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Hierarchies and Universal Inclusion in Scientific Communities

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Tensions and Contradictions in Contemporary Society

This chapter is about a fundamental tension and contradiction in contemporary world society. Society and its function systems such as science are, since the eighteenth-century world, fundamentally based in egalitarian inclusion. But from the operation of egalitarian inclusion arise again and again hierarchical structures in scientific communities and in the system of science that transform this function system into a system with significant and ever-renewing inequalities. These are new inequalities coming from equality—and they are not based in continuities to premodern patterns (Stichweh, 2022).

The argument in this chapter is about the system of science as one of the function systems of society. Functional differentiation is the primary form of social differentiation in contemporary world society. Besides

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science other global function systems crystallize around key social problems: the polity, the economy, religion, law, education, the health complex, the arts and the sports. They shift the 'profile' of society from inequality to heterogeneity. But in the function systems of society new inequalities emerge and therefore the argument of this chapter that is only about science may prove to be paradigmatic for the rise and the forms of inequality in other function systems in society. This will have to be explored in future work.

In looking at science one central interest of this chapter focuses on peer review. Peer review is thought to be a core institution of autonomy and equality in science. It holds the promise that a scientist is judged by those who share his/her interests (autonomy of science) and share the same social status (equality of peers). But just by the selective recruitment for being a peer reviewer and by acquiring scientific influence in becoming a peer reviewer the status of a scientist rises in taking these reviewer roles and therefore the institution of equality contributes to the generation and cumulative expansion of inequalities.

Universal Inclusion

Universal inclusion is a characteristic of all the function systems of society. Inclusion means that there arise possibilities of participation and roles for participation for everyone. Exclusion becomes illegitimate, although it factually is there in numerous variants.

The history of modern society can and should be written as the history of *inclusion revolutions* coming about between the eighteenth and the twenty-first century. These inclusion revolutions are turning points in the differentiation histories of all the function systems. What is meant by this can best be explained in briefly looking at some cases.

In premodern economies the economic well-being of the population was often endangered by population growth. The economies could not absorb the growing populations, and from this condition poverty and hunger, epidemics and loss of population ensued, until on the basis of smaller populations an equilibrium was reestablished. It was for the first time in the second half of the eighteenth century that an economic

system, the English economy, succeeded to combine a significant population growth with even faster-growing average incomes. This was the beginning of the inclusion revolution of the modern economy. In the political system the beginnings of democracy (e.g. in France, the United States, Switzerland) started an inclusion revolution. The long-term expansion of voting rights until they included everyone was in this respect the most important process, but to this were clearly added other forms of political inclusion. In the education system the inclusion revolution is coupled to schooling and higher education. Universal schooling already existed in some European regions late in the eighteenth century, and the university transformed itself between 1750 and 2020 from an institution for 1% of the male population to inclusion rates that in some cases approach or even surpass 90%. Religion probably is an especially important and interesting case, as religion is the function system for which arguments claiming the irrelevance and marginality of significant parts of the population would never have made any sense. It is an interesting feature in the history of European Christianity that poor persons and other marginalized groups took central roles in the history of salvation just because of their marginal status. As they had no resources that tied them to this world, poor people were nearer to God than rich people ever could have been and were able to function as mediators and prayed for the salvation of the rich. This is a feature especially prominent in fourteenth- and fifteenth-century Europe, and 100 years later in early modern Europe, confessionalization and its activist and disciplinary demands on the population could be understood as the first inclusion revolution happening before the onset of modernity (Stichweh, 2020a).

We will not look here at all these fascinating cases. Instead we only analyze science. Which are the institutions of universal inclusion in the system of science? The chapter presents the core institutions relevant for our problem (Sections "Publication as the Elementary 'Unit-Act' of the System of Science", "Authorship of Publications as the Form of Inclusion in Science", and "Citations as the Internal Structure of Publications"). And then it analyzes the hierarchies emerging in science on the basis of the operation of these institutions (Sections "Reading and Writing in Scientific Communities: The Hierarchy of Authorship", "The Emergence of Peer Review: The Hierarchy of Readership", "The Two Hierarchies:

Authorship and Readership", and "The Third and Fourth Hierarchy: Hierarchy of Publication Places and Hierarchy of Recruitment for Co-authorship"). The questions we have in view here, in presenting our case, are as much practical questions of the optimal institutional design of a system of science holding to universal inclusion as they are theoretical questions of conceiving a theory of inequality for a functionally differentiated world society.

