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Accountants and Engineers - Why the Difference?

Supporting paper submitted by Statistics Sweden¹

I. INTRODUCTION

1. This paper takes its point of departure in the Question(s): Why the current increasing interest in small area statistics?
2. We suggest here that we (the NSI's), are due to important changes in the societies we study, compelled to extend the scope and improve the usefulness of our statistical systems that traditionally were/are based on "input/output" models of societies. The current solution to this inadequacy is to stress the importance of process reengineering of organisations and institutions. In spite of the immense complexity of many systems value chains are managed through minutely described processes that are closely monitored through a host of sensors and simulated using complex dynamic models. This paradigm shift must necessarily have an effect on the way statistics are produced and used. In order to exploit these, better micro datasets are needed.
3. The inadequacy of the "input-output" model also points to the inadequacy of the "accountant" approach to statistics due to its focus on macro data sets focussing on structures rather than processes. Given high quality Micro datasets referring to the smallest feasible system of regions (tessellations). From such datasets any micro "Engineering" and macro "Accountant" states may be produced, whereas a statistical system structured as a system of macro-level tables is of very limited use.
4. One increasingly important use of micro data is illustrated by the demand for insights into the spatial distribution of phenomena². Here it has become clear that most the current "small" administrative areas are by far too large to be used for statistical analysis.

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II. Systems Knowledge & information

"Knowledge in the form of an informational commodity indispensable to productive power is already, and will continue to be a major, perhaps the major stake in the world-wide competition for power. It is conceivable that the nation-states will one day fight for control over information, just as they battled in the past for control over territory, and afterwards for the of access to and exploitation of raw materials and cheap labour. A new field opened for industrial and commercial strategies on one hand, and political and military strategies on the other" (Lyotard 1979) *The Post-modern Condition: A Report on Knowledge*

5. The French philosopher Francois Lyotard, as indicated in the quotation (above) taken from his book "The Post-modern condition, a report on knowledge", argued in the 1980's for the increasing importance of knowledge (structured information?) in most aspects of our societies. Lyotard used the term "knowledge" to make a clear distinction between "information" as defined and treated in the informational sciences (Shannon information), and "knowledge" as qualified information structured and "woven" into collectively shared "information systems" that are constantly restructured and improved upon by through endless iterations over time

6. It is not possible to discuss this important question in detail here, so we will merely stress the growing importance of developing ever more effective methods to produce and accumulate information and knowledge structured according to the rules of the scientific method. This foundation for the development of statistical systems have changed radically during the recent decades, both in terms of scope and content.

i) Production costs are rising.

The production of Official statistics is very expensive and rising at the same time that it becomes increasingly difficult to prevent budget cuts. This fact force us to seek new sources of income funds beyond that which comes from taxes.

ii) Demand for multi-usability of data.

The general acceptance of the Internet is at present forcing all institutions and organisations involved in information processing world-wide, to make their products and production processes compatible with standards generally accepted on the Internet. The result of this development is the emergence of one potentially vast information system that allow, whether we like it or not, all information to be combined with everything else. The question of how these systems of knowledge or models should be structured, and upon which observations they should be founded, is of vital importance also for the future of our "Statistical systems".

iii) Larger scope and finer resolution.

There is a clear need to provide harmonised data forever-larger regions with an ever-increasing resolution.

III. Two uses of Knowledge & Information

7. I have, in another paper³ discussed how two major cultures in our societies; "Guardians"⁴ and "Traders"⁵ have, during the last decades, appeared to become less different, probably due to developments in organisational and technical tools used in shared search for improvements in productivity and efficiency. One central issue for both of these groups has been to embark on radical reengineering efforts.

² One current example of this need is the demand for better information to map and follow the effectiveness of measures to limit and reduce the spread of the "foot and mouth" disease in Europe. Macro statistics on administrative units are useless here. The "engineers", involved in the counter measures, call for micro information related to the smallest possible units.

