UvA-DARE (Digital Academic Repository)

The Flow of Cognitive Goods

A historiographical framework for the study of epistemic transfer

Bod, R.; van Dongen, J.; ten Hagen, S.L.; Karstens, B.; Mojet, E.

DOI

[10.1086/704673](https://doi.org/10.1086/704673)

Publication date

2019

Document Version

Final published version

Published in

Isis

[Link to publication](#)

Citation for published version (APA):

Bod, R., van Dongen, J., ten Hagen, S. L., Karstens, B., & Mojet, E. (2019). The Flow of Cognitive Goods: A historiographical framework for the study of epistemic transfer. *Isis*, 110(3), 483-496. <https://doi.org/10.1086/704673>

General rights

It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations

If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: <https://uba.uva.nl/en/contact>, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.

Critiques and Contentions

The Flow of Cognitive Goods: A Historiographical Framework for the Study of Epistemic Transfer

Rens Bod, *University of Amsterdam*

Jeroen van Dongen, *University of Amsterdam*

Sjang L. ten Hagen, *University of Amsterdam*

Bart Karstens, *Vrije Universiteit Amsterdam*

Emma Mojet, *University of Amsterdam*

Abstract: Historians of science have described various cases of disciplines influencing one another. Such exchanges across disciplinary boundaries often signal innovation, intellectual change, and breakthroughs. A satisfactory framework from which the historical phenomenon of epistemic transfer between disciplines can be studied systematically, however, has not yet been proposed. This essay intro-

Rens Bod is Professor of Digital Humanities and History of Humanities at the University of Amsterdam. He is Codirector of Amsterdam's Vossius Center for the History of Humanities and Sciences. His most recent book is *A World of Patterns: The History of Knowledge* (Amsterdam, 2019) (in Dutch). Institute for Logic, Language, and Computation, University of Amsterdam, Science Park 107, 1098 XG Amsterdam, Netherlands; rens.bod@gmail.com.

Jeroen van Dongen, Professor of History of Science at the University of Amsterdam, is Codirector of Amsterdam's Vossius Center for the History of Humanities and Sciences. His most recent book, coedited with Chaokang Tai and Bart van der Steen, is *Anton Pannekoek: Ways of Viewing Science and Society* (Amsterdam, 2019). University of Amsterdam, Science Park 904, Postbus 94216, 1090 GE Amsterdam; j.a.e.f.vanDongen@uva.nl.

Sjang L. ten Hagen is a Ph.D. candidate at the Vossius Center for the History of Humanities and Sciences and the Institute of Physics, University of Amsterdam. His research focuses on the transfer of knowledge across disciplinary and national boundaries. University of Amsterdam, Science Park 904, Postbus 94216, 1090 GE Amsterdam; s.l.tenhagen@uva.nl.

Bart Karstens is a postdoctoral researcher at the Vrije Universiteit Amsterdam. He works on the long-term history of the concepts of structure and structuralism. Other topics that interest him are discipline formation, interdisciplinarity, the history of linguistics, and evaluations of past science. Vrije Universiteit, De Boelelaan 1081, 1081 HV, Amsterdam; b.karstens@vu.nl.

Emma Mojet is a Ph.D. candidate at the Vossius Center for the History of the Humanities and Sciences and the ILLC program at the University of Amsterdam. Her research focuses on the history of disciplines and interdisciplinarity; she uses the "Flow of Cognitive Goods" framework to study discipline formation processes. University of Amsterdam, Science Park 904, Postbus 94216, 1090 GE Amsterdam; g.e.n.mojet@uva.nl.

Acknowledgments. This work is part of the research program "The Flow of Cognitive Goods: Towards a Post-Disciplinary History of Knowledge," Project Number 360-69-040, which is partly funded by the Dutch Research Council (NWO). This essay benefited substantially from comments from two *Isis* referees and from the constructive feedback of H. Floris Cohen. We also thank Herman Paul for his commentary at "The Making of the Humanities VI" conference at Oxford in 2017, as well as Hans-Jörg Rheinberger for his feedback during his Zeeman Fellowship at the Vossius Center for the History of Humanities and Sciences at the University of Amsterdam.

Isis, volume 110, number 3. © 2019 by The History of Science Society.
All rights reserved. 0021-1753/2019/0110-0003\$10.00.

duces the notion of “cognitive goods,” a tool of knowledge making that can be transferred across disciplinary boundaries. Cognitive goods include, for example, methods, concepts, and instruments. The essay proposes to study historical interactions between disciplines as instances of the “flow” of cognitive goods. The notion of cognitive goods may serve as a springboard for a systematic analysis of flows occurring throughout the history of the disciplines. Such an analysis could be instrumental for an integrated historiography of knowledge, including the humanities and the natural and social sciences.

How do crossovers between disciplines occur? In recent decades, numerous research fields have been formed that transcend the boundaries of traditional disciplines: nanoscience, digital humanities, and environmental studies are familiar examples, and many more are easily found. Indeed, cross-fertilization between disciplines is ubiquitous, and this has been so throughout history.

Historians of science have documented a vast number of cases of transfer between disciplines.¹ The influx of physicists in molecular biology, the influence of modern historical thinking on geology, the use of the linguistic notion of grammar in computer science, and the dispersion of concepts such as entropy and energy from thermodynamics to other fields are cases that have been well researched, and others are equally familiar.² Indeed, Rudolf Stichweh has argued that the modern system of scientific disciplines has been characterized not only by differentiation through specialization but also by interdisciplinarity. The latter, he believes, “depends on borrowing and transfers. One picks up a concept, theory or method that has proven itself in a different discipline, and tries to make it fruitful in one’s own by a gradual process of naturalization.”³ According to Stichweh, such transfers are fundamental to scholarly innovation.

Disciplines are often considered conservative forces because they shape the organization of education, careers, and funding. Yet that picture is due to a narrow understanding of their role: behind their static appearance, one quickly finds a rich variety of practices.⁴ The history of this variety is contingent, dynamic, and full of epistemic crossovers. In this essay, we develop a historiographical framework that may offer a more systematic study of the transfer between disciplines: we interpret such crossovers as “flows” of “cognitive goods.” The notion of cognitive goods

¹ See, e.g., the contributions on knowledge transfer across disciplinary boundaries in Catherine Herfeld and Chiara Liscandra, eds., “Knowledge Transfer and Its Contexts,” special issue, *Studies in the History and Philosophy of Science*, forthcoming. For historical examples of interdisciplinary model transfer see the contributions in Till Grüne-Yanoff and Uskali Mäki, eds., “Special Section: Interdisciplinary Model Exchanges,” *ibid.*, 2014, 48:52–116. On model transfer within the humanities see Rens Bod, “Modelling in the Humanities: Linking Patterns to Principles,” in *Models and Modelling between Digital Humanities: A Multidisciplinary Perspective*, ed. Arianna Ciula *et al.* (*Historical Social Research*, Suppl. 31) (Cologne: GESIS, 2018), pp. 78–95.