Publication as the Elementary 'Unit-Act' of the System of Science

Late in the eighteenth century were established the first scientific journals—some of them with disciplinary specializations—('Chemisches Journal' 1778, 'Annales de Chimie et de Physique' 1789, 'Journal der Physik' 1790, 'Philosophical Magazine' 1798) (Hund, 1990; Stichweh, 1984) that are similar to the social and communicative forms that we still use today in communicating science. Journals published scientific papers, which over the next 200 years became an ever more standardized form of the communication of scientific insights. Besides scientific papers in specialized journals there arose the book or the monograph as the second significant form of publication in the system of science. Both publication forms—papers and monographs—then function as the elementary 'unit-acts' (Parsons, 1937) of the communicative and cognitive reproduction of science. 'Unit-acts' are elements; what they say can in principle be reduced to a brief synopsis of their essential insights, and this is even true for long monographs. They share an important property with other elements in other social and natural systems, for example, with atoms. Elements are as well simple as they normally will have an enormous internal complexity. Scientific observers can either focus on the simplicity or on the complexity of elements (i.e. publications or atoms) and the oscillation between the one and the other option is an important part of the practice of science.

Authorship of Publications as the Form of Inclusion in Science

Scientific publications as communicative unit-acts are claimed by authors as their products. The institutionalization of scientific authorship is another core feature of modern science. Authorship is not organizational authorship; a paper is not published by the University of Uppsala or the University of Leiden. And there is no longer a top level of academicians in the major European academies to whom one sends the report of one's discoveries and who decide if these informations are printed (as a letter to the respective academicians) in the pages of the academy journal. Instead of these hierarchical or organizational solutions there now is individual authorship that at the same time is inclusive authorship as everybody who is able to write a paper can now publish a paper under his or—later—her name. Therefore, it can be claimed that the genesis of the specialized scientific journal is at the same time the starting point of an inclusion revolution in the system of science that over time significantly expands the author space of the science system.

Around 1800 it can safely be said that authorship is nearly always individual authorship. There are some cases of co-authorship even at this early point in time—perhaps 2% of all papers in 1800 and still not more than 7% in 1900 (Beaver & Rosen, 1978, 1979)—but the dominant pattern is individual publication by authors who enter science by this act of individual publication. When this changes again, in the twentieth and twenty-first centuries, behind these changes are transformations in the social structure of scientific communities. There are two major changes, the normalization of co-publication by at least two authors and added to this an escalation of the number of authors per paper that in our days may include significantly more than two authors (the most frequent number of authors today is three) or even dozens of authors and in some cases (in high energy physics and clinical medicine) hundreds and thousands of authors (Adams et al., 2019).

Some sociological characteristics of this process have to be mentioned. (1) It is still individual authorship. The system of science never opted for the substitution of collective or organizational authorship for individual

authorship. There are some cases of collective authorship among whom the collective of French mathematicians called Bourbaki may be the most famous. But Bourbaki was primarily established for the production of mathematical textbooks. (2) The rise of co-authorship and then of multi-authorship reflects the emergence of cooperation and division of labor as the normal modus operandi of doing scientific research. (3) Co-authorship expands once more the author space, as it opens the way to publication for all those who could not produce a paper alone. Or, in the ironic formulation of De Solla Price, it allows publication for those who only have half a paper in them at the present time (Price, 1986). (4) But co-authorship is not only about cooperation and division of labor; it implies an expansion of the number of cognitive perspectives integrated into one scientific paper. There are more methods, more theories, more subdisciplines and disciplines that are integrated into one scientific paper. This expansion of the number of cognitive perspectives drives the growth of multi-authorship. (5) Co-authorship changes the relation of authorship and writing. Not everyone who is one of the authors of a paper has been participating in the writing of the paper. On the other hand, writing a paper may become a relevant competence in its own right and may become for some persons the major contribution they made to the paper. (6) Over time there arise ever more social roles and statuses and contributions that may be accepted as legitimate claims for authorship. There are places for senior scientists, guest authors and honorific authors, reciprocal offers of 'free tickets' on one's papers exchanged between two scientists, authorship for departmental heads and for other positions in organizational hierarchies (Adams et al., 2019). (7) There is, finally, the question of international co-authorship and its fast expansion. Partially, it results from the same forces just mentioned: the division of labor, the need for ever more theories and methods and for knowledge from other disciplines. But there are additional reasons, too. In many projects one needs data from other countries, one has to stay and to work in these countries, and these things in many situations can't be done if one does not include authors from these countries. Often this is even a political imperative. A good example is a recent very interesting paper on the physiological and genetic adaptations to extreme diving to be observed in one of the last remaining populations of sea nomads (people living on boats and spending hours every day in and under water to catch and collect fish and

