientation towards collaboration itself.

[Figure 3: A Taxonomy of Academic Contributions. Source: Colquitt and Zapata-Phelan 2007. Permission to copy granted.]

Fisher et al. (2015) analyze academic collaborations by mapping the styles and roles that researchers assume when facilitating interdisciplinarity or transdisciplinary research via stakeholder and public engagement. They study four projects to develop a taxonomy of efforts to develop "communities of socio-technical integration," (see Figure 4) suggesting that some researchers seek to promote the native values of the experts or communities they work with, whereas others seek to challenge teams with alternative values; some projects focus on building on and clarifying existing capacities, whereas others seek to introduce new capacities into the collaborative context.

[Figure 4: A taxonomy of communities of integration and researcher forms, means, and ends. (Note: STIR= Socio-Technical Integration Research. VSD= Value Sensitive Design). Source: Fisher et al. (2015). Permission to copy granted.]

Finally, looking at the narrower domain of a particular interdisciplinary synthetic biology and social science project, Balmer et al. (2015) identify different roles undertaken by the research team, some of them formal (i.e., acting as representatives of the public or educators), and some more informal (i.e., acting as spouses or tricksters). Most relevant to our study is their notion of the academic "chameleon" who navigates different roles at different times and spaces. Some of these roles offer ideal opportunities for genuine knowledge co-production (i.e., brainstorm within talented undergraduate students) whereas others do not (i.e., formal meetings with civil servants or corporate executives). Calvert (2013) also picks up on this theme of shifting roles within projects, noting that in many situations researchers will shift between social science researcher or

critical theorist (almost like an advocate) to scientific informant or realist (more like a dispassionate and neutral analyzer).

These typologies and varying roles each offer insight into collaboration management as well as the possible spaces and places for knowledge creation, but do not provide language to specifically think through the central question of pluralistic collaboration: what sorts of differences can be bridged, and how, to foster problem-focused work in complex systems? And how do we address the question of pluralism at the individual level?

4.2 A TYPOLOGY OF ACADEMIC WORK STYLES

In 1987, MC Jackson articulated four "developmental strategies" for the field of management science: 'isolationist', 'imperialist', 'pragmatist', and 'pluralist' (see Figure 5). He proposed these as different ways of constructing the discipline and resolving debates between an orthodoxy and newer challenges to that orthodoxy. In essence, he is exploring how the field should approach diverse theories, by either silo-ing them in separate, incompatible schools (isolationism), selecting one in a winner-take-all system that subsumes and disassembles competing methodologies into a dominant one (imperialism), picking and choosing the best elements from each (pragmatism), or allowing each to fully flourish in conversation with each other, with the acknowledgement that each has strengths and weaknesses (pluralism).[1] He argues for the last of these by setting up a matrix of different problem types and showing how different kinds of theories might be most relevant to addressing each context. Only pluralism, he argues, can allow all of the different theories to thrive and be selected for contextual relevance (isolationism allows each to survive, but provides barriers to contextual selection). He goes further, suggesting that systems problems are the most important, and are precisely the kind that require pluralism to resolve, so pluralism is also preferred for that reason.

[Figure 5: A Typology of Academic Collaborative Working Styles. Source: Authors.]

In 1989, Flood linked Jackson's work specifically to conflicts within systems theory, and buttressed Jackson's argument theoretically. Like Jackson, Flood finds pluralism to be the best approach to dealing with complex, systems problems in the real world. "A pluralist way forward is a powerful call for complementarity. The aim here is to investigate situational complexity, or complexity textures, and, in addition, to analyze how various systems methodologies deal with complexity" (78). He deepens the descriptions of each of the 4 approaches, providing a stronger sense for the orientation and preferences of each. For Flood:

a. Pragmatists avoid theory – they do not theorize their selection of tools, but rather select based on tacit learning or trial and error or least resistance or simplicity & efficiency. Strategic pragmatists are purposeful in their pragmatism; whereas, unwitting pragmatists fall into this by necessity or ignorance of other options. Pragmatists tend to accept pre-conceptions and starting conditions because the task itself is undertheorized – often leading to reinforcement of existing power structures. "Management consultants" are often pragmatists.
b. Isolationists are theoretically oriented, but hold on to a static or internally refined theory or method, guarding against intrusions. For isolationists, everything fits into a pre-defined perspective. While methodological isolationism is generally unwarranted in complex systems, it can be quite powerful in well-characterized situations (thus, probably, better oriented towards disciplinary problems). Theoretical isolationism is more robust in that it provides stable foundations for exploring complex problems, and can incorporate and

make sense of a wide variety of disparate phenomena (i.e., boundary drawers who are supremely comfortable in their own domain).

c. Imperialists are similar to pragmatists, but with a theoretical core that cannot be touched or altered. Imperialists will either annex or subsume other theories and approaches – taking what is useful and discarding that which does not help or fit the existing theory. Since they are beholden to a core theory, incorporation will always be selected so as not to disrupt that core (avoiding contradictions), thereby hampering change, learning, and growth. Structurally, imperialism is unlikely to prevail in a field because it fails to enroll new people. However, we might expect that imperialist programs, projects, and people can easily flourish in bounded time.

d. Interestingly, pluralists are the least clearly defined in Flood's text, even though it is articulated as his preferred approach. He primarily defines pluralism in contrast to isolationism in that "The whole conception of a pluralist way forward is methodological incommensurability and theoretical commensurability" (85) whereas isolationism promotes theoretical incommensurability.

