

Interdisciplinary Research Collaborations

Characteristics – Impeding and Enabling Factors – Implications

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The interdisciplinary approach is becoming one of the prominent characteristics of [science] and represents a synthesizing trend which focuses the specialized research techniques on problems common to a number of separate disciplines. Such cooperative research has to overcome serious obstacles when operating within the existing departmentalized framework of the universities. It appears that real progress in this direction will be made in institutions which are organized on a permanent and frankly cooperative basis. Psychologically, interdisciplinary research requires not only abstract, theoretical intelligence (and, frequently, manipulative skill) but also ,social intelligence.’ Cooperative work is a social art and has to be practiced with patience.¹

¹ BROZEK JOSEF/KEYS ANCEL, General aspects of interdisciplinary research in experimental biology, Science 100/1944, p. 512.

I. Introduction

Research is becoming increasingly interdisciplinary due to the inherent complexity of the phenomena under study. Interdisciplinarity is „en vogue“ – associated with creative, progressive scientific research likely to lead to applicable results. Complex problems cross the boundaries of traditional disciplines and thus, require individuals and groups to engage in interdisciplinary inquiry and collaboration to generate knowledge that is more than the sum of its parts. FIORE submits that „to truly understand complex phenomena, we must transcend disciplinary boundaries.“² The following intrinsic and extrinsic drivers are considered to propel the development of interdisciplinary research collaborations (IRC) and thus, interdisciplinary research (IDR):

- the inherent complexity of nature and society,
- the desire to explore problems and questions that are not confined to a single discipline,
- the need to solve societal problems,
- the power of new technologies.³

And while European scholars are working on mapping the contours of „the disciplines“ in the course of the Bologna process to further brachiate the tree of knowledge, KLEIN states in her recent landmark book „Creating Interdisciplinary Campus Cultures“ that the concept of „the disciplines“ has increasingly taken on the stance of an „inconvenient fiction.“⁴ In the twenty-first century „a single discipline alone cannot cope with the challenges of complex societies, competitive knowledge-based economies or pluralistic democracies.“⁵ In this regard, science and technology, social sciences and humanities are all crucial disciplines addressing the needs of a knowledge economy and society. However, IDR provides new opportunities to pursue challenging intellectual questions, address complex issues, solve problems that are too broad for a single approach and thus, counterbalance specialization and advance fundamental understanding and practice. IDR facilitates the *integration*

² FIORE STEPHEN M., Interdisciplinarity as teamwork: How the science of teams can inform team science, *Small Group Research* 39/2008, p. 258.

³ NATIONAL ACADEMY OF SCIENCES/NATIONAL ACADEMY OF ENGINEERING/INSTITUTE OF MEDICINE [NATIONAL ACADEMIES], *Facilitating interdisciplinary research*, Washington D.C. 2005, pp. 2 and 40.

⁴ KLEIN JULIE THOMPSON, *Creating interdisciplinary campus cultures. A model for strength and sustainability*, San Francisco 2010, p. XV.

⁵ BOŽIĆ SAŠA/POHORYLES RONALD J., Why bother with interdisciplinarity in the social and human sciences?, *Innovation – The European Journal of Social Science Research* 22(2)/2009, p. 144.

of disciplinary theories, concepts, methods and tools to advance a particular purpose. Similar to a painter mixing one or more of the basic colors to make a new color, IDR places a distinctive emphasis on the integration of theories and methods from different disciplines like political science, philosophy, sociology, pedagogy, economics, law or medicine, for example.⁶ KLEIN stresses that interdisciplinarity is a major variable in the new academy of the twenty-first century.⁷

In the following I will introduce a definition of IDR as well as selected characteristics of IRC (section II). After that I will focus on impeding (obstacles) as well as on enabling factors regarding IRC (section III) and outline some implications (section IV). Finally, I will sketch out ideas for (future) research on IRC (section V).

II. Characteristics of Interdisciplinary Research Collaborations

In general, the term „interdisciplinary“ is used as an umbrella term to indicate that a research team synthesizes ideas and methods from more than one discipline. The American NATIONAL ACADEMIES define *interdisciplinary research* as

a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/ or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice.⁸

This definition highlights important characteristics of IDR: The mode of research (teams or individuals), the centrality of integration, the embeddedness of disciplines as knowledge sources and the aim of advancing theoretical and practical understanding. JACOBS/FRICHEL point out that „the transformative promise of interdisciplinarity lies in its capacity to interpenetrate disciplines, changing what they do by providing communicative forms and channels for renegotiating disciplinary boundaries and generating new epistemic stand-

⁶ CHENG JOSEPH L.C./HENISZ WITOLD J./ROTH KENDALL/SWAMINATHAN ANAND, From the editors: Advancing interdisciplinary research in the field of international business: Prospects, issues and challenges, *Journal of International Business Studies* 40/2009, p. 1071.