² See, e.g., Michel Morange, *A History of Molecular Biology* (Cambridge, Mass.: Harvard Univ. Press, 2000); M. J. S. Rudwick, *Bursting the Limits of Time: The Reconstruction of Geohistory in the Age of Revolution* (Chicago: Univ. Chicago Press, 2005); Bart Karstens, “Bopp the Builder: Discipline Formation as Hybridization: The Case of Comparative Linguistics,” in *The Making of the Humanities*, Vol. 2: *From Early Modern to Modern Disciplines*, ed. Rens Bod, Jaap Maat, and Thijs Weststeijn (Amsterdam: Amsterdam Univ. Press, 2012), pp. 103–127; Anson Rabinbach, *The Human Motor: Energy, Fatigue, and the Origins of Modernity* (Berkeley: Univ. California Press, 1992); Lorenz Krüger, Lorraine Daston, and Michael Heidelberger, eds., *The Probabilistic Revolution*, 2 vols. (Cambridge, Mass.: MIT Press, 1987); Simon Schaffer, *From Physics to Anthropology and Back Again* (Cambridge: Prickly Pear, 1994); and Richard Staley, “Conversions, Dreams, Defining Aims? Following Boas, Malinowski, Physics, and Anthropology through Laboratory and Field,” *History of Anthropology Newsletter*, 2012, 39(2):3–10.

³ Rudolf Stichweh, “Interdisziplinarität und wissenschaftliche Bildung,” in *Fundiert forschen*, ed. Hanna Kauhaus and Norbert Krause (Wiesbaden: Springer Fachmedien, 2017), pp. 181–190, on p. 184. For Stichweh’s account of the creation of the modern system of disciplines see Stichweh, *Entstehung des modernen Systems wissenschaftlicher Disziplinen: Physik in Deutschland 1740–1890* (Frankfurt am Main: Suhrkamp, 1984).

⁴ This is one of the main points of Julie Thompson Klein, *Crossing Boundaries: Knowledge, Disciplinarity, and Interdisciplinarity* (Charlottesville: Univ. Virginia Press, 1996).

aims to capture everything of relevance that moves between disciplines—including, for example, methods, concepts, and instruments.

Our proposal is motivated by the arrival of the “history of the humanities” as a recognizable field of study.⁵ Practitioners have noted repeatedly that epistemic transfer between scientific and humanistic disciplines has been frequent and reciprocal.⁶ What is lacking so far, however, is a methodological framework that allows for describing and understanding these knowledge transfers. For example, in his 2013 book *New History of the Humanities* Rens Bod describes, among other things, how formalisms such as context-free grammars and genealogical trees are transferred from humanistic disciplines (linguistics and philology, respectively) to scientific disciplines (computer science and biology, respectively), but no theory that allows for conceptualizing interactions and transfers between disciplines is provided. Jeroen van Dongen and Herman Paul’s edited volume from 2017 discusses the epistemic virtues of humility, persistence, and impartiality, which are transferred between the sciences and the humanities, but without arriving at a more general view as to the underlying processes that have been at work in these transfers.⁷ The current essay takes a next step and raises the question of whether we can come up with a general historiographical framework for describing interactions and transfers on a “mesoscopic” level, transcending the confines of discipline, location, and the short term. Such a framework should not only generalize over our own work but should also prove useful for others who are concerned with the relation between the meso level and the micro level in the history of science and the humanities.

I. SOME EXAMPLES OF EPISTEMIC CROSSOVER

A few examples will help clarify the sorts, and the variety, of epistemic transfers we have in mind. We will focus explicitly on the period when discipline formation took off on a large scale for the first time—that is, in the nineteenth and twentieth centuries.

Although this period is commonly portrayed as the era of academic differentiation, the sciences and humanistic disciplines, such as physics and history, exhibited close ties in Germany throughout the nineteenth century.⁸ For example, the large-scale nineteenth-century projects of archive building and source collecting became the first templates for “big science” in their efforts at data harvesting. Furthermore, the virtues of exactitude and devotion to technique, which had been articulated as part of a philological ethos in the late eighteenth century, became exemplars in nineteenth-century natural scientific disciplines such as physics and chem-

⁵ Academic conferences on the general history of the humanities have been organized since 2008, and there is now an edited book series (“The Making of the Humanities”). The journal *History of Humanities* has been published since 2016. This development has also resulted in the production of textbooks, and the field is being taught on a par with the history of science at several universities on different continents. The Society for the History of Humanities was founded in 2015 (www.historyofhumanities.org).

⁶ See Rens Bod, *A New History of the Humanities: The Search for Principles and Patterns from Antiquity to the Present* (Oxford: Oxford Univ. Press, 2013); Bod, “A Comparative Framework for Studying the History of the Humanities and Science,” *Isis*, 2015, 106:367–377; and, for a long-term approach to transfers between humanistic and scientific disciplines, Bod, *Een wereld vol patronen: De geschiedenis van kennis* (Amsterdam: Prometheus, 2019). See also Karstens, “Bopp the Builder” (cit. n. 2); Jeroen van Dongen and Herman Paul, eds., *Epistemic Virtues in the Sciences and the Humanities* (Cham: Springer, 2017); Lorraine Daston and Glenn W. Most, “History of Science and History of Philologies,” *Isis*, 2015, 106:378–390; and Hans-Jörg Rheinberger, “Culture and Nature in the Prism of Knowledge,” *History of Humanities*, 2016, 1:155–181.

⁷ Bod, *New History of the Humanities*, Ch. 5 (see also Stefani Engelstein, *Sibling Action: The Genealogical Structure of Modernity* [New York: Columbia Univ. Press, 2017]); and Van Dongen and Paul, eds., *Epistemic Virtues in the Sciences and the Humanities*.

