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# Editorial

## Information Systems Research: A Teleological Approach?

The request to write this editorial came at a very opportune time, coinciding as it did with an intense examination of the development of the field of information systems and an analysis of the progress of IS research. I have therefore used this opportunity to focus my thoughts and outline some of my conclusions. By doing so I don't pretend to answer any questions, merely perhaps to stimulate thought amongst those SACJ readers involved in IS research.

The last fifteen years has seen a tremendous growth in the study of information systems. During this period a number of journals devoted to IS research appeared such as *MIS Quarterly, The Journal of MIS, Information and Management* and *Data Base.* There are now many research-based activities: the International Conference on Information Systems; the annual IS doctoral dissertation colloquium; and various awards for IS research contributions. Hundreds of universities world-wide have formed information systems departments with (reasonably) standard curricula.

Yet with all this, what has *really* been achieved from a research viewpoint? Are we any closer to understanding the true nature of information systems? Is there a general unified theory of information systems? Is there even an accepted, unique body of IS knowledge? The answer to all of these must surely be no.

We have, I believe, achieved precious little. Yes, we do understand something of IS development approaches. We understand a little more now than we used to about how users interact with systems. But to get back to the first question, do we really understand what information systems *are* and how they work? No. Which begs the question: Why not?

There are, again I believe, a number of reasons, but the foremost must be that the majority of people in the IS research community either reside in the business schools of the USA or are drawn from other disciplines. These people, it would appear, are researching for research's sake; to publish in order to secure tenure or develop a research track record, not to further the body of knowledge of the subject. There seems an almost frantic zeal to generate and test hypotheses, trying to adopt and pursue what is seen to be a "scientific approach". But there is very little focus - there can't be, or the answers to my questions earlier would be yes rather than no!

Let me hasten to add that there is nothing unique about these IS researchers. "Publish or perish" is still very much alive and well! But also they are really not all that different from other social scientists. As Nagel [3] observed:

> "... in no area of social enquiry has a body of general laws been established, comparable with outstanding theories in the natural sciences in scope of explanatory power or in capacity to yield precise and reliable predictions ..."

Why should this be the case? Is it because the great intellects gravitate to the natural sciences and the social sciences pick up the second best who are incapable of generating these general laws? I hope not! The answer may well be that we have become locked into a particular research approach which is inappropriate to developing a body of social science, and more particularly, IS knowledge. Maybe we should be learning from our own source discipline (systems theory) and be developing a real research approach which complements our field of study.

To explore this further let me go back to the roots of information systems. What is an information system? Do we really have an accepted definition? Probably the most widely referenced is that provided by Davis and Olson [2]:

> "an integrated, user-machine system for providing information to support operations, management and decision-making functions in an organization. The system utilizes computer hardware and software; manual procedures; models for analysis, planning, control and decision making; and a database".

Note how this emphasizes the man-machine interrelationship and underscores computers as a core component when they are not even necessarily a part of the information system. The worst aspect is that it does little to describe what a system is, and this may well be one of the causes of our research dilemma. Again, if we draw on systems theory then a more appropriate definition might well be: "a hierarchical set of procedures utilizing information to monitor and control organizational performance". Note that this definition fits with general systems theory that *all systems* have four basic foundations: cybernetics, hierarchy, control and information [1].

An additional aspect not apparently recognised by IS researchers is that the information system, just like any other system, biological or otherwise, suffers from the problem first identified by our own Jan Christiaan Smuts [4]: that of holism. Simply put, this says that the whole is greater than the sum of the parts. This means that information systems, unlike science, cannot be reduced to simple isolated fields of enquiry and then analyzed or tested using hypotheses and laboratory experiments from which elaborate generalizations may be inferred. They have levels of complexity with new factors emerging at each level. The problem with most of the current research is that it starts out with a reductionist approach and then focuses on the highest (or lowest) level. Thus the majority of the topics have as their target the interaction between user and computer or the management or application of technology. There is very little research that is taking place at fundamental level, that of developing a general theory of information sytems. This is the teleological approach, searching for the natural laws and developing the theory based on deduction and logical development. Until we can advance *that* area of knowledge and, from a basis of these fundamental laws, develop a hierarchy of hypotheses that can *then* be tested, we will have little focus to our IS research. It will remain a fragmented, uncohesive smattering of the work of individuals who are merely grasping at tenure. There are few people who would today argue against the inclusion of information systems as a field of study at a university or as a fruitful research area. But until such time as we focus on the foundation theory, it will remain unstructured and immature.

