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Chapter VIII: Integration & Conclusions

Review

In the introductory chapter of this study a central problematic was identified: given the centrality of media to academic communications, the need to understand the impact of media form increases with the advent of electronic media into the academic environment. The impact of this new media landscape on the scientific process is not yet well represented, nor is it well understood. It was argued that the previously dominant media (print) fostered particular types of networking, and that new electronic media can be expected to foster different ones. Importantly, sorting the complexity between media biases demands that we not only observe the new media environment in terms of how it compares to the former, print networks, but that we acknowledge these print networks to also be in transition. The identified challenge of the dissertation was 'how do we compare media bias given this complexity of interrelation?' The *Architecture – Network – System* triad was used as a heuristic model for the empirical analyses, and thereby enabled a means of classifying and comparing the different network architectures fostered by each medium.

We first turned to the history of the metric approach in order to highlight similar analyses which could inform this study. The review included a short history of bibliometrics as a tradition that stretches back to the scribal culture of the Middle Ages, scientometrics as a related tool to map the publication behaviour of scientists and the evolution of disciplinary foci, and cybermetrics as a means of coping with the myriad of new accessible datasets available for analysis given electronic media. In this way it was argued that metric analyses could be used to address this problematic. Further, it was argued that the various existing metric approaches lacked sufficient comparison of media forms with each other, and that such an approach could be achieved with operationalized theorizing.

In *Chapter II: Theoretical Grounding* a range of approaches relevant to the problematic of mediation were addressed to provide a theoretical grounding for the study. It was argued that existing metric analyses were largely not theoretically informed and it was expected that by providing a rich theoretical backdrop to this study, we might be able to enhance the interpretation and integration of the metric results in the respective chapters. Medium Theory was introduced as the theoretical baseline for the study, as the approach covered both the historical use of media through time as an epochal framework encompassing oral, literate and electronic stages of mediation, and the notion of transformation between these stages. We can understand the current study to be primarily concerned with the transformative stage implied with the shift from print to electronic media as the predominant medium of social intercourse. An important concept was introduced here: the *information network*, which Meyrowitz argued was a viable heuristic for understanding the changing nature of social relations through time as mediated phenomena.

In addition to the theoretical backbone provided by Medium Theory, two other modelling approaches were addressed: Actor Network Theory (ANT) and Self-

Organization Theory. ANT provided the theoretical lens that enabled a means of comparing the print and electronic communicative domains of the Self-Organization of the European Information Society (SOEIS) research project, as the approach has a rich history of use as a grounding to perform and interpret textual analyses. Importantly, the ANT provided a means of conceptualizing how individual events (as word use, publications or threaded emails) compile to form networks of interrelation. Self Organization Theory was then employed to provide a birds-eye view perspective whereby these networks of interaction could be understood from a macro perspective which sought systemic properties of the SOEIS communications, that in principle remained outside the full comprehension of the individual actors of the network. These three bodies collectively helped form the dissertation heuristic: the *Architecture – Network – System* model.

The theory chapter also reviewed a number of approaches concerning the symbolic aspects of mediated communication. Here the central proponents of Structuralism, Poststructuralism, and Structuration Theory were addressed. These theoretical bodies were introduced to help interpret the results of the analyses which pertained more to changes identified with the cognitive orientation of the SOEIS group. This laid the foundation for the analyses to follow, precisely because each of these theoretical bodies speak to the problematic of mediation as it relates to knowledge production, as introduced in *Chapter I: Introduction – Key Concepts*. The theoretical framework, while dense in its appropriation of concepts from a broad range of disciplines, proved to be an effective means of assessing the empirical analyses (with respect to both modelling and symbolic aspects) and thereby helped illustrate the unique relationship between print and electronic media.

Chapter III: Materials & Methodology, the third and final chapter of *Part I*, served to bind the theoretic triad of *Architecture – Network – System* with the metric analyses identified in the introduction. Here the particular metric analyses to be performed on the different communicative domains of the SOEIS research project were aligned with the points of the theoretic triad. This provided the conceptual link between the theoretical priorities of this study and their operationalization using metric analyses. In this way both were positioned into an overall framework, and geared towards a common end – the exploration of the differences between print and electronic media given the problematic introduced by the centrality of both media forms to processes of knowledge production. Accordingly, the chapter produced an overarching research question for the dissertation; this integrated the priorities of the analysis, and juxtaposed them with a set of general expectations.

