

Interdisciplinary Resources: A Bibliographical Reflection

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Abstract: The richest resource on interdisciplinary teaching and research is the voluminous literature on the subject. This literature reveals the considerable range as well as different theoretical and ideological positions on the nature and significance of interdisciplinary activities. Spanning the twentieth century, these published resources chronicle the evolution of interdisciplinarity, from its earliest manifestations in education and the social sciences to recent postmodern, “postdisciplinary” critiques of the structure of society and knowledge. This bibliographical reflection sketches the prominent works and ideas in that history, providing a broad view of the material that is available to teachers and researchers.

WE ARE, ONCE AGAIN, in the midst of a revival of interdisciplinary studies (IDS). “**The Resurgence of Interdisciplinary Studies**” was, in fact, the title of an article **Jerry Gaff** wrote for a recent special issue of *National Forum* devoted to “**Interdisciplinary Studies: Defining and Defending**” (69:2 [Spring 1989], 4-5). Citing interdisciplinary reforms in undergraduate education at hundreds of U.S. colleges and universities, Gaff noted that “The present climate of reform creates a very different dynamic for interdisciplinary studies than the dynamics of the last period of resurgence during the late 1960s and early 70s.” The emphasis then was on women’s studies, ethnic studies, urban studies, environmental studies, and a number of cluster colleges within larger institutions. The programs of that era were typically small, involved only a limited portion of faculty and students, and were often “relegated to the periphery” of their host institutions. As a result,

many had difficulty surviving into the 1980s. In contrast, the new interdisciplinary programs of today tend to be part of a mainstream reform of general education.

William Newell has also observed a “renaissance” of IDS. Similar to Gaff, Newell found the current IDS movement linked with a nationwide desire to revitalize the core of the liberal arts, this time by fostering coherence and excellence in the higher-order skills of integration and synthesis. The evidence Newell gathered in compiling a 1986 directory of interdisciplinary undergraduate programs in the United States showed the current movement is dominated by general education reform, followed by humanities, honors, and, predominant among topical and area studies, programs in women’s studies. In contrast to the 1960s and ’70s, Newell concluded, IDS today tends to be “renovative rather than radical.” (**William Newell reflected on his findings in “Interdisciplinary Studies are Alive and Well,” originally published in the Association for Integrative Studies Newsletter, 10:1 [March 1988], 1,6-8; subsequently reprinted in the AAHE Bulletin, 40:8 [April 1988], 10-12 and in the National Honors Report, 9:2 [Summer 1988], 5-6).**)

Renewed interdisciplinary activity is equally apparent in the realms of basic and applied research. It takes place on a day-to-day basis in a multitude of borrowings, including the tools of computer technology, lasers, physical measurement, and statistical analysis. It also has a collective life in the formation of interdisciplinary teams, whether their task is to deliver integrated care at a health facility, formulate and market new pharmaceutical products, take part in an archaeological project, solve environmental problems, or deliver general education in an integrated fashion. It has a further institutional visibility in centers and institutes organized to promote interdisciplinary research in the humanities, social sciences, and science and technology; in the emergence of new journals and organizations devoted to discipline-crossing topics and subjects; and in the escalation of mission-oriented research on aeronautical and defense systems and, especially in the last decade, biomedicine and national economic competitiveness. Inevitably interdisciplinary research has had an impact on the shape of modern disciplines. It has been a means of extending and contextualizing disciplinary practice in order to incorporate the social, ethical, and political dimensions of a subject. It has been linked with a rich variety of new scholarly discourses, from Marxism, structuralism, and general systems theory to social constructivism, rhetoric of inquiry, and chaos theory. It has also played a role in the redefinition of formal relationships among disciplines: in the influence of plate tectonics on geology and the other earth sciences, in the integrative

thrust of the modern neurosciences, and in the linguistic, interpretive, rhetorical, and historical “turns” in the human sciences. It has even attained a level of disciplinary formality in such recognized “interdisciplines” as social psychology, biochemistry, American studies, area studies, systems engineering, materials sciences, and the expanding field of science, technology, and society.

Given the diversity of interdisciplinary activities, there are considerable differences of opinion about their nature and epistemological status. These differences are embodied in the form of three competing voices in the academy. Voice #1 argues that traditional divisions of knowledge are being redefined: that increasing specialization has led to an inevitable intersection of some disciplines, that the magnitude of modern problems has prompted new social and intellectual structures to solve them, and that the blurring and mixing of genres Clifford Geertz observed in 1980 signals a refiguration of thought which goes beyond the moving of a few borders to what Geertz called a “jumbling of the varieties of discourse.” Voice #2 scoffs in response: insisting that disciplinary boundaries are as firm as ever, citing the struggle interdisciplinary programs always have to achieve autonomy and legitimacy, and noting the way that biochemistry and several other interdisciplinary fields eventually became disciplines themselves. Voice #3 rejects both arguments in an indictment of the way both disciplines and many interdisciplinary programs have become intellectual technologies: subverting gender, race, and class; valorizing authority and received notions of “truth”; totalizing knowledge under the name of a single paradigm or world view; normalizing, domesticating, and blunting once radical critiques of the way knowledge is delimited and channeled toward unexamined ends.

All three voices must be reckoned with, for they are accurate barometers of the complexity of knowledge in the late twentieth century. Voice #1 identifies a remapping of disciplinary terrain that has taken place as accelerating specialization and the urgency of modern problems have promoted new organizations of intellectual work. It embodies a critique of the dichotomy of disciplinarity and interdisciplinarity in an appreciation of the necessary, complementary, and some argue the dialectical relationship of the two. In-terdisciplinarity is thus emplotted in a narrative of crisis and change. Voice #2 documents the continued power of disciplinary hegemony within the university: manifested in the training patterns of departments, the granting of research funds, the awarding of tenure and promotion, the making of editorial decisions and the very definition of excellence in scholarship. In a reaffirmation of the dichotomy, interdisciplinarity is thus emplotted in a narrative of business as usual. Voice #3 embodies a postmodern critique that

replaces the telos of canon and coverage with the telos of pluralism and reflexivity. Interdisciplinarity is thus emplotted in a narrative of postdisciplinary transformation and oppositional criticism.

While not labeled as such, the differences in these voices are readily apparent in the dispersed literatures on interdisciplinarity.

I. Core Definitions

The ability to use those literatures has been hampered in the past by their dispersion and the lack of adequate bibliographies. There are, however, two reliable points of entry. **J.T. Klein's *Interdisciplinarity: History, Theory, and Practice* (Detroit: Wayne State University Press, 1990)** is a comprehensive synthesis of modern scholarship on the concept of interdisciplinarity in research, education, and practice. This book also contains a 94-page bibliography on interdisciplinary theory and method, problem-focused research, education, and health care, with selected references from the humanities, social sciences, natural sciences, and technology. ***Interdisciplinary Analysis and Research: Theory and Practice of Problem-Focused Research and Development*, edited by D.E. Chubin, et al. (Mt. Airy, Maryland: Lomond, 1986)**, is an anthology of important essays on the nature of interdisciplinary research, including such classics as Donald T. Campbell's "Ethnocentrism of Disciplines and the Fish Scale Model of Omniscience," Barmarck and Wallen's "The Interaction of Cognitive and Social Factors in Steering a Large-Scale Interdisciplinary Project" (focused on the ecosystem of a coniferous forest in Sweden), Robert Chen's "Interdisciplinary Research and Integration: The Case of CO² and Climate," Darden and Maull's "Interfield Theories," Jacob Stucki's "A Goal-Oriented Pharmaceutical Research and Development Organization: An Eleven-Year Experience," Bella and Williamson's "Conflicts in Interdisciplinary Research" (focused on the impacts of dredging on estuaries), Rossini, et al.'s "Interdisciplinary Integration within Technology Assessments," and William R. McDonald's "Characteristics of Interdisciplinary Research Teams." *Interdisciplinary Analysis and Research* also contains a 29-page annotated bibliography of references on interdisciplinary research which, like the book itself, emphasizes problem-focused research.

There is, in addition, one major book that has long been regarded as the seminal work of scholarship on the subject, ***INTERDISCIPLINARITY: Problems of Teaching and Research in Universities* (Paris: OECD, 1972)**. This pioneer collection of scholarship contains results of the first international conference on interdisciplinarity, organized by the Organization for

Economic Cooperation and Development (OECD). Propelled by worldwide educational reforms of the 1960s and '70s, the book is dominated by the structuralist and general systems thinking of its major theorists, among them Jean Piaget, Leo Apostel, Guy Berger, and Erich Jantsch, whose influential vision of the transdisciplinary organization of knowledge and the university appears in this book under the title "Towards Interdisciplinarity and Transdisciplinarity in Education and Innovation." The book also contains fundamental definitions of the relationship between disciplinary and inter-disciplinarity, and its core terminology remains the most widely cited set of definitions. OECD theorists established basic distinctions among a "multi-disciplinary" juxtaposition of disciplines that are not necessarily connected, a "pluridisciplinary" juxtaposition of disciplines assumed to be more or less related, "interdisciplinary" interactions, and a more "transdisciplinary" system of axioms (25-26). In assessing results of an international survey conducted prior to the conference, OECD theorists also concluded that interdisciplinarity arises from five major demands:

- (1) *the development of science itself*, as the result of increasing specialization leading to the intersection of two disciplines, the splitting up of an over-rigid discipline, or setting off into new fields of knowledge as well as and attempts to define elements common to disciplines;
- (2) a student-demand, usually as a protest against parcelization and artificial subdivisions of "reality";
- (3) problems of university operation or administration resulting from increasingly elaborate equipment and the need for budget management;
- (4) vocational and professional training requirements based on both student demand and contracts extending outside the university, thus leading to the fifth demand;
- (5) an original social demand for responding to particular needs and devising new subjects which cannot be contained within a single disciplinary frame (39-41).

