The Homological Transfer Research Method Revisited

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Abstract

The Homological transfer method is a very efficient research method which is based on similarities between manufacturing, financial, educational, informational and other productive processes. The existence of these similarities imply that corresponding disciplines should have similar models – i.e. laws, techniques. Therefore existing models in one discipline should be capable of being transferred to another discipline. This article suggests three improvements to the transfer research method proposed by Mende [15] and identifies the benefits that may be obtained by using the method.
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Computing Review Categories: *H.I.I. General Systems Theory*

1 Introduction

The use of homologies in research was originally suggested by Von Bertalanffy [4]. He showed that there are similarities between models in different disciplines and attached the names "homology" or "isomorphy" to such similarities. The existence of these similarities implies that related disciplines should contain similar models. Therefore an existing model in a donor discipline should be capable of being transferred to a recipient discipline where the model is not yet being used.

The literature provides many examples of successful transfers between donor disciplines and recipient disciplines using the idea of "homology". The following are some examples of taxonomic models that were transferred between Management Information Systems (MIS) and related disciplines.

1. Nolan and Wetherbe [16] developed a comprehensive taxonomy for classifying MIS research. The model consisted of two dimensions – the MIS transformation process, and the interaction between MIS and its organisational environment. The latter dimension of their model was derived from a model developed by Kast and Rosenzweig [10]. A successful homological transfer was thus made between Organisation Theory and MIS.
2. Du Plessis and Lay [7] subsequently adapted the Nolan and Wetherby model to develop a framework for classifying computer auditing research. This successful homologous transfer introduced a robust framework for the classification of research into a discipline lacking such a framework. It enabled the authors to identify several areas of Computer Auditing that required further research. They also indicated that further homologous transfers may be possible between MIS and Auditing.
3. Banville and Landry [2] derived a MIS taxonomy from the work of Whitley [19]. Their taxonomy classified intellectual fields in terms of three variables – functional dependence, strategic dependence and strategic uncertainty. Banville and Landry thus effected a successful homologous transfer between the Sociology of Science and MIS.
4. Ives, Hamilton and Davis [9] developed a comprehensive framework to categorise all previous MIS research, using concepts of System Theory. Their model consisted of three information system environments, three information systems processes, and the information sub-system itself, all surrounded by an organisation environment and an external environment. Their research resulted in a successful homologous transfer between Systems Theory and MIS.

Additional South African examples of research using homologous transfers were published by Mende [14] and O'Donovan [17].

2 The Homological Transfer Research Method

Previous authors made knowledge transfers intuitively, without being aware of the potential or pitfalls of their approach as formal research procedures were lacking.

In the June 1990 edition of this journal, Mende [15] developed Van Bertalanffy's idea of "homology" into a formal research method. He recognised that there are many similarities between productive processes such as manufacturing, investment, learning and systems development and that many homological transfers should therefore be possible between disciplines such as Economics, Finance, Education, Information Systems, etc. These disciplines have, inter alia, models in the form of (1) laws to describe cause – effect relationships between elements of productive processes, and (2) techniques that prescribe how people should manipulate productive processes.

The Mende research method consisted of five steps as illustrated in Figure 1

In step 1 the researcher recognises the similarity between two productive processes to determine whether a homologous transfer is possible. The existence of simi-

larities between productive processes implies that the corresponding disciplines could contain similar models. For example, an information system is similar to an education system, and the subject Information Systems contains an I-P-O model which is similar to the process model of an instructional system [15].