## References


[1] P Checkland, [1984], *Systems Thinking, Systems Practice*, John Wiley and Sons, New York.

[2] Davis and Olson, [1985], *Management Information Systems: Conceptual Foundations, Structure and Development*, 2nd Ed: MacGraw-Hill, New York.

[3] E Nagel, [1962], *The Structure of Science*, Routledge and Hegan Paul, London.

[4] J C Smuts, [1929], *Holism and Evolution*, MacMillan, London.



**Prof Peter Lay**
**Assistant Editor: Information Systems**



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# Guest Contribution

*In his opening address to the Vth SA Computer Symposium, Prof Viljoen touched on several issues of importance to computer and information scientists, the computer industry and the government. As a result of a number of requests, and by kind permission of Prof. Viljoen, the text of his address has been reproduced below.*

## Opening Address: Vth SA Computer Symposium

Prof H C Viljoen
*Dean of Engineering, University of Stellenbosch*

### Introduction

You may know that I am sitting on two chairs at the present moment: one, at the University of Stellenbosch in the Chair of Electronic Engineering as Dean of Engineering; the other at the SABC as chairman of the Board of Control. (The latter is a chair known to have a built-in hot seat.) At both places considerable advances in the area of computer technology were made in the recent past, and you will excuse me if I refer to both organisations this morning.

### SABC and computers

The SABC has decided to be a follower, rather than a leader in the area of computer applications, and to rather utilise proven technology where applicable or necessary. Because of the high cost of upgrading and replaceming of our mainframe computers, we are at present investigating the use of distributed systems, ie the use of more but less costly mini- and micro-computers to undertake processing suitable for such hardware, and which seems to be eminently applicable to our own environment.

As far as mini-computers are concerned, the SABC's plan is to move to UNIX, but we have found that in the area of distributed systems and especially the way in which the SABC wishes to utilise it, there are indeed shortcomings in the existing technology. In view of this, it was decided to first investigate the use of Natural/Adabas in a distributed environment and to possibly move in this direction if the technology can be fully proven for our own specific needs.

Soos die meeste organisasies, het die SAUK 'n agterstand in die ontwikkeling van rekenaartoepassings. In 'n poging om hierdie agterstand te verminder, het die SAUK besluit om meer gebruik te maak van CASE ("Computer Aided Software Engineering") gereedskap en ook van die tegniek van Gesamentlike Toepassings Ontwerp, die sogenaamde JAD ("Joint Applications Design"). Daar is gevind dat die SAUK baie beter, en veral gouer, toepassings kan ontwikkel wat nader aan die gebruikers se behoeftes is as wat dit daarsonder sou wees. Alhoewel die ondersoek- en ontwerptyd langer is, is die programmeringstyd asook die implementeringsperiode baie korter.

Microcomputer systems are becoming more and more indispensable in our broadcasting environment to efficiently process information for management purposes, and to enhance office productivity. It is small wonder, then, that a few hundred are being implemented and will be implemented in the near future at the SABC. A considerable number of these microcomputers have been coupled to a LAN, allowing the interchange of data as well as access to data on the mainframe computers. It is expected that the SABC will experience considerable expansion in this area, and a significant increase in the number of both dedicated and LAN-coupled computers can be anticipated.

The SABC also utilises a computer aided design system for its architectural and professional design and draughting work. Interesting applications of this system are assistance in decor design and in the layout and illumination of stage sets for TV studios. In this regard the possibility of three-dimensional walk-through facilities is an exciting possibility.

