

1. Empirical testing and further development of sociological middle-range theories

There has been a debate in sociological research about the relationship between theory and empirical research. On the one hand, this debate concerns the question of what is meant by "theory" or "good theory" (Abend 2008) and what significance empirical studies should have in the further development and testing of theories (Besbris & Khan 2017). On the other hand, it is about quality assurance in sociological research (Otte et al. 2023). This debate is also being conducted in the field of quantitative empirical science research with a focus on "middle-range theories." Such middle-range theories, as defined by sociologist Robert K. Merton, are a prerequisite for gradual, cumulative advancement of knowledge in empirical-analytical sociological research. In this regard, Heinze & Jappe (2020) argue that there are middle-range theories that have not yet been subjected to empirical testing. Instead of formulating new theories, the authors recommend examining existing theories more closely empirically using concrete examples, thereby consolidating and further developing them. The following section explains which medium-range sociological theories are being empirically tested in Prof. Heinze's research group or used for the analytical structuring of empirical questions. This includes PhD dissertation projects from the DFG-funded Research Training Group "Transformations of Science and Technology since 1800: Topics, Processes, Institutions" (RTG 2696).

1.3 Gradual transformations from a historical-sociological perspective

Transformation processes in science and technology can be analyzed particularly well using *historical institutionalism*, another middle-range theoretical perspective. Prof. Heinze's research group has made numerous contributions to this theoretical perspective, including in the context of the DFG-funded Research Training Group 2696 "Transformations in Science and Technology since 1800: Topics, Processes, Institutions. Streeck & Thelen (2005) developed a conceptual framework for the context of research institutions (Fig. 5). To this end, two dimensions relevant to the transformation of research were cross-tabulated dichotomously: the establishment of new research capacities on the one hand, and the reuse or continuation of existing research capacities on the other. This results in a coordinate system in which four transformation processes of research are represented.

In the case of building new capacities (e. g., working groups, institutes, journals) while continuing existing structures, we are dealing with "*layering*." However, if existing structures are replaced when new units are built, this is "*displacement*." In the case of "*conversion*," existing research capacities are thematically reoriented and aligned with new goals. Finally, there is the dismantling of existing structures without the simultaneous establishment of new units. This is synonymous with the "*dismantling*" of research capacities.

Building up new research capacities?	Yes	<p>Layering</p> <ul style="list-style-type: none"> - New research fields (e.g. Structural Biology) - New large-scale Instrumentation (LCLS) - New organizational units (SSRL, Division of Photon Science, LCLS) 	<p>Displacement</p> <ul style="list-style-type: none"> - Replacement of HEP research at large-scale HEP machines (SPEAR) - Replacement of HEP research by photon research (SPEAR)
	No	<p>Conversion</p> <ul style="list-style-type: none"> - Redeployment of former large-scale HEP research facilities for photon science research (SPEAR, LINAC) 	<p>Dismantling</p> <ul style="list-style-type: none"> - Decommissioning of large-scale HEP research facilities (PEP, SLC)
		Yes	No
		New purpose for / continued use of existing research capacities?	

Figure 5: Four processes of institutional change, using the example of experimental high energy physics (HEP).
Sources: Heinze & Münch (2012); Hallonsten & Heinze (2016); Heinze & Hallonsten (2017).

The definition of different forms of institutional change raises the question of how widespread the four change processes are and what contextual factors enable them. The four types differ in terms of the expected resistance of the affected stakeholder groups and, consequently, in terms of the associated chances of success in implementation. In addition to numerous examples from the history of science that can be used to understand these four processes (Heinze & Münch 2012, 2016; Pichler & Heinze 2024), Prof. Heinze's research group has presented historical-sociological case studies on the transformation of large-scale government research in Germany and the United States (Fig. 6) and, in a dissertation completed in 2017, examined the post-socialist transformation of the Polish research system (Heinze et al. 2015b, 2015a; Heinecke 2016; Heinze & Hallonsten 2017; Heinze et al. 2017; Heinze 2024).