⁸ On the relation between the history of humanities and science in general see Rens Bod and Julia Kursell, eds., “Focus: The History of Humanities and the History of Science,” *Isis*, 2015, 106:337–390; Fabian Krämer, ed., “Forum: The Two Cultures Revisited: The Sciences and the Humanities in a *Longue Durée* Perspective,” *Hist. Humanities*, 2018, 3:5–88; and Michiel Leezenberg, *History and Philosophy of the Humanities: An Introduction* (Amsterdam: Amsterdam Univ. Press, 2018).

istry. Finally, historiography and physics shared a common veneration and preoccupation with the novel notion of the “fact.”⁹

Such examples are of course not limited to the nineteenth century. Factor analysis is a statistical template for decomposing the variance-covariance matrix of a set of test items into a part that is due to a common factor (e.g., a psychological attribute) and a part that involves random error and specific variance (i.e., variance that is not shared among the items). It stems from the field of psychometrics and is commonly used in the analysis of test scores to assess the degree to which different items measure the same attribute.¹⁰ But after its application in psychometrics, factor analysis came to be used in a wide variety of disciplines such as geochemistry, ecology, astrophysics, and molecular biology.

The nineteenth-century scholar Vilfredo Pareto modeled economic equilibrium on the mechanical notion of equilibrium by using mathematically analogous notions of forces.¹¹ While Pareto was initially skeptical about the use of concepts from physics in the emerging field of economics, he did not have to look far for inspiration: his own 1869 doctoral thesis in engineering was titled *Principi fondamentali dell'equilibrio dei corpi solidi* (“Fundamental Principles of Equilibrium in Solid Bodies”). Following Pareto, concepts and their related formulas began making the move from physics to economics. For example, in analyzing market dynamics, the nineteenth-century British economist William Stanley Jevons introduced an exchange equation that took precisely the same form as the law of the lever.¹²

Until the second half of the nineteenth century, the word “structure” was used as a synonym for “building.” The few references to the term in scholarly discourse up to the middle of the nineteenth century convey this meaning: in publications about parts of the body such as hair or teeth, for example, the concept of structure was used to explicate how these are built. The chemist F. A. Kekulé (1829–1896), who actually trained briefly as an architect, saw that the term could be useful in chemistry. His use of the concept was innovative because, along with the spatial buildup of the chemical compound, it also referred to the stereographical projection of a more general regular pattern. Kekulé introduced the notion in his treatment of benzene, which consists of a ring of six atoms, with alternating single and double bonds; he used the concept of structure to capture both the symmetrical form of the ring (the basic structure) and the alternating relational patterns of the bonds in it.¹³ Molecules, such as benzene, could now be characterized not just according to the number of atoms of a particular type but also by the “structural” form of their connections.

⁹ Rüdiger vom Bruch, “Mommson und Harnack: Die Geburt von Big Science aus den Geisteswissenschaften,” in *Theodor Mommsen: Wissenschaft und Politik im 19. Jahrhundert*, ed. Alexander Demandt, Andreas Goltz, and Heinrich Schlange-Schöningen (Berlin: De Gruyter, 2005), pp. 121–141; Lorraine Daston, “Objectivity and Impartiality: Epistemic Virtues in the Humanities,” in *The Making of the Humanities*, Vol. 3: *The Modern Humanities*, ed. Rens Bod, Jaap Maat, and Thijs Weststeijn (Amsterdam: Amsterdam Univ. Press, 2014), pp. 27–41, esp. p. 38; and S. L. ten Hagen, “How ‘Facts’ Shaped Modern Disciplines: The Fluid Concept of Fact and the Common Origins of German Physics and Historiography,” *Historical Studies in the Natural Sciences*, 2019, 49(3):300–337.

¹⁰ Regarding factor analysis in psychometrics see C. E. Spearman, “‘General Intelligence,’ Objectively Determined and Measured,” *American Journal of Psychology*, 1904, 15:201–293.

¹¹ Vincent J. Tarascio, *Pareto's Methodological Approach to Economics: A Study in the History of Some Scientific Aspects of Economic Thought* (Chapel Hill: Univ. North Carolina Press, 1968). See also Philip Mirowski, *More Heat Than Light: Economics as Social Physics, Physics as Nature's Economics* (Cambridge: Cambridge Univ. Press, 1991).

¹² William Stanley Jevons, *The Theory of Political Economy* (London: Macmillan, 1871). See also I. B. Cohen, *The Natural Sciences and the Social Sciences: Some Critical and Historical Perspectives* (Berlin: Springer, 1994), p. 248.

¹³ Wolfgang Göbel, *Friedrich August Kekulé* (Leipzig: Teubner, 1984), p. 37; and Alan J. Rocke, *Image and Reality: Kekulé, Kopp, and the Scientific Imagination* (Chicago: Univ. Chicago Press, 2010).

These examples demonstrate that a broad and inclusive approach is needed to gain a proper understanding of the phenomenon of cross-disciplinary epistemic transfer. The examples reflect real diversity in what is transferred from one field of study to another: virtues, institutional practices, concepts, formalisms, methods, material objects, and metaphors. Transfer takes place in all directions: from the humanities and the social sciences to the natural sciences, from the life sciences to the humanities, and so on.

II. CURRENT HISTORIOGRAPHY AND THE PHENOMENON OF EPISTEMIC CROSSOVER

The literature on scientific disciplines is rich and deserving of attention. Timothy Lenoir has shown that disciplines are not monolithic structures but consist of a heterogeneous set of practices. The presence of an overarching disciplinary structure is, according to Lenoir, “crucial for organizing and stabilizing this heterogeneity. Silent but powerfully operating, discipline is what makes disunified science work.”¹⁴ Tony Becher has further pointed out that disciplines “may have significant features in common with component entities in other disciplines, and accordingly may have the potential to promote greater interdisciplinary understanding. The central theme, however, is that the existence of these elementary particles in the world of academe is deserving of consideration in its own right, and that their nature and characteristics are too important to be ignored in any serious study of disciplinary cultures.”¹⁵

Thomas Gieryn has called attention to the situated character of disciplinary boundaries. In his view these boundaries are never permanently fixed but are instead continuously negotiated during “boundary work.” Gieryn concludes that disciplinary boundaries are porous: that is, boundary work may involve boundary crossing. Even in a single field boundary complexes exist, and crossing the line “internally” may already involve complicated sets of interests, actions, and structures. This chimes with the trading zone concept introduced by Peter Galison to capture how physicists belonging to different research communities find ways of understanding and collaborating with each other.¹⁶ The trading zone is a place of interaction in which a hybrid community seeks ways to communicate, often through new forms of interlanguage. Trading zones can thus be the springboard for new institutional structures and new categories of knowledge.

