

## **Threaded email messages in Self-Organization and Science & Technology Studies oriented mailing lists**

ANDRÉS ZELMAN, LOET LEYDESDORFF

*Science & Technology Dynamics, The University of Amsterdam, Amsterdam (The Netherlands)*

The paper addresses the potential of Internet mailing lists to enhance academic research with respect to *Gibbons'* distinction between Mode I and Mode II knowledge production (*Gibbons et al.*, 1994). We examine threaded email messages in a selection of Self-Organization and Science & Technology Studies oriented Internet mailing lists to illustrate the internal dynamics involved in the electronic production of knowledge. Of particular interest is the EuroCon-Knowflow mailing list which houses the electronic communication of the Self-Organization of the European Information Society (SOEIS) research group.

The research focuses upon the discussion threads of mailing lists. The use of threaded messages as our hermeneutic units of analysis provides the basis for a reflection upon three key theoretical positions: Medium Theory, Actor-Network Theory, and Self-Organization Theory. With respect to the latter, we measure for self-organized criticality by comparing the frequency and size of threaded messages. Using this and other methods as operationalized modes of theorizing we reveal network dynamics particular to the Internet mailing list.

### **Introduction**

Arguably, the introduction of the Internet mailing list has contributed a new dimension to academic research and its communication. The primary aim of this study is to outline the dynamics of the Internet mailing list with respect to its potential to enhance networked communication, and by extension, influence the process of knowledge production. We argue that network relationships fostered by the use of electronic media can be understood in part through an examination of threaded email messages. Importantly, email messages do not occur at random but are the product of collective directed action – they are events that occur in succession, often with reference to each other. We understand email messages in threads to be like words in sentences – they only achieve meaning within context. Our analysis is therefore focused upon how threaded email messages, as individual units of communication, can be understood together as concerted collective action.

The secondary aim of this study is to outline the key similarities and differences between the EuroCon-Knowflow mailing list, which houses the communication of the Self-Organization of the European Information Society (SOEIS) research project, and a selection of other related mailing lists. We compare the frequency of interaction with the size of the threads to reveal network dynamics particular to the Internet mailing list. Clearly, the examination of threaded messages as instances of interaction is what makes this study quite unique. Moreover, by focusing on threaded messages our analysis of Internet mailing list dynamics aims to incorporate several distinct but overlapping theoretical perspectives. Self-Organization and Science & Technology Studies mailing lists were selected to reflect the theoretical perspectives employed in the analysis.

The study itself is motivated by a number of current debates concerning the impact of electronic media on the academic environment. (For debates concerning the impact of electronic media and the changing nature of academic research, see: *Melody*, 1994; *Lubanski*, 1998; and *The Information Society*, Vol. 11, special issue on the Harnad-Fuller debate, 1995.) We work from the assumption that changes in the mode of communication indicate changes in the networked relations between those communicating. The key point here is that new electronic means of communicating one's research are perceived to supplement already existing relations between scholars, and that this changes the dynamics of information producing institutions.

*Gibbons et al.* (1994) have addressed similar concerns but from a sociological perspective. They describe the changing nature of scientific research as a shift from Mode 1 to Mode 2 knowledge production which indicates a move away from knowledge produced in traditional research contexts to an environment in which knowledge is created in broader trans-disciplinary social and economic contexts. This development, they argue, is related in part to the introduction of electronic media into academic environments. Similarly, two recent publications of the OECD (1996, 1997) recognize these changes in the science system as part and parcel of the introduction of new Information and Communication Technologies (ICTs).

Empirically, our work is related to *Korenman and Wyatt's* (1996) analysis of group dynamics within email lists, *Hernandez-Borges'* comparative study of Pediatric mailing lists on the Internet (1997), and *Matzat and Lubanski's* (1998) analysis of informal academic communication via Internet mailing lists. However, despite these previous studies, there appears to be a gap in the literature related to how *threaded* email communications can be understood as a mode of knowledge production particular to the technology of the Internet. Accordingly, our contribution to this discourse analyzes *threaded messages* to illustrate the production of knowledge as an ongoing process, and it employs several theoretical positions to describe electronic communication using

network metaphors. A thread is a string of messages originating around a single topic of discussion; it is a series of messages in which each message refers to the previous. The focus on threaded messages permits us to infer how information is exchanged, and how this mode of exchange differs among lists. Arguably, our use of theoretical positions that concern network (not individual) behaviour may enhance our understanding of mailing lists as a unique mode of knowledge production.

### Theoretical context

The theoretical bodies selected to ground the analysis are *Medium Theory*, *Actor Network Theory*, and *Systems Theory*. Each is relevant as a perspective that examines the nature of human interaction, and each employs network metaphors to describe patterns of social relation. They are collectively employed for this analysis as they help frame the types of questions we can ask about the operation of mailing lists as conduits for social communication. Individually they offer original insight into the nature of networked communication, and considered in tandem they provide a cohesive frame for our analysis.

Medium Theory provides this analysis with both a language to address media impact, and a historical framework with which to contextualize this impact. Recently this tradition has gained some ground as a methodology that can be formally employed as a means of observing these differences. *Meyrowitz* (1994) introduces a distinction between first and second generation Medium Theory. First generation concerns the formation of deep, unconscious frameworks that influence human perception and interaction. By contrast, second generation concerns the role of human agency in the production of meaning. Most relevant here is *Meyrowitz's* position that the physical setting of any situated communication is far less important than the informational worlds which are being exchanged. He argues that media should therefore be understood as facilitating networks of information. Medium Theory thereby provides us with the important notion of the *information network*. This helps frame our analysis in the sense that the notion of information networks informs our understanding of the nature of *threaded messages* as collectively produced informational worlds.

