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## Introduction:

# The International Contexts of Swedish Science A Network Approach to the Internationalization of Science

### I.

Networks have become an increasingly important concept in the sociology of science. In an early article Derek J. de Solla Price (1965) used the concept to demonstrate kinship between scientists as measured by citations. Since then a lot has happened. The bibliometric approach is a line of research that has expanded tremendously with the spread of desk top computer technology and on line bases for mass handling of data. However, applications of the concept “networks” or network theory have since expanded to include a whole set of problems: the spread of information in the scientific community; the study of recruitment, entrance and legitimization; the study of scientific institutions and their social organization; the daily practice of scientific work; the study of social applications of scientific results, etc. The founding fathers of this whole approach

to science were Robert K. Merton and, even more so, Merton’s teacher Pitirim A. Sorokin with his quantitative sociology of science, technology and culture. (For an overview see Sörlin 1990.)

The concept has not been as widely used in historical studies but recent developments in the historical sociology of science provide exceptions to the rule. An example of quantitative sociological research focused on communications and spatial organization of the scientific community is Daniel Roches thorough and pioneering study *Le siècle des lumières en province*, 2 vols. (1978), although the English concept “networks” is not consciously adopted by Roche. The most eminent example is Bruno Latour’s *Science in Action* (1987). Latour uses “network” as a key concept in determining the boundaries of the scientific community. If you are within the network of scientific communication you are part of an epistemological universe which

is thinking of itself as “scientific” and the world outside as something “not scientific”. There is, writes Latour, a “Great Divide” between “them and us”. Latour’s discourse is theoretical but he uses historical evidence, e.g. from the 18th century, to verify his ideas. However, the concept has, to my knowledge, not been used as an overriding theoretical or empirical instrument in any major work of the history of science.

## II.

The present special issue of *Science Studies* is the result of a project that has not only consciously and consequently adopted the network-concept, it is also unique in the sense that the scientific relations of an entire nation-state, Sweden, since the Middle Ages are analyzed under its framework. The project, with the title “The Idea of Europe and the Migration of Culture”, of which I am the coordinator, was started in 1989 as an integrated part of a major research program, “Sweden in European Networks”, launched by the Institute of Futures Studies of Stockholm and the Center for Regional Science (CERUM) at the University of Umeå. The multidisciplinary research program consisted of the project mentioned, based primarily in the history and sociology of science, plus four other simultaneous projects with their disciplinary focus in, respectively, political science, political economy, cultural geography and business economics. The results of the program have been presented in a wide array of papers, articles and books and will be finally recorded in a set of five volumes, one from each project, planned for publication in Swedish during 1993.

The *motif* behind the research program was the rapid momentum of European integration in the latter half of the 1980’s and the growing dissatisfaction with traditional integration research. A conclusion drawn at the Congress of the International Political Science Association in Washington D.C. 1988 was that integration itself developed far more quickly than did integration re-

search! (Azzi 1988) Sweden is strongly affected by integration, with ties to the rest of Europe being developed in all possible dimensions, from foreign investments to tourism. But, again, the tools of analysis that had previously been used to describe and explain the ongoing transnationalization from a Swedish point of view were felt inadequate and connected with a past era, when it was still possible to regard international events from an insular nation-state perspective.

The main trust of the research program, and the common denominator of the five projects, was to use the network-concept to explore how Sweden is and has been connected to other parts of Europe. Networks, then, were given a wide definition: physical networks such as infrastructure, economic networks such as business relations and innovation networks, political and administrative networks such as international organizations. For the project presented in this special issue they consisted of intellectual networks.

What, then, are intellectual networks and how can they be used as an analytical tool in the study of a given country’s history and sociology of science? The Swedish answer to this question has to do with the particular geopolitical position of Sweden. The Nordic countries were, to begin with, never a part of the Roman Empire. And they have retained a northern, quite peripheral position in Europe, not only in the geographical sense.