Given the centrality of media to processes of knowledge production, and the responsibility of these changes as related to media (as argued by Gibbons *et. al.,* 1994, the OECD publications introduced in *Chapter I*, and Medium Theory as described in *Chapter II*), it was assumed that Information and Communication Technologies (ICT) affect the ways that scientists communicate. To address this problematic both empirical approaches and theoretical bodies were reviewed and integrated into a framework to carry out a series of analyses. This gave rise to more central expectations: that metric analyses and modelling techniques could aid in understanding the different roles that print and electronic media play in academic environments, and thereby help accurately describe the dynamic character of the

evolving research practice. And finally, that the theoretical triad as created for the analysis could both contextualize and aid in the interpretation of the results of the empirical analyses.

With these expectations a guiding research question was then asked: "*Given that mediated communication and mediated processes of knowledge production are mutually implicated phenomena, and given that the changing information environment in academic contexts can be theorized with respect to differences between print and electronic media, can the application of metric techniques to academic communications in tandem with applied theorizing show biases particular to each medium and thereby reveal the nature of said changes?*" The metric analyses upon the mediated traces of the SOEIS communicative domains has shown that ICTs impact academic communications in different ways, and that this difference was attributable in part to the function of each medium (print and electronic) as conduits of knowledge production. This observation was made possible through the use of the theoretic triad heuristic to interpret the results of the metric analyses. The central research question has been answered with respect to the expectations of this *exploratory* analysis.

The following section: *Integration* will review the results of the individual analyses with respect to how the respective questions were answered and their respective expectations met (or not). Here the theoretic triad of *Architecture – Network – System* is used to bind the central findings of each analysis. In this way the main architectural, network, and systemic features of the SOEIS group were collated and a core set of results isolated. A concluding section will then highlight the central findings of the dissertation. The final chapter of the dissertation will address the limitations identified through the execution of this analysis, and will provide relevant guidelines for those interested in pursuing similar analyses into the future.

Integration

This section will serve to conceptually integrate the four previous empirical analyses together, using the theoretical triad of *Architecture – Network – System* to bind their central findings. Overall, *Chapter IV: Analysis of Print Communication* and *Chapter V: Analysis of Electronic Communication* served to isolate and characterize the internal communicative dynamics of the SOEIS research group by analyzing the patterns of word exhibited by the group as the key units of analysis. By contrast, *Chapter VI: Analysis of Journal Publication* and *Chapter VII: Analysis of Mailing List Environment* served to delimit the external communicative dynamics of the SOEIS by focusing upon word use, but here the focus of the analysis did not revolve around patterns of word use, per se, but rather from the next order perspective – where words were used in combination to generate journal articles and emails. By analyzing and then comparing the internal and external dynamics of the SOEIS using the theoretical triad, a general set of conclusions concerning the role of media in processes of knowledge production was generated.

While running the risk of being repetitive, each of the four empirical chapters of this study is reviewed in this section by addressing their central research questions and

expectations in tandem with a integrative review of the central findings of each sub-analysis. In this way, we gain a general understanding of the overall *architecture* of the SOEIS mediated environment, its *networked* properties, and finally its *systemic* dimensions.

Architecture:
As argued in *Chapter II: Theoretical Grounding*, the notion of architecture is best understood in the context of the *information network* as characterized by Meyrowitz, the central proponent of second generation Medium Theory. It was argued that while social reality is constituted through interactions among people, it is the patterns of information flow which operate as the catalyst for change, not physical setting. Social situations (such as the SOEIS research project) are therefore best perceived as *information networks* whereby different actors, events, and (by default) media converge to create social reality. Thus, the aim in introducing the notion of the information network was to provide a useful metaphor with which to understand the architectural parameters of the different communicative domains examined in this study. The term *architecture*, as used in this analysis, was employed to encapsulate the complex structure of these four communicative domains of the SOIES research project with the ultimate aim of integrating them into a general understanding of the *architecture* of mediated processes of knowledge production.