plants from the sea). The paper (Ilardo et al., 2018) has 17 authors, with institutional addresses from six countries. One of these addresses is from Indonesia. The author is from a Department of Education. In a short note on author contributions it is said in the paper that this author contributed logistical support to the project (obviously a strange claim for authorship). Shortly after the publication of the paper in *Cell* objections were raised in Indonesia that the researchers had violated Indonesian rules by not sufficiently consulting with Indonesian institutions and researchers (Rochmyaningsih, 2018; Van Groenigen & Stoof, 2020) and not getting permission for the transport of DNA material out of the country. (8) There are other strong reasons for the international extension of the recruitment of coauthors. International coauthors clearly enhance the visibility of scientific papers. Adding a further country demonstrably has a stronger effect on future citations of a scientific paper than simply adding one more author from a country that is already represented by an author, and this is true up to the eighth country (Adams et al., 2019).

The scientific paper becomes an extremely flexible instrument for the inclusion in science. The list of authors is a very simple list of names, with footnotes added to the individual names that point to organizational addresses. In some cases in our days, the list of names is longer than the paper. The list is nearly never alphabetical. It is bidirectionally rank-ordered, with positions at the beginning and the end especially prominent. But nonetheless the list suppresses hierarchy more than it makes hierarchy visible. It symbolizes science as a collective endeavor. But the collectivity is represented as a collection of individuals, and the point is incessantly made by every scientific paper that every individual counts in the production of science.

Citations as the Internal Structure of Publications

In the nineteenth and twentieth centuries another core structure slowly arose in science. Science invariably became second-order observation. Scientific observers observe reality but they always do this in relating their observations to the observations other scientists have made before.

From this arises a core obligation for every scientific paper: It has to review the insights proposed by other scientific papers and it has to relate the novelties it claims to these anterior insights. These relations between the present paper and earlier publications have to be documented by precise citations to these publications.

Citations are a microstructure of the publications in which they occur. If two papers make use of the same citations the papers are seen as cognitively similar, as belonging to a network of papers who are related to one another by cognitive neighborhoods. But the most remarkable property of citations is that they combine two heterogeneous functions. They are units of cognitive information. They inform readers of a paper where further relevant information is to be found. For a scientist to read a specific paper is often primarily motivated by the hope to get access to the population of papers that are relevant for work on a specific scientific problem. But besides being of informational relevance citations are at the same time social rewards for the authors of the papers that are cited. In the social dimension citations are acts of recognition. They certify that the authors of the cited publication have done something worthwhile. They have contributed to science. Even if the citing scientist(s) try to refute the citing paper and its cognitive claims, the social function of the citation remains intact. It is still said that the respective paper is a relevant part of science and that it is useful for the progress of science to refute its cognitive claims. As we know since Karl Raimund Popper (Popper, 1963), science deals in a symmetrical way with affirmations and refutations of the cognitive claims of other publications.

For the cited authors it can be said that a new atom of reputation is added to their balance sheet by the act of citation. Among other things citations are acts of inclusion. As long as one has only published, there remains a fundamental insecurity: Has my paper ever been read by anybody? After the first atom of reputation created by the first citation, careers can begin and inequality can start to arise. There is a cumulation of citations over time—and this happens on the basis of 'preferential attachment' (Newman, 2001) and 'cumulative advantage' (DiPrete & Eirich, 2006; Merton, 1988) as mechanisms of the production of inequality.