Throughout Swedish history the uniqueness of Sweden and her superior qualities vis à vis the rest of Europe have been oft-repeated themes of Swedish national mythology and self-understanding. In previous writing of Swedish history of science this division between Europe and Sweden has been paradigmatical. It is not false to characterize the main current of the subject up to the 1970’s as one of scrutinizing the Swedish reception of European scientific theories or modes of thought: from Ramism via Cartesianism, Newtonianism, Enlightenment, Romanticism up to Modernism. This humble analysis of reception has been countered by

a self-conscious research and international marketing of highlights in the Swedish contributions to the corpus of scientific knowledge, with Linnaeus and Berzelius as the most prominent figures.

Against the backdrop of this *Sonderweg* tradition, which is a combination of fact and fiction (meaning story-telling, not sheer fantasy), we can discern the everyday practices of Swedes and their fellow Europeans. For the cultural and scientific community these practices have meant contacts and collaborations in various forms and with varying frequency and intensity. Swedish scientists have belonged to the same scientific universe as their colleagues in other parts of our continent. In the project I coordinated I decided to draw focus away from the study of reception and instead try to explore, in a very fundamental sense, the size and nature of these contacts. This shift of focus is another central feature of the project, namely the focus on scientific practice rather than on scientific ideas.

### III.

Apart from the dissatisfaction with certain elements of integration research and with the inability of old Swedish history of science to reflect the interplay of scientists and their actions over space and time, I also took inspiration from new perspectives in the study of international science, as that notion has developed over the last couple of decades, focussing on colonial science, scientific colonialism and Western relations to the third world. These perspectives have in various ways criticized George Basalla's Diffusion Phase model from the 1960's (Basalla, 1967). Basalla's model was parallel to contemporary stage theories of economic growth in the third world. He assumed a one way flow of scientific ideas and practices from the Western Centre to the third world Periphery. The first phase of the theory meant import of scientific ready-mades such as experts and instruments from the colonial power. The

second phase implied the setting up in the colonies of scientific sites — laboratories, places of observation, training centres, etc. — by the colonial power and manned by the colonizer's and a few of the colonized in the lower ranks. The third phase referred to the establishment of scientific institutions owned and staffed by the former colony, now independent, but again with varying degrees of dependency on the former colonial power.

In recent years this model has been severely criticized, explicitly or implicitly, by a number of scholars. Some of the most important contributions have been presented in influential collections such as *Scientific Colonialism* (Rheingold & Rothenberg, 1987), *International Science and National Scientific Identity* (Home & Kohlstedt, 1991), *Science and Empires* (Petitjean et al, 1992), and in a new volume that has grown partly from our project, *Denationalizing Science* (Crawford et al, 1992b). It was in the first of these three that Roy MacLeod proposed his idea of the "Moving Metropolis" (MacLeod, 1987). In the second David Wade Chambers published an important paper, "Does Distance Tyrannize Science?", on the growth of Australian science. Chambers concludes that the distance to London, the simple geopolitical fact of being "peripheral", does not result in any corresponding intellectual backwardness or lagging behind. On the contrary, in certain disciplines and fields, varying in space and time, the "periphery" has a science as mature and advanced, if not more so, as the "centre". (Chambers, 1991a)

Chambers followed up with a broader theoretical analysis at the international Science, Discovery and the Colonial World meeting held in Madrid, June 1991. There he suggested a new Locality Model to replace Basalla's. In it he depicts a global scientific network operating since the early days of European exploration. This network consists of a number of local centers that are in a constant and fluxing interplay with each other. As writes Chambers: "...the 'scientific centre' is nothing more than reference to the network of centres of communication". (Chambers, 1991b).