In *Chapter IV: Analysis of Print Communications* it was asked: "do the SOEIS print communications have a discernable architecture, and can particular qualities be identified with a decidedly print mode of communication?" It was expected that an analysis of the fluctuation of the percentage of unique words across each time period of the print dataset would reveal elements of information codification. The results proved greater than the original expectations: it was shown that not only did the print communications exhibit an *a priori* codification, as expected given the nature of the print medium, but also exhibited evidence of a *processual* codification. It was found that this *processual* codification could be attributed to the fact that the print dataset operated as an aggregating text, suggesting that many contributions in earlier time periods were 'cut' and 'pasted' into later submissions, thereby constraining the evolution of the print dataset.

By contrast, when the same question was asked in *Chapter V: Analysis of Electronic Communications* regarding the electronic dataset, it was expected and confirmed that the architecture of the electronic communications would be less constrained than similar communications in the print dataset. Indeed, the electronic dataset was shown to behave in a more Mode II fashion than the Mode I oriented print communications, as evidenced by the continued increase of word frequency and percentage of unique words over the four time periods. The architectural features of the internal communications of the SOEIS research project were therefore shown to have behaved differently in the print and electronic datasets, and this difference was argued in terms of evidence of information codification in the print dataset, and the resistance to codification in the electronic.

The architectural analysis of the communicative domains external to the SOEIS project entailed a slightly different approach than that employed for the analysis of the

internal communications. Instead of prioritizing 'codification', which was effective for the analysis of the internal communications, here the emphasis was placed on the 'cognitive biases' or realms that could be identified in the publication and mailing list datasets. The analyses of these latter two communicative domains focused on aggregate word use (i.e.: journal articles and emails) rather than on patterns of word use. The analyses of the communications external to the SOEIS therefore entailed different priorities.

In *Chapter VI: Analysis of Journal Publication* the question was posed: "what are the architectural parameters of the SOEIS publication environment with respect to its Cited and Citing dimensions, and to what degree does their overlap reveal a cognitive bias?" The subsequent analysis of the publication architecture showed that the citation environment of the SOEIS was predominantly oriented towards Policy and Informatics journals; this cognitive bias was evidenced by the centrality of *Scientometrics* and *Research Policy*. The publication architecture was further enriched by highlighting the European bias of SOEIS publications, and the consistency of co-authorship frequency which proved to be proportionately higher in the SOEIS group than in the core membership. In this way the SOEIS publications were shown to exhibit a particular architecture that operated as an information network in the Medium Theory sense of the term.

Similarly, the mailing lists analysed in *Chapter VII: Analysis of Mailing List Environment* were shown to operate as information networks, but there the emphasis was less on the cognitive orientation of the lists, as this was 'given' due to the restriction of the analysis to Science & Technology and Self-Organization Theory oriented mailing lists. Here it was asked: "can qualities common to all lists be identified, or do different lists perform specific functional roles in academic communication?" Prior to performing the analyses it was expected that the different lists under examination should vary with respect to the status of each as either project, intermediary, or field level lists. When compared, the lists were found to have discernable network architectures that were actively created and maintained; a direct correlation was found between list participation and thread participation, and the field level lists were found to perform roles particular to their expected function as evidenced by the participation levels of project, intermediary, and field level lists.

Given that the communicative domains differed so much in their composition, the examination of each necessarily entailed a different set of analyses. It was possible to compare the results of the analyses of the internal print and electronic communications, since their databases were so similar, but it remains a matter of comparing apples and oranges when the different architectural parameters of the external communicative domains of the SOEIS. Nevertheless, each was shown to operate as an *information network* in its own right, and they can be conceptually linked in this way. That is to say, the SOEIS research project certainly operated as a 'social situation' defined by a myriad of different patterns of information flow which collectively comprised the information network of the SOEIS. The analyses of the different architectural parameters of each communicative domain as an essential part of the collectively created and maintained information network of the SOEIS permitted an initial means of collating the results of these and subsequent analyses.

