A PERSPECTIVIST FOUNDATION FOR CROSS-DISCIPLINARY SCIENCE

HUGO F. ALRØE
ASSOCIATE PROFESSOR IN PHILOSOPHY OF SCIENCE AND ETHICS, AARHUS UNIVERSITY

This is a proposal for a scientific book. Some of the material in this book has been or will be published in a more elaborate form in scientific articles. At present, three core source articles have been published (abstracts appended in Appendix 1).

PRELIMINARY SYNOPSIS WITH SUMMARIES OF CHAPTERS

Working titles. Short summaries of each part and chapter.

INTRODUCTION: WHY PERSPECTIVIST?

Confronted with the complex and 'wicked' problems of today, such as sustainable development, resilience and climate change, a concerted effort across different scientific disciplines is needed and required by society. But it is well-known that there are fundamental problems of communicating across disciplines and carrying out such cross-disciplinary research in practice (e.g. Miller et al. 2008, Bracken and Oughton 2006, Harrison et al. 2008, Noe et al. 2008, Pennington 2008). The more ambitious the collaboration is, in terms of using and integrating very different scientific perspectives in solving real, complex problems, the more difficult the task.

There is a growing recognition in philosophy of science that all scientific knowledge is perspectival; i.e. that the context established by a scientific discipline is decisive for the kind of observations that can be made by that discipline. The perspectivist view of science has two roots; one in the sciences of cognition and one in the sciences of communicative systems (Alrøe 2000). The cognitive understanding of science has been growing and developing in philosophy of science over the last three decades, and has recently been labelled as "scientific perspectivism" by Ronald Giere (2006). The understanding of sciences as communicative systems and the evolution of science as a differentiation of social systems has been developed in the same period by Niklas Luhmann (1990) and others (e.g. Stichweh 1992).

What this book does, which has not been done before, is to analyse the contested notion of interdisciplinarity and the conundrum of doing cross-disciplinary research in depth by means of a perspectivist understanding of science, and establish a new perspectivist foundation for cross-disciplinary science.

PART ONE: A PERSPECTIVIST THEORY OF OBSERVATION

The first part of the book establishes the foundation for seeing a scientific discipline, 'school', theory, or method as a special perspective on the world, by clarifying and exploring the underlying model of observation. An important starting point is that 'perspective' and 'observation' designate relations that are not passive but pragmatic, performative and enactive.

A model of scientific observation

This chapter gives a detailed analysis of scientific observation based on a combination of systemic and semiotic theories. The model in Figure 1 illustrates three pivotal conditions for observation: delimitation of the observed from the observer, a semiotic reference to the 'dynamical object' (*sensu* Peirce) and a causal interaction with the dynamical object (Alrøe 2000, Alrøe & Noe 2011). The observer in the model is a scientific perspective understood as an autopoietic communicational system, *sensu* Luhmann, but the cognitive, semiotically based understanding of observation goes beyond Luhmann's theory of social systems. And the thoroughly semiotic understanding of a scientific perspective also goes far beyond Giere's (2006) scientific perspectivism, in this respect. A key aim of this chapter is to observe scientific approaches primarily as perspectives and not as social groups, discourses, or 'sciences working on different domains,' and thereby be able to observe the 'tacit' cognitive structures in research. For example, to be better able to observe the research objects of different perspectives (e.g. accounting cows, full time enterprises, soil quality, sustainable development) as the 'immediate objects' (*sensu* Peirce) within that perspective, immediate objects that refer to dynamical objects which science cannot represent directly. The fundamental work with understanding scientific observation is a necessary basis for elaborating a perspectivist understanding of the possibilities for cross-disciplinary work in later chapters.