⁷ KLEIN 2010, p. 35.

⁸ NATIONAL ACADEMIES, p. 188.

ards.⁹ IDR creates an additional complexity as it transgresses boundaries between scientific disciplines and between science and practice. IDR tackles more broadly defined goals as compared to disciplinary research to understand complex problems with an explicit reference to practical relevance and societal value. Its problem-driven nature strives to leverage cognitive resources, achieve cognitive integration and strongly depends on situational factors and circumstances (e.g. institutional structure, funding) largely determining success or failure.¹⁰ IDR has both, potential for scientific discovery and the capacity to target societal problems. According to FIORE „interdisciplinary research is team research,“ that is, scholars from different disciplines jointly produce IDR.¹¹ Consequently, interdisciplinarity is a team activity – a process coordinated by a scientific team. Teams are characterized by substantial interdependence¹² along with clearly articulated goals and role differentiation.¹³ Furthermore, interdisciplinary teams are characterized by heterogeneity and complexity appearing to be a double-edged sword: Through the heterogeneous composition interdisciplinary teams are able to generate more differentiated views drawing from a wide range of expert knowledge sources. Hence, they can create a more holistic picture of the problem at hand. However, heterogeneity also poses major challenges for IRC as it leads to a greater chance of disagreement and conflict destabilizing the team and thus, undermining the interdisciplinary research process.¹⁴ FIORE suggests that „by reframing interdisciplinarity as a process of teamwork to be mastered, that is, as an understanding of the teamwork activities necessary for success, and not as a product that emerges, we may be able to make the achievement of interdisciplinarity more tractable.“¹⁵ Consequently, difficulties can arise rather from the interaction of knowledge experts (e.g. due to conflicting epistemologies, values) than from the content itself.

⁹ JACOBS JERRY A./FRICKEL SCOTT, Interdisciplinarity: A critical assessment, *Annual Review of Sociology* 35/2009, p. 57.

¹⁰ HOLLAENDER KIRSTEN/LOIBL MARIE CÉLINE/WILTS ARNOLD, Management, in: Hirsch Hadorn Gertrude/Hoffmann-Riem Holger/Biber-Klemm Susette/Grossenbacher-Mansuy Walter/Joye Dominique/Pohl Christian/Wiesmann Urs/Zemp Elisabeth (Eds.), *Handbook of transdisciplinary research*, Dordrecht, London 2008, pp. 386-387.

¹¹ FIORE, p. 253.

¹² Team interdependence means that „group members jointly diagnose, problem solve, and collaborate to complete a task“ (SAAVEDRA RICHARD/EARLEY P. CHRISTOPHER/VAN DYNE LINN, *Complex interdependence in task-performing groups*, *Journal of Applied Psychology* 78/1993, p. 63).

¹³ FIORE, p. 263.

¹⁴ HOLLAENDER ET AL., pp. 385-386.

¹⁵ FIORE, p. 256.

Against this background, the following section will outline selected impeding and enabling factors with a special focus on social-interactive factors challenging or facilitating IRC.

III. Impeding and Enabling Factors of Interdisciplinary Research Collaborations

A) Impeding Factors

Interdisciplinary researchers encounter a host of daunting obstacles in the form of cultural barriers like differences in epistemologies, styles of thought, research traditions, professional terminologies and language as well as research techniques. Thus, difficulties to bridge divisions within the social sciences or humanities and between the natural sciences and other disciplines are omnipotent in research. Current research highlights the following impeding factors regarding IRC:

(1) LÉLÉ/NORGAARD identify *barriers to interdisciplinarity* that scholars from different disciplines are likely to encounter when working together on a research project:¹⁶

- *Values* being embedded at all stages of the interdisciplinary inquiry bear the risk that scientists are talking past each other because they are not explicating their normative priorities and concerns. However, at the same time, „collective judgment“ is required and some scientists are expected to make the necessary conceptual adjustments (e.g. choice of questions, research design);
- *Differences in epistemology*¹⁷ and hence, beliefs and perceptions regarding methodology and truth, for instance (e.g. humanities vs. the sciences).

¹⁶ LÉLÉ SHARACHCHANDRA/NORGAARD RICHARD B., Practicing interdisciplinarity, Bio-Science 55(11)/2005, p. 968.