My and my colleagues' work on the networks connecting science in Sweden to science in Europe owes a lot to this general understanding of how science develops. One may even say that it adheres (even if we did not know that when we set out in 1989) to the first point in Chambers' five point research program for the study of the worldwide rise of the science movement: "to chronicle its emplacement in specific localities, first principally in Europe". (Chambers, 1991: 14)

Now, this does not mean to suggest that Sweden from the Middle Ages onwards is a crude and simple parallel to 20th century tropical colonies, not at all. But there is something important to be gained from the way of looking at scientific practice as something that is carried out not only in centres from which knowledge spreads like waves on the water, but rather as an activity going on in many places at the same time creating a far more complex interplay. In that sense — this is one conclusion of our project— Swedish science will from now on have to be regarded not primarily as a receiver of scientific ready-mades and theories but as a partner in a complex, multicentred system of knowledge transfer in Europe from the Middle Ages up to present time.

It is obvious that there are power relations to this picture. Swedish science has, over the centuries, been strong in fields such as mineralogy, botany, chemistry and, to some extent, astronomy. Swedish science has had periods of flourishing, like the heyday of the 18th century with the creation of the, at first highly creative, Royal Swedish Academy of Sciences. (Frängsmyr, 1989) In many fields and for long periods of time Sweden has had little original to contribute but has been living essentially on an input gained from elsewhere. Still, the overriding perspective describing the ups and downs of this historical topography matters to us, as it matters even more, emotionally and politically, to those scholars around the globe who are trying to find a fruitful narrative of their own much younger scientific practices and still not give in to colonial subordination.

#### IV.

What is dealt with in the following papers is, thus, not so much the subtleties of scientific ideas elaborated in "Sweden" and exported to "Europe", or vice versa. On the contrary our prime interest has been to try to identify the roads of exchange, the trading posts of knowledge, the relay stations of cultural and scientific work in the transnational arena.

Networks has been a very useful concept in this analysis. The concept is by definition geared towards communication and it has been a stimulating task to reflect on the means of communication of different historical periods. The resulting questions have been simple and straightforward: with whom did Swedish scientists have contacts? Where did they go when abroad? Which visitors did they receive and where did these visitors come from? What books and journals were imported and read (not necessarily the same thing), and what books and journals left Sweden to make an imprint on Europe? What parts of Europe have been the principal areas of Swedish scientific exchange? Have these changed over time, or can we identify a stable pattern? If so, why?

Mostly, these questions have been dealt with in a long historical perspective. By necessity, since the period covered spans more than a thousand years, from the arrival of the German Christian missionary Ansgar in the Ninth Century up to the present day, we have had to rely mainly on previous research and written sources. What we have, hopefully, contributed is a new perspective on the given corpus of facts and figures, a reorganization of already gained knowledge.

We have also undertaken a number of specialized empirical studies, mainly in order to test the validity and workability of the network perspective. It is a selection of these studies that are presented here in abbreviated and adapted versions. (A list of all the studies, the majority of which are in Swedish, can be obtained from the Center for Regional Science at the University of Umeå, address below.)

The first of the studies included here is a bibliometric survey by Thomas Schott, Pittsburgh, of the integration of Swedish science into European, Nordic and American environments. Using data from the Science Citation Index (SCI) and a survey of 507 scientists Dr Schott concludes that Sweden in the late 20th century is a periphery to the North American center of scientific *influence* as measured by citations in articles published by Swedish scientists. However, Swedish scientists' *collaboration* has been stronger with Western Europe than with the United States and Canada.

Schott's results draw attention to the role of size of the scientific community. The great influence of the American scientific community is to be expected, because of the overwhelming volume of American science. Now, if a reduction base is introduced such as population or GNP, the results change. The other Nordic countries, small in population, at once seem far more important than their absolute figures suggest with an observed ratio of mutual influence far exceeding the expected (Schott's Table 4). This picture is reinforced by the fact that Swedish scientists have a high rate of coauthorships together with their Nordic neighbours. With the same method of comparing observed with expected level of mutual influence we find that Swedish integration into European environments does not differ much from integration into the North American.