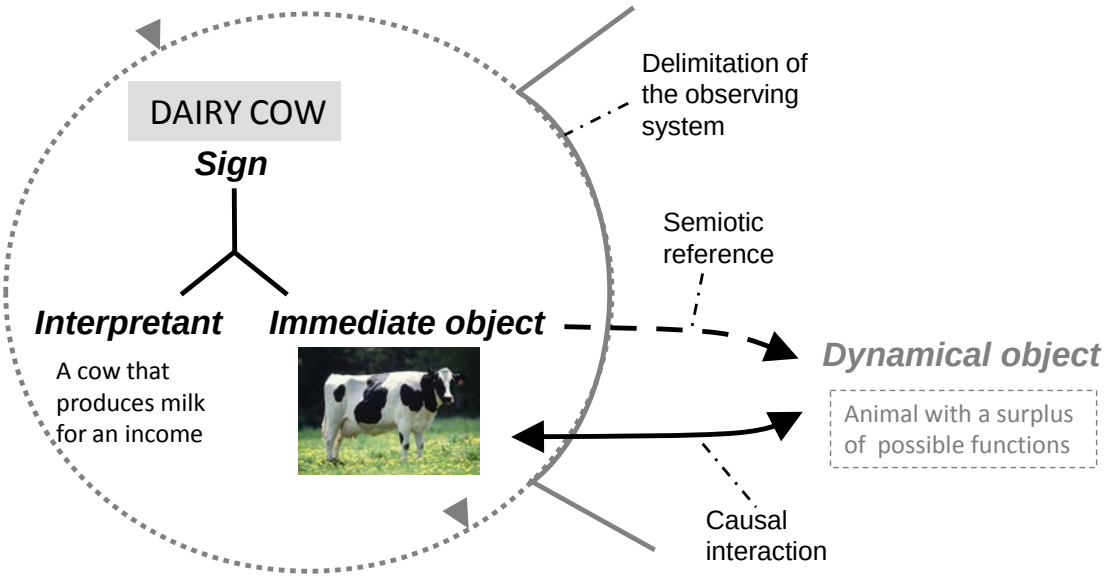

Figure 1: Systemic and semiotic model of a scientific perspective (Alrøe & Noe 2011: 157).

Limits of observation

Based on the previous chapter "A model of scientific observation", this chapter focuses on the limits for observation that come to light in relation to the three pivotal conditions for observation in the model of scientific perspectives (Figure 1). For instance the well-known limits in relation to approaching extremities with regard to causal interaction with dynamical objects: the effects of the quantum of action in observing extremely small objects, described by quantum mechanics, and relativity effects in observing objects with extremely high velocities relative to the speed of light, described by special relativity. Analogous limits can be found in other sciences, and they establish fundamental conditions for what knowledge to expect from scientific observations in different scientific areas.

Form and sign: Two complementary models of observation

This chapter compares form and sign as two complementary ways to understand and analyse scientific observation. Form (*sensu* Spencer-Brown/Luhmann) is observation understood as indication based on distinction – to observe something as different from something else. Sign (*sensu* Peirce) is observation understood as representation – to observe something by way of something else. These two different understandings of scientific observation occur as the basis for understanding observation in two different scientific approaches to science, the systems theoretical and the semiotic. In other words, form characterises the kind of observation found in communicational systems, whereas sign characterises the kind of observation found in cognitive systems (retaining the idea that these two kinds of systems are themselves perspectival and not ontologically given). Thereby they constitute a fundamental starting point for how different scientific approaches observe a given object (such as the environment, see the analysis in Alrøe & Noe 2012).

PART TWO: PERSPECTIVIST METAPHYSICS

The perspectivist approach starts from observation and is thereby essentially epistemological and (radical) constructivist. This does not mean that there is no use for a metaphysical or ontological foundation, even though this foundation must always have the form of a "working ontology" in accordance with the fallibilist nature of science. Part two of the book contains an exploration of perspectivist metaphysics that is to help form a firm theoretical foundation for the perspectivist approach to research and science. Furthermore the relation of perspectivism to different versions of constructivism, relativism and realism is unravelled.

Three kinds of kinds

This chapter presents a 'working ontology' for perspectivism based on its semiotic foundation. Building on the key semiotic concept of representation, three metaphysical kinds or levels are posited: (1) non- or pre-semiotic processes, without representation (physical or causal processes), (2) semiotic processes, with representation (processes of life and cognition), and (3) self-reflexive processes, with representation of representation (self-conscious and self-reflexive communicative processes). Ian Hacking distinguished between indifferent and interactive kinds (e.g. Hacking 1999: 103ff). This chapter will, firstly, clarify the relation between interactive kinds and realism about kinds (against the misunderstandings in e.g. Khalidi 2010). Secondly the paper will argue (with Khalidi 2010) that interactive kinds are not restricted to the human sphere. But it will move beyond Khalidi's analysis to distinguish not two, but three kinds of ontological kinds: indifferent, adaptive and reflexive, where the last two hitherto have not been clearly distinguished. Constructivism does not imply that one does not

have foundational 'working ontologies'. Such foundations are indispensable and must be discussed just as intensely as realists discuss 'reality'. This chapter builds a strong argument for the three kinds of kinds, or levels, as a fundamental working ontology for perspectivism, and indicates some implications for a perspectivist approach to science, systems theory, ethics, etc., which are developed more fully in later chapters.