¹⁷ Academics hold a variety of beliefs and perceptions about epistemic cultures of their own field and those of other fields. Differences in epistemological styles appear with regard to *theory*, that is, whether the styles are grounded in knowledge for knowledge's sake or knowledge for the sake of social change, and *methodology* (e.g. reductionism vs. „verstehen“). LAMONT differentiates four *epistemological styles*, meaning „preferences for particular ways of understanding how to build knowledge, as well as beliefs in the very possibility of proving those theories“ (LAMONT, p. 54): *Comprehensive*: values „verstehen,“ attention to details and contextual specificity; *Constructivist*: values reflexivity, different perspectives; *Positivist*: favors generalizability and hypothesis testing; *Utilitarian*: values the production of instrumental knowledge

Each field has established different approaches to producing and evaluating knowledge and research indicating that research networks are shaped by the diversity of and the distance between the researchers' disciplines;

- *Different theories and assumptions* according to one's school of thought and the need to establish a common means of understanding, to synthesize theories and/or to make joint choices according to the particular context;
- *The way society interacts with and organizes academia*, that means, forces shaping the importance of a certain discipline (e.g. the differences in the manner in which society treats the social and natural sciences, the higher standing of economics vis-à-vis other social science disciplines).

(2) To solve complex problems researchers need to create shared understandings and develop shared meaning across different scientific disciplines. Hence, open *discourse* is necessary to clarify and analyze definitions and terminology to improve understanding. Moreover, in the course of *deliberations* researchers can take advantage of the different theoretical frameworks as well as of tacit knowledge and experiences of team members to come to a qualified judgment depending on the problem or task at hand. Finding '*common grounds*' requires time and effort. Researchers have to negotiate common ground – they „must each discover what concepts they have in common with the others and agree on the terms they will use to denote these concepts.“ To correctly understand each other's contributions, a grounding process is needed causing high transaction costs of interdisciplinarity '*grounding*' in scientific research projects for the following reasons:¹⁸

- Researchers have different disciplinary backgrounds and therefore, need to negotiate common ground to bridge the epistemological gap.
- Costs increase with the number of researchers and disciplines involved as each researcher needs to negotiate common ground with all the other researchers.
- Further factors affecting the transaction costs of grounding are: (a) Objectives of the interdisciplinary research project (e.g. targeted level of integration); (b) '*Conceptual distance*' between disciplines and researchers' in-

(LAMONT MICHÈLE, *How professors think: Inside the curious world of academic judgment*, Cambridge 2009, pp. 57-58 and 174-176).

¹⁸ BROMME RAINER, *Beyond one's own perspective: The psychology of cognitive interdisciplinarity*, in: Weingart Peter/Stehr Nico (Eds.), *Practicing interdisciplinarity*, Toronto, Canada 2000, pp. 115-133 and GALISON PETER, *Image and logic: A material culture of microphysics*, Chicago 1997. See also BEERS PIETER J./BOTS PIETER W.G., *Eliciting conceptual models to support interdisciplinary research*, *Journal of Information Science* 25/2009, pp. 262-263.

interdisciplinary experience and openness; (c) Errors stemming from the use of different terminologies resulting in (undetected) misunderstandings.

(3) *Communication problems* are extricably interwoven with problems of (disciplinary) language. Gaps in communication occurring between different cultures like physical sciences, biology, medicine, economics, sociology and pedagogy are among the most pressing impeding factors regarding IRC. Hence, interdisciplinary teams have to create a context that constrains and channels differences, and leaves room for negotiating common ground as disciplines use the same words with different meanings, for instance. Thus, the „illusion of consensus“ appearing when the team agrees on common terms to avoid semantic difficulties and, consequently, arrives at premature solutions and simplistic conclusions for the sake of amity, can be reduced. In the face of the absence of a shared understanding the team would risk to reduce the number of creative problem-solving conflicts leading to misunderstandings and therefore, to high transaction costs. Moreover, groups could be affected by „groupthink“ likely to lead to limited alternatives and false decisions due to self-censorship or pressure on dissenters, for example.¹⁹ „Difference, tension, and conflict emerge as important parts of integrative process“ and are part of the character of interdisciplinary knowledge underscoring the importance of communication, e.g. translation, negotiation and conflict-solving.²⁰

(4) IRC can also create *territorial* and *status conflicts* reflecting external hierarchies („pecking order“) and disciplinary chauvinism („status games among disciplines“), for example. These barriers can be rooted in professional rank, institutional affiliation, in a prestigious person or discipline (reputation), in professional style (habitus) or in an individual with „the greatest clout or loudest voice“ attempting to dominate the team. Therefore, the theory of status concordance suggests high levels of concordance regarding ranks among members' age (seniority), gender, racial identity, academic rank, highest degree obtained and discipline, for example. However, studies indicate that higher-status individuals tend to give less communication that is judged „irrelevant“ by team members, receive more communication and are better liked.²¹ Furthermore, senior faculty can act as a knowledge base and is more likely to capture attention within the scientific community and thus, presumably can attract funds as well as political and business players to the advantage of the network and its members. In addition, senior researchers tend to be

¹⁹ JANIS, IRVING L., *Victims of groupthink*, New York 1972.