Actor Network Theory (ANT) offers this analysis a perspective similar to that of Medium Theory in that both theoretical bodies share a common emphasis on outlining networked relationships. In the case of ANT, *Latour's* principle of symmetry provides

us with a rich example.\* He argues that: “networks of associations replace both the content of science and society. The growth of networks through translations replaces differences of scale between micro- meso-, and macrolevels.” (Latour, 1992, p. 275).

In short, like Medium Theory, Latour’s actor-network description aims to harness that aspect of human communication that exists above and beyond individual action. Callon et al. (1986) provides us with another relevant actor-network perspective; it is argued that word and co-word analyses can be framed conceptually with actor-network approaches. The shared perception between these two disciplines is that it is not the content that ‘makes’ the relationship but rather the nature of the interrelationships themselves that determine the outcome of the communication. Thus, for the purposes of this paper, we observe that both Medium Theory and Actor Network Theory share a common focus on patterns of communicative interaction.

Finally, the third theoretical position employed here also shares this network approach to studying human communication. However, for second-order Systems Theory, or more accurately, Self-Organization Theory, individual actors are not of key concern.\*\* What we examine are the networks within which we operate. Luhmann (1982; 1990) describes social interaction as a recursive operation that systemically (re)organizes society. Again, the concern is not individual human action, but rather, human interaction, and hence communication. Self-Organization Theory is useful to our project as the phenomenon of threaded messages can be seen as a recursive operation through which knowledge is recursively produced via collective interaction. Like Medium Theory and ANT, Self-Organization Theory helps frame the *thread* as our key unit of analysis. More importantly, it theoretically grounds our comparison of the frequency of interactions (how often threads occur) with the size of interactions (the number of messages per thread) as a test for self-organizational properties in Internet mailing lists.

Each of these theoretical perspectives provides a window upon the network dynamics of mediated communication. Clearly each helps frame the context of the examination through highlighting the networked dimensions of the Internet mailing list, and each lends a perspective that permits a more detailed description of the distinction between Mode I and Mode II knowledge production. Together, these theoretical bodies

---

\* Latour’s contribution to ANT cannot be merely summed up by the principle of symmetry. However, his position that actors contribute different things in different contexts, and at different times is relevant to our analysis, as we observe this phenomenon occurring in mailing list thread dynamics.

\*\* Self-Organization theory is a particular branch of Systems Theory. Clearly the notion of Self-Organization extends beyond the work of Luhmann, but his ideas ground the principles that frame this analysis.

frame this analysis in the sense that the node through which they intersect is the notion of the thread: the observation of threaded messages achieves a different meaning with each perspective.

In light of Medium Theory, individual email messages can be understood to collectively form an information network along a historical axis; list activity thus becomes the measure of the degree of shared informational world formation. In light of Actor Network Theory, *threaded* email messages can be understood as an indicator of information network formation created and sustained through individual actions. This extends *Meyrowitz's* notion of the information network in the sense that actions are isolated as the means through which the information network is continually reproduced. Finally, with Self-Organization Theory we lift the notion of information network from local actors and actions to a next-order perspective that treats thread size and frequency as fingerprints of the recursive operation of the social system, above and beyond individual agency.

### Research questions and expectations

With respect to the Internet mailing list, our concern is primarily limited to the *network* dynamics involved; only secondarily do we address the content of the information exchanged. To be clear, we do not address how the content has changed, but rather, how the networked relations between people communicating are changing. The theoretical bodies outlined above reflect this approach, and they help frame the types of questions we can ask about network dynamics. Clearly there is no necessary relation between the theories and methodologies employed in our analysis; the methodologies are best perceived as operationalizations of specific modes of theorizing.

As indicated, threaded messages are our key unit of analysis because they serve as a focal point for questions concerning both individual and collective behaviour. Through analyzing (threaded) email messages as events using the theoretical perspectives outlined above we can gain an understanding of the networked dynamics of the Internet mailing list. Three *research questions* can thereby be identified, each with reference to a particular theoretical body.

- How does the Internet mailing list operate as an information network, and can we identify qualities common to all lists, or do different lists perform specific functional roles in academic communication? This question is informed by the Medium Theory notion of the *information network*, and aims to characterize each list with respect to its perceived function in the academic network.

- Are there notable differences between Internet mailing lists with respect to their communication statistics? That is, what can we determine about each list given the threaded-ness of its communication? The question is informed by Actor Network Theory, and aims to outline the network qualities of the Internet mailing list as a product of collective actions. The key focus here is how individual messages compile to form information networks.
- Can we identify discernible self-organizational network properties of the Internet mailing list, and if so, which lists appear to be self-organizational, which do not, and why? Self-Organization Theory informs this research question. By comparing the size and frequency of threads irrespective of the individual contributors, we aim to outline the recursive aspects of the information network itself.

Clearly each additional theoretical perspective enables a new type of question to be posed and a new frame of analysis to be employed. Given these research questions, we now highlight some of the expectations of the mailing list analysis. In what follows we will briefly describe the central expectations of each research question.