Reading and Writing in Scientific Communities: The Hierarchy of Authorship

In most of the function systems of society there is a split that distinguishes performance roles and observer roles (Ahlers et al., 2020; Stichweh, 2016). There are professionals and clients, doctors and patients, professional artists and their public, and so on. In scientific communities there are authors and readers. One is included in scientific communities as an author (of papers and monographs) and as a reader (of papers and monographs). Role-taking is in both cases based on self-selection, although the decision to write a paper does not guarantee that the presumptive author is able to publish the paper.

There is a strong preference toward authorship in scientific communities. One enters a scientific community by authorship, by contributing publications, not by reading publications. Science is a community of publishing authors, not a community of readers. The fact of reading (scientific papers) becomes visible and relevant not as a creative act in itself (as is the case in literature) (Moretti, 2013) but by citations in publications that document the readings of authors. The hierarchy of science is not a hierarchy of perceptive readers but a hierarchy of authors who are highly cited by other scientific authors in their publications.

But there is an outer fringe of participants in scientific disciplines who only read publications and who do not and mostly cannot contribute publications to the respective discipline. These participants in most cases are visible as authors in other disciplinary communities. Therefore, this phenomenon is akin to interdisciplinarity and is related to the learning processes of which interdisciplinarity consists (Stichweh, 2017).

The Emergence of Peer Review: The Hierarchy of Readership

The self-selection for doing research and for publishing the research one has done that was for a long-time characteristic of modern science is strongly changed in twentieth-/twenty-first-century science by the

emergence of peer review (Cole & Cole, 1981; Cole et al., 1978; Squazzoni et al., 2020).

Peer review means the institutionalization of a new class of readers in science who decide on the research that can be done (by preparing funding decisions) and who decide on the papers and books that will be published (by preparing publication decisions for journals and for book publishers). The readings of these readers do not enter the public communication processes in science. They are mostly private (private to the journals and publishers they work for), invisible readings. But they are very influential. And they imply the rise of a new type of reader roles (readers who do not channel their readings into publications) and a new hierarchical level of especially influential readers in science that establishes a supervenient level of control in science that wasn't there before.

The Two Hierarchies: Authorship and Readership

In the modern system of science the inclusion in authorship is the primary mode of inclusion. It is universal (only demanding the capability to write a scientific paper) and it demonstrates the primacy of performance roles in science. Science is about doing science and not about knowing science by reading scientific papers. Only when reading is part of a production process it is integrated into this understanding of science.

Peer review creates a new kind of reader role in science. The access to these new reader roles presupposes previous success as a scientific researcher and author. Therefore, these reader roles are highly selective and are mostly accessible only at later points in one's career. When these roles are offered, the persons to whom they are offered know that they are advanced in their careers and participate in science not only as researchers and authors but additionally as reviewers who decide on the quality of the research and authorship of other scientists.

The semantic term for this activity is 'peer review' and this suggests that one is judged upon by one's equals. But these peers are a little bit

more equal than others. Peer review creates a level and forms of influence that differs from the influence derived from publishing papers. It creates a new hierarchical level of influence.

This hierarchy of influential readers prominent in peer review restructures the inclusion in research and publication. Reviewers as readers decide who can do research (funding decisions in funding agencies) and who can publish (as reviewers for journals and publishing houses)—and they decide on scientific careers by reviewing publications that are counted for advancement, and by reviewing suggestions for hiring decisions.

The most influential readers as reviewers are often no longer authors and researchers themselves. Their readings have enormous weight. But these readings do not enter the scientific discourse and they do not enter the ongoing cumulation of scientific knowledge.