Given the size, the universality and the financial resources of the North American scientific community it is almost surprising that it does not exert an even greater influence on science in Sweden. If the Nordic countries are counted together with the rest of Europe it is actually quite clear that the *overall relations* of Swedish science are largest with Europe, both in absolute and in relative terms.

What comes out of Schott's overview is the notion of a contemporary science in Sweden that is well integrated into the major centers of the scientific world, particularly in the Nordic countries and Western Europe, but also to a high extent North Ameri-

ca. The pattern is in no way surprising (except, perhaps, for the Nordic integration); Western Europe and North America are where scientists of good quality are found in great numbers.

The European connections, however, do not only depend on the actual situation, they are embedded in networks and institutional ties that go back many decades and even centuries. In Pär Eliasson's contribution on Swedish students' study tours to Europe such ties are identified and analyzed. He distinguishes two epochs in the history of Swedish peregrinations. The first starts in the 13th century and is directed to southern European centres of learning, primarily Bologna and Paris. The University of Paris was by far the largest receiver of Swedish students with a total of some seven hundred visiting Swedes up to ca 1450 when Paris had lost its attraction almost totally. After a short interreigning period during which the university of Prague received a portion of Swedes, the universities of northern Germany came to the forefront, thus establishing the second period. The most important universities were Rostock, Greifswald and Leipzig. Common to these, apart from the fact that they were Lutheran universities, was that they were situated on or close to the Southern shores of the Baltic. For Swedish students, they were therefore easy and comparatively cheap to reach. Once the university had been visited by a few Swedish students they spread the word back home and over time there grew what we could term traffic links from Sweden to the German universities, just as there had been links between the Late Medieval centres of learning in Sweden and the European *studia* (Buttmer, 1989). These links were quite permanent and they had their stable nodes. They formed what we just as well may call a network.

With the rise of modern science from the 17th century onwards other kinds of networks grew: those between scientists communicating ideas and results between each other. A lot has been said about the establishment of the early scientific newsletters and journals, but the fact still remains that scientists'

autonomous and deliberate correspondence and travels were kept alive nonetheless. In Sven Widmalm's contribution this is amply demonstrated for the case of astronomy in the 18th century. Widmalm finds many parallels between, on the one hand, the organization of collaboration and communication between astronomers in Sweden and Europe (including letters, scientific academies and societies, publications, surveying organizations) and Thomas S. Hughes' model of technological systems, on the other. Still, he also finds one important difference. The astronomical communication networks lacked the hierarchical dimension implied in Hughes' "system". They were horizontal; 18th century astronomy had no center on the international level. The communication network, with correspondents situated at various centers of observation and calculation across Europe, redefined, writes Widmalm, "geographical space". One of these centers, forming an important node in the network of 18th century astronomy, was Pehr Wilhelm Wargentin in his double capacity as astronomer working at the Stockholm Observatory and as Permanent Secretary of the Academy of Sciences in Stockholm.

One conclusion of Widmalm's study is that Swedish astronomy formed part of a wider scientific network. The forms of international communication and collaboration were still in a developing phase in the 18th century, and astronomy was in many respects an *avantgarde*. One century later the situation was radically different. When Swedish physicists, discussed by Elisabeth Crawford, sought recognition in the international arena from the mid-19th century onwards they did so through an array of well established journals together with strong institutional links and informal personal networks. One of Crawford's main findings is that up to World War I the Swedish physicists were cosmopolitan, i. e., individualistic and universal, whereas after the war their contacts became international, i. e. their research area at home formed their platform for connections to groups and institutions working in the same area abroad. The scientist's role

as an individual was gradually replaced by his role as a representative of his country, a tendency that had been in the making throughout the 19th century. (Crawford et al, 1992a) It is evident from Crawford's study that Germany played an important role for the Swedish physicists. It was to Germany that many of them went for study and research, and they published in German journals, however quite often publishing the same article in Swedish journals before the turn of the century 1900. The trend is not so strong, but it is clear enough in the case of Manne Siegbahn that the Anglo-American world grows in importance as a publication outlet in the mid-war period.