With respect to research question one, our primary expectations concerned the variation among the lists with respect to their descriptive statistics; we did expect that the lists under examination would vary according to the status of each. The EuroCon-Knowflow mailing list, for example, functions in the context of the SOEIS research project and in this sense was expected to differ in relation to lists at the field level. We have therefore identified three levels: *project*, *intermediary*, and *field*. This is of concern to our analysis because while printed communication fostered a division between formal and informal communication, we expect that this distinction blurs with electronic media. Thus we are motivated to ask a secondary research question here: what does this blurring mean for formal communication at the field level and for informal communication at the level of the research practice? Accordingly, we expect that our analysis will provide insight for mailing list participants involved with project, intermediate and field level lists.

As with the first research question, our primary expectations of research question two concern how the EuroCon-Knowflow list compares to the sample set. The primary difference here is that the comparison relates to the communicative statistics (the threaded-ness of the communication) of each list. Unlike the aforementioned expectation of a blurring between formal and informal knowledge production at the project, intermediary and field levels, we expect that one can find a reflection of these differences through an examination of threaded email behaviour. The intentional

positioning of email-listings at the project, intermediary or field levels is expected to reinforce these differences despite the blurring capacity of electronic media. In this sense we expect that electronic communication does not supplant traditional media (print) but supplements it. Our concern is whether individual emails (actions) reinforce the distinction between formal and informal communications or whether the dynamics of the net erase the original differences.

Finally, with respect to research question three, our expectations revolve around the issue of net dynamics in a collectively produced sense. We expect that when observed from a macro perspective some mailing lists will exhibit self-organizational properties while some will not. The key issue here is how the network dynamics can be compared so as to make this distinction. Accordingly, we expect that comparing thread size and frequency using *Bak and Chen's* (1991) measure of self-organized criticality will enable a next order analysis of Internet mailing lists as information networks that are collectively created and maintained regardless of individual action.

### Materials and methodologies

As indicated, we have selected Science & Technology Studies and Self-Organization oriented Internet mailing lists as they reflect the theoretical priorities of our analysis. In addition, the lists used for this study were selected on the basis of whether the message archives were publicly available. Using these criteria, eleven mailing lists were selected for the analysis: Autopoiesis, CyberUrbanity, Deukalion, ETK, EuroCon-Knowflow, Luhmann, Principia Cybernetica, Sci-Tech Studies, SimSoc, SOIS, and Xaos.\*

The eleven mailing lists were observed from their dates of inception up to and including November 6, 1998 (6/11/98). The first step in the gathering of the materials involved the collection of the critical information for each list. This information included the member list, email address list, messages per member, and the total number of messages. Table 1 provides an overview of the relevant critical features of each mailing list, including date of list inception, duration in days, number of subscribers, and total number of mails.

---

\*See Appendix A for the subscription data, list-server data, and archive location for each list employed in this analysis.

Table 1  
List information (up to and including 6/11/98)

Mailing list	List inception date	Duration in days	Number of subscribers	Total number of mails
Autopoiesis	9 / 5 / 96	910	300	653
CyberUrbanity	30 / 5 / 95	1255	68	1151
Deukalion	8 / 4 / 97	577	51	580
ETK	11 / 5 / 97	544	41	558
EuroCon-Knowflow	17 / 6 / 96	872	110	672
Luhmann	13 / 12 / 95	1058	355	1553
Principia Cybernetica	10 / 5 / 94	1640	127	1767
Sci-Tech-Studies	1 / 1 / 97	675	967	950
SimSoc	14 / 4 / 97	571	413	366
SOIS	22 / 4 / 98	198	77	190
Xaos	14 / 1 / 97	661	171	835

Once the preliminary data for each list was collected we were able to gain an initial sense of the role that each list plays in the academic environment. It may prove beneficial here to distinguish which lists are project, intermediate and field level, respectively. The only list which functions solely at the project level is the EuroCon-Knowflow. However, the SOIS\* list can also be considered as project level as it originated as an extension of the EuroCon-Knowflow list; the Autopoiesis and SimSoc lists similarly have their roots as project lists but have acquired the status of field level lists. The intermediary lists examined in the analysis are all of Greek origin; they include: CyberUrbanity, Deukalion, ETK, and Xaos.\*\* Finally, the field level lists include: Luhmann, Principia Cybernetica, and Sci-Tech Studies. Interestingly, the field level lists have more members than the project or intermediate levels, but this appears to be the only constant variable in this observation.

In the following section we describe in detail the three central empirical analyses performed on the data collected from these eleven lists. Briefly stated, we analyze the data for 1) *Basic statistics* to determine how we can compare each list based on the information given above, 2) *Communication statistics* to determine the degree of 'information network' formation occurring in each list, and 3) *Self-Organizational Statistics* to determine which lists operate self-organizationally and which operate hierarchically.

\* The SOIS was created in order to facilitate communication about the Information Society in general, not specifically in relation to Europe or the SOEIS research project.

\*\* This research was performed in Patras, Greece, enabling access to a several Greek Science & Technology Studies and Self-Organization Theory oriented mailing lists.



## Results

Again, we have performed three distinct levels of analysis in this study. Respectively, the three steps entailed the analysis of descriptive, communicational, and self-organizational statistics. These steps align with the three key theoretical positions employed in this analysis: Medium Theory, Actor Network Theory, and Self-Organization Theory.