³ See (Backer 1997) *Towards an integration of Space, Time and Statistics*. Here, under the heading "One country, two systems" I have discussed the role played by two complimentary groups of actors "the Guardians" and "the Traders" in the pursuit of national and regional "projects". For these metaphors please see Jane Jacobs in (Jackobs 1994) *System of survival: A Dialogue on the moral foundations of Commerce and Politics*

⁴ The values characterising the "Guardians" were traditionally represented by the king, the nobility and the armed forces on the one hand and the church and the public bureaucracy on the other. (See (Jackobs 1994, above))

⁵ The values characterising the "Traders" were traditionally represented primarily by the groups who were involved in the production and distribution of goods and services. (See (Jackobs 1994, above))

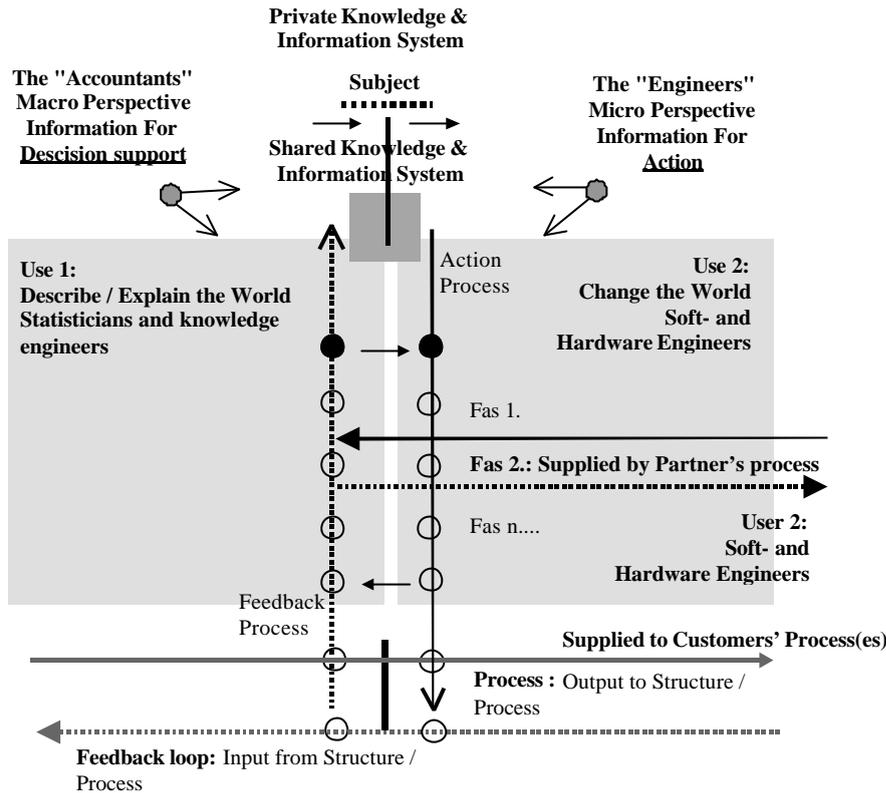


Figure 1: Every "Closed system" action a two-way process

8. In these efforts it was, and still is, essential to model both the business/industrial system and its environment as a network of "closed systems" considered as processes with feedback loops (rather than "open" systems of structures without them). In the figure above we have tried to describe a combination of one main actor delivering a service to a customer, and in turn getting assistance from a supplier⁶. All actors are thus connected into a many-dimensional network of networks, a web that constitutes the main infrastructure for the "Informational society". This perspective differs radically from that of the classical modernist "planning" paradigm focussing on the structures rather than processes⁷.⁸ Reengineering efforts like these generally call for detailed descriptions of all processes that are later constantly improved using quality control and benchmarking techniques⁹.