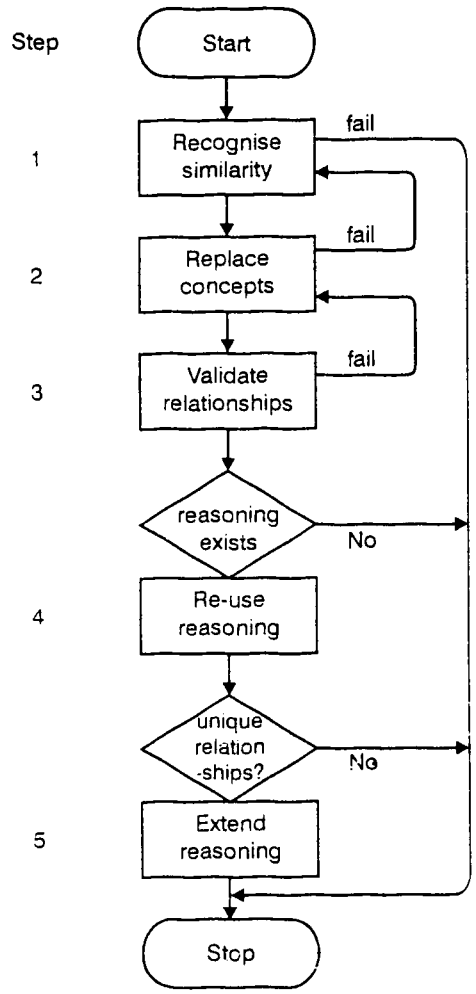

Figure 1. Homological transfer procedures

In step 2 the researcher takes a particular model from the donor discipline and replaces its concepts with the concepts of the recipient discipline. Although homologous models express similar relationships, the concepts of the two disciplines will usually differ. For example, in the I-P-O model of Information systems, concepts such as data input, data process and information output would have to be replaced by educational concepts such as resource input, instructional process and knowledge output [15].

In step 3 the researcher validates the relationships of the transferred model in the recipient discipline. For example, an information system has a set of programs which interact with a dynamic environment, whereas an instructional system has a set of lessons which interact with a dynamic environment [15].

In step 4 the researcher re-uses any reasoning that may be available in the donor discipline to derive new arguments in the recipient discipline. For example, the rationale behind the analysis-design-programming approach adopted in information systems development can also be used in instructional design [15].

In step 5 the researcher extends the reasoning by incorporating relationships which are unique to the recipient discipline. If the extended model reflects more features than the original model, it describes the process more accurately and is therefore more useful. For example, in instructional design the possible impact of environmental changes requires the inclusion of a monitoring phase before the analysis phase [15].

3 Improvements to the Homological Transfer Research Method

The author [11, 12] used the Mende research method to identify and transfer an appropriate taxonomy from MIS to Accounting. Previous taxonomies and frameworks in Accounting addressed only specific problem areas, and none covered the whole domain of the discipline of Accounting. As domain coverage taxonomies are well researched in MIS, the author studied several robust and well tested models in MIS [1, 2, 9, 16], and identified one of them [16] as suitable for transfer to Accounting.

Before effecting the transfer the author found three areas where Mende's method could be improved. As the method was adjusted before it was applied, the research [11] also served to validate the improved method. These three areas of improvement are now discussed briefly.

Updating the donor model

The first improvement is necessary in order to counteract two historical factors which were not considered by Mende. First, the model that is selected in step 1 may have been published many years ago, and the process which it describes may have changed. To illustrate, the Nolan- Wetherbe taxonomy [16] was published in 1980 when information technology was used in a purely support role, providing information almost exclusively to the host organisation [11]. Since the publication of the Nolan-Wetherbe model, information technology has progressed from a support role to a means of gaining competitive advantage by serving the host organisation business environment [18, 20].

Second, the published model may contain inadequacies that may have been revealed through subsequent research, application or validation. To illustrate, the Nolan-Wetherbe model identified only the "environment of the organisation" while Kast and Rosenzweig [10] had since then refined the environment into three different types; the host organisation, the task environment and the general environment.

Therefore, an additional step 1C "update donor model" is required between steps 1 and 2, as illustrated in Figure 2.

Validating the extended reasoning

The second improvement is necessary in order to reduce three risks that were not considered by Mende.