²⁰ KLEIN JULIE THOMPSON, *Crossing boundaries: Knowledge, disciplinarity, and interdisciplinarity*, Charlottesville/London 1996, p. 216.

²¹ See also KLEIN JULIE THOMPSON, *Interdisciplinarity: History, theory, and practice*, Detroit MI 1990, p. 142, see also KLEIN 1990, p. 221.

freer to take risks and are no longer concerned with tenure or promotion requirements.²²

Interdisciplinary research collaboration requires not only cognitive but also social competencies. However, many researchers *lack training* in (intercultural) communication and (interdisciplinary) team work (e.g. group dynamics, leadership, problem-solving, conflict resolution) and thus, often don't have the knowledge, skills and attitude essential for reciprocal intercultural learning and successful IDR and management. Negative comments made about other team members „often concern how they interact with others, handle differences of opinion and contribute to shared goals.“²³ As IDR is typically collaborative involving people of disparate backgrounds, it may take extra time for building consensus, developing a shared cognitive framework, defining joint objectives, establishing commonality, forming working relationships and enabling intercultural learning with regard to new methods, languages and cultures. As a consequence, researchers often try to avoid to work with colleagues from different disciplines, and instead concentrate on „pure research“ in their single disciplines to further enhance their knowledge and skills in this discipline. Also, due to disciplinary academic career affordances, junior faculty is often not willing to risk time out of the disciplinary mainstream. IDR is usually incompatible with academic incentive and reward structures. To conclude with a bird's-eye view, RHOTEN names the following main two reasons for difficulties in practicing IDR: „First, within the culture of science – that is, how researchers conduct themselves individually and socially – interdisciplinarity goes against the grain of everything disciplinary researchers have been taught to do and to protect. Second, it flies in the face of virtually every bureaucratic structure in the university, most obviously the departmental system which confers upon researchers their funding, reputation, tenure and status.“²⁴

From the outlined characteristics and impeding factors above it becomes clear that up to date the social and intellectual processes necessary for successful IRC are multi-faceted, not fully understood and pending. However, what could make a productive environment for IRC? This question will be tackled in the next section outlining enabling factors.

²² See also KLEIN 1990, pp. 127-128.

²³ LAMONT, p. 115.

²⁴ RHOTEN DIANA, Lead, follow, get out of the way: Sidestepping the barriers to effective practice of interdisciplinarity, The Hybrid Vigor Institute 2001, p. 7, retrieved February 28, 2010, from <www.hybridvigor.net/interdis/pubs/hv_pub_interdis-2001.04.30.pdf>

B) Enabling Factors

What does it take for interdisciplinary teams to flourish? It is suggested that the „success of an interdisciplinary group pivots on its capacity to amalgamate theories, concepts, methods, techniques rooted in distinct disciplinary traditions to leverage understanding.“²⁵ According to STOKOLS ET AL. the following conditions produce collaborative readiness for team science: institutional support, the breadth of disciplines, departments and institutions encompassed by a center, the degree to which team members have worked together on prior projects, the proximal location of offices and laboratories and the availability of electronic linkages.²⁶ STOKOLS/TAYLOR/HALL/MOSER also underline the need for strong leaders that could motivate and manage the work, engage in team building and execute conflict management competencies when necessary.²⁷

DINGFELDER introduces three major ingredients for success while rich team communication is considered to be among the most important indicators of success: (1) *Institutional support* encompassing funding mechanisms that encourage interdisciplinary collaboration and support structures in researchers' home universities enabling interaction (e.g. space for local groups, cyber infrastructure); (2) *Visionary leaders* fluent in different research languages keeping scientists with different backgrounds on the same page to bridge disciplines and integrate knowledge to a new coherent whole; (3) *Collaborative members* who are willing and prepared to work with members of different scientific communities.²⁸

Informed by a two-year research project in UK higher education institutions WOODFIELD/KENNIE highlight *guidelines* important to *develop team working* in top management teams in a higher education context. Their findings indicate an increased focus on team formation, inducting new members, facilitating effective teamwork and joint or collective agenda setting. Developing a collective agenda, for instance, can help to build commitment to the collective

²⁵ LAMONT MICHÈLE/BOIX MANSILLA VÉRONICA/HUUTONIEMI KATRI, Fostering successful interdisciplinarity through shared cognitive platforms, Internal paper, Cambridge 2007, p. 2.

²⁶ STOKOLS ET AL., Evaluating transdisciplinary science. *Nicotine Tob Res*, 5 Suppl 1, 2003, pp. 21-39.