Clearly, historians of science have already developed a number of concepts that can be used to study interaction. These concepts highlight that knowledge is shared: it continuously moves from person to person. In fact, its communication is part of its constitution.¹⁷ The aggregate result of all “microscopic” person-to-person interactions is knowledge that transgresses geographical, social, temporal, and disciplinary boundaries. This transfer process is what we would like to address on a larger scale—that is, at a “meso level” of analysis—in particular as it is found in cross-disciplinary traffic. We need a mesoscopic approach because, in the words of Daston and Galison, it involves “grappling with scales that reveal the spread of techniques across disciplinary and geographical lines and communities of technique bound together by working objects that

¹⁴ Timothy Lenoir, *Instituting Science: The Cultural Production of Scientific Disciplines* (Stanford, Calif.: Stanford Univ. Press, 1997), p. 51. His views are strongly inspired by Robert E. Kohler, *Lords of the Fly: Drosophila Genetics and the Experimental Life* (Chicago: Univ. Chicago Press, 1994).

¹⁵ Tony Becher, “The Counter-Culture of Specialization,” *European Journal of Education*, 1990, 25:333–346, on p. 333.

¹⁶ Thomas F. Gieryn, *Cultural Boundaries of Science: Credibility on the Line* (Chicago: Univ. Chicago Press, 1999); and Peter Galison, *Image and Logic: A Material Culture of Microphysics* (Chicago: Univ. Chicago Press, 1997). See also Galison and David J. Stump, eds., *The Disunity of Science: Boundaries, Contexts, and Power* (Stanford, Calif.: Stanford Univ. Press, 1996).

¹⁷ Jürgen Renn, ed., *The Globalization of Knowledge in History* (Berlin: Open Access, 2012); James A. Secord, “Knowledge in Transit,” *Isis*, 2004, 95:654–672; and Klein, *Crossing Boundaries* (cit. n. 4).

could circulate . . . even where more detailed strategies stopped at disciplinary or national lines.”¹⁸

Most of the research that focuses on the circulation of knowledge has addressed concrete interactions of past actors and the practices of which those interactions formed a part. While the scope of these studies has on occasion widened beyond the local, there has not been much effort to analyze the circulation of knowledge at a more abstract level that allows for conceptualizing wholesale mesoscopic interactions and transfers between disciplines in their full generality—as the diversity of our earlier examples illustrates.

We propose to fill this lacuna through the introduction of a novel tool for historiographical analysis: “cognitive goods.” This notion will assist us in seeing how disciplines innovate by sharing knowledge and enable us to track such motions through long periods of time; it is chiefly meant as an instrument for mesoscopic historiography. At the same time, it may also assist us in understanding moments when transfer does not happen, when conditions are such that co-construction and flow are obstructed.

Abstracting attempts in the history of science are often met with skepticism.¹⁹ In recent years, however, there have been various calls to strive again for a bigger picture or a grand narrative, as exemplified by the discussions on the relevance of Jo Guldi and David Armitage’s *History Manifesto* for historiography of science in this journal in 2016 or by Frans van Lunteren’s suggestion of a machine-based periodization.²⁰ Such proposals and discussions do remind us how difficult it is to make grand narratives work. Big-picture historiography involves generalization from more dense microhistories. This necessarily abstracts away from crucial forms of causal interaction, thereby risking distortion. The challenge is to introduce an additional level of analysis that captures the large-scale dynamics of science, while remaining connected to the microscopic complexity of the practice of science, in all its social, cultural, material, spatial, and cognitive dimensions.

III. COGNITIVE GOODS

So, then, we wish to introduce an inclusive concept that serves to capture what moves between disciplines: “cognitive goods.” Cognitive goods are the shared epistemic tools of knowledge-making disciplines that can be transferred across disciplinary boundaries. Examples of cognitive goods include methods, concepts, models, metaphors, formalisms, principles, modes of representation, argumentative and demonstrative techniques, technical instruments, institutional arrangements, and intellectual, theoretical, and epistemic virtues.

One of the examples offered earlier was the dispersion of methods from statistics to other fields; we also pointed to the transfer of the concepts of structure or equilibrium and the linguistic formalism of context-free grammar to different disciplines. Material cognitive goods can be considered as well: an instrument can turn out to be useful in multiple fields of study and thus migrate. The spectrograph, for example, has played an important role in chemistry, physics, astronomy, and medicine. Integrated studies of the history of the sciences and the human-

¹⁸ Lorraine Daston and Peter Galison, “Objectivity and Its Critics,” *Victorian Studies*, 2008, 50:666–677, on p. 677. This article draws a distinction between the micro level and the meso level in historiography similar to what we have in mind. See also Jennifer Tucker, “Objectivity, Collective Sight, and Scientific Personae,” *ibid.*, pp. 648–657.

¹⁹ Theodore Arabatzis, “The Structure of Scientific Revolutions and History and Philosophy of Science in Historical Perspective,” in *Shifting Paradigms: Thomas S. Kuhn and the History of Science*, ed. Alexander Blum *et al.* (Berlin: Open Access, 2016), pp. 191–201.

²⁰ Jo Guldi and David Armitage, *The History Manifesto* (Cambridge: Cambridge Univ. Press, 2014); for the discussion of *The History Manifesto* see *Isis*, 2016, 107:309–357. For the suggestion of a machine-based periodization see Frans van Lunteren, “Clocks to Computers: A Machine-Based ‘Big Picture’ of the History of Modern Science,” *ibid.*, pp. 762–776; for discussion of this proposal see the articles that follow in the same issue of *Isis*.

ities, through a focus on epistemic virtues, or on principles and patterns, aim to capture the dynamics of scholarship on a larger scale and can be seen as examples of attempts at historiography through the prism of cognitive goods.²¹

The adjective “cognitive” is not intended to refer only to the realm of ideas, theories, and metaphors. Cognitive goods can also be of a material or socioinstitutional kind. That said, we are not so much interested in offering detailed classifications of types of cognitive goods. The advantage of using an umbrella term to refer to all things that can move from one discipline to another is that it can include goods that are hard to fit into one of the categories listed above. An example is the use of footnotes in historiography, which can be seen both as an argumentative practice and as a mode of representation.²² A strict classification of cognitive goods might unnecessarily hamper this flexibility.