Relational metaphysics

This chapter takes a step further in investigating the metaphysical foundation for perspectivist methodology, looking at how science as an observer can relate to the world and at the implications of perspectivism for the notions of space and time, and the notions of cause and probability. The chapter explicates the relational metaphysics behind the semiotic approach to phenomena and phenomenology. Relational metaphysics is a radical break with the conventional scientific way of describing qualities as properties of objects, replacing this with the idea of qualities as relational (Pirsig 1999). Value relations are primary, there are no objects or subjects before the relation, and a value can be defined as the unity of subject and object (Noe & Alrøe 2011). The chapter forms a basis for handling values in scientific observations, building on previous work on the role of values in science (Alrøe & Kristensen 2002). Furthermore, it forms a basis for the perspectivist approach to ethics.

PART THREE: PERSPECTIVIST ETHICS

This part investigates the normative aspects of the perspectivist understanding of science based on previous work on systems, values and ethics.

Systems and ethics

This chapter is based on the theory of systemic ethics (Alrøe & Kristensen 2003), the aim of which is to provide a framework for understanding the new ethical concepts of sustainability and precaution. The framework goes beyond the traditional distinction between non-consequentialist ethics, which focus on the intention or motivation behind the act (such as character, virtues, duties), and consequentialist ethics, which focus on the consequences of the act (such as utility), to develop a systemic ethic of responsible acting which incorporates the other approaches. Systemic ethics starts from acts rather than intentions or consequences, building on a systemic and semiotic model of moral acting (closely related to the model of observation from Part one) and the ethics of responsibility (Jonas 1984). In this approach to ethics the awareness of a choice of action (which includes the ability to act) implies moral responsibility. In this chapter the systemic conception of ethics is confronted with the theory of social systems (Luhmann 1995 and much more), where the conception of a modern functionally differentiated society questions the very idea of general ethical responsibilities. In this way a concept of ethics is developed that can relate to the perspectivist understanding of science and the ongoing fragmentation of scientific expertise.

Trust and truth

Trust is a key concept for working with the sustainability of modern food systems and other complex socio-ecological systems. This chapter develops an analysis of trust as a fundamental characteristic of knowledge about autonomous and reflexive systems, based on the three kinds of kinds (treated in a previous chapter): indifferent, adaptive and reflexive. In this understanding trust plays an even more

foundational role than hitherto acknowledged. Trust with regard to reflexive systems thus corresponds functionally to truth with regard to indifferent systems. Thereby the concept of trust gains a key role in the perspectivist approach, opening up for new ways to understand socio-ecological systems. On this basis, the chapter explores the role of trust in relation to complex and inscrutable systems, and whether trust is understood differently in relation to adaptive and reflexive systems (e.g. systems trust, personal trust).

PART FOUR: OBSERVING SCIENTIFIC PERSPECTIVES

Whereas the first parts of this book are concerned with 'science' as perspectivist and the related implications for metaphysics and ethics, the remaining parts of the book look at the variety of disciplines, theories, approaches, etc. Part four thus investigates how the actual, different, and often quite separate kinds of science relate to each other, and to their environment, from a perspectivist point of view.

The variety of scientific perspectives

Firstly, this chapter explores the relation between scientific disciplines as 'ontological' and 'epistemological.' The ontological understanding of science, which goes back to Aristotle, sees disciplines as an organisation of science based on what concrete area of reality it has as its object. The epistemological understanding of science, as it is unfolded in cognitive, radical constructivist and perspectivist approaches to science, sees ontology as strictly "working ontologies;" that is, the ontological understanding is secondary to the epistemological. Secondly, the chapter investigates the relation between different scientific disciplines, schools and methodologies based on their functional similarities and differences. Based on a pragmatist understanding three different forms of science are distinguished, empirical, normative and hypothetical (Alrøe & Kristensen 2002). Within these forms, the variety of specific scientific perspectives can be ordered in two methodological dimensions: the degree of reduction of the research world and the degree of involvement in the research world. Showing the relation between more and less reductive kinds of science (cf. the metaphysical levels discussed earlier), and between more detached and more involved kinds of science, and exposing the abilities and limitations attendant on these methodological differences, is a precondition for successful research collaboration across these differences.