Twelve years later, in 1984, the OECD was to return to the subject of interdisciplinarity when it cosponsored a second international conference on the subject, selected results of which appear in *Inter-Disciplinarity Revisited: Re-Assessing the Concept in the Light of Institutional Experience*, edited by Lennart Levin and Ingemar Lind (Stockholm; OECD, Swedish National Board of Universities and Colleges, Linköping

University, 1985). The difference in the tone of the two OECD books is instructive. The 1972 book reflected the optimism of educational reform, with accounts of experimental programs at such landmark institutions as the Universities of Sussex, Wisconsin-Green Bay, and the University of Paris VIII (Vincennes). While their objective was not to demolish the disciplines these experiments nonetheless embodied the belief that a new way of learning and knowing could be institutionalized through innovative organizations of teaching and research. In contrast, the 1982 book depicts a markedly different climate for interdisciplinary programs. OECD representative Hans Schütze cited a loss of momentum and the limited impact of earlier experiments. His colleague Georges Papadopoulos concurred, noting a clear shift from the optimism of the '70s to an "empirical realism" in the '80s, from developing concepts to testing their ideas in the forge of daily practice and disciplinary constraints. Even in the face of continued evidence that disciplinary barriers are not impenetrable, "The quest for academic responsibility," Papadopoulos concluded, "leads inevitably to a regression back to individual disciplines" (208).

Throughout the Twentieth Century definitions of interdisciplinarity have reflected an inevitable tension between specialization and integration as well as two fundamental distinctions: (1) between a lower-level and a higher-level form of integration; (2) between external demands for interdisciplinarity arising from outside the university and internal demands arising from the evolution of knowledge. These distinctions explain a good deal of the conflict that exists among Voices #1, #2, and #3, who assign rather different meanings to movements across disciplinary borders. They also reflect two fundamentally different metaphors of interdisciplinarity, that of "bridge-building" and "restructuring." The first, "bridge building," takes place between complete and firm disciplines. The second, "restructuring," entails changing parts of several disciplines. Bridge-building, which often has an applied orientation, is more common and less difficult because it essentially preserves disciplinary identities. Restructuring is more radical and often embodies a critique of not only the state of the disciplines being restructured but also, either implicitly or explicitly, the prevailing structures of knowledge. The Group for Research and Innovation, which noted these two metaphors, also cited a third possibility, one that comes from a new overarching concept or theory comparable to what the OECD labeled "transdisciplinarity." (*Interdisciplinarity; A Report by the Group for Research and Innovation* [Regents Park, England: Group for Research and Innovation, The Nuffield Foundation, July 1975]).

The distinction is evident in the history of interdisciplinarity in the social sciences, where Landau, Proshansky and Ittelson found two quite different movements. The first, dating from the close of World War I to the 1930s, was characterized by the “interdisciplinary” borrowing of techniques and instruments primarily for instrumental purposes. This process, embodied in attraction to the quantitative methods of the natural sciences, still preserved the status quo of disciplines. The second, which dates from the close of World War II and is embodied in the concept of area studies, reflects a more ambitious search for newer “integrative” categories capable of producing a new conceptual unity. While the second might grow out of the first, they are on different logical levels. (M. Landau, H. Proshansky, and W. Ittelson, “The Interdisciplinary Approach and the Concept of Behavioral Sciences,” in *Decision, Values and Groups*, ed. Norman F. Washburne [New York: Pergamon Press, 1962], II, pp. 7-25). A parallel distinction also arose in education circles. Alastair Taylor, representing the Foundation for Integrative Education, contrasted “integration” as a synthesis of presently accepted postulates with an “integrative” building of new conceptual models capable of producing a holistic educational philosophy. (Alastair M. Taylor, “Integrative Principles and the Educational Process,” *Main Currents in Modern Thought*, 25:5 [1969], 126-133). Similarly, Richard Pring has argued that “interdisciplinary” and “integrated” descriptions of the curriculum are on different logical levels. “Integration,” which incorporates the idea of unity, raises certain epistemological questions to which “interdisciplinary” remains indifferent. “Interdisciplinary,” Pring contends, merely refers to the use of more than one discipline in pursuing a particular inquiry, even though further thinking might show epistemological questions are unavoidable. (Richard Pring, “Curriculum Integration,” *Proceedings of the Philosophy of Education Society of Great Britain, Supplementary Issue*, 5:2 [July 1971], 170-200)

The distinction between lower and higher level forms of integration has been linked with the distinction between external and internal demands. In the 1985 OECD book *Inter-Disciplinarity Revisited*, J.T. Klein (104-36) and Ernest Lynton (137-52) presented independently authored theories based on two major justifications for interdisciplinary work: a more conceptually based “synoptic” justification, apparent in arguments for unity and synthesis, and a more pragmatically based “instrumental” justification, apparent in arguments to solve problems of either a “practical” nature (such as social, technological, or environmental problems) or a methodological nature (for purposes of limited borrowing, akin to the first movement identified by Landau, et al.). Noting a growing sense of urgency in the literatures about the

need for “instrumental” interdisciplinarity, Klein cited a 1982 endorsement of instrumentality in a report published by the OECD. Based on results of a survey conducted among OECD member nations, authors of the report concluded the urgency of modern problems means more weight should now be given to the development of “interdisciplinarity exogenous to the university.” Exogenous interdisciplinarity originates in the continuous momentum provided by “real problems” of the community. It then supplements, enriches, and interrogates “endogenous interdisciplinarity,” an interdisciplinarity based on the production of new knowledge with the aim, more or less, of realizing a “unity of sciences.” (**Communities Have Problems, Universities Have Departments,** in *The University and the Community: The Problems of Changing Relationships* [Paris: OECD, 1982], pp. 127-31)

At the same time this sense of urgency about externally, instrumentally driven interdisciplinarity has been growing, and weighing heavily upon Voice #1, a counter, even anti-instrumental, urgency has been growing in the academy, informed by contemporary critique and weighing heavily upon Voice #3. While implied in earlier distinctions between lower- and higher-level forms of integration, it is increasingly conceptualized, in an age of postmodern scholarship, as a form of postdisciplinarity. Writing a decade ago in a special issue of the *Journal of Canadian Studies* focused on interdisciplinary studies, Arthur Kroker distinguished “vacant interdisciplinarity,” a style of discourse that mechanically applies the bland “integrations” of normalization, from “critical interdisciplinarity,” a reinvention of discourse that would entail collective deliberation on problems of Canadian history and experience. Critical interdisciplinarity would foster a new style of scholarship that is simultaneously public, discursive and archaeological, based on a vigorous pluralism that constitutes a rediscovery and rethinking, indeed a resocialization and reintellectualization of knowledge. (Arthur Kroker, “**Migration Across the Disciplines,**” *Journal of Canadian Studies*, 15 [Fall 1980], 3-10)

While not cited directly, Kroker’s notion of a “critical interdisciplinarity” is echoed in a number of recent additions to the literature on interdisciplinarity. Bruce Robbins, discussing the interdisciplinary nature of textualism, speaks of an “eventual interdisciplinarity,” “a different interdisciplinarity” that does not simply borrow across and thereby preserve existing disciplinary boundaries but reorganizes inquiry around alternative procedures of interchange. (Bruce Robbins, “**Poaching off the Disciplines,**” *Raritan*, 6:4 [Spring 1987], 81-96). This transformed, reconstituted form of inquiry has a transgressive relationship to discipline, positing a new notion

of disciplinarity. Diane Elam recently argued that feminism should be viewed as a “discipline of difference,” a concept of discipline that calls into question the autonomy of discipline by reconstituting disciplinarity as crossdisciplinarity, a concept that challenges the disciplinary structure of the university by demonstrating that borders are neither stable nor impenetrable while also realigning epistemological concerns with their political implication. **Diane Elam’s essay, “Ms. en Abyme,” appears in v. 4 (July/September 1990) of the journal *Social Epistemology*, a special issue of that journal devoted to the subject of “Crossdisciplinary Inquiry.”** Likewise, **Patrick Brantlinger**, in his recent book *Crusoe’s Footprints: Cultural Studies in Britain and America* (New York: Routledge, 1990) is mindful of the postdisciplinary conditions of scholarship. Brantlinger describes cultural studies as a “coalescing movement, a sort of magnet gathering the various theories that now often go under the label ‘theory’ into a problematic and perhaps impossible synthesis” (10). One of the significant aims of the movement has been the counterdisciplinary project of breaking down barriers to culture while establishing new patterns of intellectual and political critique both inside and outside the university, recalling Kroker’s concept of a “critical interdisciplinarity” that, Brantlinger likewise observes, is simultaneously academic and public, literary and political.