*Step one:* calculation of descriptive statistics. As indicated above, for each of the eleven mailing lists we compiled the member list, email address list, messages per member, and the total number of messages. For each list we then calculated list activity by dividing the total number of mails by list duration (in days). Figure 1 shows the results.

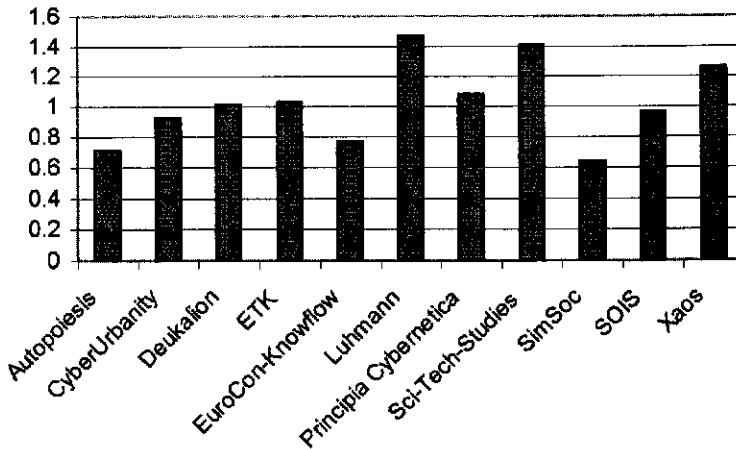


Fig. 1. List activity (mails / day)

We see from the information presented here that over half of the mailing lists under observation have a list activity of at least one email per day. The mean is just over 1, and the standard deviation is 0.27. Here we can understand *list activity* as an indicator of network formation – in the sense of the Medium Theory “information network”. Interestingly, there are three groups of lists visible here. The first are the cognitively driven lists with field-type characteristics (Luhmann, Principia Cybernetica, and Sci-Tech-Studies); these exhibit particularly high traffic density. The second group of lists are project related (EuroCon-Knowflow, SOIS, SimSoc, and Autopotesis) and they exhibit lower levels of traffic density. Finally, the third grouping includes national lists

with an in-between level of traffic density. We observe that the national level relates the cognitive dimension with an institutional one. This runs counter to our original expectation that electronic media blur the formal/informal distinction reinforced by print media – we have observed variation between project, intermediary, and field level lists.

Equally meaningful are the *list participation* statistics calculated as a percentage of active subscribers. (Those who do not contribute to the list are referred to as lurkers (non-active). Mailing list activity is calculated as the percentage of members who have contributed at least one message.) List participation provides us with another means of comparing each mailing list on the basis of the dynamics involved in the fostering and maintenance of an Internet mailing list as an information network. Figure 2 shows the results of this calculation.

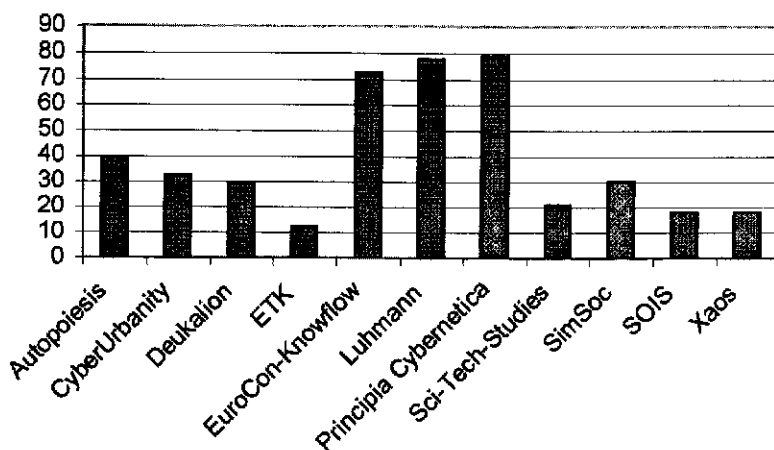


Fig. 2. List participation (%)

We learn from this second calculation that some lists (like Sci-Tech-Studies) have a remarkably high list activity, while the actual list participation remains considerably low. This indicates that for some lists there are few very active subscribers, and an overwhelming amount of members who subscribe but do not participate (lurkers). Perhaps more interesting is that the EuroCon-Knowflow list ranks among the top three lists with particularly high degrees of participation. The Luhmann and Principia Cybernetica lists both operate at the field level, whereas the EuroCon-Knowflow list operates at the project level. In these cases we observe a high degree of “active” information network formation. Interestingly, these lists are very related in terms of the subject matter addressed.

As indicated, our expectations concerning the capacity of electronic networking to blur formal and informal dimensions traditionally associated with print were not confirmed. When we considered list participation, however, we did expect that given the intentionality involved in sending messages in response to another (thereby forming threads) we could identify the differences between project, intermediate and field levels. This was indeed the case – the calculation of list participation seems to indicate that the lists with the highest degrees of participation are generally field level lists with the exception of the EuroCon-Knowflow. This observation is further reinforced in the next section where we examine list participation in *threads*.

*Step two* entailed the calculation of the communication statistics for each list, and reflects the ANT theory of network formation. For each list we counted the number of threads and the number of individuals participating in each thread. Once this data was collected we measured the percent of members participating in threaded mails to enhance our understanding of how each individual mailing list is the collective product of distinctly individual actions. The *percentage of threaded mails* was determined by dividing the number of messages occurring in threads by the total number of messages. The *percentage of contributing members* was then calculated by dividing the number of members participating in threaded messages by the total number of active subscribers. Figure 3 shows the results of this calculation.