Still, the term “cognitive goods” was deliberately chosen. The word “goods” was chosen not because of any evaluative concern but because we are interested in processes of transfer. Cognitive goods can move around: sometimes they are objects of negotiation and transaction; at other times they are shared or simply copied. The notion of “goods” connotes an economic perspective, from which it is natural to distinguish between phases of production, circulation, and consumption. The flow of cognitive goods is a form of circulation that occurs with the purpose of knowledge production.²³ Our usage of the term “goods” should not be confused with the “goods of excellence” and “goods of efficiency” of the virtue ethicist Alasdair MacIntyre. These are conceived as epistemic goals—that is, as “good” things to strive for in a particular research context.²⁴ Here, as said, we interpret the term “goods” in a neutral, nonevaluative way.

The adjective “cognitive” refers to the factors that do the explaining in historiography of science. We take our cue from Nancy Nersessian, who has argued that scientific practice can be explained with reference to cognitive factors. According to Nersessian, placing specific scientific practices “within the broader framework of human cognitive activities makes it possible to move beyond the specifics of the case to more general conclusions about the nature and function of the scientific practices.”²⁵ Through cognitive strategies, goods aimed at acquiring knowledge are selected, transferred, and processed. Taken together, cognitive goods comprise the research practice of a group of historical actors.

Other authors who work on interdisciplinarity and epistemic transfer have made observations that are equally relevant to our point. For example, Antoine Lilti has argued that it is possible to analyze knowledge making while focusing on mental processes as practices. From this point of view, the effort here is not to document “the social conditions of intellectual activity”; rather, “modes of thinking migrating from one area of inquiry to another” become central and “intellectual processes that are too often assumed to be universal” are historicized. The advantage of a focus on mental processes, according to Lilti, is that “it brings together texts and mental tools that are usually studied by specialists working in different fields.” In the work of Lindley

²¹ Van Dongen and Paul, eds., *Epistemic Virtues in the Sciences and the Humanities* (cit. n. 6). For an example of historiography that uses epistemic virtues and personae to cross disciplinary lines see Chaokang Tai and Jeroen van Dongen, “Anton Pannekoek’s Epistemic Virtues in Astronomy and Socialism: Personae and the Practice of Science,” *BMGN—Low Countries Historical Review*, 2016, 131:55–70. The principles and patterns approach is central in Bod, *New History of the Humanities* (cit. n. 6).

²² See Anthony Grafton, *The Footnote: A Curious History* (Cambridge, Mass.: Harvard Univ. Press, 1999).

²³ We are not proposing to take the analogy too far: we do not wish to include economic categories such as cost-benefit analysis, risk management, or supply-demand ratio to aid our analysis.

²⁴ For a recent discussion of MacIntyre’s goods see Daniel J. Hicks and Thomas A. Stapleford, “The Virtues of Scientific Practice: MacIntyre, Virtue Ethics, and the Historiography of Science,” *Isis*, 2016, 107:449–472. For a similar use of “goods” see Herman Paul, “Sources of the Self: Scholarly Personae as Repertoires of Scholarly Selfhood,” *BMGN*, 2016, 131:135–154, which presents virtues as “goods” that have a regulative function in scholarly practice.

²⁵ Nancy J. Nersessian, *Creating Scientific Concepts* (Cambridge, Mass.: MIT Press, 2008), p. 9.

Darden, we find an exhaustive list of cognitive strategies that are used in the pursuit of knowledge—for example, reasoning by analogy, matching exemplars to type, moving from focusing on one level of organization to making use of representational models or systems, pattern matching, extrapolation, generalization, simplification, and so forth.²⁶

The work of these authors suggests that the study of human cognition and the study of interdisciplinarity form a natural bond. We believe that cognitive strategies can be used as independent explanatory factors in the history of science.²⁷ That is, their efficacy is not wholly dependent on contextual factors; they retain a degree of autonomy and as such are useful in large-scale historiography. While cognitive goods originate in a particular context, they can be transposed to others. We call this process “flow.” In order for flow to take place, cognitive goods need to be sufficiently autonomous, not inherently bound to a particular source. This grants them a degree of autonomy from the practices in which they are used. We need to assume, then, that it is possible to identify relatively stable building blocks of the epistemic structures that the sciences and humanities comprise.

To illustrate the idea further, let us look again at an analogy with chemistry. With a limited number of atoms, an abundant variety of molecular structures can be produced. Likewise, cognitive goods underlie the surface variety of disciplines and subdisciplines. As such, they can be used as categories that help to explain how and why epistemic structures function and develop. For example, the arrival of the field of comparative linguistics in nineteenth-century Europe can be presented as a coming together of cognitive goods stemming from anatomy, philosophy, history, physics, and philology, as well as Romanticism.²⁸ Other well-known examples of fusion of (parts of) two fields to constitute a new discipline are Auguste Comte’s social physics, Justus Liebig’s organic chemistry, Emile du Bois-Reymond’s physiology and physics, and Karl Pearson’s biophysics. As the late John Pickstone said: “Different sciences should be pulled together by finding deeper elements; and substantive analysis could give rise to substantive synthesis. The combinatorial possibilities here are enormous, and so is the historiographical power: with simple working knowledge as elements, we can analyze very complex situations.”²⁹

²⁶ Antoine Lilti, “Does Intellectual History Exist in France? The Chronicle of a Renaissance Foretold,” in *Rethinking Modern European Intellectual History*, ed. Darrin M. McMahon and Samuel Moyn (Oxford: Oxford Univ. Press, 2014), pp. 56–73, on pp. 63–64; and Lindley Darden, *Theory Change in Science: Strategies from Mendelian Genetics* (Oxford: Oxford Univ. Press, 1991). See also Klein, *Crossing Boundaries* (cit. n. 4), pp. 222–223.

²⁷ Note that this constitutes an important difference between our approach and Latour’s actor-network theory, to which we are sympathetic in other respects but in which cognitive strategies are not taken as explanatory factors in historiography of science. See Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society* (Cambridge, Mass.: Harvard Univ. Press, 1987), Rule of Method 7, p. 258.