If the postdisciplinaryarians have any shared reference it is Stanley Fish’s recent pronouncement distinguishing past interdisciplinary studies and practices from contemporary movements and theories which invoke “interdisciplinarity” and “critique” in the same breath. Interdisciplinarity has attained a new force and urgency, Fish explains, in the form of a “radical interdisciplinarity” linked with the imperatives of left culturalist theory, that is, in deconstruction, Marxism, feminism, the radical version of neopragmatism, and the new historicism. While different in important ways, these movements share a common opposition to both the social structures by means of which lines of political authority are maintained and the institutional structures by means of which academic disciplines establish and extend their territorial claims. Fish pictures radical interdisciplinarity as a “*revolution tout court*” a “kind of guerilla warfare” in which the decorums disciplines ask us to observe are systematically violated, not in linear progression but through breakthroughs, leaps, and discontinuities. Fish’s definition pits tamed, domesticated, even coopted forms of interdisciplinary work — manifested in borrowing information and techniques from other disciplines, expanding into other disciplinary territories through annexation, and establishing (inter)disciplines that produce a new breed of counter professionals/experts — against a postmodern, critical interdisciplinarity that is ultimately impos-

sible to do because of the impossibility of achieving authentic critique. While a succinct and worthy articulation of a postmodern position, Fish's pronouncement ultimately fails to take into account both the panoply of interdisciplinary activities and the interactive relationship of disciplinarity and interdisciplinarity. (See **Stanley Fish, "Being Interdisciplinary is so Very Hard To Do," *Profession 89*, a publication of the Modern Language Association, [1989], 15-22.**)

It is no accident that the metaphor of territoriality pervades many recent considerations of radical, critical, and postdisciplinarity. Any interdisciplinary field or organized effort to address questions and problems that cross disciplinary borders is a negotiated "space" within and across the current rules of intellectual organization. Pervasive use of the metaphor of spatial politics in descriptions of interdisciplinary work reveals the degree to which interdisciplinary work constitutes what Jeffrey Peck has called a "topographical discourse," drawing our attention to "intellectual *surfaces* and academic *contours*, critical *boundaries* and scholarly *fields* of demarcated interests, as well as the cultures that inhabit those territories." Peck was one of the organizers of "**Germanistik as German Studies: Interdisciplinary Theories and Methods**" a special issue of *German Quarterly* 62:2 (Spring 1989). The articles in this issue reflect a variety of perspectives — anthropological, feminist, new-historicist, psychoanalytic, hermeneutic, semiotic, deconstructionist, and rhetorical — shaping cultural studies today. These perspectives are informed by questions of national, institutional, disciplinary, and sexual identity that call into question the received canon and categories of knowledge. There is a predictable tension in the issue, however, between those who conceive of interdisciplinary work as a counter-hegemonic discourse that must remain polyvocal, open, and fluid — embodied in the vision of a dialogic negotiation that questions the center/margin dichotomy while clarifying the claims of intersecting modes and models — and those who want a clearly defined disciplinary base that will structure the field by bringing order and hierarchy to a variety of discourses. This same tension has been a recurring part of debates on the interdisciplinary nature of the various "studies," organized programs of education and research centered on questions of social, ethnic, and minority experience, as well as urban and environmental issues.

Additional major definitions of interdisciplinarity may be found in several sources:

- **Corinna Delkeskamp, "Interdisciplinarity: A Critical Appraisal," in *Knowledge, Value, and Belief*, ed. H.T. Engelhardt, Jr. and D.**

Callahan (Hastings-on-Hudson: Hastings Center, 1977), pp. 324-354;

- **Claudia Huerkamp and colleagues from the Center for Interdisciplinary Research at the University of Bielefeld (Germany), “Criteria of Interdisciplinarity,”** discussed for the U.S. audience in Wilhelm Vosskamp’s, “From Scientific Specialization to the Dialogue between the Disciplines,” *Issues in Integrative Studies*, 4 (1986), 17-36.
- **Joseph J. Kockelmans, “Why Interdisciplinarity?”** in *Interdisciplinarity and Higher Education*, ed. Joseph J. Kockelmans (University Park: Pennsylvania State University Press, 1979), pp. 123-160;
- **Raymond C. Miller, “Varieties of Interdisciplinary Approaches in the Social Sciences,”** *Issues in Integrative Studies*, 1 (1982), 1-37.

II. Interdisciplinary Work at Local and Regional Levels

A good deal of the tension that exists among Voices 1, 2, and 3 stems from different views of the level at which interdisciplinary work can and should take place. In actual practice it occurs at several levels: as a comprehensive search for unity, as a regional integration of contiguous problems and questions, and as a local integration of more limited scope. The most comprehensive level is associated with the classical idea of unity of knowledge, the modern search for grand field theory, and a variety of “transdisciplinary” axioms intended to have the status of a metaparadigm, such as general systems theory, structuralism, and Marxism. Three authors have traced the relationships among traditional ideas of unity and synthesis, the rise of disciplinary, and the rise of organized interdisciplinary education and research in the twentieth century: **Joseph J. Kockelmans, “Science and Discipline: Some Historical and Critical Reflections”** (pp. 11-48), Wolfram Swoboda, “**Discipline and Interdisciplinarity: A Historical Perspective**” (49-92), and Hans Flexner, “**The Curriculum, the Disciplines, and Interdisciplinarity in Higher Education: Historical Perspective**” (93-122), in *Interdisciplinarity and Higher Education*, edited by Joseph Kockelmans (University Park: Pennsylvania State University Press, 1979). Georges Gusdorf has also reflected on the topic historically in “**Past, Present, and Future in Interdisciplinary Research,**” an article which appeared in a special section of the *Interna-*

tional Social Science Journal on interdisciplinarity (29:4 [1977], 580-99).

Individuals have considered the question of unity from a cosmological perspective in two quite different ways. Stephen Toulmin has collected essays of his own that deal with the cosmological significance of the modern scientific world picture, in assessments of the work of Arthur Koestler, Jacques Monod, Gregory Bateson, Carl Sagan, and Teilhard de Chardin. (**Stephen Toulmin, *The Return to Cosmology: Postmodern Science and the Theology of Nature* [Berkeley: University California Press, 1982]**). In a different vein, the International Cultural Foundation sponsored a 1977 conference on the unity of the sciences that brought together theologians, philosophers, social scientists, and natural scientists. Volume II of the published results includes a section on the “**Ways and Means of Multidisciplinary Studies,**” in *The Search for Absolute Values in a Changing World* (New York: International Cultural Foundation, 1978). More recently the International Christian Studies Association has begun publishing the *Journal of Interdisciplinary Studies* under the auspices of the Institute for Interdisciplinary Research.

By and large most interdisciplinary work does not take place at the level of grand unity. The idea of grand unity has been undermined by not only the proliferation of specialties, which continues to exacerbate problems of communication across disciplines, but also postmodern critiques of the dangers of totalization, metanarrative, and the uncritical centering of social, political, or disciplinary authority. Jean-Francois Lyotard, in fact, has defined “postmodern” as “incredulity toward metanarratives” (in *The Postmodern Condition: A Report on Knowledge* [Minneapolis: University of Minnesota Press, 1988], p. xxiv). On a day-to-day basis most interdisciplinary work takes place at a more local or regional level. The Soviet interdisciplinary theorist Stanislav Smirnov has written about “regional concrete-science interdisciplinarity” that constitute a condensation, consolidation, and specification of interdisciplinarity across particular spheres of science, in S.N. Smirnov, “**The Main Forms of Interdisciplinary Development of Modern Science,**” in *Integration of Science and the Systems Approach*, ed. Z. Javurek, A.D. Ursul, & J. Zeman (Prague: Academia, a Publishing House of the Czechoslovak Academy of Sciences, 1984), pp. 65-83. Stuart Hall also used the term “regionalism” to describe the work of the former Centre for Contemporary Cultural Studies, a post-graduate institute at the University of Birmingham (U.K.) devoted for two decades to research on the forms, practices, and institutions of contemporary culture and society. The research done at the Birmingham Centre spanned a wide spectrum of con-

crete areas that employed different paradigms and retained different methodological emphases: some stressing ethnographic field work and interviewing, others the centrality of texts, discourse, and practices of representation. Yet, even though work was divided into concrete areas, the themes and methodologies of different areas moved across groups. In this manner there was a certain "regionalism" to the work of the center. Each "region" had an intellectual responsibility for critically confronting the strategies, methods, and findings that were the dominant practice in its area. At the same time each was responsible for making its progress open to other groups, thereby developing cultural studies as a whole and advancing it as a field of study. (**Stuart Hall, "Cultural Studies and the Centre: Some Problematics and Problems," in *Culture, Media, Language: Working Papers in Cultural Studies, 1972-79* [London: Hutchinson, 1984], 15-47)**)

The concept of regionalism brings to mind Donald Campbell's oft-cited fish-scale model of omniscience. Campbell pictured the current structure of knowledge as clusters of specialties, each represented by a fish scale. The redundant piling up of specialties has left interdisciplinary gaps. The ideal model of knowledge would discourage disciplinary ethnocentrism in favor of novel specialties, novel ranges of competence, and new administrative structures that would facilitate communication across disciplines. Organizations such as the Birmingham Centre, the University of California Humanities Research Institute at Irvine, the Center for Interdisciplinary Research at the University of Bielefeld (Germany), the Santa Fe Institute, the Centrum Leo Apostel and the WORLDVIEWS organization in Belgium as well as the National Science Foundation-funded multidisciplinary engineering centers and the new science and technology centers are good examples of such novel structures. At a lesser level of formality so are the many networks of scholars, "schools of thought," and loosely structured fields centered on problems and questions that cross disciplines.