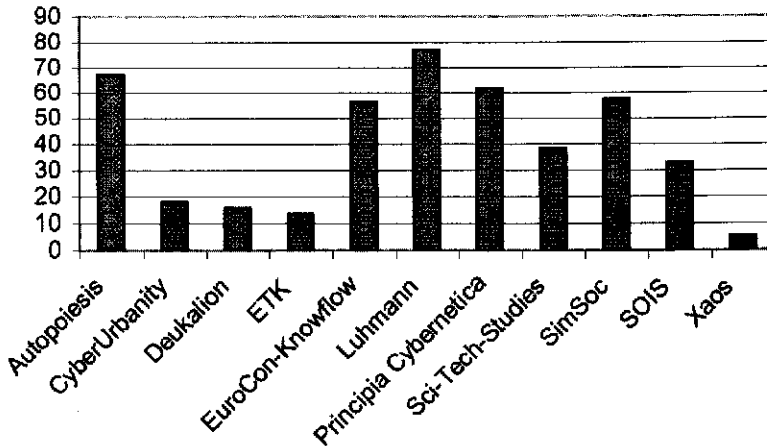


Fig. 3. Participation in threaded mails (%)

The chart reveals that the intermediary (Greek) lists do not function in terms of threads. They will be left out from further analysis because here we are particularly interested in thread dynamics. We have also identified that the lists with a (cognitive) focus on self-organization seem to be organized more in threads than the others. We consider the threaded-ness here as a codification of cognitive organization.

As noted above, our expectations concerning the lack of blurring between formal and informal dimensions traditionally associated with print were not confirmed by our calculations. Here too, as indicated in Fig. 3. we find that the distinctions between project, intermediate, and field level lists are reinforced. We have learned that there appears to be a correlation between the total list participation and the level of thread participation. The Pearson correlation is 0.96; Fig. 4. shows this correlation graphically.

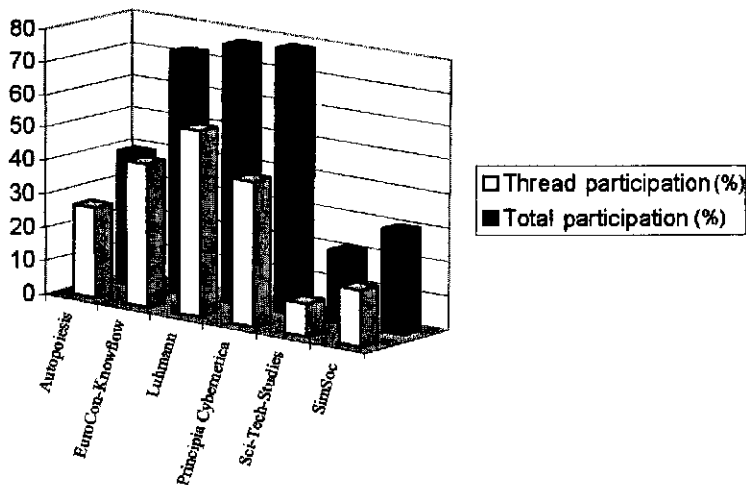


Fig. 4. Total participation (%) and thread participation (%)

As a second task in this step, we categorized each thread into one of six different message topics (*administrative, announcement, maintenance, miscellaneous, query, and theory*). We then calculated these topics as a percentage of total threaded mails. Figure 5 displays the results of this step.

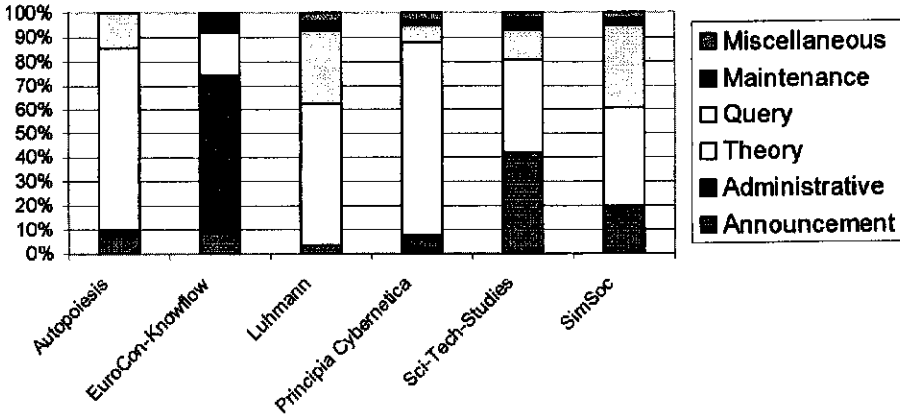


Fig. 5. Overall thread distribution

Again, we emphasize the relevance of Actor Network Theory in understanding (information) network formation as a product of collective action. By specifying thread activity by topic, we were able to assess the communicative value of each mailing list. That is to say, by specifying thread topic we isolated different types of threads to identify each list as exhibiting certain characteristics.