Complementary perspectives

The concept of complementarity in science was formulated by Niels Bohr to explain contradictory phenomena in quantum physics. But Bohr advocated for the broader use of complementarity, and here we pursue this idea and explore how and where complementarity between different scientific perspectives occur. How often is professional disagreement caused by complementarity between specialised perspectives, leading to mutually exclusive assertions? How can this be made clear so that the incompatible perspectives can be recognised as potentially equally scientific? The aim of this chapter is to clarify when perspectives are complementary, what forms of complementarity exist, and what this means for the prospects of producing unambiguous descriptions in cross-disciplinary research. Bohr and others have pointed out complementary phenomena in a range of other areas than quantum physics, and here we analyse the suggested complementary phenomena and create a typology of different forms of complementarity at different levels (a preliminary version is presented in Figure 2, to make the idea clear). The phenomenological complementarities, which show up in the

extremities of the phenomenological space of observation (referring back to the model of observation in Figure 1), are of special interest with regard to indicating where there may be complementary conditions of observation between different specialised perspectives. The relation between the notion of complementarity and the notions of reflexive objectivity and cognitive context is explicated and the implications for cross-disciplinary research are analysed.

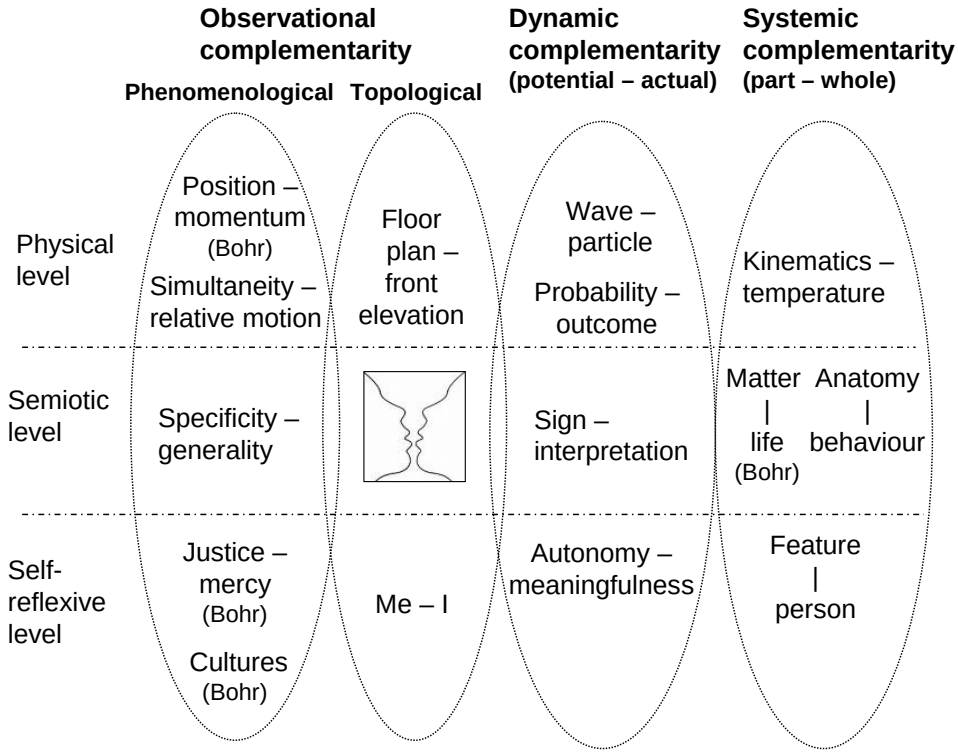

Figure 2: Preliminary outline of different forms of complementarity in science (Alrøe 2008).

Observing theories

This chapter investigates the idea that scientific theories are perspectival (Giere 2006). Based on the perspectivist approach described in this book, different scientific theories are classified on the basis of how they relate to their perspectival character, and the chapter explores what this means for the design and possible integration of theories:

0. order theory – functions independently of observation (e.g. Galilean or Newtonian mechanics).
1. order theory – includes observation within the theory (e.g. relativity theory, quantum mechanics).
2. order theory – theories about observing (1. order) theories (e.g. second order cybernetics, social systems theory, perspectivism as a theory of science).

Examples are provided from e.g. quantum physics, relativity theory, behavioural science, cognitive science, and sustainability science.