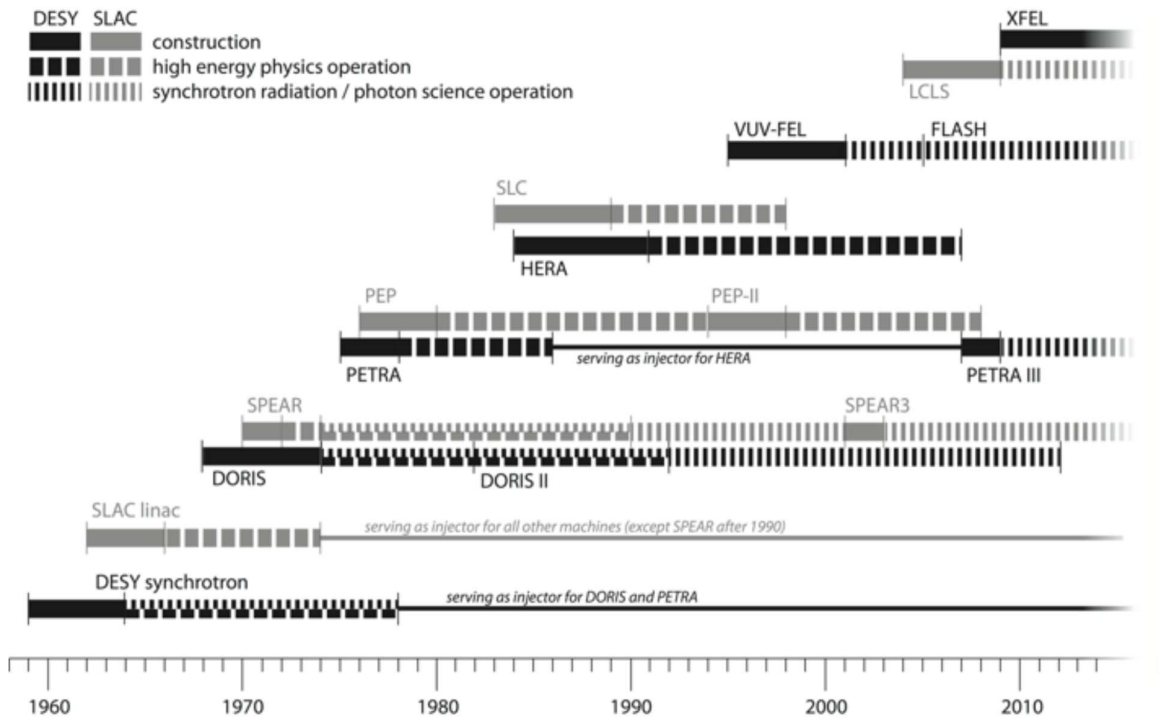


Figure 6: Transformation of large-scale equipment for experimental high-energy physics (HEP) and multidisciplinary research with photons at the German Electron Synchrotron (DESY) and the SLAC National Accelerator Laboratory (formerly Stanford Linear Accelerator Center, SLAC). Source: Hallonsten & Heinze (2016).

The analytical categories of *historical institutionalism* are also a central component of the framework concept of the DFG-funded Research Training Group 2696 "Transformations in Science and Technology since 1800: Topics, Processes, Institutions." The concept of transformation is accentuated by reference to three dimensions: topics, processes, and institutions. These dimensions are equally relevant to the development of science and technology and must be understood in terms of their historical conditioning and their interaction. In order to define changes more precisely, *displacement*, *layering*, and *drift* are examined, for example, with appropriate adjustments in each case with regard to the three dimensions.

Of the six doctoral theses in the first cohort of RTG 2696 (2022-2025), two dissertations in the field of sociology have been successfully completed. Gautheron (2025) examines transformation processes in experimental high-energy physics (HEP) to better understand the adaptation strategies of several thousand physicists between 2000 and 2019. His study shows that scientists gradually revise their research in order to preserve the advantages of their expertise while opening up new research opportunities. This entails diverse forms of intellectual change. For example, scientists can repurpose their prior knowledge for new research goals (*conversion*), but in some cases, scientists are also prompted to expand their knowledge by acquiring new concepts or techniques for their research (*layering*). Finally, scientists may have to abandon certain types of knowledge altogether in the face of new circumstances and replace them with new knowledge (*displacement*). Fundamentally, gradual change appears to be a universal adaptation strategy that arises from the need to adapt research to new realities.