From Fig. 5 we see little correlation between field and project levels in their thread distribution. We have learned that the administrative threads figure particularly low (if at all) in all mailing lists except EuroCon-Knowflow. But this is not surprising as it is the only project-related list under analysis. Here we observe that theory threads figure particularly high in all lists examined in this step of the analysis, with the notable exception of the relatively low theoretical count of the EuroCon-Knowflow list. When we compare the respective theory, query, or announcement distributions we gain a better sense of the collective priorities of each list. Perhaps more interesting would be the understanding gained by comparing the distribution of thread topics with thread participation.

*Step three* involved a slightly more detailed analysis of the thread communication statistics for each mailing list. The additional detail concerns the analysis of variance in the size and frequency of threads in order to deduce self-organizational dynamics particular to Internet mailing list communication. This procedure stems from the theory of self-organized criticality and involved the counting of the number of messages

per thread, and then calculating the frequency of thread size. We then translated the results into logarithmic scale to obtain the parameters for each list. Figures 6 and 7 show two examples of the graphs produced in this step.

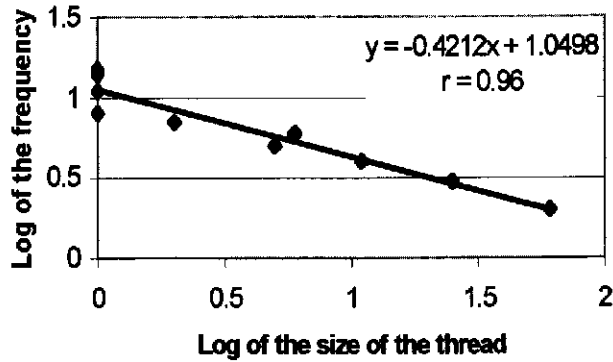


Fig. 6. EuroCon-Knowflow – messages log

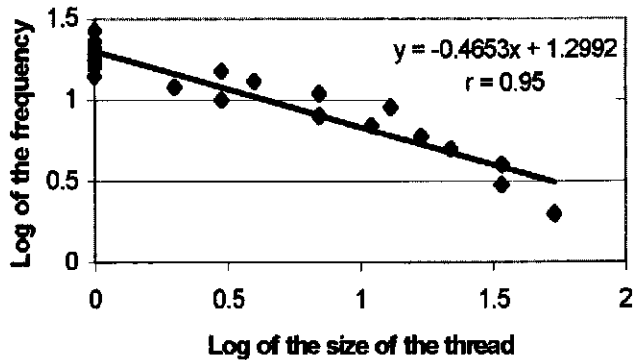


Fig. 7. Luhmann – messages log

Table 2  
*Log formulae comparison* displays the log formulae revealed through this analysis

List	y	r
All Lists <sup>a</sup>	$-0.4592x + 3.502$	0.94
Autopoiesis	$-0.05169x + 1.1533$	0.90
EuroCon-Knowflow	$-0.4212x + 1.0498$	0.96
Luhmann	$-0.4653x + 1.2992$	0.95
Principia Cybernetica	$-0.6234x + 1.3955$	0.87
SimSoc	$-0.6616x + 1.1104$	0.84
STS	$-0.8952x + 1.248$	0.70

<sup>a</sup>All Lists refers to the complete set of eleven Internet mailing lists selected for the analysis.

Unfortunately, we are unable to determine from this analysis which lists are self-organizational and which are hierarchical. While none of the lists appear to be self-organizational, we cannot conclude that there are none at all, because we are not able to determine which level would in fact indicate self-organization. It may be the case that we have isolated mixtures of self-organization and non-self-organization, since we have a middle grouping which has an average of  $-0.716$ , while there are periphery lists ranging from  $-0.0517$  to  $-0.895$ . Nonetheless, Self-Organization Theory remains a relevant stance here. While we expected to observe some semblance of self-organization, we have learned that the data sets themselves appear to be too limited to reveal any self-organized criticality. Indeed, more traditional measures of self-organized criticality employ much larger data sets, and the measure of self-organizational properties employed here is of little use given the limited amount of thread frequencies in each of our lists.

Again, the reader should note that this does not necessarily imply that there are *no* self-organizational elements operating here, but that the data sets as they have been compiled are not suited to this type of analysis. Thus, while our (third) research question highlighted the difference between hierarchically and self-organizationally oriented dynamics, we have not abandoned the possibility that there may be self-organizing aspects at hand. We have learned that we cannot observe self-organization here – given the limitations of the data – but this does not lead us to conclude that mailing lists do not, in fact, have any self-organizing qualities. Indeed, it may be that hierarchical and self-organizational dynamics operate in tandem.

## Conclusions

Our primary aim in this analysis was to outline the dynamics of the Internet mailing list with respect to its potential to enhance networked communication. Addressing this aim involved a detailed study of the processes of knowledge production evident in the email messages that constitute the exchange between members of Internet mailing lists. We examined a selection of Science & Technology Studies and Self-Organization oriented mailing lists to understand the network relationships fostered by the use of electronic media, and we have found significant results.