²⁷ STOKOLS DANIEL/TAYLOR BRANDIE/HALL KARA/MOSER RICHARD, The science of team science: An overview of the field, Paper presented at the National Cancer Institute Conference on the Science of Team Evaluation, Bethesda, MD 2006. Presentation slides retrieved February 24, 2010, from <http://dccps.nci.nih.gov/brp/scienceteam/team_science_overview_stokols_etal.pdf>.

²⁸ DINGFELDER SADIE F., Team science, *Monitor on Psychology* 2007, retrieved February 24, 2010, from <www.apa.org/monitor/jan07/team.aspx>.

vision, to the defined shared goals and trust among team members. Relationship building can be fostered through supporting informal interaction and by making time for members to gain experience of working together on team issues. Moreover, establishing team behaviors, team roles and a more or less explicit set of behavioral ground rules can help the team to operate more effectively and constructively. In addition, balancing power and influence of the team leader with contributions from those within the team with high levels of expertise in specific areas is considered to be important too. Other relevant factors are the availability of location and resources, a focus on collective performance management processes and evaluation techniques and the fostering of team development. The latter involves the development of team working skills including processes and activities that encourage informal interaction, networking and social bonding between team members. Finally, a supportive institutional context helps the team to focus their work on the important thinking and strategic-level influencing work.²⁹

Facilitating *character traits and skills* associated with interdisciplinary individuals are reliability, flexibility, patience, resilience, sensitivity for others, risk-taking, a thick skin, and a preference for diversity and new social roles, for example. RHOTEN reports, that researchers with a pre-existing, positive attitude toward other disciplines and prior interdisciplinary exposure tend to be more open to work with other disciplines and can act as „bridges“ or „ties“ between individuals and groups of „unlike“ disciplines.³⁰ Moreover, interdisciplinary researchers must be able to differentiate, clarify, relate, compare, contrast, analyze and synthesize, look at things from different perspectives and know how to learn.³¹ They need *team competencies* viewed „as a collection of knowledge, skills, and attitudes (KSAs) that form the foundational precursors to effective team interaction behaviors.“ Such competencies require generic, specialized as well as integrative knowledge and skills.³² Team-generic competencies like communications skills as well as team-specific competencies depending on the specific team situations (e.g. knowledge of roles within the team). Moreover, one can differentiate between task-generic competencies (e.g. exchanging information and planning) and task-specific competencies (e.g. using appropriate methods).³³

²⁹ WOODFIELD STEVE/KENNIE TOM, Teamwork' or 'working as a team'? The theory and practice of top team working in UK higher education, Higher Education Quarterly 62(4)/2008, pp. 397-415.

³⁰ RHOTEN DIANA, A multi-method analysis of the social and technical conditions for interdisciplinary collaboration, San Francisco 2003, p. 18, retrieved February 24, 2010, <www.hybridvigor.net/interdis/pubs/hv_pub_interdis-2003.09.29.pdf>.

³¹ KLEIN 1990, p. 183.

³² KLEIN 1996, p. 237.

³³ FIORE, p. 266 f.

Studies of *leadership* in expert teams emphasize the importance of competencies regarding guidance of team interactions including maintaining an appropriate interaction climate as well as defining team goals, managing resources and facilitating team learning by showing empowerment behaviors (e.g. inspirational motivation, intellectual stimulation).³⁴ The NATIONAL ACADEMIES state that institutional commitment and research leadership, meaning leaders with a clear vision and effective communication and team-building skills, can catalyze the integration of disciplines. A team leader should bring together potential research collaborators early in the process and work toward agreement on key issues. Furthermore, he should ensure that each participant strikes an appropriate balance between leading and following and between contributing to and benefiting from the efforts of the team.³⁵

IV. Implications

As IDR deals with complex problems and almost always appears to be an interdisciplinary team effort, *integration* is the core methodology for successful IDR. As the quote by BROZEK/KEYS at the beginning of this chapter suggests, the following challenges are still existent: (1) The problem of the *infrastructure* of the modern university (discipline-boundedness) as well as the *prestige of pure discipline* within the disciplines hampering interaction among different disciplines; (2) The problem of *effective collaboration* across disciplines.³⁶ This chapter has focused on the second challenge highlighting the importance of the interactional process. IRC requires complex intellectual and social processes enabling information sharing and knowledge generation.³⁷ In order to facilitate the collaborative integrative process, KLEIN provides *three core principles* of interdisciplinary communication: (1) *maturing and deepening*, that is working towards excellence in stages in the course of a recursive and iterative process; (2) *cooperation and interplay*, that is, team members

³⁴ FIORE, p. 270 f.