Dierkes (2025) examines the transformation of medical education at German universities since the 1980s, with a particular focus on the establishment and diffusion of so-called "skills labs" – facilities where practical medical skills are practiced in the form of simulations. Dierkes (2025) identifies simulation-based training as a process of layering in teaching and *displacement* in assessment – creating new standards for competence, safety, and accountability. She also discusses the ongoing power struggles within medicine, where pedagogical expertise is increasingly challenging traditional clinical hierarchies. The dissertation thus not only traces how skills labs have changed medical education, but also shows how professions evolve over time through the interplay of knowledge, institutions, and social practice.

Of the 12 other RTG dissertations in the 2nd cohort (2024-2027) and the 3rd cohort (2025-2028), four are in the field of sociology. Two dissertations examine transformations in the German university system, with Tobias Grabosch's dissertation (2nd cohort) focusing in particular on the sharp increase in grant-funded research and exploring the consequences of this funding for the diversity and scientific performance of university research. He also examines the prestige stratification of university subjects by examining the effects of the organizational field of universities on the recruitment of their top personnel – professors. In this way, questions of neo-institutional organizational theory (cf. 1.2) are linked with those of historical institutionalism. In contrast, the dissertation project by Artem Antonyuk (3rd cohort) mentioned in 1.2 examines the change in university curricula at universities in North Rhine-Westphalia and eastern Germany over a period of several decades. To this end, all course catalogs are collected in machine-readable format. Antonyuk examines the extent to which new subject areas are being incorporated into the university curriculum (*layering*), possibly displacing established subjects (*displacement*) in the process, and the extent to which universities and their subjects are becoming increasingly similar over time (isomorphism) or specific subject profiles are emerging.

Two other sociological dissertations relate to areas of technology that have become increasingly important to society in recent years. One is the field of space technology, in which private companies have increasingly established themselves and become technology leaders. In this context, Fabienne Grimm (2nd cohort) explores the question of whether this field of technology is more influenced by the state or the private sector. Current developments in the United States and Europe could potentially represent a new era of privately-driven space technology (*displacement*). However, it remains unclear to what extent this represents a discontinuity or a gradual process of organizational or governmental transformation. In this context, she examines *publicness theory*, which was developed primarily by Bozeman (1987, 2007) and applied to the context of large-scale government research in the United States (Crow & Bozeman 1998). Second, Marc Pelzer's dissertation (3rd cohort) examines the increasing spread of digital technologies in the field of individual health and performance optimization. Specifically, it addresses the question of the extent to which these new technologies replace (*displacement*) or complement (*layering*) existing technical applications, and which cultural beliefs determine whether individuals decide to use these technologies.

The theoretical perspective of historical institutionalism also underpins the DFG-funded research project "Political Upheavals and Disciplinary Change: Mathematics in Germany, 1920-1960" (DFG-497971890, duration: 2022-2027), which is being carried out by Prof. Heinze's research group together

with the research group of historian Prof. Remmert. The project focuses on the development of mathematics in terms of content, institutions, and personnel under the influence of political upheavals (Weimar period: 1920-1933, National Socialism: 1933-1945, post-war period: 1945-1960). The aim of the project is to provide a detailed scientific-historical and sociological mapping and analysis of the development of mathematics in the German higher education system on the basis of a prosopographic-bibliometric database. The project will be carried out along research-guiding hypotheses. These include the *displacement* of abstract subfields of mathematics during National Socialism in favor of "war-relevant" areas and the targeted financial support of application-oriented fields (*layering*). We also assume that military patronage during the Cold War led to a focus on certain fields of research (*drift*).