Network:
Where the architecture analyses used the metaphor of the *information network* to discern the overall parameters of the four communicative domains of the SOEIS, the network oriented analyses were generally more concerned with the dynamics of information exchange via these information networks. *Chapter II: Theoretical Grounding* introduced Actor Network Theory (ANT) as a discourse often used in the field of Science & Technology Studies to contextualize textual analyses. The ANT provided this study with a grounding for the analyses of the network properties of the respective SOEIS communicative domains under analysis. Whether comparisons between print and electronic keyword networks, citing and cited dimensions of SOEIS related publications, or threaded email communications, the ANT provided a soluble means of simultaneously appreciating the significant differences between the communicative domains while rendering a general network metaphor to bind the analyses. To assist with the interpretation of the 'meaningful' content of the communications analyzed, several *meaning,* or *symbolic,* oriented discourses from Structuralism, Poststructuralism and Structuration Theory were also reviewed. The dominant network metaphors obtained therein provided a number of different conceptualizations of where meaning could be 'located'.

It was argued that where the structuralist discourse maintained a transcendent and relatively closed meaning system devoid of human context, poststructuralist approaches were shown to localize meaning in the social: in the act of communicating. Structuration Theory was then introduced to incorporate both approaches. Meaning is something that is both social in the sense of being created, but is also structural by definition – our operationalization of language through speech or writing systemizes the language structure. Spoken language leaves only traces in the mind, whereas the written word leaves traces that can be observed both synchronically and diachronically. Each discourse offered a network metaphor that proved instrumental to understanding the overlap of the four communicative domains of the SOEIS. The datasets under analysis were all necessarily 'closed', by definition; the time periods selected for analysis were finite, but one can appreciate the evolutionary nature of communications geared to a collective end. Given the SOEIS as a research project with an advent and a termination, the datasets are best perceived as 'closed' in the structuralist sense of the term, but 'open' in the sense that the information *content* is expected to be different in each of the respective datasets and time periods under analysis. Hence, the SOEIS communicative domains were each assessed as time series.

For the analysis of the print and electronic communications the two years of the SOEIS research project were each divided into four periods of six months; for the analysis of journal publication the scope was stretched to five years to incorporate those publications which occurred before and after the SOEIS; and finally, the analysis of mailing lists measured the duration of threads over a finite period of analysis. Simply stated, the value of the symbolic approaches was to provide a sense of 'meaning making' in each of these communicative domains, thereby illustrating how each operated as an individual domain of knowledge production.

The first network analysis compared the fluctuations of keyword use over the four time periods of the SOEIS print communications, expecting that a discernable pattern of keyword reoccurrence would be visible. By comparing the top 50 keywords general topic words were found to be predominant and little was learned. Comparing each time period with the overall dataset proved more useful as particular emphases were found for each time period. The most impressive results of the keyword network analyses were found by comparing each period with the subsequent period, to reveal the transmission of word use over the four periods of the project as a process. Here it was found that words which concern the general *functioning* of the SOEIS research project appeared to increase in frequency over the time periods.

When the electronic communications were assessed as a time series, it was asked: "does this distribution differ significantly from the results of the print analysis?" It was expected that the top electronic keywords would contain similar keywords as the print, but that a different emphasis will be located. Indeed this proved to be the case. With the comparison of the top 50 keywords similar topics as the print dataset were predominant – hardly surprising given their shared participation to a common end. Yet when the individual time periods were compared with electronic dataset, and with each other, it was found that keywords which appeared to supplement the *activities* of the SOEIS actually increased over time, whereas words which supplement the *functioning* of the SOEIS decrease. This is in stark contrast to the results of the print analysis where the occurrence of *function* oriented keywords appeared to increase.

Thus, internal communicative domains of the SOEIS were shown to be different; the difference between the print and electronic datasets can be partially explained by the role of each medium through the course of the project. The email communications were more process oriented, in terms of activity; rightly so, as it was largely by using this medium that SOEIS participants mutually decided upon meeting locations, introduced new ideas and suggested alternatives. Writing, as a formalized mode of communication, was shown here to be geared towards the functioning of the project and this can be understood with respect to the constraints placed upon communication by the pressure to create milestones and final reports.