The Natural Sciences

The general tendency toward regional and local work is affirmed both in Smirnov's essay and in William Bechtel's analysis of "The Nature of Scientific Integration." Bechtel explains: "The objective of most scientists working across disciplinary boundaries has not been to achieve ontological simplification or unification," despite the drive toward grand field theory. Bechtel makes this point in the introductory chapter to a collection of essays on the interdisciplinary "regions" of biochemistry, the evolutionary synthesis, cognitive science, and animal ethology. (***Integrating Scientific***)

Disciplines, edited by William Bechtel [Dordrecht: Martinus Nijhoff, 1986]) Lindley Darden and Nancy Maull have also considered the topic of scientific integration in their now classic essay on interfield theorizing. They focus on the chromosome theory of Mendelian heredity as it bridged the fields of cytology and genetics, the operon theory as it related the fields of genetics and biochemistry, and the theory of allosteric regulation as it connected the fields of biochemistry and physical chemistry. These theories, they point out, have played an important role in the progressive unification of the modern physical and biological sciences. (Lindley Darden and Nancy Maull, "Interfield Theories," *Philosophy of Science*, 44 [March 1977], 43-64.) In addition to these two major works on interdisciplinary science, J. Vlachy has outlined "Interdisciplinary Approaches in Physics: Section B (B32:II [1982], 1311-1318, and James Gleick has explained the theme of chaos in the work of physicists, biologists, astronomers, and economists. Chaos theory is often cited as an example of interdisciplinary activity. It offers a way of seeing order and pattern where once only the random, the erratic, and the unpredictable were observed. The work being done in this area is linking hitherto unrelated kinds of wildness and irregularity such as the turbulence of weather, the complicated rhythms of the human heart, the design of snowflakes, and the whorls of windswept desert sands. (James Gleick, *Chaos: The Making of a New Science* [New York: Viking, 1987]).

A number of recent reports on interdisciplinary science and technology are also important indicators of current interdisciplinary work, cast in the language and logic of Voice #1. Like most of these reports the **National Research Council report on *Scientific Interfaces and Technological Applications*, a volume in the *Physics through the 1990s* series (Washington, D.C.: National Academy Press, 1990)** has a strong future orientation which emanates from the exhilarating pace of discovery and application in the past decade. New technologies and sophisticated physical methods such as highspeed electronics, optical communications, advanced medical instrumentation, exotic defense systems, and energy and environmental systems have "nucleated" and grown to maturity within only a few years of the initial discoveries on which they are based. Simultaneously new ideas and methods born at the scientific interfaces are increasing the ability to address complex problems. In the realm of fundamental science the most vigorous interdisciplinary interactions are in biophysics, materials science, the chemistry-physics interface, geophysics, and mathematical and computational physics. In the technical applications of physics, which are pivotal to large-scale in-

dustrial technology, the outstanding examples involve electronics, optical information technologies, and new instrumentation being used in the fields of energy and environment, national security, and medicine. All of the recent reports emphasize the urgency of utilizing this knowledge for national economic competitiveness, a narrative logic echoed in recent evaluations of interdisciplinary research in Europe and the United Kingdom as well. The recent **National Research Council report on Bioengineering Systems Research in the United States: An Overview** (National Academy Press, 1987), for example, points out that interactions among the core disciplines of engineering, economics, social values, and the burgeoning of technical and scientific knowledge are “reordering world trade and the strategic balance among nations.”

A new story of science emerges from these reports. In describing the interface between physics and chemistry, the authors of *Scientific Interfaces* report this particular crossdisciplinary space “has been crossed so often in both directions that its exact location is obscure; its passage is signaled more by gradual changes in language and approach than by any sharp demarcation in content.” This crossing and recrossing of boundaries is apparent all across the sciences of molecules and atoms, surfaces and interfaces, and fluids and solids, resulting in a merging of disciplinary cultures within the integrated study of complex problems and materials of interest to scientists in both disciplines. In the areas of polymers and complex fluids, condensed-matter physicists are increasingly concerned with problems involving macro-molecular systems, to the point that traditional boundaries between chemistry, physics, and to an extent biology, have become blurred. The blurring of disciplinary boundaries is in fact the major theme in this new story of science, and in many areas of advanced technology this blurring has created a continuum that speeds technology transfer and innovation, pulling scientists and engineers involved in research and development “inexorably” toward the continuum and away from disciplinary boundaries. **Robert Sproull and Harold Hall**, in their report on *Multidisciplinary Research and Education Programs in Universities* (National Academy Press, 1987), note the shift from a disciplinary to a multidisciplinary character in problem- and product-oriented research as well as fundamental science. Similarly, the authors of *New Alliances and Partnerships in American Science and Engineering* (National Academy Press, 1986) emphasize the blurring of boundaries between basic and applied research, in a retelling of science history that highlights practical applications of science in physics, chemistry, computer science, and the whole set of applied scientific fields which call themselves engineering disciplines.

The narrative logic of the most recent full-length report from the **National Research Council, *Interdisciplinary Research: Promoting Collaboration Between the Life Sciences and Medicine and the Physical Sciences and Engineering* (Washington, D.C.: National Academy Press, 1990)** is also rooted in an evaluation of the relationship among past disciplinary structures of science, the abundance of recent and current crossfertilizations, and an unrealized future. An unrealized future is in fact a strong presence in all of the reports. The promises are great, including synthetic systems able to replace a range of human organs and all the functions a single organ performs. Yet, despite all that is known and a lot of talk about interdisciplinary research, there is a great deal more to do in order to improve integration than translate results of basic knowledge in cell biology, biochemistry, and physiology into effective therapies. The obstacles, embodied in the prevailing disciplinary organization of knowledge, are continually emphasized in all of the reports, which offer formal recommendations for accelerated and restructured funding of interdisciplinary research, effective coordination across NSF and NTH funding categories, more appropriate peer review systems, increased use of new organizational structures such as centers and institutes, and more favorable tax policies for academic-industrial alliances.

The Social Sciences

In the social sciences, there are two important essays that introduce readers to the different types and levels of integrative activity, both of them mentioned above: **Landau, Proshanky, and Ittleson's "The Interdisciplinary Approach and the Concept of Behavioral Sciences"** and **Raymond C. Miller's "Varieties of Interdisciplinary Approaches in the Social Sciences."** Miller defined seven categories of "cross-disciplinary" integration in the social sciences: (1) *a topical focus*, such as crime, gerontology, area studies, or religious studies; (2) *professional preparation*, such as business, nursing, home economics, or public administration; (3) *a life experience perspective*, manifested in such programs as ethnic studies and women's studies; (4) *shared components*, using similar research methods, such as statistics; (5) *cross-cutting organizing principles*, such as the concept of role and exchange; (6) *hybrids*, such as social psychology, economic history, culture and personality; and (7) *grand synthesis*, a systematic integration of disciplinary structures. In addition, Miller noted what he labels the "trans-disciplinary" approaches of general systems theory, structuralism, Marxism, phenomenology, policy sciences, and evolution-sociobiology.

There are also other major resources on the interdisciplinary social sciences. *Interdisciplinary Relationships in the Social Sciences* is a collection of essays edited by Muzafer and Carolyn Sherif (Chicago: Aldine, 1969). This book is the original source of Donald Campbell's "Ethnocentrism of Disciplines and the Fish-Scale Model of Omniscience." In addition, it contains Marvin Mikesell's "The Borderlands of Geography as a Social Science," the Sherifs' "Interdisciplinary Coordination as a Validity Check: Retrospect and Prospects," and Robert Dubin's "Contiguous Problem Analysis: An Approach to Systematic Theories about Social Organization." Readers in the social sciences should also take note of D.C. Phillips' *Holistic Thought in the Social Sciences* (Stanford: Stanford University Press, 1976). Phillips saw in holism three distinguishable theses about complex entities. Stanley Bailis, in a subsequent rejoinder to Phillips, has critically assessed both the concept of holism and the logic of Phillips' case against it. (Stanley Bailis, "Against and for Holism: A Review and Rejoinder to D.C. Phillips," *Issues in Integrative Studies*, 3 [1984/85], 17-41) Beyond these resources, Quentin Skinner has edited a collection of essays entitled *The Return of Grand Theory in the Human Sciences* (Cambridge: Cambridge University Press, 1985). Skinner concedes his title may be ironic, since the various thinkers discussed in this book — Gadamer, Derrida, Foucault, Kuhn, Habermas, Althusser, Levi-Strauss, and the Annales school of historians — posit considerably different and in some cases highly skeptical views of social theory. Indeed they might be called "anti-theorists" because of the way they emphasize the importance of the local and the contingent. Nonetheless, they have proved to be powerful "grand theorists" both within and beyond the social disciplines.