While Jackson and Flood focus on approaches to a field of study, we use this discussion to think about the orientations of individuals within collaborative contexts. This move from the field to the individual may seem strange at first, but not if we understand that orientations within fields are carried by individuals, and that individuals are oriented in their work by the disciplinary systems we discussed above.

4.3 COMPATIBILITY, COMPLEMENTARITY, AND CONFLICT BETWEEN WORK STYLES

The 4 workstyles outlined above may have differential impacts on collaboration, independently of the alignment of other factors (epistemological, cultural, and normative). In other words,

many collaborations succeed or fail because the individuals involved in them work or do not work well together. However, recognizing that such work styles are not reductively "psychological" opens the possibility of actively building bridges and relations, rather than simply accepting inherent compatibility.

Both Flood and Gregory (1996) explore how particular kinds of theories are more or less compatible with (or even require) one of their 4 approaches to research. Each thus grapples implicitly with the idea that every theory is itself aligned with one of these approaches.

Flood, for example, argues that scholars who work with or rely on principles of reflexivity in their work tend to be more pluralist, because they tend to treat knowledge structures themselves as malleable and tied to social life. Stirling (2006) also suggests that reflexive scholars are better able to avoid a mainstream fallibilism that sees one representation as always true, and naïve realism that sees one representation as precisely true, instead practicing grounded perspectivism that is able to appreciate a number of representations as being true, with high degrees of both reflectiveness and reflexivity. Structural functionalists on the other hand tend toward isolationism because of their commitment to a well-defined methodology. In other words, Flood provides a way of thinking about the relation of work styles to particular disciplinary orientations, suggesting that work styles and theoretical (and, indeed, disciplinary) commitments may not be separable categories of analysis.

These discussions thus clarify that, even as we bring the typology to an individual level, it remains informed by the field level discussions from which it emerged, and can contribute to the discussion of disciplinary norms and practices.

The remainder of this section, though, explores a more practical question for the work-style typology: how might various work styles contribute to the compatibility, complementarity, or discord of any particular collaboration? And how might we use this discussion to think about what pairings facilitate or undermine collaborations of various sorts?

Compatibility: Compatibility, at first blush, suggests pairing researchers who have similar work styles, and thus can easily meld their practices. This can certainly be true for both pluralists and pragmatists. Isolationists may not be able to collaborate directly, but by breaking problems into smaller pieces, they may easily work in parallel to great effect. As boundary maintainers, as long as they can work out a mutual understanding of relevant boundaries, such collaborations can work. We might expect, however, that imperialists will conflict particularly strongly with other imperialists, as each works to impose their own image and practice on the project.

Complementarity: Compatible researchers may not actually be productive together if they do not also bring complementarity to the table. Is it best to work with those who are like us, which is easy and can be helpful for a divide and conquer approach, but may not add much imaginative value, or to work with those unlike us, which is hard but can lead to more dynamic scholarship?

Discord: Discord in a collaboration is generally considered undesirable, but this may not always be the case, particularly if properly approached. History is full of famous stormy collaborations that were nevertheless highly fruitful. This general insight can be equally true for work styles, and so we might consider Gregory's (1996) "discordant pluralism", Connolly's (2005; 2008) constructions of pluralism, and Mouffe's (2000) sense of "agonistic pluralism" as an important component of collaboration. Schwartz & Thompson (1990) provide a classic STS example of discord leading to an effective outcome (while not exactly in the context of collaboration). In their story, a group of Greens highlighted a toxic substance in toilet fresheners, and the product

was removed from the market. “Within three months there was a replacement product: one which not only eliminated the offending paradichlorobenzene but also had the major advantages of a better smell, lower evaporation in store, and production by continuous extrusion instead of the previous batch-molding technique. The corporation's newsletter put it like this: ‘The result was actually a better product in terms of perfume delivery and product life - a less expensive product and a new process with higher production capability.’” (p 3). Their focus is less on the quality of the product, than on the idea that conflicting views of nature were essential to this “win-win” outcome. Halfon et al (2020) likewise suggest productive aspects of an agonistic approach to collaboration in a public engagement project.