²⁸ See also Karstens, “Bopp the Builder” (cit. n. 2); and Bod, *New History of the Humanities* (cit. n. 6), Ch. 5. The idea that disciplines have interdisciplinary origins can be found in Marc De Mey, *The Cognitive Paradigm* (Chicago: Univ. Chicago Press, 1982); György Darvas and Ágnes Haraszthy, “The Tendency of Fields of Science to Form Interdisciplinary Relationships,” in *Managing Interdisciplinary Research*, ed. S. R. Epton *et al.* (Hoboken, N.J.: Wiley, 1984), pp. 66–71; James Strick, “Creating a Cosmic Discipline: The Crystallization and Consolidation of Exobiology (1957–1973),” *Journal of the History of Biology*, 2004, 37:131–180; and Prabhakar Singh, “The Scandal of Enlightenment and the Birth of Disciplines: Is International Law a Science?” *International Community Law Review*, 2010, 12(2):5–34.

²⁹ John Pickstone, “From Structures and Tensions in Science to Configurational Histories of the Practices of Knowledge,” in *Shifting Paradigms*, ed. Blum *et al.* (cit. n. 19), pp. 265–284, on p. 276. Pickstone and other authors have suggested approaches that recognize a limited set of elements as forming a multitude of compounds. See the reticulation model in Larry Laudan, *Science and Values: The Aims of Science and Their Role in Scientific Debate* (Berkeley: Univ. California Press, 1984); idea systems in Olga Amsterdamka, *Schools of Thought: The Development of Linguistics from Bopp to Saussure* (Berlin: Springer, 1987); the “brick model” in Peter Galison, “History, Philosophy, and the Central Metaphor,” *Science in Context*, 1988, 2:197–212; and the five ways of knowing in Pickstone, *Ways of Knowing: A New History of Science, Technology, and Medicine* (Chicago: Univ. Chicago Press, 2000). These works are interesting and stimulating, but we feel that in each of these cases the set of elements picked out is too limited for our all-inclusive purposes.

To be sure, we do not make the ontological claim that disciplines are only a constellation of cognitive goods and the relations between them. Our proposal is aimed at historiography that aspires to address large-scale dynamics: cognitive goods are intended as tools that allow for mesoscopic historiography. As such, they can reveal historical patterns that otherwise are not straightforwardly captured.

Cognitive goods and cognitive strategies are of course always invoked in a particular context. That is, they are not identical in all contexts in which they appear. Indeed, cognitive goods adapt when moving from one disciplinary context to another. For example, the comparative method has taken different forms in anatomy, linguistics, literary studies, anthropology, and so forth. These forms include synchronic comparison, diachronic comparison, cross-comparison, parallel comparison, structural comparison, and functional comparison. Yet the key element of the meaning of the comparative method—namely, establishing similarities and differences through the application of some standard of comparison—remains the same. Hence the “comparative method” remains recognizable as a cognitive good even though changes in its application have taken place as its contexts varied. It is precisely the cross-disciplinary trajectory of flows that makes the constant and variable aspects of cognitive goods explicit.³⁰

Our approach may remind the reader of Arthur Lovejoy’s notion of the “unit idea.” Lovejoy thought of unit ideas as building blocks that combine and recombine in differing historical contexts. However, there are two important differences between his notion of unit ideas and our notion of cognitive goods. First, Lovejoy supposed that unit ideas were unchangeable; change in science is brought about only through new constellations of unit ideas. In our framework, on the other hand, the building blocks may themselves undergo changes as they are transferred. For the same reason, cognitive goods should be distinguished from Bruno Latour’s “immutable mobiles”: we do not think of cognitive goods as completely “finished,” and hence immutable, before they are apt to move. On the contrary, in the course of flow changes may occur through processes of appropriation to the new disciplinary context.³¹ A further distinction from Lovejoy’s notion must also be made, as he focused only on “ideas” and did not include the much broader category that we have in mind.³² Furthermore, we certainly do not propose a return to a history of ideas that leap across periods or domains without any material counterpart in the real world.³³

The fear of a return to a “disembodied” history of ideas may be what holds most historians back from embarking on analysis at a cognitive level. In our view, this fear is unwarranted. First, we imagine the use of two complementary levels of description: thick micro description and a more analytical meso description. Second, including the cognitive in historical explanation should imply that one involves the social as well.³⁴

³⁰ For an illustration of this point with respect to the comparative method see Devin Griffiths, “The Comparative Method and the History of the Modern Humanities,” *Hist. Humanities*, 2017, 2:473–505.

³¹ Arthur O. Lovejoy, *The Great Chain of Being: A Study of the History of an Idea* (Cambridge, Mass.: Harvard Univ. Press, 1936). Latour introduced the concept of immutable mobiles in Bruno Latour, “Visualization and Cognition: Thinking with Eyes and Hands,” *Knowledge and Society*, 1986, 6(6):1–40. On the “appropriation” processes that characterize knowledge in circulation see Kostas Gavroglu *et al.*, “Science and Technology in the European Periphery: Some Historiographical Reflections,” *History of Science*, 2008, 46:153–175, esp. pp. 159–161.

³² We should also not forget that material objects help humans in executing their cognitive strategies—for example, to record, store, and transmit information, as an *aide-memoire* (computer, calculator), and to extend perception, as in the use of the telescope and the microscope. See Steven Mithen, “Human Evolution and the Cognitive Basis of Science,” in *The Cognitive Basis of Science*, ed. Peter Carruthers *et al.* (Cambridge: Cambridge Univ. Press, 2002), pp. 23–40, esp. p. 24.

³³ Compare Daston and Galison, “Objectivity and Its Critics” (cit. n. 18), p. 672, which addresses the same point while arguing for a mesoscopic analysis. They cite their own history of objectivity as an example: Lorraine Daston and Peter Galison, *Objectivity* (New York: Zone, 2007).

³⁴ Nancy Nersessian has highlighted the social dimensions of the cognitive in a 1995 programmatic paper that addressed the value of cognitive science for history of science and vice versa: Nancy J. Nersessian, “Opening the Black Box: Cognitive Science and History of Science,” *Osiris*, 1995, N.S., 10:194–211.