The external communicative domains of the SOEIS were then assessed. Journal referencing activity and mailing list activity were subjected to different kinds of analyses, but were assessed with the same conceptual grounding. That is to say, both domains were unique in their manifestation, but were conceptually similar: both journal articles and threaded messages are written as *responses* to the literature relative to their respective domains, and are characterized by *continued* discourse. As representative of the internal dynamics of the SOEIS, print was selected as the exemplar of a Mode I oriented process of knowledge production and the electronic as more Mode II oriented. Similarly, journal publication is traditionally Mode I oriented, whereas mailing lists are Mode II. One must take caution, however, not to assume these to be mutually exclusive, since the dynamics of journal publication are certainly affected by the rise of new disciplines and hence new journals, as evidenced by the appearance of the Innovation literature in the citation neighbourhoods of *Research Policy* and *Scientometrics*, as shown in the publication systems analysis. Similarly, mailing lists were shown to exhibit traditional print oriented Mode I characteristics.

In *Chapter VI: Analysis of Journal Publication*, it was asked: "can networks of interrelationships be discerned by comparing the sum of most cited and most citing referenced journals? The SOEIS reference environment was shown to be policy and informatics oriented with the predominance of references going to *Research Policy* and *Scientometrics*. The SOEIS group was found to heavily cite *Research Policy*, while the group was itself cited primarily by *Scientometrics* articles which revealed a cognitive bias of the SOEIS group. It was shown that the publication environment exhibited a unidirectional flow of citation behaviour – *Scientometrics* was shown to heavily cite *Research Policy*. *Research Policy* is understood here to be the context of the application of analyses performed in *Scientometrics*; *Research Policy* is where scientometric studies are used and authenticated.

The network analysis performed in *Chapter VII: Analysis of Mailing List Environment* answered the question of whether Internet mailing lists differ significantly with respect to their list participation and threaded-ness. Differences were found between project, intermediary and field level lists and the examination revealed that the national lists did not operate in terms of threads. It was found that email communication via Internet mailing lists do foster unique network relations but also reinforce network relations associated with print media; a mixture of transition was found.

System:

The SOEIS communications have been observed as unique domains through which knowledge has been produced. Self-Organization Theory was used, in part, to describe how print and electronic media use should be understood as mutually implicated phenomena as they have formed the single operation of the system of SOEIS communication. The systemic analyses performed on the four communicative domains analyzed treat each as a unique operation (of the collective SOEIS system), responsible in part for the recursive production of knowledge. By observing patterns in the observable phenomena, the analyses sought to identify the (largely unobservable) system of communication.

It was expected that an analysis of the print communications would reveal points of critical revision, showing path dependencies in the dataset. Each stage was expected to be instrumental to the furthering of the project communications in this medium. The measure juxtaposed each time period with each successive time period for its expected information content. Contrary to the expectation, critical transitions were not found to be necessary for the communication to develop over the dataset. While path dependencies were not found in this analysis, it was shown that the transmission of words was better over the entire document set than the transmission over the document set of shared words. Similarly, for the systemic analysis of the SOEIS electronic dataset, no path dependencies were found to indicate critical revisions in the information exchanged. When the electronic dataset was subjected to an analysis of word transmission and specificity, and the results compared with the results of the print analysis, transmission was found to be better across electronic datasets, which was caused by the occurrence of words in some time periods and not in others. Specificity remained lower in the electronic dataset. The systems analyses of the internal communicative domains of the SOEIS revealed that the print dataset achieved

the same communication as the electronic with less words, yet it was also shown here that the transmission of words was better in the electronic dataset than in the print.