³⁵ NATIONAL ACADEMIES, 2005.

³⁶ BROZEK/KEYS, p. 252. See also ABOELELA SALLY W. ET AL., Defining interdisciplinary research: Conclusions from a critical review of the literature, Health Services Research 42/2007, pp. 329-346.

³⁷ RHOTEN (2003, p. 18) defines these activities as follows: „The process of sharing information requires collaborators to participate in the exchange of ideas and/or data in order for each to learn new methods, acquire new theories, or develop new approaches. And, the process of creating knowledge requires collaborators to work together to construct concepts and integrate areas of expertise in order to generate new theories, applications, or methods collectively.“

learn from each other utilizing feedback loops and reflection as they work together; and (3) *creativity*, that is an iterative and dynamic process crafting multiple elements into an organic whole.³⁸ In an attempt to not only collect the lower hanging (cognitive) fruits but to have a grasp of some of the higher hanging (interactional) fruits, the implications outlined below can support the integrative process with regard to interdisciplinary research collaborations.

A) Towards Integration: Customary Rules

With regard to the core principles of interdisciplinary communication, considering the notion that interdisciplinary team science is a highly interactional undertaking and due to the fact that researchers often work together for the first time, have only a limited (face-to-face) time together as well as limited resources available, the development of *rules for interdisciplinary collaboration*, agreed upon by all members, seems to be one crucial sphere to enable maturing and deepening, cooperation and interplay as well as creativity and thus, integration. An example can be drawn from LAMONT's recent study of multidisciplinary panels. LAMONT identifies a number of pragmatic *customary rules*³⁹ that emerged from the requirements in the context of evaluative processes. These established rules act as constraints on and regulators of behavior, but also function as justifications that create commitments.⁴⁰ The same could be true for IRC: In general, researchers with different disciplinary backgrounds work together to conduct research around some shared interest sponsored by research foundations interested in the outcome.⁴¹ In the course

³⁸ KLEIN 1996, pp. 221-222.

³⁹ „Customary“ because the rules are not formally spelled out and are instead created and learned by researchers during their immersion in collective work. Respecting these customary rules increases one's credibility with colleagues and facilitates deliberations (LAMONT, pp. 111 and 157).

⁴⁰ LAMONT conducted 81 open-ended and inductive interviews with highly regarded experts who evaluate research proposals or are involved in this process (panelists, panel chairs, program officers), and conducted observations of deliberations as well as document analysis over a two-year period. Her findings suggest that evaluation is a process that is deeply interactional and culturally embedded.

⁴¹ RHOTEN 2003 submits that a collaborative group which is supposed to have both knowledge creating and information sharing activities, should consist of no more than 10 to 15 researchers (p. 45). Furthermore, rotating appointments, that is, flexible, intermittent stays rather than long-term administrative mandates of an organization, seem to prove successful as they „allow researchers to experience new communities of practice and build extensive networks of practice that will satisfy their intellectual curiosities without jeopardizing their professional responsibilities“ (p. 10).

of *deliberations* researchers are presenting their own expertise and background defining their identity in relation to that of other researchers. As researchers get to know one another, they develop a group style – continuing interactions seem to contribute to the creation of a repertoire of customary rules organizing members’ behavior and contributing to the group’s identity formation. Group members engage in role negotiation and role clarification so that they know what to expect from each other, work towards a common vocabulary, agree for the best research strategy, develop tolerance, humility and an appreciation for colleagues and other disciplines and their contributions. Group members engage in an interactional process of collective decision making and they draw emotional and cognitive boundaries within relationships of exchange and deliberation.⁴²

LAMONT suggests *three customary rules*: Deference to expertise, respect of disciplinary sovereignty and collegiality. (1) *Deference to expertise* means that researchers mark their territory and draw on previously established proofs of competence. They defer to the expertise of others if the situation requires that they take positions on topics about which they know little. (2) *Respecting disciplinary sovereignty* means that group members’ opinions generally are given more weight according to how closely the area of deliberation overlaps „their“ fields. (3) *Collegiality* refers to the quality of researchers in cognitive terms and in terms of presentation of self and moral and emotional characteristics. It encompasses a consistently respectful tone toward one another and the creation of an amicable environment where members listen carefully and are influenced by one another and thus, limit the potential for frictions and tensions hindering decision making. Collegiality “is the oil that keeps the wheels of deliberation turning.”⁴³ During deliberations conditions of equality are equally important: For example, convince one another with the force of reason, each participant be given full liberty to express his or her opinion without any reprisal, each be provided opportunity for full and equal voice. However, it has to be taken into account that members vary in age, race, and gender, they represent institutions of uneven prestige and each researcher can only claim expertise on a specific subset of topics.⁴⁴ Neverthe-

⁴² See also BOIX MANSILLA VÉRONICA/SATO KYOKO/CHUA FLOSSIE/IVANIER ANALIA/LAMONT MICHÈLE, Building socio-cognitive platforms for interdisciplinary collaboration. Internal working report, Cambridge 2009; BOIX MANSILLA VÉRONICA/SATO KYOKO/ LAMONT MICHÈLE, Successful interdisciplinary collaborations: The construction of shared socio-emotional-cognitive platforms for interdisciplinary synthesis, Internal paper, Cambridge 2010.