Jürgen Renn, for example, uses the notion of “mental models” to capture anthropomorphic cognitive structures.³⁵ These shared models are part of the “knowledge economy” of a particular social constellation. Cognitive science tends to overlook this social aspect, according to Renn, as it does not focus on social processes. To study the history of the transmission of knowledge, Renn widened the interpretation of the concept of mental models to include their social dimension. Likewise, Ronald Giere uses the concept of “distributed cognition” to capture how the propagation of information takes place through “relational networks.” Since no person possesses all knowledge in a given field of study, the total cognition of a discipline is the sum of all the information that is being processed in the network. This resonates with the idea that disciplines have a cognitive identity that precedes specific theories or methods.³⁶ These examples illustrate how historiography that addresses the cognitive may coalesce with the social in its reconstructions.

IV. FROM MICRO TO MESO AND BACK

The flow of a cognitive good from one field to another, like the concept of “entropy” that flowed from thermodynamics to information theory, does not take place on its own. The incorporation of a new cognitive good in a discipline rests on the concrete interactions of historical actors through various modes of appropriation. In order to gain a systematic understanding of the phenomenon of epistemic transfer, its study must be grounded in such detailed accounts. Historians of science have grown accustomed to accounting for the actions of historical actors in such a microscopic fashion. As Steven Shapin has famously argued, we should study “science as if it was produced by people with bodies, situated in time, space, culture, and society, and struggling for credibility and authority.”³⁷ If, however, anything in such accounts moves, it moves slowly, because it is always closely tied to concrete interactions.

Our approach builds on such microhistorical explanation but wishes to do more. If we focus on micro interactions only, we run the risk of missing regularities that obtain at higher levels of abstraction. Scientific vocabularies and personae are examples of concepts that cannot be reduced to the local.³⁸ The framework of cognitive goods prescribes a connection between micro-level description and more abstract meso-level analysis of past science. In the end, flows are of course the result of person-to-person interactions during a coffee break, a teaching session, conference discussions, and so forth. Were we to focus only on the many individual “small-scale” interactions, however, we might fail to capture the eventual flow of the cognitive good and its incorporation in the mainstream of the receiving discipline (see the representations in Figures 1 and 2).

Flows of cognitive goods reveal themselves thanks to the scale of analysis chosen: they are grounded in the collective epistemic endeavor of the many, not reducible to the historical agency of a few individual actors. This is the scale of mesoscopic historiography. At this level, one sees beyond the usual disciplinary or geographical boundaries that can confine historiog-

³⁵ Renn, ed., *Globalization of Knowledge in History* (cit. n. 17), p. 35. Renn puts these ideas to use in, e.g., Renn and Tilman Sauer, “Pathways Out of Classical Physics: Einstein’s Double Strategy in His Search for the Gravitational Field Equation,” in *The Genesis of General Relativity*, Vol. 1, ed. Renn *et al.* (Dordrecht: Springer, 2007), pp. 113–312; and Jochen Büttner, Renn, and Matthias Schemmel, “Exploring the Limits of Classical Physics: Planck, Einstein, and the Structure of a Scientific Revolution,” *Studies in History and Philosophy of Modern Physics*, 2003, 34:37–59. On “mental models” and cognitive history of science see also Nersessian, “Opening the Black Box” (cit. n. 34), pp. 207–208.

³⁶ Ronald Giere, *Explaining Science: A Cognitive Approach* (Chicago: Univ. Chicago Press, 1988). See also Giere, “Scientific Cognition as Distributed Cognition,” in *Cognitive Basis of Science*, ed. Carruthers *et al.* (cit. n. 32), pp. 285–289; and Rudolf Stichweh, “The Sociology of Scientific Disciplines: On the Genesis and Stability of the Disciplinary Structure of Modern Science,” *Sci. Context*, 1992, 5:3–15.

³⁷ Steven Shapin, *Never Pure: Historical Studies of Science as if It Was Produced by People with Bodies, Situated in Time, Space, Culture, and Society, and Struggling for Credibility and Authority* (Baltimore: Johns Hopkins Univ. Press, 2010).

³⁸ See Peter Galison, “Ten Problems in History and Philosophy of Science,” *Isis*, 2008, 99:111–124, esp. pp. 121–122.

Figure 1. Abstract representation of the flow of a cognitive good (C1) from one discipline to another. The flow can be understood as a mesoscopic result of microscopic interactions. The circles represent cognitive goods that together constitute a discipline (connected by dashed lines). The black arrows represent the microscopic interactions at the level of person-to-person communication, while the grey arrow represents the mesoscopic interaction at the level of the flow of the cognitive good that is the result (represented by the horizontal gray bracket) of the microscopic interactions. Figure 2 shows the result of the flow of the cognitive good.

raphy that focuses on the local.³⁹ Although the geographical or the temporal scale of the meso level of analysis has never been immediately “real” for any single historical actor, this scale is part of history too, even if it is revealed by historians only when using their analytical toolkit.⁴⁰ On this scale, patterns in the history of knowledge-making disciplines that enhance our understanding of the past can be identified.

At the elementary, atomic level, one may fail to note “relaxation” or “equilibration” processes, as these are not explained by local interactions.⁴¹ Indeed, substantial cross-disciplinary traffic may simply be missed if we do not include a meso level of analysis. Focusing on the meso level is a matter of choice of scale, and this choice depends on what type of dynamics one wishes to investigate. Here, using the cognitive goods perspective should help. Yet one can still zoom in on concrete particulars; the microscopic will always be needed to get at the underlying mechanisms of the process of flow.

V. PROSPECTS

The proposal outlined here promises two new kinds of perspective: the construction of a dynamic network of historical flows and the introduction of a comparative level of analysis.

A Network of “Flows”

Focusing on the flows of cognitive goods offers a natural way to probe interconnections between the sciences and the humanities, buttressing the notion that the sciences and the hu-

³⁹ See also Tucker, “Objectivity, Collective Sight, and Scientific Personae” (cit. n. 18).

⁴⁰ The meso level can also be revealed by the study of primary sources such as the contents of textbooks, citation patterns, conference themes, funding policies, and so forth.

⁴¹ In this respect see also Peter Galison, “Limits of Localism: The Scale of Sight,” in *What Reason Promises: Essays on Reason, Nature, and History*, ed. Wendy Doniger et al. (Berlin: De Gruyter, 2016), pp. 155–170.

Figure 2. When arriving in the new discipline, the cognitive good (C1) is adjusted to the new disciplinary context, becoming (C1').

manities form an interconnected whole.⁴² Probing the connections between disciplines by describing them in terms of the flow of cognitive goods should make the connected nature of that system visible.