To help us think through the question of productive pairings, Figure 6 below provides a matrix of the 4 work styles, mapped along the dimensions of dogmatic vs. reflexive (certainty or intellectual arrogance vs. openness to other ideas), and collaborative vs. non-collaborative (working with others vs. individualistic, solo work). Collaborative relationships may form between or within any of the quadrants, to different effect, though we suggest that different types of collaborative projects benefit from different sorts of pairings. For example, those high on the collaboration dimension will be important to any functioning collaboration on complex problems, but simpler problems may benefit more from the efficiency offered by less collaborative work styles.

We provide a brief, prospective discussion of some possibilities, recognizing that any such exploration risks essentializing the categories and relations. We also recognize that complex collaborations are often emergent rather than consciously formed, so the purpose here might be more about understanding collaborations in process than about their initial construction.

[Figure 6: Collaborative pairing across working styles. Source: Authors.]

Here is an incomplete sampling of some specific ways to think through pairings:

1. Isolationistben/Imperialist: Manager (visionary) and worker relationship would work fine, with distributed tasks. Friction around misrepresentation of outputs and imposition on time and habits.

2. Isolationist/pragmatist: Neither likely to organize ongoing collaboration, so interactions will be short and functional. Pragmatists would not organize, but rather borrow liberally, with friction around simplification of detailed results (sloppiness) and questions of efficiency.

3. Pragmatist/pluralist: Pragmatists might appreciate the synthetic knowledge of pluralists as a resource to mine, but would be frustrated by inefficiencies of process and reflection. Pluralists might be similarly frustrated by the push to impose closure and top-down outcomes.

4. Pluralist/pluralist: Productive of long-term collaborative relationships with diverse and creative solutions, but at the cost of slow outputs and the risk of getting mired in procedural and reflexive process. Different types of pluralists might also end up in disputes over process and goals, for example a push for consensual versus agonistic outcomes.

5. Imperialist/imperialist: Unless they begin with a range of shared perspectives, such collaborations are likely to lead to rancor. This could be productive in the short term, but is unlikely to last.

There, of course, cannot be one best collaborative pairing. Instead, we can think about such relationships along two angles.

Goals: Different collaborative goals may suggest different combinations, and different combinations might likewise give rise to vastly different goals. For example, do collaborators prefer smooth and long-lasting working relations or highly productive (i.e. innovative) collaborations. Pragmatists will generally push for outcome goals; whereas, pluralists may be more amenable to process goals. Thus, long term collaborations seem to require some degree of pluralism, but pluralism may work against short term goals due to inefficiencies – such collaborations may be better served by pragmatic or imperial approaches. But multiple imperialists cannot work together – they probably work better with any of the other three. Pragmatists work well with anyone if they are in charge, but are best at incremental rather than deeply innovative approaches to problems – if not in charge, they will get quickly frustrated with the process orientation of pluralists, the closed mindedness of isolationists, and the pushiness of hierarchists. Balmer et al. (2015) highlight how opening up discussions of *unshared goals* between collaborators can help negotiate expectations and also generate more mutual understanding and shared interests.

Problem framing: Do different kinds of problems require different kinds of collaborations? Do different kinds of collaborations require different kinds of problems? Narrowly technical questions are likely to result from non-collaborative work styles – isolationists may view the world through their own methodological frameworks and pragmatists tend to minimize

complexity in formulating questions. Pluralists (and imperialists to a lesser extent) will tend to pose questions that build on the full complexity and multiplicity of the collaborators – if both technical and social scientists are involved, such questions move toward socio-technical framings. So, perhaps the question is not whether forms of collaboration work better or worse for different problems, but the ways problems are defined is going to depend on the type of collaboration.

5 DISCUSSION AND CONCLUSIONS

Four key ideas emerge from our discussion.

First, we move from interdisciplinarity to pluralistic collaboration. Interdisciplinarity, multidisciplinarity, transdisciplinarity, and a flurry of other monikers used to explain and explore collaborations across intellectual divides overemphasize the epistemic features and practices of such work. While bridging epistemological divides are crucial and productive in addressing complex socio-technical problems, an emphasis on pluralistic collaboration opens a range of other factors and considerations when working with others in complex arenas.

We identified four crucial dimensions of difference that constitute the pluralism of collaboration: knowledge systems, institutional cultures, norms, and work styles. Each of these divides can be homogenized or pluralized within a collaboration, to varying effect. Pluralizing each dimension requires unique bridging mechanisms, and has different implications for the success and nature of a collaboration.

For example, epistemic pluralism relies on mechanisms such as trading zones and contributory expertise to bridge explicit and subtle differences between the epistemic communities embedded both within and outside of disciplines. Epistemic pluralism is a useful category for understanding

relations between both authorized communities of experts and forms of expertise that lie outside of dominant frames.