⁴³ LAMONT, p. 120.

⁴⁴ Furthermore, in her study, LAMONT (pp. 112-120) suggests that the following character traits and skills go into the equation that defines and establishes an individual’s credibility: Show up properly prepared for meetings, demonstrate intellectual breadth

less, customary rules can help to neutralize conflicts and encourage interdisciplinary conversations in the context of deliberations despite perceived inequalities of prestige and influence across disciplines.⁴⁵

B) Towards Integration: Collaborative Competencies and Leadership

Drawing from the analysis of the impeding and enabling factors of IRC, the following factors seem to be critical for the development of a cohesive group and for effective collaborations in the course of interdisciplinary debate and discussion: Leadership (team management) and collaborative competencies (knowledge, skills, attitudes). Intensive interactions are the glue that binds members together and allows for successful research collaborations.

Collaborative competencies of team members

The selection of suitable collaborators from other disciplines seems to be the starting point of successful IRC among scientists. Potential network members need both, a clear expertise in a disciplinary field as well as a deep commitment to work collaboratively in defining a research agenda in order to conduct research that would otherwise not be possible. In general, the need for collaboration and communication increases with the degree of synthesis, that is, the level of integration of the expertise of each group member. In order to allow for constructive communications and productive deliberations, overcome disciplinary preconceptions and language barriers and establish an atmosphere of mutual trust and belonging as well as positive relationships and a positive work climate, interdisciplinary researchers should be willing and able to

- show mutual respect, tolerance and patience with regard to the diversity of viewpoints, methods and models presented by others,
- develop an appreciation for other experts and disciplines as well as for their epistemological approaches and methodologies and accept them as equally valid deferring to one another's expertise where appropriate,
- listen carefully to others and establish and follow customary rules to allow for an effective communication,
- demonstrate curiosity, enthusiasm, openness and flexibility,

and expertise, be succinct, speak across disciplinary boundaries and respect other people's expertise and sentiments.

⁴⁵ LAMONT, p. 50-51.

- establish and commit to cooperative goals and articulate clearly the perspectives of their disciplines,
- engage in continual communication to enable reciprocal intercultural learning (e.g. create a common language or learn each other's disciplinary language to be able to talk the talk of several disciplines and thus, permit mutual understanding and integration),
- commit to share information and exchange knowledge with others, engage in constructive argumentation and ask thoughtful questions,
- engage in role definition and role negotiation,
- commit to epistemological reflexivity of self and discipline.

These qualities are crucial for group cohesion, bonding and smooth functioning of the group.⁴⁶ Scientists from different disciplines speak different languages, thus, they have to make their perspectives as well as important terms explicit and they need to agree upon the meaning of key terms, for example. Hence, interdisciplinary researchers have to „constantly learn, unlearn, and relearn across disciplines.“⁴⁷ In the course of the integration „boundary objects,“ that is, jointly created products (e.g. research plan, interim reports, publications, recommendations) are generated to facilitate the collaborative interdisciplinary process and outcome. However, more education and training is needed to prepare for interdisciplinary team work and to further develop collaborative competencies (e.g. group dynamics, conflict resolution, problem-solving, decision-making, communication).

Effective team management – leadership

Team leaders face different challenges in the management of complexity and heterogeneity in small or large interdisciplinary teams. IRC involves individuals with diverse professional and social backgrounds as well as individual goals and interests which need to be incorporated to create synergies. Interdisciplinary researchers „operate within various frames of reference when it comes to defining common research problems, identifying research tasks, and assessing research outcomes.“⁴⁸ Effective management reduces complexity and is crucial for success involving the joint formation of research goals and tasks, stimulation of the collaboration between team members and integration of different viewpoints and interests by facilitating the effective flow of information and exchange of knowledge to foster intercultural mutual learning.

⁴⁶ See also LYNCH JOHN, It's not easy being interdisciplinary, *International Journal of Epidemiology* 25/2006, p. 1121, for example.

⁴⁷ RHOTEN 2003, p. 9.

⁴⁸ HOLLAENDER/LOIBL/WILTS, p. 389.