Publication of Prof. Heinze's research group

- Dierkes, Jasmin. 2025. *Professionalisation of medical education: The ascent of simulation-based trainings*. Wuppertal: Unpublished Doctoral Dissertation.
- Gautheron, Lucas. 2025. *Social dilemmas in science. A computational approach to collective action problems and trade-offs in collective cognition*. Wuppertal: Cumulative Doctoral Dissertation.
- Heinze, Thomas, Rafael Josek. 2025. Have public universities in Germany become more isomorphic? Methodology and empirical test, 1995–2020. *Quantitative Science Studies* 6:99-118.
- Heinze, Thomas. 2024. Wandel und Erneuerung der Großforschung. Historisch-soziologischer Vergleich der Transformation zweier Forschungszentren der experimentellen Teilchenphysik. In: *Organisationsformen der Erkenntnisgewinnung: Organisatorische Gestaltung und Wissensproduktion in der außeruniversitären Forschung*. Hrsg. Rupert Pichler, Thomas Heinze, S. 31-50. Heidelberg: Springer.
- Pichler, Rupert, Thomas Heinze (Hrsg.) (2024): *Organisationsformen der Erkenntnisgewinnung. Organisatorische Gestaltung und Wissensproduktion in der außeruniversitären Forschung*, Heidelberg: Springer.
- Jappe, Arlette, Thomas Heinze. 2023. Verlässliches Expertenwissen für die Hochschulpolitik? Aktuelle Befunde zur bibliometrischen Forschungsevaluation in Europa. In: *Wissenschaft in der Verlässlichkeitsfalle? Praktiken der Konstruktion von Relevanz und Neutralität.*, Hrsg. Stefan Bösch, Alfred Nordmann, Carsten Reinhardt, S. 89-103. Stuttgart: Wissenschaftliche Verlagsgesellschaft.
- Pithan, David. 2021. *Corporate Research Laboratories and the History of Innovation*. New York: Routledge.
- Heinze, Thomas, Arlette Jappe. 2020. Quantitative science studies should be framed with middle-range theories and concepts from the social sciences. *Quantitative Studies of Science* 1:983-992.
- Jappe, Arlette, Thomas Heinze. 2020. Jurisdiction of Bibliometrics. In: *Handbook Bibliometrics*. S. 91-98: Berlin/Boston: DeGruyter.
- Cox, Andrew, Elizabeth Gadd, Sabrina Petersohn, Laura Sbaffi. 2019. Competencies for bibliometrics. *Journal of Librarianship and Information Science* 51:746-762.
- Jappe, Arlette. 2019. Professional standards in bibliometric research evaluation? A meta-evaluation of European assessment practice 2005–2019. *PLoS ONE* 15:e0231735.
- Jappe, Arlette, David Pithan, Thomas Heinze. 2018. Does bibliometric research confer legitimacy to research assessment practice? A sociological study of reputational control, 1972-2016. *PLoS One* 13:e0199031.
- Petersohn, Sabrina, Thomas Heinze. 2018. Professionalization of bibliometric research assessment. Insights from the history of the Leiden Centre for Science and Technology Studies (CWTS). *Science and Public Policy*:565-578.