No discussion of the interdisciplinary social sciences would be complete without mentioning three perennial favorites on the syllabi of interdisciplinary courses. Loren Eiseley's *The Immense Journey* (New York: Random House, 1956) has long been a favorite because of Eiseley's deft skill at combining anthropological knowledge with literary imagination in a passage through time. Published the same year, Kenneth Boulding's *The Image: Knowledge in Life and Society* (Ann Arbor: University of Michigan Press, 1956) is a classic case for integrated knowledge based on the idea of *the image* as the sum of our knowledge and behavior. Drawing on biology, psychology, sociology, political science, economics, and history, Boulding proposes a new crossdisciplinary science of "eiconics." Gregory Bateson's essay "The Pattern Which Connects" is also a popular selection. In the book which contains this essay, *Mind and Nature: A Necessary Unity* (New York: Dutton, 1979), Bateson views biological

evolution as a paradigm for understanding the processes of thought, cultural change, and education. More recently, two other books have also begun appearing on interdisciplinary syllabi: **Robert Bellah et al.'s *Habits of the Heart: Individualism and Commitment in American Life* (New York: Knopf, 1982)** makes rich use of the interview as an interdisciplinary tool in what has been called a "moral anthropology of modern America." In ***Gödel, Escher, Bach: An Eternal Golden Braid* (New York: Basic Books, 1979)**, **Douglas Hofstadter** presents the idea that reality is a system of interconnecting and interrelating braids that are endlessly folding in upon each other. Juxtaposing expository essays with imaginative, witty dialogues in the spirit of Lewis Carroll, Hofstadter explores the notions of recursion and endless regress, interweaving the underlying order and self-reference of Gödel's Incompleteness Theorem, Escher's paradoxical drawings, and the fugues of Johann Sebastian Bach.

The Humanities

Less has been written about interdisciplinarity in the humanities than in the natural and social sciences. Nevertheless there is a substantive literature on the subject. In some instances authors have sought to trace the interdisciplinary relations of a particular discipline, in, for example, ***Relations of Literary Study: Essays on Interdisciplinary Contributions***, ed. **James Thorpe** (New York: Modern Language Association, 1967); **Jost Hermand and Evelyn Torton Beck's *Interpretive Synthesis: The Task of Literary Scholarship*** (New York: Ungar, 1975); **Jean-Pierre Barricelli and Joseph Gibaldi's *Interrelations of Literature*** (New York: The Modern Language Association of America, 1982), and treatises of particular movements such as ***The New Historicism***, ed. **H.A. Veaser** (New York: Routledge, Chapman and Hall, 1989). Recently Barbara Stafford has explored the problem of humanistic theory and specialist theory in a thoughtful and bibliographically dense essay. Stafford ponders the possibility for forging links between dissimilarly evolving disciplines and similar themes that go beyond eclecticism, reductionism, appropriation, and analogy. She takes as her "region" of exploration the eighteenth century in general and, more particularly, interdisciplinary issues and problems in the study of art. (**Barbara M. Stafford, "The Eighteenth-Century: Towards an Interdisciplinary Model," *The Art Bulletin*, 70:1 [March 1988], 6-24**) In a broader vein Nancy Anne Cluck has proposed that R.S. Crane's four groups of skills central to the humanities may be joined with conventional disciplinary designs to form systematic interdis-

ciplinary approaches. Crane's four groups belonged to linguistics, the analysis of ideas, literary and artistic criticism, and historiography. Thus historical periods, ideas, aesthetic themes and structures furnish junctures that might serve as means and as temporary ends for common ground among the traditional disciplines of the humanities (**Nancy Anne Cluck**, "Reflections on the Interdisciplinary Approaches to the Humanities," *Liberal Education*, 66:1 [Spring 1980], 67-77).

The integrative force of the humanities has also been a topic of discussion in three areas: in relations with the natural sciences; in the role ethics and values play in contextualizing professional practice, technological expertise, and scientific work; and in the function of the humanities in the curriculum. On the latter see especially **Lin Foa**, "The Integrated Humanities in Higher Education; A Survey," *Journal of Aesthetic Education*, 7 (July 1973), 85-98; **Deborah Crandall and Elizabeth Rinnander**, "Interdisciplinary Humanities: Sources and Information," *New Directions for Community Colleges*, 12 (Winter 1975), 95-102; and **Anne Brooks and Un-chol Shin**, "Past, Present and Future of Interdisciplinary Humanities," *Humanities Education* (September 1984), 3-9.

The most vital interdisciplinary work in the humanities today is taking place within a variety of networks and schools of thought that may be considered "regions" of a growing intersection of the social sciences and humanities. There are a number of different movements involved in this intersection, though all of them center on the belief that "reality" is not only socially and linguistically constructed but also rooted in historical contexts. **Beth Casey** has commented on some of the major themes and texts of this intersection in "The Quiet Revolution: The Transformation and Reintegration of the Humanities," *Issues in Integrative Studies*, 4 (1986), 71-92. One of the major signs of interdisciplinary convergence is the use of shared texts and metalanguage. **Clifford Geertz's** "Blurred Genres: The Refiguration of Social Thought" is an example of a major text that has functioned as a point of disciplinary interchange. In this much-cited essay Geertz explains how analogies drawn from the humanities — game, drama, text, speech-act analysis, discourse, and representationalist approaches related to cognitive aesthetics — have played an increasingly visible role in sociological and anthropological explanation. (Geertz's essay appeared originally in *American Scholar*, 42:2 [Spring 1980], 165-79; it was subsequently reprinted in *Local Knowledge: Further Essays in Interpretive Anthropology* [New York: Basic Books, 1983], pp. 19-35). A second work, edited by **James Clifford and George Marcus**, is enjoying equal canonical status among interdisciplinarians. *Writing Culture: The Poetics and*

Politics of Ethnography (Berkeley: University of California Press, 1986) is evidence of the growing convergence among ethnography, interpretive anthropology, and literary theory. The central problematic of this convergence is the question of how social reality is represented. (See, in addition, James Clifford's *The Predicament of Culture: Twentieth-Century Ethnography, Literature, and Art* [Cambridge: Harvard University Press, 1988] and George E. Marcus and Michael M.J. Fischer's *Anthropology as Cultural Critique: An Experimental Moment in the Human Sciences* [Chicago: University of Chicago Press, 1986].)

Like earlier talk of an "interpretive turn" in the social sciences, current talk of a "rhetorical turn" in scholarship signals the growing convergence of questions about the nature of knowledge that have emerged from many disciplinary quarters. The movement, often dubbed "rhetoric of inquiry," has stimulated widening attention to the role of language and argument in the construction of knowledge. Broad views of the "rhetorical turn" are available in *The Rhetoric of the Human Sciences: Language and Argument in Scholarship and Public Affairs*, edited by J.S. Nelson, A. Megill, and D.N. McCloskey (Madison: University of Wisconsin Press, 1987); *Rhetoric in the Human Sciences*, ed. Herbert W. Simons (London: Sage, 1989), and *The Rhetorical Turn: Invention and Persuasion in the Conduct of Inquiry*, ed. Herbert W. Simons (Chicago: University of Chicago Press, 1990). The rhetorical turn is further apparent in the work of individual scholars. In *The Great Cat Massacre and Other Episodes in French Cultural History* (New York: Vintage Books, 1985), Robert Darnton writes history in the "ethnographic vein." Darnton investigates ways of thinking in eighteenth century France by looking not at the traditional high road of intellectual history but the "mental undergrowth" of cultural history, reading a remarkable assortment of texts, including a primitive version of Little Red Riding Hood, an account of a massacre of cats, a description of Montpellier by a middle-class citizen of the city, and a file kept by a police inspector. The rhetorical turn is further apparent in the evolution of several poetics: a poetic for sociology in Richard Harvey Brown's *A Poetic for Sociology: Toward a Logic of Discovery for the Human Sciences* (Cambridge: Cambridge University Press, 1977; rpt. University of Chicago Press, 1989), a poetic for history in Hayden White's *Metahistory: The Historical Imagination in Nineteenth Century Europe* (Baltimore: Johns Hopkins Press, 1973), and a poetic for the law in James Boyd White's *Heracles' Bow: Essays on the Rhetoric and Poetics of the Law* (Madison: University of Wisconsin Press, 1985).

No discussion of regional and local work would be complete without mentioning a small but rich genre of works on the genealogy, problems, and nature of interdisciplinary fields and movements. Two of the entries in this genre include valuable discussions of the organizational forms that interdisciplinary fields tend to assume in the university. Daniel Rich and Robert Warren found considerable diversity in the ways urban affairs has been institutionalized: (1) as a *program* composed of courses taught in traditional departments and held together by interdisciplinary core courses and a faculty coordinator; (2) as an *“augmented specialization”* within an existing department; (3) as a *component of a large program* that combines urban affairs with such related areas as environmental studies, public administration planning, or policy analysis; and (4) as a *freestanding department, center or school* either with or without degree-granting authority. Lynton Caldwell found at least four different ways of institutionalizing environmental studies: (1) treating the environmental as a *focus for a coordinated program of multidisciplinary studies*, (2) forming a *new discrete discipline*, (3) *comprising a field of professional and technical preparation*, and (4) *achieving* an interdisciplinary synthesis. The first, Caldwell observed, has been the most common because it is the easiest and least disruptive. The fourth is the most difficult and, in his view, awaits a more thorough critique of the divisions of knowledge that impede integration. Rich and Warren suggested a genuine synthesis in urban affairs, if it does emerge, might take the form of a “tentative and shifting coalescence of concepts,” manifested in a coexistence and competition among perspectives rather than a cumulative linear development of new explanatory knowledge. **(Daniel Rich and Robert Warren, “The Intellectual Future of Urban Affairs: Theoretical, Normative, and Organizational Options,” *Social Science Journal*, 17:2 [January 1980], 53-66; Lynton Caldwell, “Environmental Studies: Discipline or Metadiscipline?,” *Environmental Professional*, v. 5 [1983], 247-258)**