Differently oriented analyses were employed to assess the systemic dimensions of the external communicative domains of the SOEIS. The systems analysis of the SOEIS publications analyzed the co-citation relationships between *Scientometrics* and *Research Policy* given their centrality to the citation environment of the SOEIS. Using the relations between these two journals as the baseline as measured through the factorial structure of their aggregated mutual citations, the question was asked: "can parallels be found in journal-journal distributions over time." In accordance with the expectations of the analysis, the relationships between the identified clusters of journals provided an overview of the changing disciplinary emphases in the science system relevant to the SOEIS during the time period 1996 thorough 2000. *Research Policy* and *Scientometrics* were shown to have a unique relation vis-à-vis each other. On the side of *Scientometrics* the two journals appeared to grow closer together over the five years of the analysis; on the side of *Research Policy*: the two journals grew apart, with the exception of the year 2000 in which they appeared closer. The systemic analysis of the SOEIS publication environment has shown a cognitive orientation of the SOEIS group toward policy and informatics journals and has reinforced the finding of the network analysis that revealed a unidirectional citation behaviour: *Scientometrics* relies upon *Research Policy* for the legitimization and authentication of published analyses, but *Research Policy* was not shown to cite *Scientometrics* with the same fervour.

The systemic analysis of the SOEIS mailing list environment aimed to find self-organizational properties of the project and field level Internet mailing lists under analysis (the intermediary or national level lists were left out of the analysis, as it was shown before that they do not operate in terms of threads). When observed from this macro perspective it was expected that some mailing lists would exhibit self-organization while some would not, thereby enabling a distinction. When compared for thread size and frequency none of the mailing lists were found to exhibit these properties. It was concluded that the datasets as compiled were not suited to the analysis since it became evident that much larger datasets would be needed to find statistically significant evidence of Self-Organization.

Conclusions

Finally, the concluding section of this chapter will highlight the central findings of the dissertation. Here the core findings are listed in rank order with the most significant findings down to those of lesser significance. The findings are also divided into those which concern the internal communicative dynamics of the SOEIS and those which concern the external.

1. Internal: Print and electronic writing differed in their architectural make-up; the SOEIS print communications proved to be heavily codified and aggregative, whereas electronic communications appeared resistant to codification. These findings were argued in the architecture and system

analyses in *Chapter IV: Analysis of Print Communication* and *Chapter V: Analysis of Electronic Communication.*

2. Internal: Print and electronic keyword distributions were different in their respective emphases; the SOEIS print communications were shown to bias *function* oriented words, which were shown to increase over the dataset, in contrast to the electronic communications which were shown have a decreasing occurrence of *function* words in favour of words which contributed to the *activity* of the SOEIS project; email communications were found to supplement project activity. These results were shown in the network analyses of *Chapter IV: Analysis of Print Communication* and *Chapter V: Analysis of Electronic Communication.*

3. External: SOEIS publications were shown to bias Policy and Informatics oriented journals as evidenced by the strong predominance of *Scientometrics* and *Research Policy*. The SOEIS group was shown to cite *Research Policy* articles in an effort to authenticate the policy relevance of scientometric research; the group was in turn cited by journals published in *Scientometrics* thereby revealing a one way publication flow. This result was shown in the network and system analyses in *Chapter VI: Analysis of Journal Publication.*

4. External: SOEIS mailing list environment revealed that email does foster unique network relations between researchers, but that email serves to supplement the print medium as evidence was found to support the expectation that the informal / informal distinction associated with print was found to be imported into this new medium as project, intermediary and field level lists. The project mailing list EuroCon-Knowflow was found to behave like field level lists, as revealed by its high level of mail activity and thread participation as shown in the architecture and network analyses of *Chapter VII: Analysis of Mailing List Environment.*

Overall it can be argued that the internal dynamics of the SOEIS as contained in the print and electronic communications conformed to the expected distinction between Mode I and Mode II processes of knowledge production, respectively. However, in the external communicative domains it was found that although predominantly Mode I, journal publication did exhibit Mode II characteristics (Innovation literature) and the mailing lists were shown to exhibit characteristics associated with the print medium such as the distinction between formal and informal communications, and was therefore also Mode I oriented. The distinction between Mode I and Mode II was clear in the analyses of the internal communicative domains of the SOEIS, but was less so in the analysis of the external domains thereby revealing the intricacy of the overlap.

This exploratory analysis has highlighted some specific ways in which we can examine these phenomena into the future. In the last and final chapter the limitations identified in the course of this research will be discussed, suggestions for further analyses provided, and finally it will deliver some design specifications for an envisaged software program to aid in the performance of similar analyses into the future.