Observing environments (source article published 2012)

Constructivist theories are theories that take the significance of the observer, or the observing system, as the starting point for scientific observation, and where the environment is therefore relative to the position of observation. But different constructivist theories have different ways of observing their environment. The aim of this chapter is to clarify different constructivist approaches to observing environments as a contribution to the sciences of complex systems and complex environmental problems. The chapter explains the importance of distinguishing between inside and outside perspectives on the environment, and it shows how the theory of social systems can be useful in confronting complex and 'wicked' environmental problems in society if one is aware of its blind spots: that it is only concerned with communicational systems and that it is based on a concept of observation building on distinction, not representation.

PART FIVE: PERSPECTIVIST SCIENCE

This final part of the book investigates the implications of the perspectivist understanding for cross-disciplinary collaboration on complex problems like sustainable food production, global environmental problems and climate change, and for how the variety of scientific expertise is used in democratic decisions on such problems. Second-order science is suggested as a way to transgress the paradoxes connected to the differentiation of modern science and modern society and help overcome wicked problems.

The paradox of scientific expertise

The paradox of scientific expertise is that the growth of science leads to a fragmentation of scientific expertise (Alrøe & Noe 2011). Subsequently this leads to problems of communicating and collaborating across different specialised scientific perspectives. The participants in a cross-disciplinary collaboration need to point to some 'real thing' that this collaboration is concerned with. For instance, we can point at or hint at some dynamical object called a cow (see Figure 1), but the specialised perspectives are never able to communicate anything but immediate objects by way of scientific concepts, such as 'year cow' (in accounting), 'lactation curve' (in agronomy) or 'grazing pressure' (in conservation ecology), and the specialised scientific models that go with them. What is seen depends on how it is seen. The same dynamical object can be observed in different ways in different scientific perspectives, but none of the immediate objects found in these perspectives are the same as the dynamical object in itself. When one perspective speaks of 'sustainable agriculture', 'soil quality', 'farm enterprise' or 'cow', it does not necessarily mean the same as when another perspective uses the same words. The paradox of cross-disciplinary communication is that the common language is not sufficiently precise to communicate the immediate objects of the specialised perspectives, but a more precise communication, using specialised concepts and models, moves us away from the common language with which we can communicate across perspectives. This chapter investigates these paradoxes in order to create a better basis for understanding and communicating across different sciences, and for the use of fragmented scientific expertise in society.

A polyocular framework for cross-disciplinary research

The existing approaches to cross-disciplinary research in relation to so-called 'wicked problems' are problematic because they remain first-order observations, whether in form of independent and uncoordinated research approaches (multidisciplinary), a network of coordinated but still

independent approaches (interdisciplinary), a synthesis through the lens of a hegemonic research discipline (often, but not always, economics), or a synthesis based on a new integrated, but still first-order, research approach (transdisciplinary, in one sense). This chapter introduces second-order science and what we call a polyocular framework based on second-order observation (Figure 3), as a radically new way to understand and overcome the problems of cross-disciplinary research and to deal with specialised scientific expertise in democratic processes. The polyocular framework is based on earlier work (including Alrøe & Noe 2008, 2011; Noe et al. 2008; and the synthesis in Alrøe & Noe 2014), and on experiments with perspectivist and polyocular methods in two large cross-disciplinary research projects (www.multitrust.org; www.healthygrowth.eu) and a special feature in *Ecology and Society*, including some 'polyocular' papers (e.g. Læssøe et al. 2014, Thorsøe et al. 2014). The perspectivist and polyocular framework is a method for how to handle (observe and communicate) observations of the (presumed) same complex problem made by different specialised research perspectives and stakeholder perspectives. Such a second-order framework is necessary to successfully carry out genuinely cross-disciplinary research on wicked problems, and it offers a new way to handle specialised scientific expertise in the complex democratic processes of modern societies.