The other major entries in this genre include:

- Arnold Binder’s “Criminology: Discipline or Interdiscipline?” in *Issues in Integrative Studies*, 5 (1987), 41-67;
- Robert Chen’s “Interdisciplinary Research and Integration: The Case of CO² and Climate,” in *Climatic Change*, 3 (1981), 429-47, also reprinted in Chubin et al., pp. 253-69;
- Stephen Cutcliffe’s “Science, Technology, and Society,” in the *National Forum* special issue on interdisciplinary studies, 69:2 (Spring 1989), 22-25;

- Maurice deWachter's "Interdisciplinary Bioethics: But Where Do We Start? A Reflection on Epoche as Method," *Journal of Medicine and Philosophy*, 7:3 (August 1982), 275-87;
- Ronald Grele's "A Surmisable Variety: Interdisciplinarity and Oral Testimony," *American Quarterly*, 27 (August 1975), 275-95;
- Tamara Haraven's "The History of the Family as an Interdisciplinary Field," *Journal of Interdisciplinary History*, 2:2 (Autumn 1971), 339-414;
- Theodore Hershberg's analysis of a large-scale collaborative investigation of urban history, in the prologue, introduction, and epilogue to *Philadelphia, Work, Space, Family, and Group Experience in the Nineteenth Century: Essays Toward an Interdisciplinary History of the City*, ed. Theodore Hershberg (New York: Oxford University Press, 1981); see also "The Fragmentation of Knowledge and Practice: University, Private Sector, and Public Sector Perspectives," *Issues in Integrative Studies*, 6 (1988), 1-20;
- T.C. Horn and Harry Ritter's "Interdisciplinary History: A Historiographical Review," *History Teacher*, 19:3 (May 1986), 427-48;
- Shinichi Ichimura's "Interdisciplinary Research and Area Studies," *Journal of Southeast Asian Studies* (Singapore), 6:2 (September 1975), 112-20;
- N. Lebow's, "Interdisciplinary Research and the Future of Peace and Security Studies," *Political Psychology*, 9:3 (1988), 507-25;
- E. Michael Lipton's "Interdisciplinary Studies in Less Developed Countries," *The Journal of Development Studies*, 7:1 (October 1970), 5-18; with a reply by M.P. Moore, "The Logic of Interdisciplinary Studies," *The Journal of Development Studies*, 11:1 (October 1974), 98-106;
- R. Lotchin's, "The New Chicano History: An Urban History Perspective," and D. Webber's "The New Chicano History," in *History Teacher*, 16:2 (1983), 223-29 and 229-47 respectively;
- Eugene P. Odum's "The Emergence of Ecology as an Integrative Discipline," *Science*, 195, 25 March 1977, 1289-93;
- Lucien W. Pye's evaluation of the relationship of modernization and development with the discipline of political science in "The Confrontation between Discipline and Area Studies," in *Political*

- Science and Area Studies: Rivals or Partners?*, edited by Lucian Pye (Bloomington: Indiana University Press, 1975);
- Henry A. Regier's study of *A Balanced Science of Renewable Resources. With Particular Reference to Fisheries* (Seattle: Washington Sea Grant, University of Washington Press, 1978);
 - Rustum Roy's analysis of materials science, in "Interdisciplinary Science on Campus: The Elusive Dream," *Chemical and Engineering News*, 29 (August 1977), 28-40; also in *Interdisciplinarity and Higher Education*, pp. 161-96;
 - Michael Wolff's "Victorian Study: An Interdisciplinary Essay," *Victorian Studies*, 8:1 (1964), 59-70.

Interdisciplinary work has also been the focus of close inspection in a number of special issues and sections of journals beyond the special issues already cited in *German Quarterly*, the *Journal of Canadian Studies*, and *Social Epistemology*:

- On political decision making:
September/October 1976 issue of *American Behavioral Scientist*;
- On eighteenth-century studies:
Spring 1979 issue of *Eighteenth Century Life* (v. 5:3);
- On U.S./Mexico borderlands studies:
October 1975/January 1976 double issue of *Social Science Journal* (vs. 12/13);
- On convergences in history and sociology:
January 1969 issue of *Social Science Quarterly* (v. 50:1);
- On structuralism:
1975 issue of *Soundings* (v. 58:2);
- On policy studies:
Autumn 1973 issue of *Policy Studies Journal* (v.2:1).

In addition, the journal *Social Science Information* has published periodic reports on interdisciplinary research and bibliography (in vs. 7:2 [1968], 8:2 [1969], 10:2 [1972], and 14:2 [1975]), and the *International Social Science Journal* has published three special sections: "Problems of Surveying the Social Sciences and Humanities" (v.16:4 in 1964), "Multidisciplinary Problem-Focused Research" (v.20:2 in 1968) and "Facets of Interdisciplinarity" (v. 29:4 in 1977). Finally, drawing from experiences discussed in the *Social Science Journal*'s special issue on U.S./Mexico borderlands

studies, **Ellwyn Stoddard** has chronicled the difficulties of procuring funding for interdisciplinary research, in “**Multidisciplinary Research Funding: A ‘Catch 22’ Enigma,**” *The American Sociologist*, 17 (November 1982), 210-16.

III. Interdisciplinary Education

There are several good places to begin. **William H. Newell's** *Interdisciplinary Undergraduate Programs: A Directory* (Miami, Ohio: Association for Integrative Studies, 1986) is the most current compilation of interdisciplinary programs in the United States. There are also several sound introductions to the subject. **William Mayville** in *Interdisciplinary: The Mutable Paradigm* surveys fundamental definitions, educational models, and model programs (Washington, D.C.: American Association for Higher Education, 1978. AAHE-ERIC/Higher Education Research Report No. 9). David Halliburton has also surveyed the topic of IDS, covering definitions, types of curricula, the value of interdisciplinary approaches and their significance for adult learners as well as organizational issues. (**David Halliburton**, “Interdisciplinary Studies,” Section 23 in *The Modern American College*, ed. by Arthur Chickering [San Francisco: Jossey Bass, 1981], pp. 453-71) Drawing on their experiences at Miami University, **William H. Newell and William H. Green** offer fundamental definitions in “Defining and Teaching Interdisciplinary Studies,” (in *Improving College and University Teaching*, 30:1 [Winter 1982], 23-30). And, finally, **Alvin White** has edited a collection of reflections on *Interdisciplinary Teaching* (San Francisco: Jossey Bass, 1981). Readers should also take note of **Thomas Benson's** analysis of “Five Arguments against Interdisciplinary Studies” in *Issues in Integrative Studies*, 1 (1982), 38-48. In subsequent years a number of individuals wrote rejoinders to this succinct presentation of the five most common arguments against a substantial role for IDS in the undergraduate curriculum, all of which appear in *Issues in Integrative Studies*.

Beyond these introductions there are a number of major articles that provide, in respective order, a review of literature, an analysis of levels of integration, a description of the life cycle of interdisciplinary programs, and a model of integrative process. **James Palmer** reviews resources culled from the ERIC data base in “Interdisciplinary Studies: An ERIC Review,” (*Community College Review*, 11:1 [Summer 1983], 59-64), and **Forrest Armstrong**, in an article on “Faculty Development through Interdisciplinarity,” has discussed the four different levels of integration in IDS, as

well as issues of faculty and institutional development. Like Caldwell in environmental studies, Armstrong found the least integrated structure the easiest and therefore most common model. (**Forrest Armstrong's "Faculty Development Through Interdisciplinarity"** appeared in *JGE: The Journal of General Education*, 32:1 [Spring 1980], 52-63). Reflecting on the experience of the interdisciplinary of the 1960s and '70s, **Martin Trow** analyzes the life cycle of telic institutions in "**Interdisciplinary Studies as a Counterculture: Problems of Birth, Growth, and Survival,**" while drawing lessons about the prospects for survival of interdisciplinary programs (**in *Issues in Integrative Studies*, 4 [1984/85], 1-15).**

One of the first questions teachers and administrators of interdisciplinary programs and courses always ask is how to actually do interdisciplinary work. A number of authors have reflected on the process, including Maurice deWachter in "Interdisciplinary Bioethics," cited above. The most widely applicable model for educators is the one devised by Barbara Hursh, Paul Haas, and Michael Moore. The theoretical foundation of their model lies in the work of Dewey, Piaget, and Perry. The actual model consists of a description and graphic illustration of the process for interdisciplinary study of a given problem (**B. Hursh, P. Haas, & M. Moore, "An Interdisciplinary Model to Implement General Education," *Journal of Higher Education*, 54 [1983], 42-59**) Beyond these resources the literature on IDS includes three major philosophical discussions of the arguments for IDS. Richard Pring has appraised proposals for integrating the curriculum including a strong thesis, reflected in an implicit belief in the unity of knowledge, and a weak thesis, a more limited claim for unity in broad fields of experience. (**Richard Pring, "Curriculum Integration," *Proceedings of the Philosophy of Education Society of Great Britain, Supplementary Issue*, 5:2 [July 1971], 170-200**). Len Doyal has assessed three different theories of IDS: (1) *a pragmatic approach* to integration, in which students have the opportunity to formulate and analyze problems from the perspectives of the disciplines they have encountered; (2) *a methods and concepts approach*, in which students are exposed as soon as possible to an analysis of conceptual and methodological similarities and differences between disciplines; and (3) *a large integrative scheme* running throughout the entire curriculum. (**Len Doyal, "Interdisciplinary Studies in Higher Education," *Universities Quarterly, Higher Education and Society*, 28:4 [Autumn 1974], 470-87**) In addition **Philip Phenix** has discussed the "**Use of the Disciplines as Curriculum Content**" in *Educational Forum*, 26 (1962), 273-80.