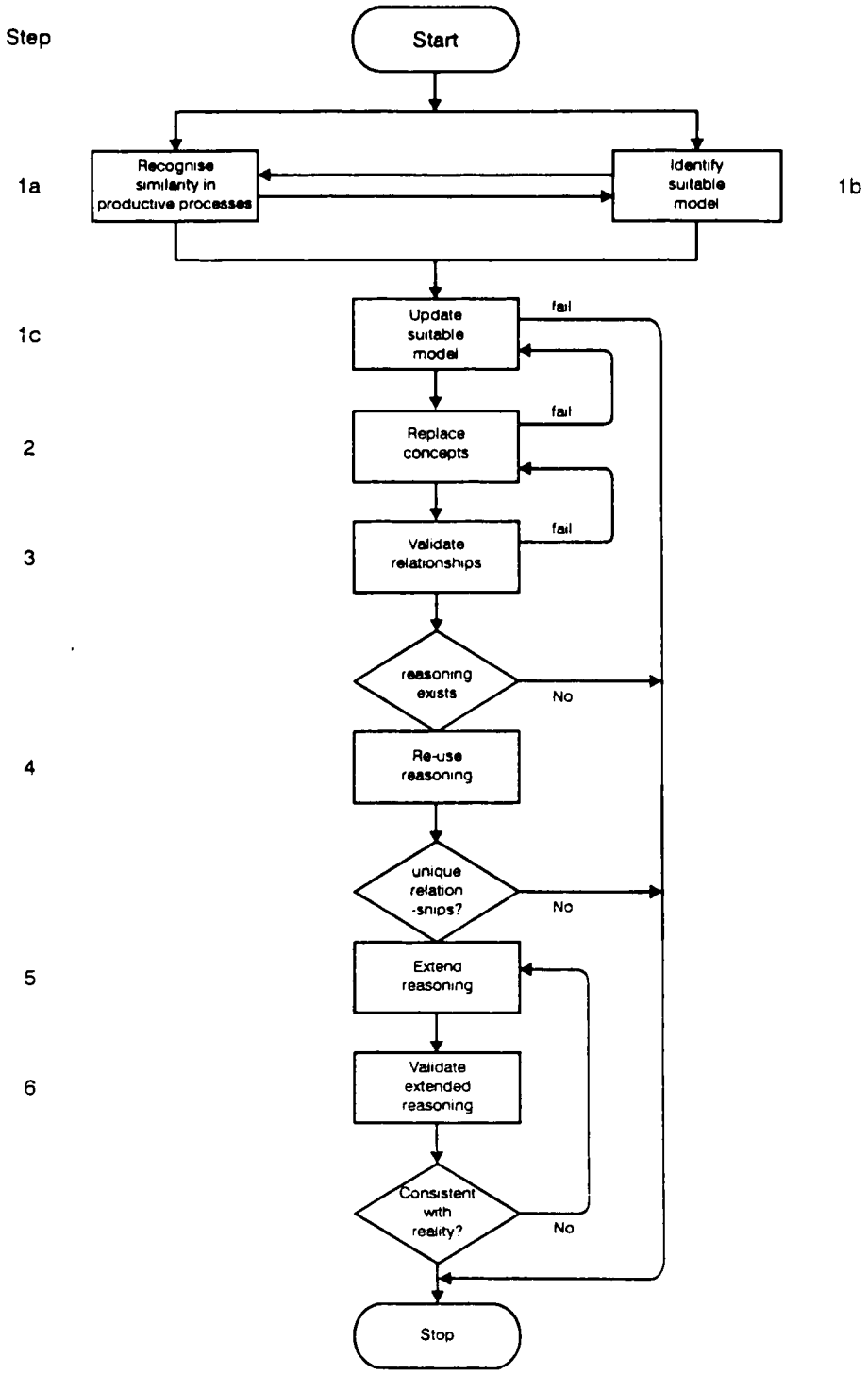

Figure 2. Improved homological transfer procedures

First, the model that was selected in step 1 may have been based on methodological premises which are incompatible with those used in extending the model. To illustrate, the model may be developed using a functionalist research method such as systems theory whereas the reasoning may be extended using an interpretive research method such as phenomenology [6].