Indeed, it is fascinating to imagine all disciplinary and interdisciplinary relations in one overview, as a “flowchart.” The flow of cognitive goods and the meso level of description offer a revealing perspective on how the system of disciplines has evolved over time and add to our understanding of disciplinary identities and processes of specialization and integration.

Our first results following this approach have reinforced the idea of a single interconnected, dynamic supradisciplinary system. For example, by focusing on the cognitive good of the “fact” in the German context, we have been able to see how, from its origins in eighteenth-century theology, it gradually found a place in the study of both history and physics. Many interrelations between the latter two fields *in statu nascendi* can be witnessed in the course of this process.⁴³ Another example is equally illustrative of the fruitfulness of the cognitive goods approach: in the late nineteenth and early twentieth centuries the method of the questionnaire, which stemmed from the social sciences, was taken up in linguistics. The introduction of this method to linguistics brought benefits but also problems, such as how to select a representative set of participants or how to formulate a set of neutral questions. Another example: the architectural notion of structure we discussed in Section I found its way not only into chemistry but also to other fields: to literary studies and linguistics and from there on to the social sciences.⁴⁴ All this illustrates that the full range of disciplines—humanities, natural sciences, social sciences, computational sciences, life sciences, and more—is involved in the epistemic crossover of cognitive goods.

⁴² See Stichweh, “Interdisziplinarität und wissenschaftliche Bildung” (cit. n. 3), p. 183. See also Stichweh, *Entstehung des modernen Systems wissenschaftlicher Disziplinen* (cit. n. 3).

⁴³ Ten Hagen, “How ‘Facts’ Shaped Modern Disciplines” (cit. n. 9). For the British history of the “fact” see Mary Poovey, *A History of the Modern Fact: Problems of Knowledge in the Sciences of Wealth and Society* (Chicago: Univ. Chicago Press, 1998); and Barbara J. Shapiro, *A Culture of Fact: England, 1550–1720* (Ithaca, N.Y.: Cornell Univ. Press, 2000).

⁴⁴ Emma Mojet, “Interdisciplinary Discipline Formation: The Origins of General Linguistics,” paper presented at “The Making of the Humanities VI,” 22–24 Sept. 2017, Univ. Oxford; and Bart Karstens, “From ‘Strukturtheorie’ to Structuralism: Multiple Flows of a Cognitive Good” (forthcoming).

To visualize the historical dynamics of the disciplinary system and its “flows,” one might turn to network science. In multilayered dynamic networks nodes can represent a variety of entities, such as people, locations, tasks, or resources.⁴⁵ If we can construct such a network from a catalogue of “flows” we can start to ask a new set of questions. What are the central nodes in a research network and how do these develop through history? Do these nodes represent the “frontier” of research in a given period of time? What kinds of network typically arise and what does that tell us about the kind of information flow that takes place? Do flow patterns reflect a contemporary hierarchy of knowledge in a given period? How far into the past can we probe flow trajectories and what can this tell us about the origins of particular cognitive goods?

Comparative Analysis

Our understanding of epistemic crossover between various domains of knowledge will be greatly aided by the comparison of individual cases of flow. Comparative questions one can address include: Why do disciplines borrow from one another and why do different fields of study share their cognitive goods? Does it matter what kind of cognitive good? When is a flow successful? Could we quantify success?

The relative context independence of human mental faculties plays an important role in the apparently easy transfer of some cognitive goods. As humans apply similar strategies of research in different places and at different times, a particular cognitive good may find itself in a relevant role in more than one field of study. We would like to know how conditions, such as a shared object of study or a similarity of vocabulary, shape particular cases of transfer and similitude; whether particular combinations of such conditions may play a role or are perhaps even required; and whether we can infer typical regularities from such cases.

To gain systematic insight into both the role of the conditions required for flow and the factors determining the success of such a flow requires empirical comparison of a multitude of particular cases. Assessment should not focus only on whether the integration of a particular cognitive good succeeds but also on the question of whether migrated cognitive goods produce scholarly innovation and meet the ends for which they were selected. A comparison of successful cases with unsuccessful cases might be particularly useful, because failed cases could indicate what factors were lacking in a particular situation.

Comparative historiography is sometimes criticized for assuming similarities between historical contexts that simply may not be there or for forcing the past into predetermined categories.⁴⁶ We agree that the identification of specific cognitive goods needs to be appropriate to specific contexts. However, cognitive goods retain a degree of independence from these contexts, implying that a degree of similarity before and after flow can remain. This is a consequence and advantage of looking at the meso level, which remains nonetheless anchored in the local and microscopic once you move in closer.

VI. CONCLUSION

When we view the concrete dynamics and a comparative level of analysis of the past as complementary instead of contrary, then the door is opened to an enrichment of historiography, including the discovery of interesting (and possibly unexpected) similarities and differences be-

⁴⁵ See, e.g., Kathleen M. Carley, “ORA: A Toolkit for Dynamic Network Analysis and Visualization,” in *Encyclopedia of Social Network Analysis and Mining*, ed. Reda Alhajj and Jon Rokne (Berlin: Springer, 2014), pp. 1219–1228.

⁴⁶ See, e.g., Lissa Roberts, “Situating Science in Global History: Local Exchanges and Networks of Circulation,” *Itinerario*, 2009, 33:9–30.

tween distinct times and places.⁴⁷ This perspective may lay bare relations between disciplines that would otherwise remain hidden from view and, as a consequence, lead to new ways of understanding change and innovation in both the sciences and the humanities. By describing the phenomenon of epistemic transfer as a flow of cognitive goods, we capture a history in which moments of innovation and change are made directly visible. This enables us to compare and systematically analyze such moments, in order to ask new questions about the dynamics of disciplines.

We thus argue for an inclusive historiography of knowledge, which *prima facie* includes all knowledge-making disciplines and which takes the interaction between the natural sciences, the social sciences, and the humanities in all directions into account; cognitive goods are a concrete means to that end. Such a historiography of knowledge can significantly change our view of the nature of disciplines, unpack the complexity of the phenomenon of specialization, lay bare relations between disciplines that otherwise would remain hidden, and, as a consequence, lead to new ways of understanding change and innovation.

---

⁴⁷ This complementarity is forcefully defended in Chris Lorenz, "Comparative Historiography: Problems and Perspectives," *History and Theory*, 1999, 38:25–39. See also Paul, "Sources of the Self" (cit. n. 24), p. 151.