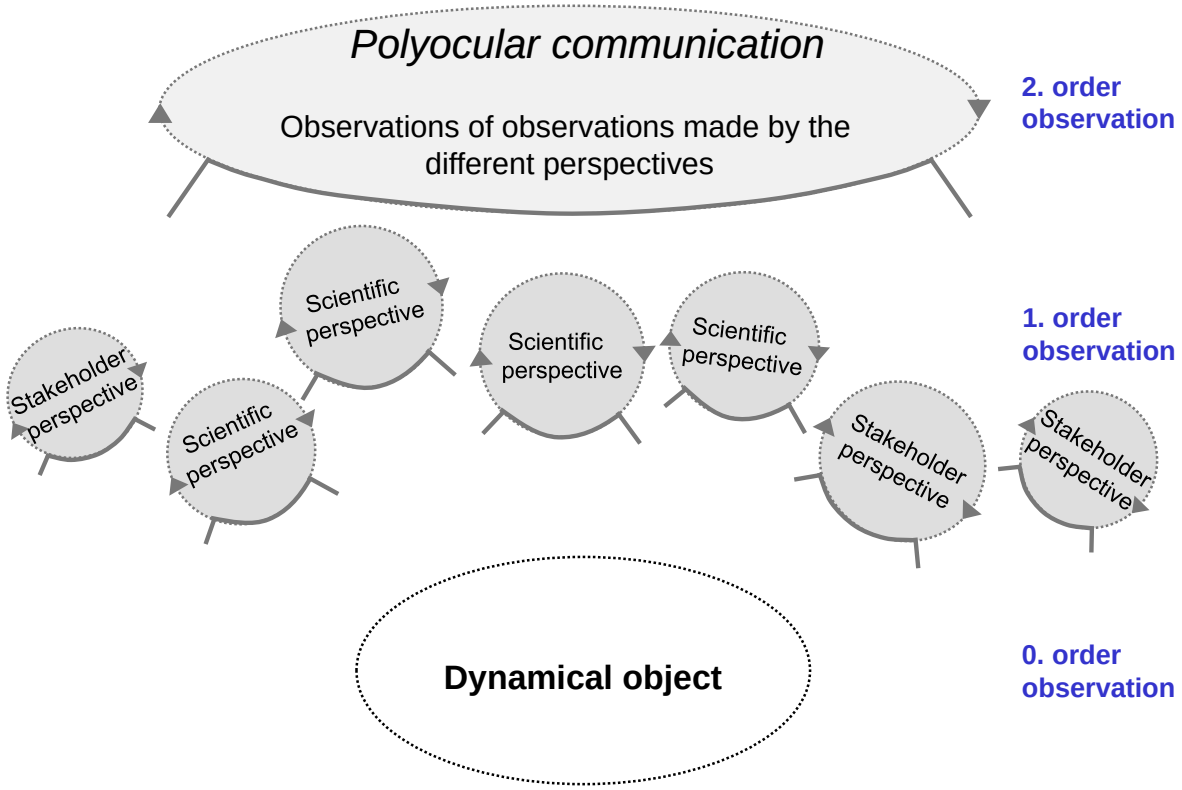

Figure 3: The polyocular framework for cross-disciplinary research, with three levels of observation (Alrøe & Noe 2014).

REFERENCES

Alrøe, H.F. (2000) Science as systems learning: Some reflections on the cognitive and communicational aspects of science. *Cybernetics and Human Knowing* 7(4): 57–78. **Offprint**

Alrøe, Hugo F. (2008) *The phenomenology of observation - A tool to deal with disciplinary perspectives, expertise and disagreement in cross disciplinary research and democratic debate.* Project description, 1. Sep. 2008 (unpublished).

Alrøe, H.F. and Kristensen, E.S. (2002) Towards a systemic research methodology in agriculture: Rethinking the role of values in science. *Agriculture and Human Values* 19(1): 3–23. - **Offprint**

Alrøe, H.F. and Kristensen, E.S. (2003) Toward a systemic ethic: In search of an ethical basis for sustainability and precaution. *Environmental Ethics* 25(1): 59–78. - **Offprint**

Alrøe, H.F. and Noe, E. (2008) What makes organic agriculture move - protest, meaning or market? A polyocular approach to the dynamics and governance of organic agriculture*. Int. J. Agricultural Resources, Governance and Ecology* 7(1/2): 5–22 - **Offprint**.

Alrøe, H.F. and Noe, E. (2011) The paradox of scientific expertise: A perspectivist approach to knowledge asymmetries. *Fachsprache - International Journal of Specialized Communication* Vol. XXXIV, 3–4/2011: 152–167. – **Offprint**

Alrøe, H.F. and Noe, E. (2012) Observing environments. *Constructivist Foundations* 8(1): 39–62 - **Offprint**

Alrøe, H. F. and Noe, E. (2014) Second-order science of interdisciplinary research: A polyocular framework for wicked problems. *Constructivist Foundations* 10(1): 65–95. - **Offprint**

Bracken, L.J. and Oughton, E.A. (2006): "What do you mean? The importance of language in developing interdisciplinary research." *Transactions of the Institute of British Geographers* 31: 371–382.