This development in physics reflects a general trend in Swedish science in the 20th century. The strong connections to Germany go back, as we have seen, to the Late Middle Ages. After World War I the strong Swedish-German links (that were not restricted to science but included cultural life in general) started to give way to more and more Anglo-American contacts, a trend that grew to full swing after the advent of Nazism. From the 1930s onwards many first and second generation Swedish social scientists went to the United States to work. At least one of those exchanges, that of Alva and Gunnar Myrdal, has become world famous. After World War II the US has been a main recipient of Swedish researchers both in the social and the natural sciences.

This transatlantic migration of knowledge, explored earlier for especially German-speaking Jewish intellectuals, is dealt with here for Swedish scientists in the contribution by Ron Eyerman and Andrew Jamison (who both incidentally reflect a migration of knowledge in the opposite direction). Their primary cases are sociology, where the migration started before World War II, and systems ecology, which underwent a fascinating international career as a transdisciplinary field of inquiry (Jamison, 1992) before it was taken up in Sweden in the 1960's much as a direct result of contacts with the two American brothers Odum, but also as a response to a growing environmental awareness and

demands for political action.

As the authors note, the transfer of knowledge between nations is never a simple process. The social sciences and the natural sciences have responded differently, the former being more open to the American influences, sometimes even imitative. The natural sciences, with a stronger indigenous tradition in Sweden, have proved more selective, which the case of systems ecology demonstrates; its Swedish version is not a copy, but rather a variant of the American one. Swedish-American intellectual relations grew strong, not only because the US was the magnet only a scientific superpower can be. They were also "kin" nations, both pursuing policies of social engineering and social planning and fostering a "scientistic" outlook.

But, again, as is shown in other studies in this special issue, the exchange can only be understood against the background of earlier contacts, in this case the extensive Swedish migration to North America in the late 19th and the early 20th century. There were old personal and institutional networks that kept working well into the mid- and post-war periods.

Eyerman's and Jamison's study halts at 1970. At that time Swedish-American intellectual relations had passed zenith. With Swedish criticisms of the Vietnam war and a general scepticism towards what was sometimes called "American imperialism" a chill entered the transatlantic atmosphere. The growing momentum of European integration also affected the intellectual community in the 1980s and 1990s. New EC programs for research and higher education (some with access for Sweden, still in 1993 a non-member) have been launched, and in the 1990's students cross European borders in their hundreds of thousands through the exchange program ERASMUS.

A few years into the 1990s it seems as if European developments have taken the lead, reducing the North American share of Swedish intellectual exchange somewhat, although it is not a matter of any substantial loss in absolute figures. When it comes to Latin America and indeed the Ibero-Ameri-

can world altogether, there has never been any great scientific exchange, as the contribution by Regis Cabral shows. Interestingly enough, it is here rather a question of growth, partly since Spain and Portugal are part of the EC where exchange grows generally, and partly because of the ongoing globalization of world affairs that affects science as well. The case discussed explicitly by Cabral is Nordita, the Nordic Institute for Theoretical Physics, that has developed intellectual networks between the Nordic countries and the Ibero-American world.

The articles that follow in this special issue of *Science Studies* do not give the last word on the international contexts of Swedish science. Rather they demonstrate a series of applications of the network approach. Many disciplines are left outside, wide periods of time lie blank. Swedish exchange with many parts of the world are mentioned only in passing or not at all. The only excuse on the part of the guest editor and project coordinator is perhaps that it is a matter of a first excursion into a new field of study where we hope many will tread after us to go further than we have.

### *Acknowledgements*

The research presented in this special issue of *Science Studies* was, unless otherwise indicated, financed and supported by the Institute for Futures Studies, Stockholm, and the Center for Regional Science, University of Umeå.

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