The list comparison provided us with evidence that Internet mailing lists operate as information networks (Medium Theory), and that they are actively produced and maintained through concerted collective action (Actor Network Theory). We learned that field level lists perform roles particular to their specific functions with respect to participation in general, and that there is a strong correlation between list participation and thread participation. This reflected our original expectations that despite the blurring capacity of electronic media, the formal/informal distinction is maintained with respect to project, intermediate and field level lists when examined for their respective levels of participation. We expected that since mail-listings are intentionally posted we would find that the formal distinctions apparent in traditional (print) media would in fact be discernible. We therefore conclude that electronic relations do not supplant these original distinctions, but reinforce them. However, this is not to say that they remain identical. Clearly, electronic media do foster new and unique types of network relations but they also appear to reinforce those relations associated with the use of traditional (print) media. We argue that electronic media do not replace earlier dynamics, but that they in fact supplement them. The Internet does not erase these original differences; such communication does not occur in a vacuum, but with reference to substantive communication, and we therefore find the mixture of a transition.

For formal communication at the field level, and for informal communication at the level of the research practice, these results imply that one may expect significant differences in the ways that individuals may electronically communicate with each other regardless of rank or experience. But, despite this observation, the formal/informal distinction is nevertheless imported into this new media environment. Finally, with respect to our primary aims for this study, contrary to our expectations, we were unable to discern self-organizational network properties in any of the Internet mailing lists under analysis.



The secondary aim of this study was to outline the key similarities and differences between the EuroCon-Knowflow mailing list, which houses the communication of the Self-Organization of the European Information Society (SOEIS) research project, and a selection of other related mailing lists. We have learned that while the EuroCon-Knowflow list exists primarily as a project meeting place, its dynamics reflect those of the field level lists. We take this to be a positive sign in the sense that there appears to be a rich level of threaded discussion, making the list both interesting and dynamic. This changes the relation between informal and formal since it brings the field dynamics within the control of intentional action.

### **Suggestions for future research**

Among the most interesting insights obtained during the process of this research can be communicated here in a number of recommendations for those pursuing similar analyses. We found during the course of the research that mailing list providers employ a myriad of different programs for enabling, indexing and archiving messages. While we were able to obtain all of the information required for the analyses from the respective archives on the Internet, the reader should note that there is no standardized form of archiving mailing list output. The primary difference between list processors is the way the archival function operates, meaning that while some list archives were quite comprehensive, many were poorly constructed, making this research particularly labour intensive. In the case of the latter, it was necessary to manually count the threaded messages, and (often) reverse the date order of messages to obtain comparable results. Thus, through slightly altering the collection method in some cases we were able to achieve comparable data sets. It quickly became apparent how much more could be done along these lines of research if a means of standardizing list archival functions were available. If future researchers were to find evidence of self-organized criticality in Internet mailing lists, the examination would necessarily demand that a much greater amount of raw data be collected. Presumably, an analysis performed on a greater amount of lists would find a much richer distribution of email messaging behaviour. And indeed, this would only be possible through the development of a software program that could perform the necessary standardization of indexical, archival, and retrieval functions.

In conclusion, we specify some recommended features of such a software program. An appropriate design would necessarily have to consider several basic features such as an indexing program to record, archive and retrieve threads efficiently, as well as an exportation function to enable further interpretation of the results in standard statistical

and graphing programs. The key problematic here is related to standardizing the output of such a wide range of different list processors. Indeed, it would be difficult if not impossible to implement a commonly shared archival input standard. Alternatively, a program\* could be written which would serve to standardize the output of all Internet mailing lists, but the problem remains that if the individual mailing list provider were to change the design of the web-archive, the program coding would become obsolete. There is no easy solution to this problematic, but clearly as the Internet grows the demand for this type of research program will become more salient.

\*

This research has been partly funded by the European Union under the Targeted Socio-Economic Research (TSER) program (SOE1-D197-1060). The authors would like to thank Moses *Boudourides* for valuable contributions to this research.

## References

- BAK, PER, CHEN, KAN (1991), Self-organized criticality, *Scientific American*, January, 26-33.
- CALLON, M., LAW, J., RIP, A. (1986), *Mapping the Dynamics of Science and Technology: Sociology of Science in the Real World*, Basingstoke: Macmillan.
- GIBBONS, M., et al. (1994), *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*, Sage Publications, London.
- HERNANDEZ-BORGES, A., PARERAS, L., JIMENEZ, A. (1997), Comparative analysis of pediatric mailing lists on the Internet, *Pediatrics*, 100(2): e8.
- KORENMAN, J., WYATT, N. (1996), Group dynamics in an email forum, *Computer Mediated Communication: Linguistic, Social and Cross Cultural Perspectives*; SUSAN C. HERRING (Ed.), John Benjamins Publishing Company, Amsterdam / Philadelphia, pp. 225-242.
- LATOUR, B. (1992), One more turn after the social turn..., In: *The Social Dimensions of Science*, E. MCMULLIN (Ed.) Notre Dame, Indiana, Notre Dame Press, pp. 272-294.
- LUBANSKI, A. (1998), *Socio-Economic impact of the Internet in the academic research environment*, IRISS Conference paper, Bristol, UK at <http://www.sosig.ac.uk/iriss/abstracts/iriss18.htm>
- LUHMANN, N. (1990), *Essays on Self-Reference* Columbia University Press, NY.
- LUHMANN, N. (1982), *The Differentiation of Society*, Columbia University Press, New York.
- MATZAT, U., LUBANSKI, A. (1998), *Informal academic communication and scientific usage of internet discussion groups* IRISS Conference paper, Bristol, UK at <http://www.sosig.ac.uk/iriss/abstracts/iriss19.htm>
- MELODY, W. (1994), Electronic networks, social relations and the changing structure of knowledge, In: *Communication Theory Today*, D. CROWLEY, D. MITCHELL (Eds), Stanford University Press, Stanford California, pp. 254-273.