Institutional pluralism relies on bridging a range of constraints, norms, practices, and other cultural factors that accompany collaborators into new settings. Different disciplinary cultures often need careful and open negotiation, and become increasingly difficult as collaboration moves across technical, humanistic, and artistic fields. Collaboration reaching outside of the academy raises particularly difficult institutional and cultural issues, often risking various forms of institutional incompatibility and imperialism.

Normative pluralism requires explicit recognition and negotiation of normative questions about the nature of the work and the underlying values of the participants. Aspects of this difference can include: whether collaborators understand the research as problem-driven and socially relevant or "pure" and "objective" research; what visions of society and the future might shape researcher goals and questions; how the research connects with the various researchers' social and professional identities. Normative pluralization requires negotiation of languages of normativity and the very personal aspects of ethics and politics that researchers bring to the work.

Lastly, individual pluralism requires bridging, merging, and managing individual and group dynamics, matched to our notion of working styles. Psychological personality types might be managed, but sociological work styles require deeper consideration of the institutional spaces and normative practices surrounding any collaborative effort. Of particular importance are clear expectations about the instrumental versus process goals, and time frame, of the collaboration.

Our second insight is an appreciation for the pluralism of pluralisms. We mapped a range of dimensions along which we might pluralize collaborations and among which collaborators need to negotiate in order to pluralize (the dimensions of Table 2). We also mapped some dimensions that might push collaborators towards or away from pluralism (work styles, problem frames). Thus, collaborations can be measured not merely across the scale of pluralism versus homogenization, but also in terms of different forms of pluralization. Whether a collaboration is focused on a specific goal with hierarchical relations or is process oriented and open to working through inherent conflict will produce very different outcomes. The invocation of pluralistic work styles within a larger discussion of pluralistic collaboration was a purposeful attempt to explore additional dimensions of pluralism.

Third, pluralistic collaboration has no academic bias, and centrally includes long-standing STS calls to integrate non-academic contributors and non-authorized epistemologies, ontologies, and practices centrally into collaborative practice. There is no linguistic or structural orientation in this formulation limiting collaborations to those between academic disciplinarians.

Fourth, we hold that pluralism is valuable for addressing complex sociotechnical problems, but forms and degrees of pluralism can be varied greatly. While pluralism is not the best way to solve every problem, the complex problems that benefit from collaboration are precisely the types of situations in which diverse skills, perspectives, and epistemologies are most helpful. Yet complete pluralization across all of the divides is not always necessary to take advantage of this feature, and may undermine the ability to collaborate effectively.

In sum, this paper has largely been a mapping exercise, exploring how a range of existing literature can be drawn together to understand the broad dimensions of what we call pluralistic

collaboration. In doing so, we have identified at least one significant gap in the literature – a sociology of academic work styles - and have begun building a model for addressing that gap.

We also offer a few practical conclusions that emerge from a reframing of interdisciplinarity as pluralistic collaboration.

1. Don't try to be pluralist in all dimensions simultaneously, but find and build commonalities across these forms of pluralism. Collaborations can fail from too much pluralism along multiple divides, but our mapping provides a range of sites for introducing homogeneity in an otherwise pluralized collaboration. In particular, we point to the benefits of workstyle homogeneity as providing a significant opportunity to pluralize a range of other dimensions.
2. Pluralist work styles among core collaborators are essential to long-term collaborative stability, but short-term action is often facilitated by imperialists. Structuring systems of decision-making and accountability around these different workstyles can have profound impacts on the form and outcomes of any collaboration.
3. Broadening the language and frame of collaboration beyond the current terms and towards pluralistic collaboration may help to surface invisible barriers and opportunities.

Ultimately, this discussion provides a broad overview and call for the shift from interdisciplinarity to pluralistic collaboration. But in its breadth, it leaves a number of issues underexplored. While epistemic, institutional, and normative pluralism have strong or emerging literatures already in place, work style pluralism remains under-researched. We offer two suggestions for further exploration. We suggest some expected relationships between work styles within a collaboration, but these are theoretical rather than empirical, and rather narrowly conceived. Further study is needed to understand their relevance. We also leave somewhat open

the question of whether to conceptualize work styles as deeply sociological rather than psychological. While our orientation is towards sociological treatment, we have not studied this issue with sufficient precision to convincingly make that case. The conceptualization of work styles helps to shape the ways that they may or may not connect to the other three elements of pluralization that we discuss as well as how fixed versus fluid they are, and how to change contexts to better facilitate collaboration.

6 NOTES

[1] We are using the term "pragmatist" as introduced by the authors we are reviewing, and who are using it in its commonsense meaning, i.e. someone who is practical and goal oriented rather than idealistic. These authors do not engage with the long, highly theorized tradition of philosophical pragmatism.

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