Second, the model may be based on a paradigm [13] which conflicts with the paradigm used in the extension. For example, in a homologous transfer between branches of a discipline such as Accounting, the original model may be developed using the decision usefulness paradigm but may be extended using the information economics paradigm [3].

Third, the model may be based on specific assumptions and limitations which may conflict with those used in the extension. To illustrate, the model may be developed on the assumption that markets are efficient in the semistrong form, but may be extended on the assumption that the markets are not always efficient due to functional fixation [8].

The extended reasoning in step 5 may extend beyond the scope of the underlying premises and may result in a model that is inconsistent with reality. Therefore an additional "validate extended reasoning" (step 6) should be inserted after step 5 as shown in Figure 2. Step 6 should be connected to step 5 with feedback loop because inconsistencies discovered during validation should be eliminated by modifying the extended reasoning.

Structuring the research approach

The third improvement is necessary because step 1 in the Mende model can be approached in two different ways. One way is to start by identifying a donor process which is similar to the process being researched and then to survey a selected donor discipline to find a model suitable for transfer to the recipient discipline. The other approach is to start by surveying the literature of various productive processes to find a model suitable for transfer. Once a model is identified, the researcher would assess whether similarities exist between the two processes and whether a homologous transfer is therefore appropriate.

Step 1 should therefore be divided into two sub-steps:

Step 1a the recognition of similarities between productive processes and

Step 1b the identification of a suitable donor model.

These sub-steps can be carried out in two alternative sequences: a-b or b-a. For example, the author structured her research on taxonomies using the a-b alternative. Consequently a related donor discipline was selected (MIS), the existence of similarities in productive processes in the two disciplines was motivated and a literature survey was conducted within MIS to find a suitable model. Various models in MIS were considered, and assessed, prior to the selection of the Nolan-Wetherbe model [11]. The risk attached to this approach (a-b) is that although the donor discipline and the recipient discipline will have related processes, the most appropriate model may not be transferred as the search is restricted to one, or at best, a few selected disciplines. If the b-a alternative is selected, the emphasis of the research changes to finding a suitable model within a large variety of productive processes and disciplines. The assessment of the relationship between the donor and recipient disciplines would be deferred until a suitable model is found. The risk attached to the second approach (b-a) is that although a suitable model is found, it may be from a discipline so unlike the discipline under research, that a homologous transfer may be neither feasible nor valid.

The alternative chosen in step 1 affects the whole approach to the research, the literature surveyed, the choice of model, the structure of the final report and even the conclusion.

The three proposed improvements to the Mende research method are incorporated in Figure 2.

4 Benefits of the improved Homological transfer research method

A number of benefits can be derived from the use of the improved homological transfer research method. First, the method saves unnecessary research effort because it eliminates the need to reinvent models that are already available in other disciplines. For example, the taxonomy of Nolan-Wetherbe in MIS was transferred and amended for use in Computer Auditing instead of inventing a new model [7].

Second, the method will encourage the updating of donor models prior to transfer. Thus the donor discipline will reap the benefits of improvements to the model. For example, the Nolan and Wetherbe model was updated and improved prior to its transfer Accounting [11]. Any extended reasoning included in the model in the recipient discipline also has the potential to feed back improvements to the original model in the donor discipline. For example, if the analysis-design- programming approach is extended in the instructional system by introducing a specification phase, the additional phase may also be useful in informational systems [12].

Third, the method may stimulate the search for similar models in different disciplines. The identification of similarities between disciplines will, in turn, facilitate and encourage further homologous transfers. For example, the fact that the Nolan-Wetherbe model in MIS was successfully transferred to both Accounting and Computer Auditing suggests that further homologous transfers could be made between these three information based disciplines.

Fourth, research into underresearched areas of the recipient discipline may be stimulated as ideas for research and hypotheses are gleaned from related disciplines. For example, the extensive and successful domain coverage taxonomies in MIS have served as precedents for other disciplines such as Accounting and Computer Auditing [11, 7].