---

\* For example, the following XML coding could be used to standardize mailing list output: <thread> <item> <topic>How does one standardize mailing list archival functions?</topic> <authorname>Andrés Zelman</authorname> <authoremail>zelman@chem.uva.nl</authoremail> <response\_to>Thread Id 12345</response\_to> <content>Suggestions for future research</content> </thread>.

- MEYROWITZ, J. (1994), Medium Theory, In: *Communication Theory Today*, D. CROWLEY, D. MITCHELL (Eds), Stanford University Press, Stanford California, pp. 50-77.
- OECD (1996), *Science, Technology and Industry Outlook 1996*, Head of Publications Service, Paris-Cedex 16, France.
- OECD (1997), *STI Outlook 1998: The Global Research Village: How Information and Communication Technologies Affect the Science System*, Industry Committee for Science and Technology, DSTI/IND/STP(97)4.

## Appendix A

### Autopoiesis Mailing List\*

List Name: [autopoiesis@thinknet.orange.ca.us](mailto:autopoiesis@thinknet.orange.ca.us)  
Listserver: [listserv@thinknet.orange.ca.us](mailto:listserv@thinknet.orange.ca.us)  
Archives: <http://www.webconn.com/mail/autopoiesis/>

### CyberUrbanity Mailing List

List Name: [cyberurbanity@demokritos.cc.duth.gr](mailto:cyberurbanity@demokritos.cc.duth.gr)  
Listserver: [listproc@demokritos.cc.duth.gr](mailto:listproc@demokritos.cc.duth.gr)  
Archives: <http://platon.ee.duth.gr/data/maillist-archives/cyberurbanity/>

### Deukalion Mailing List

List Name: [deukalion@platon.ee.duth.gr](mailto:deukalion@platon.ee.duth.gr)  
Listserver: [listproc@platon.ee.duth.gr](mailto:listproc@platon.ee.duth.gr)  
Archives: <http://platon.ee.duth.gr/data/maillist-archives/deukalion/>

### ETK Mailing List

List Name: [etk@thrace.ee.duth.gr](mailto:etk@thrace.ee.duth.gr)  
Listserver: [listproc@thrace.ee.duth.gr](mailto:listproc@thrace.ee.duth.gr)  
Archives: <http://platon.ee.duth.gr/data/maillist-archives/etk/>

### Eurocon-Knowflow Mailing List

List Name: [eurocon-knowflow@mailbase.ac.uk](mailto:eurocon-knowflow@mailbase.ac.uk)  
Listserver: [mailbase@mailbase.ac.uk](mailto:mailbase@mailbase.ac.uk)  
Archives: <http://www.mailbase.ac.uk/lists/eurocon-knowflow/archive.html>

### Luhmann Mailing List

List Name: [luhmann@listserv.gmd.de](mailto:luhmann@listserv.gmd.de)  
Listserver: [listserv@vm.gmd.de](mailto:listserv@vm.gmd.de)  
Archives: <http://stil.uni-duisburg.de/Luhmann/home.html>

---

\* Note that the Autopoiesis mailing list, links and addresses are now obsolete.

**Principia Cybernetica Mailing List**

List Name: [prncyb-l@bingymb.cc.binghamton.edu](mailto:prncyb-l@bingymb.cc.binghamton.edu)  
Listserver: [listserv@bingymb.cc.binghamton.edu](mailto:listserv@bingymb.cc.binghamton.edu)  
Archives: <http://www.cpm.mmu.ac.uk/~bruce/prncyb-l/>

**SimSoc Mailing List**

List Name: [SimSoc@mailbase.ac.uk](mailto:SimSoc@mailbase.ac.uk)  
Listserver: [mailbase@mailbase.ac.uk](mailto:mailbase@mailbase.ac.uk)  
Archives: <http://www.mailbase.ac.uk/lists/SimSoc/archive.html>

**SOIS Mailing List**

List Name: [sois@thrace.ee.duth.gr](mailto:sois@thrace.ee.duth.gr)  
Listserver: [listproc@thrace.ee.duth.gr](mailto:listproc@thrace.ee.duth.gr)  
Archives: <http://platon.ee.duth.gr/data/maillist-archives/sois/>

**STS Mailing List**

List Name: [sts@kant.ch.umkc.edu](mailto:sts@kant.ch.umkc.edu)  
Listserver: [listserv@utkvm1.utk.edu](mailto:listserv@utkvm1.utk.edu)  
Archives: [http://vest.gu.se/vest\\_mail/](http://vest.gu.se/vest_mail/)

**XAOS Mailing List**

List Name: [xaos@demokritos.cc.duth.gr](mailto:xaos@demokritos.cc.duth.gr)  
Listserver: [listproc@demokritos.cc.duth.gr](mailto:listproc@demokritos.cc.duth.gr)  
Archives: <http://platon.ee.duth.gr/data/maillist-archives/xaos/>

---

Received February 7, 2000.

*Address for correspondence:*

ANDRÉS ZELMAN  
Science & Technology Dynamics, Faculty of Social & Behavioural Sciences,  
The University of Amsterdam, OZ Achterburgwal 237,  
1012 DL Amsterdam (The Netherlands)  
E-mail: [zelman@chem.uva.nl](mailto:zelman@chem.uva.nl)