9. If we study our (the NSI's) value chains in combination with the needs of our customers from this revised and broader perspective, we may discern two main uses of structured information.¹⁰

i) Analysis for Decision & Support (analogous to "reading")

To arrive at decisions as to what action to take as a reaction to the state revealed by the model

⁶ It is important to note the two-way processes that signify that the systems are structured as "Closed systems". For a discussion of the properties of "Closed" vs. "Open" systems please see Jay Forrester (Forrester 1968) *Principles of Systems; Text and Workbook*

⁷ For this paradigm change I am following that of Collingwood as described in his book (Collingwood 1945) *The Idea of Nature*

⁸ It does however not imply that the structures are not important, only that they are not in focus here. For a complete picture both perspectives are needed. The relation ""form" follows "function" (or "pattern")" denotes the relation putting the processes in focus.

⁹ The classical work to understand these efforts is provided by Hammer (Hammer and Champy 1993) *Reengineering the Corporation: A Manifesto for Business Revolution*

¹⁰ Here we have I think the foundation to describe the "overriding project" shared by most of the actors in our (the NSI's) professional "environment".

described above. This process is of course very complex and involves not only information for high level decisions but also public discourse-, intellectual research- and journalism. The main tendency of these and related tasks are to start with detailed information and through an analytical process arrive at "simple" conclusions.

ii) Synthesis for Plan & Action (analogous to "writing")

Information and knowledge specially suited for the design and implement of concrete actions to meet the decision arrived at under the previous point. The main tendency in these processes are that one starts with crude formulations concerning objectives and seek to compile detailed designs and descriptions of the processes needed to realise them.

IV. Two users of Knowledge & Information

10. As in most contemporary examples it seems relevant to point to the idea that it is useful to build a description of socio-economic structures and processes on the idea of seeing the "project" enabled by a network, as fundamental operating unit for systems of this kind.

11. "The Traders" and "the Guardians", as described above, by no means identical, they are merely less different. This difference is not only to be found in nature of their overriding project(s) but also due cultural differences evolved over a long history.

12. We will however, refrain from stressing the differences between these two "cultures", but rather try to focus on important common denominators that have a bearing on the our present topic in spite of the fact that our examples primarily come from the public sector. When studying the general use of statistics in both "Trader" and "Guardian" cultures, we will see that both depend on two distinct professional groups responsible for the processes we termed "analysis" and "synthesis" above.

i) Accountants.(Methods for Analysis)

Traditionally it was taken for granted that bookkeeping and sophisticated systems of "Checks" and "Balances" was the most effective "decision support" tool available. This "accountant" culture is of course also clearly discernible in the structure of our statistical systems. We believe however that this is no longer "self evident". We seem to need new and better tools to cope with the effect of the disappearance of national borders and a faster pace of change. The solutions needed seem to be related to the role of the national state in a world without borders.

ii) Engineers.(Methods for Systhesis)

On the other hand we have those information users who need the information for deeper "analysis" to plan of effective action according to current policies. I suggest calling this universal user group the "Engineers"¹¹. This professional group has also, of lately been forced to redefine their professional role and "project". It seems enough here to indicate that the "Engineers" do not build railways and bridges anymore, the are involved in the development of transportation systems. For this purpose it is necessary to understand how things work not only as "kit of parts" but as "interactive wholes".

13. Professionally speaking it is interesting to note that the dividing lines, in terms of the character of the models used by "Accountants" and "Engineers" respects roughly the division between the "applied sciences" studied at our "institutes of technology" and the "theoretical sciences" traditionally studied at our universities. The one is apparently more at home in the one than in the other. "Synthesis" and "Analysis" are, as the theoretical and the applied sciences not separate and essentially different, but rather complementary and interdependent. However, due to their separate cultures their methods seem quite different and incompatible.

V. Perspectives to one system of Knowledge & Information

14. I believe that it is necessary, in order to discuss the questions of "small-" vs. "large-" area statistics in view of the call for an integration of knowledge, to "zoom out" to get the larger view, the broader perspective regarding these things.