Finally, the Homological transfer research method encourages interdisciplinary research by emphasising parallel ideas between related disciplines. Inter-disciplinary research in turn encourages researchers to rediscover the importance of adopting a holistic approach to research. A

holistic approach ensures that potential new areas for research are not overlooked. Boulding [5] for example, warns against a too monistic view of science:

> "The more science breaks into sub-groups, the less communication is possible among disciplines, so the greater the chance of the total growth of knowledge being retarded by the loss of relevant communications."

5 Summary

Homologous transfer is a very powerful research tool. It can be used by researchers to avoid "reinventing the wheel", by transferring models – discoveries, rules and methods – from donor disciplines to disciplines where such models are lacking. Mende proposed a formal structure for homologous transfers, called the Homological transfer research method. Although this method has identified the necessary procedures for transferring knowledge between disciplines, a number of shortcomings became apparent when it was used to transfer a taxonomy in MIS to Accounting [11]. This article proposes three new improvements – the updating of the donor model, the validation of extended reasoning and the planned structuring of the research approach. The article also demonstrates that several benefits may be derived from the use of the new improved research method, such as the establishment of logically consistent models in disciplines that lack them, the unification of knowledge by establishing similar models in different disciplines, and the promotion of interdisciplinary research.

References

1. E Auramëki, M Leppanen, and V Savolainen. 'Universal framework for information activities'. *Data Base*, pp. 11–20, (Fall/Winter 1987/1988).
2. C Banville and M Landry. 'Can the field of MIS be disciplined?'. *Communications of the ACM*, **32**(1):48–60, (1989).
3. A Belkaoui. *Accounting Theory*. Harcourt Brace Javanovich Inc., New York, first edition, 1981.
4. L V Bertalanffy. 'The history and status of general systems theory'. In J D Couger and R W Knapp, eds., *Systems Analysis Techniques*. John Wiley, New York, (1974).
5. K E Boulding. 'General systems theory – the skeleton of science'. *General Systems Year Book 1*, **2**(1):197–208, (1956).
6. G Burrel and G Morgan. *Sociological Paradigms and organisational analysis*. Heinemann, London, 1979.
7. R du Plessis and P M Q Lay. 'A framework for computer auditing research'. *De Ratione*, **3**(1):8–14, (Winter 1989).
8. E S Hendriksen and M F van Breda. *Accounting Theory*. Irwin, Boston, fifth edition, 1992.
9. B Ives, S Hamilton, and G B Davis. 'A framework for research in computer-based management information systems'. *Management Science*, **26**(9):910–934, (1980).
10. F E Kast and J E Rosenzweig. *Organisation and Management – A Systems Approach*. McGraw-Hill Book Company, second edition, 1974.
11. C Koornhof. Towards a taxonomy of accounting. Mcom dissertation, University of the Witwatersrand, Johannesburg, 1992.
12. C Koornhof. 'Towards a taxonomy of accounting'. *Meditari*, pp. 143–164, (1993).
13. T S Kuhn. *The Structure of Scientific Revolution*. University of Chicago Press, Chicago, second edition, 1970.
14. J Mende. 'Educational implications of similarities between productive processes'. *South African Journal of Higher Education*, **4**(2):30–37, (1990).
15. J Mende. 'Homological transfer – an information systems research method'. *South African Computer Journal*, **2**:6–11, (1990).
16. R L Nolan and J C Wetherbe. 'Towards a comprehensive framework for MIS research'. *MIS Quarterly*, **4**(3):1–9, (1980).
17. B C O'Donovan. 'Using information systems methodology to design an instructional system'. *South African Computer Journal*, **7**:126–130, (1992).
18. M M Parker, H E Trainor, and R J Benson. *Information strategy and Economics*. Prentice Hall Inc, New Jersey, 1989.
19. R Whitley. *The intellectual and social organization of the Sciences*. Clarendon Press, Oxford, 1984.
20. C Wiseman. *Strategic Information system*. Irwin Publishers, Illinois, 1988.

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