Still, the dominant genre of writing on IDS, as on interdisciplinary health care and problem-focused research, is the case study. There are, quite literal-

ly, thousands of case studies dispersed across disciplinary and professional literatures. The variety is astonishing. There are, for example, case studies on teaching bioethics, using economics in problem-oriented programs, combining learning and teaching styles in an engineering-rhetoric course, teaching technology to nontechnology students, making a comparative study of the nature of physics and history, basing a course in a national park, providing environmental education for the non-science major, teaching the philosophy and physics of space and time, linking geology with prehistoric archaeology, teaching chemical evolution to undergraduates, exploring relations between physics and biology in terms of their conceptual structures and mathematical frameworks, and interdisciplinary approaches to values education, nuclear education, and community studies. Finding these models is not so difficult as their dispersion might imply. There are three major sources: (1) the ERIC data base, (2) special issues of journals, and (3) collections of papers from conferences and symposia.

ERIC is the acronym for Educational Resources Information Center, a nationwide family of information clearinghouses sponsored by the U.S. Department of Education. Teachers and administrators involved in designing, launching, maintaining, evaluating, and revising any interdisciplinary program, from a one-semester course to an entire undergraduate or graduate program, will find ample resources by looking in **the monthly issues of Resources in Education (RIE) and Current Index to Journals in Education (CIJE)**. The monthly issues may be searched by hand or by computer, though searching by computer is the fastest and most effective way and, compared to data bases in the natural and medical sciences, the ERIC database is relatively inexpensive. There is a further advantage to computer searching: the computerized ERIC data base automatically picks up references listed in both RIE and CJIE. Items bearing an ERIC microfiche document number, prefaced by the initials ED, are available in many U.S. college and university libraries. Furthermore both fiche and hard photocopies of ED documents can be ordered from the ERIC office in Washington, D.C.

The value of the ERIC data base cannot be overstated. There are literally thousands of books, articles, conference papers, speeches, technical reports, course syllabi, case studies, program descriptions, institutional working papers, and other forms of "fugitive literature" available through the database. The ERIC data base is truly the largest source of buried treasure in higher education. Many of the items accessible through ERIC are not otherwise available in published form. Again, the wealth of resources is astonishing. **The first three numbers of the journal *Issues in Integrative Studies*, now out of print, are available on ERIC microfiche #ED 268**

015. ERIC fiche #ED 135 760 is a paper on “Managing Multidisciplinarity: Building and Bridging Epistemologies in Educational R&D,” presented by Leslie Salmon-Cox and Burkhart Holzner at a 1977 meeting of the American Education Research Association. Salmon-Cox and Holzner discuss the conditions under which multidisciplinarity nourishes. Fiche #ED 161 366 is a paper Nadia Assimopoulos and Charles Berlinger presented on “Interdisciplinary Policies and Practices” at a 1978 meeting of the Association for Institutional Research Forum. Drawing on their experiences at the University of Montreal, Assimopoulos and Belanger assess students’ responsiveness to course offerings outside their basic discipline and measure the ability of departments to attract students from both foreign and related disciplines. Fiche #ED 147 885 is a paper Samuel Becker presented on “Innovations in Administration Used and Being Used by Other Departments” at the 63rd meeting of the Speech Communication Association. Becker’s paper is rich in ideas for working cooperatively with other departments. Fiche #ED 064 238 is Arthur Kermode’s report on a Seattle middle-school project. In this discussion of “The Interdisciplinary Approach and Its Comparative Effectiveness,” Kermode delineates the characteristics of such an approach. Fiche #ED 129 134 is Thomas Connelly’s “Interdisciplinary References III, A Reference Document for Those Contemplating Interdisciplinary Education Programs in the Health Sciences.” Connelly’s work draws on the rich training programs of the Kentucky January Prototype at the Lexington College of Allied Health Professions.

The second major source of case studies is special issues and sections of journals. The major collections include the *Soundings* special section on “Experimental Interdisciplinary Programs” (54:1 in Spring 1971), the *National Forum* issue on “Interdisciplinary Studies: Defining and Defending” (69:2 in Spring 1989), the *Change Magazine* report on “Interdisciplinary Studies” (August 1989, also available as ERIC fiche #ED 157 461), the *Current Issues in Higher Education* number on “Creating an Integrated Curriculum: The ‘Higher’ in Higher Education” (2, 1981; also available as Fiche #ED 213 324), the *Forum for Liberal Education* issue on “Crossing the Boundaries” (8:4 in March 1986; also available as fiche #ED 266 758), the *Improving College and University Teaching* issue on “Interdisciplinary Studies” (30:1 in Winter 1982), the *Liberal Education* issue on “Interdisciplinary Education” (Spring 1979), and the *Teacher’s College Record* issue on “Curriculum: Interdisciplinary Insights” (73:2,1971). The special issue of *Liberal Education* features articles on many NEH-funded experiments, and the special issue of *Current Issues*

in *Higher Education* includes an introductory essay in which **Mary Jim Josephs** considers the link between IDS and skills development, as well as options for creating curricular integration (“**Curricular Integration: Mortar for the Ivory Tower,**” pp. 5-8).

The final source of case studies, collections of conference papers, is also a valuable source of national and international program models as well as reflections on the institutional and philosophical dynamics of IDS. The U.S. collections include the results of George Mason University’s annual conference on non-traditional and interdisciplinary programs, edited by James Fonseca and, subsequently, by Kathleen McGuiness. The 1985 collection, *Non-Traditional Graduate Education: A Frontier for the 1980s* (Fairfax, Va.: George Mason University) contains an insightful paper by Phyllis O’Callaghan on interdisciplinary “Graduate Liberal Arts” (pp. 28-36). The 1985 collection is also available as ERIC microfiche #ED 287 434, and other George Mason collections are also available on separate ERIC fiche. In addition, Vladimir Milicic has edited results of a *Symposium on Interdisciplinary Aspects of Academic Disciplines* (Bellingham: Western Washington University, 1973), and Stephen Dill has edited a book dominated by case studies, *Integrated Studies: Challenges to the College Curriculum* (Washington, D.C.: University Press of America, 1982). More recently, Mary E. Clark and Sandra A. Wawrytko have edited a collection of papers from a 1989 conference on *Rethinking the Curriculum: Toward an Integrated, Interdisciplinary College Education* (New York: Greenwood Press, 1990).

The European collections have a dual function. They are excellent sources of reports on interdisciplinary curricula in Europe at the same time they provide access to European reflections on the theory and method of interdisciplinarity. Beyond the 1972 and 1985 OECD books discussed above, the results of two other European conferences are also available. The Society for Research into Higher Education has published the results of a Symposium on Interdisciplinary Courses in European Education, held at City University in London in September of 1975. Entitled *Interdisciplinarity*, the collection is available in the U.S. as an ERIC fiche, #ED 165 512. The results of a 1983 UNESCO conference on “Interdisciplinarity in Higher Education,” held in Bucharest, Romania have also been published by the European Centre for Higher Education under the conference name; edited by Thor Hanisch and Wolfgang Vollman, the collection is available as ERIC fiche #ED 249 864.

IV. Problem-Focused Work

The history of interdisciplinary problem-focused research (IDR) is linked with the growth of government involvement in science and technology, the rise of large-scale mission-oriented research, and growing alliances among the university, government, and industry. Thus, IDR is an instrumental domain. Chubin, et al. date the origin of a literature on the subject to a 1951 paper about the problems of collaboration between an anthropologist and a psychiatrist (**W. Caudill and B.H. Roberts**) "Pitfalls in the Organization of Interdisciplinary Research," *Human Organization*, 10 [Winter 1951], 12-15) There are three introductions to the subject. **Pierre de Bie**, in his "Introduction" to the special section on "Multidisciplinary Problem-Focused Research" in the *International Social Science Journal* (20:2 [1968], 192-210), defines the nature of problem-focused research in both its multidisciplinary and interdisciplinary dimensions. **J.T. Klein** provides an introduction to and synthesis of scholarship on IDR in "The Evolution of a Body of Knowledge: Interdisciplinary Problem-Focused Research," *Knowledge, Creation, Utilization, and Diffusion*, 7:2 (December 1985), 117-42; a later version of this article appears in *Interdisciplinarity: History, Theory, and Practice*, pp. 121-39. And, to repeat, the Chubin et al. anthology of essays, *Interdisciplinary Analysis and Research*, collects major journal articles that have appeared on IDR while placing IDR in the broader context of interdisciplinary research and providing an annotated bibliography with an emphasis on IDR.