- Heinze, Thomas, Olof Hallonsten. 2017. The reinvention of the SLAC National Accelerator Laboratory, 1992–2012. *History and Technology* 33:300-332.
- Heinze, Thomas, Olof Hallonsten, Steffi Heinecke. 2017. Turning the ship: The transformation of DESY, 1993–2009. *Physics in Perspective* 19:424-451.
- Hallonsten, Olof, Thomas Heinze. 2016. Preservation of a Laboratory is not a Mission.“ Gradual Organizational Renewal in National Laboratories in Germany and the United States. In: *Innovation in Science and Organizational Renewal. Sociological and Historical Perspectives*. Hrsg. Thomas Heinze, Richard Münch, S. 117-145. New York: Palgrave.
- Heinecke, S. 2016. The Gradual Transformation of the Polish Public Science System. *PLOS One* e0153260.
- Heinze, Thomas, Richard Münch (Hrsg.) (2016): *Innovation in Science and Organizational Renewal. Historical and Sociological Perspectives*, New York: Palgrave Macmillan.
- Petersohn, Sabrina. 2016. Professional competencies and jurisdictional claims in evaluative bibliometrics: The educational mandate of academic librarians. *Education for Information* 32:165-193.
- Hallonsten, Olof, Thomas Heinze. 2015. Formation and Expansion of a New Organizational Field in Experimental Science. *Science and Public Policy* 42:841–854.
- Heinze, Thomas, Olof Hallonsten, Steffi Heinecke. 2015a. From Periphery to Center: Synchrotron Radiation at DESY, Part II: 1977-1993. *Historical Studies in the Natural Sciences* 45:513-548.
- Heinze, Thomas, Olof Hallonsten, Steffi Heinecke. 2015b. From Periphery to Center. Synchrotron Radiation at DESY, Part I: 1962-1977. *Historical Studies in the Natural Sciences* 45:447-492.
- Heinze, Thomas, Richard Münch. 2012. Intellektuelle Erneuerung der Forschung durch institutionellen Wandel. In: *Institutionelle Erneuerungsfähigkeit der Forschung*. Hrsg. Thomas Heinze, Georg Krücken, S. 15-38. Wiesbaden: VS Verlag für Sozialwissenschaften.

Further literature

- Otte, G., T. Sawert, J. Brüderl, S. Kley, C. Kroneberg, I. Rohlfing. 2023. Gütekriterien in der Soziologie. Eine analytisch-empirische Perspektive. *Zeitschrift für Soziologie* 52:26-49.
- Besbris, Max, Shamus Khan. 2017. Less Theory. More Description. *Sociological Theory* 35:147-153.
- Brint, S., K. Proctor, K. Mulligan, M. B. Rotondi, R. A. Hanneman. 2012. Declining Academic Fields in U.S. Four-Year Colleges and Universities, 1970-2006. *Journal of Higher Education* 83:582-613.
- Brint, S., K. Proctor, R. A. Hanneman, K. Mulligan, M.B. Rotondi, S.P. Murphy. 2011. Who are the early adopters of new academic fields? Comparing four perspectives on the institutionalization of degree granting programs in US four-year colleges and Universities, 1970-2005. *Higher Education* 61:563-585.
- Abend, Gabriel. 2008. The Meaning of 'Theory'. *Sociological Theory* 26:173-199.
- Greenwood, Royston, Renate E. Meyer. 2008. Influencing Ideas: A Celebration of DiMaggio and Powell (1983). *Journal of Management Inquiry* 17:258-264.
- Bozeman, Barry. 2007. *Public Values and Public Interest: Counterbalancing Economic Individualism*. Washington, DC: Georgetown University Press.
- Edelman, Lauren B., Christopher Uggen, Howars S. Erlanger. 1999. The endogeneity of legal regulation: Grievance procedures as rational myth. *The American Journal of Sociology* 105:406-454.
- Crow, Michael, Barry Bozeman. 1998. *Limited by Design. R&D Laboratories in the U.S. National Innovation System*. New York: Columbia University Press.
- Abbott, Andrew. 1991. The Future of Professions: Occupation and Expertise in the Age of Organisation. *Research in the Sociology of Organisations* 8:17-42.
- DiMaggio, Paul. 1991. Constructing an organizational field as a professional project: US art museums, 1920–1940. In: *The new institutionalism in organizational analysis*. Hrsg. Walter W. Powell, Paul DiMaggio, S. 267-292. Chicago: The University of Chicago Press.

- Abbott, Andrew. 1988. *The System of Professions. An Essay on the Division of Expert Labor*. Chicago: University of Chicago.
- Bozeman, Barry. 1987. *All organizations are public. Bridging public and private organizational theories*. San Francisco, London: Jossey-Bass Publishers.
- DiMaggio, Paul, Walter W. Powell. 1983. The Iron Cage Revisited. Institutional Isomorphism and Collective Rationality in Organizational Fields. *American Sociological Review* 48:147-160.
- Meyer, John W., Brian Rowan. 1977. Institutionalized Organizations: Formal Structure as Myth and Ceremony. *The American Journal of Sociology* 83:340-363.