¹¹ The name "Engineers" is intended to indicate the needs of the group of actors that are using information to change/adopt the world according to our needs. Se (Collingwood 1945)

15. From this birds-eye perspective I believe it is easier to see that we may look at our "inner" or "outer" world from two quite different perspectives. At one instance we may be focusing on the wholes delimited by more or less sharp outlines, and then at the next focusing on the parts (on an other scale as it where). We will call these two "views" the macro and the micro perspective.

i) The Macro perspective.

Zooming out to the macro perspective we tend to group and cluster things according to different ideas reflecting our relations to that which we perceive. When our hunter has discovered his prey he will immediately shift to a macro perspective in order to focus on its outline.

In equal fashion we adopt large area statistics to focus on macro-level states of selected systems. This perspective seems to be preferred by the "Accountants" as most of their documents refer to aggregations to this scale.

ii) The Micro perspective.

Zooming in on the micro perspective we see myriad's of details that form more or less distinct patterns. A hunter, looking for his prey would use this focus to scan an area in order to detect fractures in these patterns that might the location of his prey.

In an equal fashion we adopt small area statistics primarily to map patterns of distribution. This perspective seems to be preferred by the "Engineers" as most of his documents are traditionally produced and implemented on this scale.

16. We might not all agree on the question of whether we, in our work to build statistical systems are merely producers of "qualified" information (facts), or whether we should be involved in efforts to integrate systems of information into comprehensive collectively shared models of the world.

17. I believe there is really no choice here, we have obligations in two directions. On the one hand we, assisted by our partners and suppliers, are expected to constantly improve our statistical systems. On the other hand we are obliged to contribute to the integration of our statistics (official and other) with any other information system of interest to our customer(s).

VI. The macro Perspective and the "Accountants"

18. Anybody who has glanced at a "Statistical Yearbook" cannot be but struck by the similarity between the Statistical system presented there and the "Checks and Balances" as described by business Accountants.

19. Statistics seem here to be a more or less detailed list of assets, needed for public accounts. The interesting thing about accounts like these are that they are closely linked to the idea of aggregating "debit" and "credit" from detailed observation and downstream to the bottom line that demonstrates the radical difference between + or -(misery and success).

20. Discretely hidden in these documents, but always present, is still a generally very crude geographical and temporal reference that provides us with a rather poor picture of the general state of the system. Until the emergence of GIS methods it has been quite difficult to discern any "patterns" of more complex nature.

21. The temporal reference is hidden in the very few, but still present "checks" usually taken on a yearly basis but sometimes longer or shorter. Since systems on the scale of countries, at least in the more remote past, could be regarded as relatively stable over long periods, short-term variations were of little interest. There is consequently not much reference to the systems dynamic behaviour.

22. The spatial reference is of course hidden in the hierarchy of aggregation areas. The distribution of power, territorial administration and the development of the population are closely related. The borders are therefore of great importance. However, from the perspective of traditional statistics it is evident that the spatial distribution of individual occurrences of phenomena seems to be of mere peripheral interest.



Figure 2: Swedens län after (1634)

23. The map above (see Figure 2), published by Samuel Gustav Hermelin in 1747, shows the regional division of the Swedish territory that has remained stable with few changes from the territorial reform of 1634¹². It is interesting in this context due to the fact that the border to Norway and the coast was based on triangulation's, whereas features in the interior was based on older maps. This indicates, I think, the administrative importance of the borders over the details depicting the spatial distribution of detail phenomena inside. This may suffice for the use of tax collectors but scarcely as a tool to discover, map and analyse complex problems of great importance. (like the "foot and mouth" disease.)