Readers should also take note of **Paul Hoch's** recent reflections on the status of interdisciplinary research in Britain, in the "New UK Interdisciplinary Research Centres: Reorganization for New Generic Technology," *Technology Analysis & Strategic Management*, 2:1 (1990), 39-48. Hoch considers the various strategic and organizational problems associated with the introduction of university-based Interdisciplinary Research Centres (IRC) in the United Kingdom, centers designed to develop the knowledge bases underlying key new generic technologies such as biotechnology and high temperature superconductivity. Like the NSF multidisciplinary engineering centers and the science and technology centers in the United States, the British IRCs have been established to address issues of national economic competitiveness, as well as the increasing concentration of university scientific research in fewer departments and centers. The creation of such centers has stirred vigorous debate in both the U.K. and the U.S. on long-term issues of organizational development, scientific progress, and the relationship between disciplinarity and dedicated interdisciplinary research.

Interdisciplinary problem-focused work has also been the subject of six major books and several special issues. The periodic international meetings of INTERSTUDY, the International Association for the Study of Interdisciplinary Research, have yielded four books and a special issue of the journal *R&D Management* in April of 1984 (v.14:2). In addition, *SRA, Journal of the Society of Research Administrators* did a special issue on the management of interdisciplinary research in Fall of 1981, and *Technological Forecasting and Social Change* did one on problem-focused research in 1979 [v.2]). The first two INTERSTUDY books provide overviews. The first was *Interdisciplinary Research Groups: Their Management and Organization*, edited by Richard T. Barth and Rudy Steck (Vancouver, B.C.: Interdisciplinary Research Group on Interdisciplinary Programs, 1979). This book surveys the management, organizational structure, and group dynamics of IDR, with case studies drawn from the pharmaceutical and telecommunication industries, technology assessments, projects on a forest ecosystem and an urban traffic system, plus a variety of projects and institutes based in U.S., British, and Polish universities. The second book, *Managing Interdisciplinary Research* (edited by S.R. Epton, R.L. Payne, and A.W. Pearson [Chichester: John Wiley, 1983]), features a valuable synthesis of the nomenclature, concepts, and organizational forms of IDR, with additional essays on matters of peer review, performance, productivity, and leadership. The case studies in this book include projects on noise control, freshwater diversion, and marine technology, as well as the fields of biomedical sciences, genetic engineering, and futures research.

The third and fourth books represent two quite different attempts to direct the focus. *Managing High Technology: An Interdisciplinary Perspective*, edited by B.W. Mar, W.T. Newell, and B.O. Saxberg (Amsterdam: North Holland, 1985), emphasizes IDR in high technology settings. The case studies are drawn from pharmaceuticals, electronics, space engineering computer systems, environmental assessment, technology forecasting, university engineering centers, and projects based in governmental settings and industrial R&D units. Because of the increased representation from industry, there is a sustained focus on improving collaboration across not only academic disciplines in universities but also functional activities in industry. The third book contains papers on organizational forms and management strategies, plus several sociological and philosophical reflections on knowledge. The fourth book is *International Research Management: Studies in Interdisciplinary Methods*, edited by P.H. Birnbaum, F.A. Rossini, & D.R. Baldwin (New York: Oxford University Press, 1990). It features a more focused examination of the life cycle of IDR: its preconditions,

its process, and its impacts. The case studies are drawn from Brazilian, Japanese, Israeli, and U.S. settings. The book also contains a sizable bibliography.

There are, in addition, two other major books. **Margaret Barron Luszki's *Interdisciplinary Team Research: Methods and Problems* (New York: New York University Press, 1958)** is a sustained analysis of interdisciplinary teamwork based on Luszki's assessment of working relationships among psychologists, psychiatrists, and sociologists on mental-health projects. **M.G. Russell, J.M. Barnes, and J.R. Cornwell have edited a collection of essays on *Enabling Interdisciplinary Research: Perspectives from Agriculture, Forestry, and Home Economics* (St. Paul: Agricultural Experiment Station, University of Minnesota, Miscellaneous Publication #19,1982).** This book accounts for an important chapter in the history of IDR, the work done in agriculture, plant sciences, forestry, animals sciences, family studies, and home economics. The land grant tradition, the mission orientation, and the state experiment stations of the United States Department of Agriculture have long provided organizational contexts conducive to interdisciplinary collaborative research.

The literatures on problem-focused research and health care are the major sources of published information on interdisciplinary teamwork. The notable resources include not only **William MacDonald's essay on "The Characteristics of Interdisciplinary Research Teams,"** reprinted in **Chubin et al.'s *Interdisciplinary Analysis and Research***, but also three major articles. Anthony Stone, in "The Interdisciplinary Research Team," discusses interdisciplinary teams as interacting task-oriented groups that form two ideal types, primary and secondary groups. The success of teamwork depends upon a shift from secondary-group relations, which are self-protective of the individual, to primary-group relations, which are dedicated to a common task and a shared cognitive framework. (Anthony Stone's article on "The Interdisciplinary Research Team" appeared in the *Journal of Applied Behavioral Science*, 5 [July 1969], 351-65.) Mitchell Me-Corcle surveyed "Critical Issues in the Functioning of Interdisciplinary Groups" in *Small Group Behavior*, 13 [August 1982], 291-310). McCorcle found two major differences between an interdisciplinary team and a more conventional, homogeneous group. First, an interdisciplinary team is an open rather than a closed system. The team owes its very existence to an external agent who may make demands in an unpredictable sequence. Second, it has a more heterogeneous though interconnected membership, creating not only a rich diversity of experience but also status conflicts and communication problems. **Mark E. Kann offers a general theory of "The**

Political Culture of Interdisciplinary Explanation” in *Humanities in Society*, 2:3 (Summer 1979), 185-200. Kann surveys the historical rise of the “interdisciplinary ideal” and analyzes the sociopolitical positions that will tend to emerge in interdisciplinary discussions. Any list of major works on this subject must also include three items from the literature on interdisciplinary health care: **Alex J. Ducanis and Anne K. Golin’s book *The Interdisciplinary Health Care Team: A Handbook* (Germantown: Aspen Systems Corp, 1979); Donald W. Day’s “Perspectives on Care: The Interdisciplinary Team Approach,” in *Otolaryngologic Clinics of North America*, 14:4 (November 1981), 769-75; and Hughlett L. Morris’s “The Structure and Function of Interdisciplinary Health Teams,” in *Dentistry in the Interdisciplinary Treatment of Genetic Diseases*, ed. Carlos F. Salinas and Ronald J. Jorgenson (New York: Alan R. Liss, 1980), pp. 105-10.**

Clearly interdisciplinary educators and researchers have an abundance of resources on which to draw, resources that reflect a variety of theoretical positions and methodological approaches. Given their variety, some of those positions and approaches inevitably conflict. Mark Kann (186, 197-98) suggests there are three major, combined demands challenging the dominant “unidisciplinary political culture”: that of conservative elites, radical dissidents, and liberal intellectuals. These groups, which correspond roughly to Voices #2, 3, and 1 in the current academy, exert different interdisciplinary pressures of different consequences. Conservative elites want a specific kind of interdisciplinary explanation that enables them to solve problems and devise practical answers, divorcing questions of politics from questions of science. Radical dissidents demand an interdisciplinary explanation useful to oppressed groups seeking greater sociopolitical equality. Liberal intellectuals, caught between the older positivism and these newer perspectives, seek a more harmonious middle ground that would allow peaceful interaction.

These differences will continue to exert their separate pressures because the concept of interdisciplinarity will continue to have wide and varied expressions. The significant function of “critical interdisciplinarity,” though, in both its modern and postmodern guises, has been to question and requestion the forms and ends of all interdisciplinary work. Jacques Derrida placed the question of interdisciplinarity squarely in the context of current debate about the politics of research and teaching when he questioned the end to which both basic and applied research are oriented. The rational calculus of programmed research, he cautioned, has propelled even basic scientific research toward aims that are at the same time military aims. The growing

primacy of “use,” he added, is restricting other discourses as it narrows the margins of randomness, promoting a “disinterested” knowledge that is not so disinterested after all. Much of this research, he added, is “interdisciplinary” in nature. **Jacques Derrida’s** essay, “**The Principle of Reason: The University in the Eyes of Its Pupils,**” appears in *Diacritics* (Fall 1983), Response section: 3-20.

Writing in a similar vein but in a different context **Brian Turner** has reflected on “**The Interdisciplinary Curriculum: From Social Medicine to Post-Modernism**” in *Sociology of Health and Illness*, 12:1 (1990), 1-23. Interdisciplinarity, Turner explains, emerges in social medicine and sociology of health as an epistemological goal, as a result of researchers focusing on the complex causality of illness and disease and the corresponding assertion that any valid therapeutics must be based in a holistic view of the patient. In interdisciplinary research centers organized under the Thatcher government and based upon teamwork supported by private and public sector funding interdisciplinarity has been an unintended consequence of economic necessity rather than scientific theory, producing ad hoc, short-term alliances and coalitions between scientific sectors that may further fragment rather than integrate knowledge in the university. (The same debate exists in the United States regarding interdisciplinary problem-focused research centers.) At the same time, while postmodernism in social theory has involved a challenge to monodisciplinarity, the current commercialization of medicine combined with the emergence of postmodern criticism of the conventional medical curriculum may produce a “fragmentary pastiche of disciplines” rather than intellectual integration. Any interdisciplinary activity and, by implication, any attempt to theorize interdisciplinarity, must be mindful of this danger, of the problem of creating not only unification but further fragmentation.

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