HOLLAENDER/LOIBL/WILTS state that in order to successfully manage interdisciplinary team research managers „take on an active role in conflict resolution within the team, facilitating moderation between the different members' viewpoints and motivation of the team members“ to foster integration and consensus within the team. In addition, fostering plurality, expressing expectations, providing resources needed, facilitating processes of reflection, stimulating compromise and pinpoint areas of improvement are also facilitating tasks in the course of IRC. Such management behavior also promotes the development of joint goals, feelings of unity and trust, mutual openness, equality and group identity. Another task concerns improving communication and knowledge exchange between team members „to ensure that boundaries do not become barriers.“⁴⁹ In this regard, the team leader/chair is in charge of orchestrating deliberations keeping the discussion moving, ensuring that all members have a chance to contribute, express an opinion and receive fair hearing. He oversees the quality of the deliberations by ensuring substantive arguments, managing overbearing personalities and preventing the formation of excessive alliances and allegiances, if necessary.⁵⁰ Management tasks also include initiating early joint results (e.g. papers, working reports), organizing and facilitating workshops and conferences, for example, and thus, fostering integration and the dissemination of joint results.

V. Ideas for (Future) Research

„We are not students of some subject matter, but students of problems. And problems may cut right across the borders of any subject matter or discipline.“⁵¹

In the last decade more and more researchers recognize the limitations of their disciplinary lenses when faced with complex problems. The rapidly growing knowledge requires scientists from different disciplines to „join forces“ to effectively address complex societal problems. A high degree of synthesis requires interchange between disciplines in order to ensure that two or more heads representing different disciplines are really better than one and unfold potentials to enhance understanding, develop new conceptual frameworks, produce significant scientific innovations (e.g. manned space flight, discovery of the structure of DNA), solve complex problems or spawn new

⁴⁹ HOLLAENDER/LOIBL/WILTS, p. 387.

⁵⁰ LAMONT, p. 46.

⁵¹ POPPER KARL R., *Conjectures and refutations: The growth of scientific knowledge*, New York 1963, p. 88.

scientific fields like neuroscience, behavioral economics or the learning sciences. IDR seeks to advance knowledge in ways not possible through traditional, disciplinary research and aims at producing outcomes that are significant and influential (e.g. through questions addressed or methods used). It involves substantive collaboration among a team of researchers with diverse expertise and training.

This chapter tried to capture characteristics, impeding and enabling factors as well as implications for successful IRC. However, more empirical research – especially on interactional processes – is needed. Recently, a couple of multiple case studies examining the intellectual and interactional qualities of interdisciplinary and collaborative work of experts were conducted and analyzed by a group of researchers around VÉRONICA BOIX MANSILLA and MICHÈLE LAMONT at Harvard University.⁵² The study is particularly concerned with the complex practice of interdisciplinary expert knowledge production and evaluation and devoted to the dilemmas inherent in doing research in interdisciplinary research groups (academics) in the university context. It is suggested that the effective interdisciplinary integration of knowledge depends on the creation of a common platform, that is „a collectively constructed space in which individuals engage (...) to examine a relatively shared problem of study and advance productive insights through interdisciplinary exchange.“⁵³ This work illustrates the importance of a comprehensive and empirically grounded theory that does justice to the complexities of IDR. The authors investigate organizational factors (e.g. funding), interactional factors (e.g. team composition like size, roles; team leadership, identity, team communication, working styles) as well as cognitive factors like the nature of the problem under study, groups’ intellectual goals or integration strategies.⁵⁴

It is suggested that interdisciplinary science flourishes „in a culture in which discussions and interactions are constructive yet critical, rigorous but creative, momentous but playful, open but exclusive, and self-reinforcing and thus self-perpetuating.“⁵⁵

⁵² BOIX MANSILLA ET AL., 2009; BOIX MANSILLA/SATO/LAMONT, 2010; BOIX MANSILLA V./SATO, K./CHUA, F./HOIDN, S./IVANIER A./LAMONT, M., Building socio-emotional-cognitive platforms for interdisciplinary research collaborations. Report prepared for the Canadian Institute of Advanced Research, Cambridge 2010.

⁵³ BOIX MANSILLA/SATO/LAMONT, p. 6-7.

⁵⁴ See also PORTER ALAN L./ROESSNER J. DAVID/COHEN ALEX S./PERREAULT MARTY, Interdisciplinary research: Meaning, metrics and nurture, *Research Evaluation* 5(3)/2006, pp. 187-195.

⁵⁵ CACIOPPO JOHN T., Better interdisciplinarity research through psychological science, *Observer* 20(10)/2007, p. 3, retrieved March 14, 2010, <<http://psychology.uchicago.edu/people/faculty/cacioppo/jtcreprints/c07c.pdf>>.