24. As there is an obvious link between the success of business and industry and the taxes to collect, the "Guardians" have therefore generally provided business and industry with information and plans on large-scale describing general contexts in terms of infrastructures and the like. The map above was evidently of major political importance especially if attached to a collection of statistical tables and diagrams to describe the relative strength of the different administrative units. For the engineers, however, at that time contemplating the possibility of building what later became the "Göta canal", directly through the country's most fertile regions, the map would be of little practical value, with or without statistics aggregated an administrative areas. The reason for this is the direction of entropy. Each aggregation up the

¹² Rikskansler Axel Gustavsson Oxenstierna (1583-1654) gave structure to the Swedish governmental administration, and laid the foundation for the administration of the "Län" (Used as Nuts3). The system was based on a much older system of "Län" dating back to ca. 1200. adopted to the need for an effective organisation of tax collection during the 30-year war. This Map is published in (Sporrong and Wennström 1990) *Sveriges Kartor*

hierarchy will introduce more entropy and thus lead to the destruction of the value of the data-set unless the micro data upon which it is based is preserved.

VII. The micro Perspective and the "Engineers"

25. For the "Engineers" to do their job, they would be well served with qualified information (surveys) with detailed geographical reference. For them the maps and drawings are the most central documents. Tabular information (bills of quantities) are naturally there, along with documents describing temporal references are of course there but more to support the documents showing spatial references. In these documents you will find little or no reference to administrative and other borders. Here it is the distribution of phenomena that is at the focus of the engineers' interest, or else, if available statistics aggregated on areas defined by the extent of the project in question.

26. The map below (Figure 3), probably the earliest known example of a plotting of a population on grids (ca. 10x10 km), represents a surprisingly early and rare example of the use of relatively crude statistical information merged with geography to satisfy "engineering" needs. The map was produced for a discussion in the Swedish parliament (in the second half of the 1850'ies) concerning trajectories for the railroad system then under construction, this map shows no internal administrative borders and focuses on the distribution of the population in relation to the railroad "network"¹³.then under construction

27. In this map data were aggregated to the grid structure, but even so, drawing län borders (Or any other system of irregular/irregular tessellations) on the top of the grid structure could produce a useful "Macro" level map. This is of course not surprising. From one good micro dataset many useful macro datasets may be produced but not vice versa.

28. It is also important to note that documents currently produced for engineering purposes are not only used in the construction phase alone. With the emergence of digital technology drawings and models are now an important by-products that are reused in processes linked to the "monitoring" and "re-engineering" of the "project" for a long time after its completion.

¹³ Seen from a contemporary perspective we cannot refrain from thinking about how close this map (if updated over time) is to the idea of a management system where one may constantly monitor changes in the market (here population), the transportation infrastructure and operations on it (here the tracks). To transform it into a full-fledged decision- support system. In addition to the need to keep it constantly updated, we could have added information on the actual and potential competition.