The inclusion in research and publication is drastically restructured by the emergence of readership roles. In principle, science is still characterized by universal inclusion. But there are ever new control levels added (for a comparative perspective on other systems (Power, 1997)). One needs funding, one's papers have to be accepted, for a career one needs calls to professional positions, one needs recommendations and reviews for fellowships and other stays at places relevant for research and publication, teaching reviews become a part of a university career and the curriculum one teaches has to be audited, the research institute that is the place of work needs regular evaluations. The university one works for wants to be excellent and is ranked. All this is structured by two hierarchies that are strongly linked: the hierarchy of authors, in which the individual scientist climbs on the basis of publications and citations, and finally gets access to the most influential positions and then becomes a professional reader of the publications of others and does no longer do this as a preparation for one's own publications. Instead one becomes ever more important in a hierarchy of readers (= evaluators, auditors) that is the highest level of control in organizing the system of science.

The Third and Fourth Hierarchy: Hierarchy of Publication Places and Hierarchy of Recruitment for Co-authorship

Over time, there are further hierarchies built into the scientific production and communication processes. As publications are the major products of the processes of research defining the core of science and as the citation of publications and the cumulative aspects of citations become the simplest and most basic reward for the cognitive achievements documented in publications, new hierarchies emerge around publication and the authorship of publications.

Besides the hierarchy of authors and the hierarchy of readers (reviewers, evaluators, auditors) nested into one another, there comes about a hierarchy of publication places (journals, publishing houses). It is no accident that this hierarchy is defined by levels and forms of peer review, by the probability of citations (impact factors) and by rejection rates.

The same self-referential intensification of hierarchy is to be observed in the fourth hierarchy establishing itself: the hierarchy in selecting and recruiting coauthors for publication. Scientists who search for coauthors are looking for other scientists who are identified by numerous publications in highly ranked journals and by a great number of citations they succeeded to cumulate over a publication career.

In this argument it is easily to be seen how the reciprocal intensification of the four hierarchies characteristic of the communication system of present-day science transforms science as a system based on universal inclusion into a social system with extreme inequalities.

Two Modalities of Quality Control in Science

Anticipatory, Centralized Control by Scientific Elites

Cumulative rewards for successful authors, their promotion to influential readers/reviewers who are installed as central agents of quality control in science, the intensification of these patterns by a steep hierarchy of ranked

journals, and the recruitment of coauthors on the basis of advanced positions in the other three hierarchies—all these patterns create a remarkable system of quality control by scientific elites. A major property of this system of control is that it is 'anticipatory' control. Papers are rejected or printed before they have been examined by a significant number of members of the relevant scientific communities and projects are funded on the basis of prognoses regarding their probable scientific success. To believe in the rationality of these decisions demands a strong belief in the superior knowledge and wisdom of the scientific elites who practice this anticipatory control. It is a mode of control that is very conservative, as it concentrates control in the hand of elites whose individual members may have been active for decades and who may have a prejudice against innovation, newcomers, outsiders and heterodoxies.

Post-hoc, Decentralized Market Control Based on Universal Inclusion

There is one alternative control modality that is based on institutional alternatives that have already been practiced at some places. It substitutes post-hoc control of research and publications for anticipatory control by elites. This implies liberal standards for self-selected research (that is mostly done with basic funding available for everyone, a funding level that may be adapted on the basis of successes) and the publication of results on liberal publication platforms. Evaluation mostly happens after the research has been done and after the results have been published. But this post-hoc evaluation is entrusted to the decentralized expertise of diversified communities emerging on the basis of universal inclusion.

Concluding Remarks

It is probable that the two modalities of control will coexist in the foreseeable future of science. The first modality, 'anticipatory centralized control', is connected to stable hierarchies of established elite researchers who

control the access to careers, research funds, co-authorship options and possibilities of publication in high-status journals. This is a very conservative model that may hinder scientific innovation.

The second modality of control is compatible with publication of unreviewed papers on platforms such as arXiv. Peer review may be 'open peer review' (Ross-Hellauer, 2017) after publication. Reviews will often be based on self-selection for reviewing and may be published together with the papers reviewed. The whole process of publishing, reviewing and revising papers on the basis of reviews becomes an open process visible to everyone and accessible (liberalization of publication, accessibility of reviewing) in a universal way. This modality, 'post-hoc, decentralized market control', has a higher compatibility with the self-professed universalism of modern science. Even under these circumstances, inequalities will arise (as differences in success between papers will always be considerable). But the hierarchies will be much less stable, as most forms of influential writing and reading (as a reviewer) will be available to everyone.

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