Giere, R.N. (2006): *Scientific Perspectivism*. Chicago: University of Chicago Press.

Hacking, I. (1999): *The social construction of what?* Harvard University Press.

Harrison, S., Massey, D., Richards, K. (2008): "Conversations across the divide." *Geoforum*, 39(2): 549–551.

Jonas, H. (1984) *The imperative of responsibility. In search of an ethics for the technological age*. Chicago: University of Chicago Press.

Khalidi, M.A. (2010) Interactive kinds. *Brit. J. Phil. Sci.* 61: 335–360.

Luhmann, N. (1990): *Die Wissenschaft der Gesellschaft*. Frankfurt am Main: Suhrkamp.

Luhmann N. (1995) *Social systems.* Stanford University Press, Stanford. [German original 1984.]

Læssøe, J., A. Kruse Ljungdalh, H. F. Alrøe, E. Noe, T. Christensen, A. Dubgaard, S. Bøye Olsen, N. Kærgård and P. Kastberg (2014) Three perspectives on motivation and multicriteria assessment of organic food systems. *Ecology and Society* 19 (3): 7. - **DOI** - **Offprint**

Miller, T. R., Baird, T. D., Littlefield, C. M., Kofinas, G., Chapin, F., III, Redman, C. L. (2008): "Epistemological pluralism: reorganizing interdisciplinary research." *Ecology and Society* 13(2): 46.

Noe, E., Alrøe, H.F. and Langvad, A.M.S. (2008) A polyocular framework for research on multifunctional farming and rural development. *Sociologia Ruralis* 48(1): 1–15. - **DOI** - **Offprint**.

Noe, E., H.F. Alrøe (2011) Quality, Coherence and Cooperation: A Framework for Studying the Mediation of Qualities in Food Networks and Collective Marketing Strategies. *International Journal of the Sociology of Agriculture and Food* 18(1): 12–27. – **Offprint**

Pennington, D.D. (2008): "Cross-disciplinary collaboration and learning." *Ecology and Society* 13(2): 8.

Pirsig, R.M. (1999). Subjects, Objects, Data and Values, in D. Aerts, J. Broekaert and E. Mathijs (eds) *Einstein meets Magritte - An interdisciplinary reflection*, Dordrecht: Kluwer Academic Publishers, pp. 79-98.

Stichweh, R. (1992): "The Sociology of Scientific Disciplines: On the Genesis and Stability of the Disciplinary Structure of Modern Science." *Science in Context* 5: 3–15.

Thorsøe, M. H., H. F. Alrøe and E. Noe (2014) Observing the observers – uncovering the role of values in research assessments of organic food systems*. Ecology and Society* 19(2): 46. - **DOI** - **Offprint**

About the author

Hugo F. Alrøe is Associate Professor in philosophy of science and ethics at Aarhus University, Denmark. His research interests are in philosophy of science and ethics in relation to the sustainability of food, agriculture and environment, the sustainability of food, agriculture and environment, focusing on the philosophy and methods of cross-disciplinary research, the role of values in science, and ethics in relation to responsibility, systems and environment. Recently he has worked on the development of a perspectivist approach to cross-disciplinary research based on autopoietic systems theory and semiotics. Hugo Alrøe has been involved in a range of Danish and European research projects. At present he is project leader of the transdisciplinary research project "Multicriteria assessment and communication of effects of organic food systems" (MultiTrust) funded by the Danish Ministry of Food. Homepage with CV and papers for download: http://hugo.alroe.dk.

Acknowledgement

I am in many ways indebted to Associate Professor Egon Noe, Aarhus University with whom I have collaborated closely for many years, and without whom this work would not have been possible.

APPENDIX 1:
ABSTRACTS FOR PUBLISHED SOURCE ARTICLES

SECOND-ORDER SCIENCE

Alrøe, Hugo F. and Egon Noe (2014) *Second-order science of interdisciplinary research: A polyocular framework for wicked problems.* Constructivist Foundations 10(1): 65–95. (In the **special issue "Second-order science"**, with five Open Peer Commentaries and an Authors' Response: "A Perspectivist View on the Perspectivist View of Interdisciplinary Science".) -
Permalink: **http://www.univie.ac.at/constructivism/journal/10/1/065.alroe** - **Offprint**

(This paper provides a comprehensive and elaborated description of the multiperspectival framework for inter- and transdisciplinary research that I have developed over the past decade together with Egon Noe.)