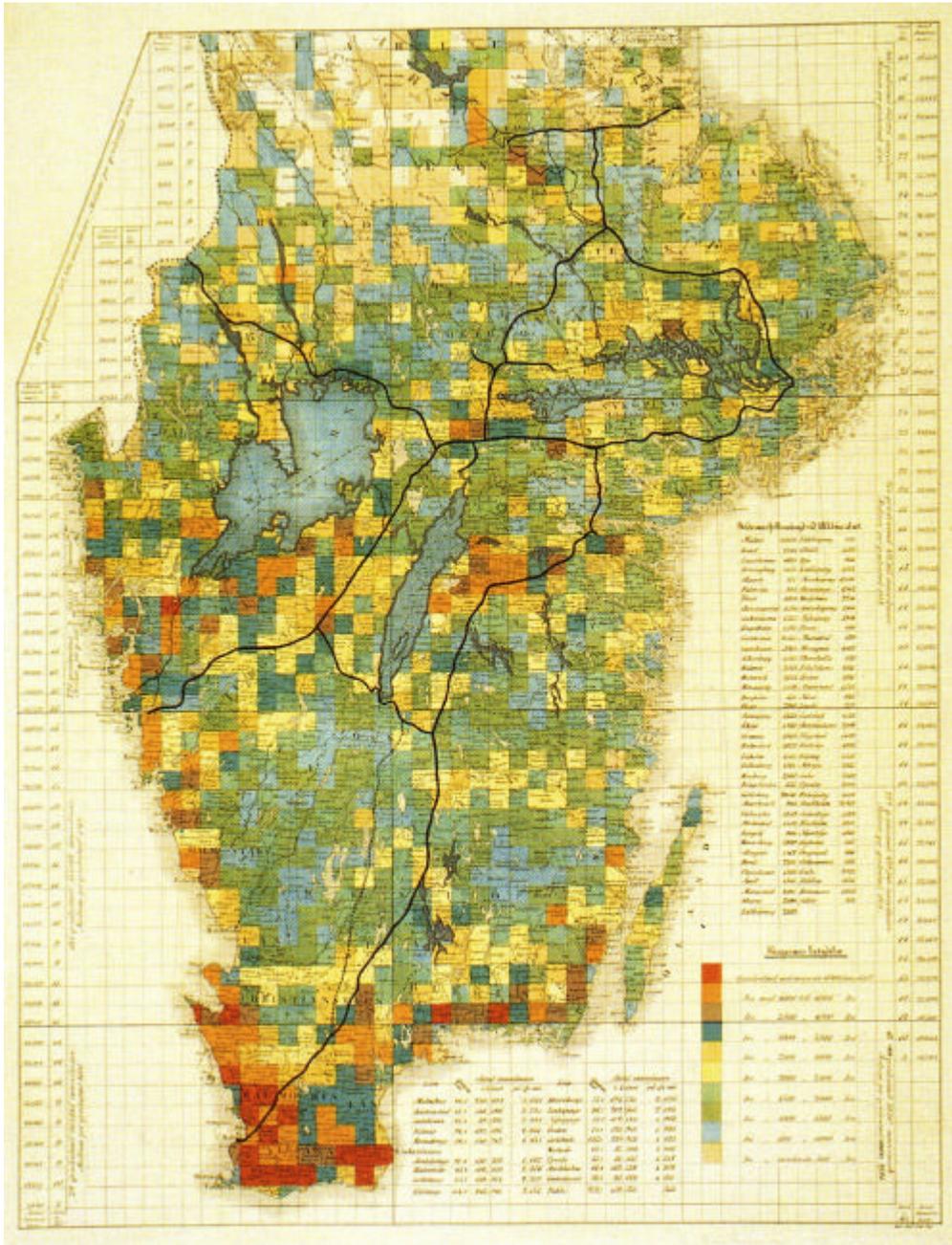


Figure 3: Population on ca. 10 km grids (1853)¹⁴

VIII. Summary

29. As Kiplings' lack of dialectical insight, when he argues that "East is east and west is west, and never the twain shall meet", it is often repeated when we assert that there are two general types of incompatible models. The one is focussing on the spatial (structural) distribution of phenomena and the other on logical (functional) interaction of processes. The "Engineers" are, as a natural consequence of their overriding project¹⁵, more interested in Micro-level data-sets that stresses properties as the spatial distribution of phenomena. The "Accountants" on the other hand are due to their overriding project¹⁶, more interested in

¹⁴ This map is published in (Öberg and Springfeldt 1991) *Befolkningen*

¹⁵ Collingwood (Collingwood 1945) points to the radical form of the "engineers'" perspective by citing Marx (Marx 1974) *Theses on Feuerbach* where he asserts that "Philosophy hitherto has confined itself to interpreting the world: the point, however, is to change it."

¹⁶ Collingwood (Collingwood 1945) points to the radical form of the "accountants'" perspective by referring to Hegel (Hegel xxx) *Philosophie des Rechts* where he asserts that "When philosophy paints its grey in grey, a form of

Macro-level data-sets that describe different aggregations of data-sets. These "twins" appear to be very different but represent two slightly different perspectives to the same system of Knowledge and Information. From a micro level data-set it is possible to produce many different macro-level aggregations but not vice versa due to the direction of entropy.

30. The production of statistics is a very expensive undertaking and cannot be legitimised by reference to their use by one or the other in isolation¹⁷; we must be prepared to serve them both from one and the same data source.

31. The increasing popularity of "small area statistics" is an indication of a trend towards the highest possible resolution i.e. a search toward ever-smaller reference areas. The lower limit is of course total registers, while fully feasible in some areas (some environmental data) they are unthinkable in others (population statistics) due to integrity and other problems. The upper limit on the other hand is indicated by the fact that statistics on most administrative areas are unusable for analytical purposes. We must therefore search for a smallest feasible system of statistical regions just and only just above current disclosure limits. These statistical "building blocks" may in turn, using clustering methods, be used to generate systems of areas better fit for statistical analysis¹⁸.

32. There are of course two hierarchies of "small areas" at hand: Regular- and Irregular- tessellations. Of these it is generally agreed that regular tessellations (grids) are better suited for spatial analysis. If, however, no total registers with point co-ordinates are available, we will have to use regions with "natural borders". With point co-ordinates, we may produce both regular and irregular tessellations from one simple set of co-ordinates when these are linked to a "code" or "link" database with references to which administrative and other administrative areas to which the point belongs.

IX. Conclusion

33. In order to meet current and future demands for "small area statistics" we must "re-engineer" the current standard statistical system that enables us to study both the "forest" and the assembly of "trees". This in turn requires better micro datasets and an improved system of 2 hierarchies of small statistical regions, one regular, the other irregular from which data may be aggregated according to the to political-, and commercial- and other customer- needs.

life has aged; and grey in grey does not enable us to make it young again, but only to know it. The owl of Minerva begins to fly only at the coming of dusk."

¹⁷ I believe that we will agree that we need neither to side with Hegels pessimism nor Marx optimism, both perspectives are needed to get the whole picture...

¹⁸ See for (Coombes, Green, and Oppenshaw 1986) *An efficient algorithm to generate official statistical reporting areas: the case of the 1984 Travel-to-Work Areas revision in Britain* for clustering of small statistical regions. In the case of grids, these and more direct methods are available.

Bibliography

- Backer, Lars H. 1997. Towards an integration of Space, Time and Statistics. Paper read at Statistical Commission and Economic Commission for Europe; Conference of European Statisticians; Work session on geographical Information systems, 22-25 September 1997, at Brighton.
- Collingwood, R. G. 1945. *The Idea of Nature*. 1960 ed. 1 vols. New York: Oxford University Press.
- Coombes, M. G., A. Green, and S. Oppenshaw. 1986. An efficient algorithm to generate official statistical reporting areas: the case of the 1984 Travel-to-Work Areas revision in Britain. *Journal of Operations Research society* 37:943-953.
- Forrester, Jay W. 1968. *Principles of Systems; Text and Workbook*. Second Preliminary Edition (1972) ed. Cambridge, Massachusetts: Wright-Allan Press.
- Hammer, M., and J. Champy. 1993. *Reengineering the Corporation: A Manifesto for Business Revolution*. New York: HarperCollins.
- Hegel, G.W.F. xxxx. *Philosophie des Rechts*. Vol. Werke, *Wissenschaft*. Frankfurt AM: Suhrkamp Taschenbuch.
- Jackobs, Jane. 1994. *System of survival: A Dialogue on the moral foundations of Commerce and Politics*. New York: Vintage Books.
- Lyotard, J. F. 1979. *The Post-modern Condition: A Report on Knowledge*. Manchester.: Manchester University Press.
- Marx, Karl. 1974. Theses on Feuerbach. In *Essays in Philosophy*, edited by H. Peterson and J. Bayley. New York: Simon & Schluster Inc.
- Sporrong, Ulf, and Hans-Fredrik Wennström, eds. 1990. *Sveriges Kartor*. Edited by L. Wastenson. 17 vols, *Sveriges Nationalatlas*. Stockholm: Sveriges Nationalatlas Förlag (SNA).
- Öberg, Sture, and Peter Springfeldt, eds. 1991. *Befolkningen*. Edited by L. Wastenson. 17 vols, *Sveriges Nationalatlas*. Stockholm: Sveriges Nationalatlas Förlag (SNA).