Abstract

Context • The problems that are most in need of interdisciplinary collaboration are "wicked problems," such as food crises, climate change mitigation, and sustainable development, with many relevant aspects, disagreement on what the problem is, and contradicting solutions. Such complex problems both require and challenge interdisciplinarity. **Problem** • The conventional methods of interdisciplinary research fall short in the case of wicked problems because they remain first-order science. Our aim is to present workable methods and research designs for doing second-order science in domains where there are many different scientific knowledges on any complex problem. **Method** • We synthesize and elaborate a framework for second-order science in interdisciplinary research based on a number of earlier publications, experiences from large interdisciplinary research projects, and a perspectivist theory of science. **Results** • The second-order polyocular framework for interdisciplinary research is characterized by five principles. Second-order science of interdisciplinary research must: 1. draw on the observations of first-order perspectives, 2. address a shared dynamical object, 3. establish a shared problem, 4. rely on first-order perspectives to see themselves as perspectives, and 5. be based on other rules than first-order research. **Implications** • The perspectivist insights of second-order science provide a new way of understanding interdisciplinary research that leads to new polyocular methods and research designs. It also points to more reflexive ways of dealing with scientific expertise in democratic processes. The main challenge is that this is a paradigmatic shift, which demands that the involved disciplines, at least to some degree, subscribe to a perspectivist view.

OBSERVING ENVIRONMENTS

Alrøe, Hugo F. and Egon Noe (2012) *Observing environments.* Constructivist Foundations 8(1): 39–62 (In **special issue on "Luhmann's Relation to and Relevance for Constructivist Approaches"**, with three Open Peer Commentaries) -
Permalink: **http://www.univie.ac.at/constructivism/journal/8/1/039.alroe** - **Offprint**

Abstract

Context • Society is faced with "wicked" problems of environmental sustainability, which are inherently multiperspectival, and there is a need for explicitly constructivist and perspectivist theories to address them. **Problem** • However, different constructivist theories construe the environment in different ways. The aim of this paper is to clarify the conceptions of environment in constructivist approaches, and thereby to assist the sciences of complex systems and complex environmental problems. **Method** • We describe the terms used for "the environment" in von Uexküll, Maturana & Varela, and Luhmann, and analyse how their conceptions of environment are connected to differences of perspective and observation. **Results** • We show the need to distinguish between inside and outside perspectives on the environment, and identify two very different and complementary logics of observation, the logic of distinction and the logic of representation, in the three constructivist theories. **Implications** • Luhmann's theory of social systems can be a helpful perspective on the wicked environmental problems of society if we consider carefully the theory's own blind spots: that it confines itself to systems of communication, and that it is based fully on the conception of observation as indication by means of distinction.

THE PARADOX OF SCIENTIFIC EXPERTISE

Alrøe, Hugo F. and Egon Noe (2011) *The paradox of scientific expertise: A perspectivist approach to knowledge asymmetries*. Fachsprache - International Journal of Specialized Communication Vol. XXXIV, 3–4/2011: 152–167. **(Special issue on "Knowledge Asymmetries")** – **Offprint**

Abstract

Modern societies depend on a growing production of scientific knowledge, which is based on the functional differentiation of science into still more specialised scientific disciplines and subdisciplines. This is the basis for the paradox of scientific expertise: The growth of science leads to a fragmentation of scientific expertise. To resolve this paradox, the present paper investigates three hypotheses: (1) All scientific knowledge is perspectival. (2) The perspectival structure of science leads to specific forms of knowledge asymmetries. (3) Such perspectival knowledge asymmetries must be handled through second order perspectives. We substantiate these hypotheses on the basis of a perspectivist philosophy of science grounded in Peircean semiotics and autopoietic systems theory. Perspectival knowledge asymmetries are an unavoidable and necessary part of the growth of scientific knowledge, and more awareness of this fact can help avoid blind and futile struggles between scientific perspectives, and direct efforts toward more appropriate ways of handling these fundamental knowledge asymmetries. Concretely, we show how different kinds of scientific knowledge, expertise, disagreement and learning can be correlated to the perspectival structure of science, and propose how polyocular communication based on (second order) observations of the observations made by specialised perspectives can be used to handle such perspectival knowledge asymmetries. This can help overcome the observed problems in carrying out cross-disciplinary research and in the collective use of different kinds of scientific expertise, and thereby make society better able to solve complex, real-world problems.