Technological developments in the broadcast area points to increased applications of microprocessors in studio equipment. The most conspicuous of these are for the graphics effects on your TV screen. And it is hardly necessary to point out that our Teledata service is computer-based.

But it is in the area of software development that activity during the past year or so has been most fervent.

A computerised TV licensing system capable of handling the approximately 2 million TV licence holders, has recently been completed. We hope to reduce pirate viewing by more than 50% during 1990, resulting in additional income of several tens of millions of rand. (During the past year some R18 million was

paid in arrear licence fees by pirate viewers.) The same system will enable TV inspectors to complete a country-wide inspection within two years, instead of the present six year cycle.

Computer applications unique to the SABC activities include a discothéque system containing information of more than a million music records, which is used to compile music programmes. Systems allowing the control of video tapes, and systems controlling the sound, video and news archives have been completed, or are about to be completed. Due for replacement in the near future is a computer-based news system, as well as a system controlling the total advertising environment, such as the sale and scheduling of advertisements, and the invoicing of advertisers.

It can indeed be said that the "new SABC" we are creating will to a large extent be a computer-based broadcasting corporation! We hope that this will also be ultimately noticeable in the quality of programmes on your TV screens!

## Universities

Being also from the academic world, you would allow me to reflect a few thoughts about the role of the universities with regards to education and research in the fields of computer science and computer engineering. Let me start off by expressing my grave concern about the level of financial support of universities under the present subsidy scheme. According to the accepted subsidy formula, universities are supposed to be financed to a level of 80% of their running expenses. However, since its inception, the subsidy formula has never been fully applied, and at present stands at a cut of about 80% of the intended amount. This means that universities only obtain some 60% of their total running expenses from the state - as opposed to 80%. One real danger of this approach is the fact that tertiary education could become available exclusively for the rich. Another real danger is that the quality of tertiary education, research and development could deteriorate.

A second aspect of concern about the subsidy formula, is the level at which universities are supported in the area of laboratory equipment. This is especially applicable to courses in engineering, computer science, physics, chemistry, etc. which depend to a large extent on laboratory facilities to facilitate the educational process. I have made a calculation in the Faculty of Engineering at the University of Stellenbosch, and found that the present level of subsidy allows us to replace our existing laboratory equipment once every 32 years (based on the present replacement cost)! This audience can imagine what the replacement of computer hardware in a computer science or computer engineering laboratory, once every 30 years, means in practice! This could mean that laboratory teaching and R & D could become totally obsolete in a few years time, unless something drastic is done to alleviate the problem.

In the Faculty of Engineering at Stellenbosch we realised some 15 years ago that the only interim solution would be to look after ourselves. Nobody else is going to do it for us. We have established eight institutes and bureau's within the Faculty, undertaking sponsored R & D and design work for industry. These institutes and bureau's are financially self-sufficient and do not receive any subsidy from either the university or the state. However, there is an inherent danger in that financial survival may force one to discard academic goals, and whereas a self-help approach such as this enables our professors and students to be engaged in "real boxing" (ie tackling real problems existing in industry) instead of shadow boxing, it should be carefully managed. To a large extent, keeping our laboratories up to date with present technological advances, depends largely on the existence of these institutes and bureau's.

Supplementing the totally inadequate university salaries by allowing university teachers to participate in sponsored projects, has enabled us to not only retain our existing staff, but also to draw the best brains to the university environment. Coupled to the establishment of Technopark outside Stellenbosch, we believe that an environment has been created conducive to an academic environment *par excellance*.

What remains a worry is the low level of research and development support undertaken in South Africa, being some 0,9% of the gross domestic product. This places South Africa squarely in the company of countries such as Togo, Somalia, Kenya, Egypt, Ghana, Madagascar and Senegal as far as this is concerned. In any developing country a minimum level of some 1,5% is regarded necessary. In this regard, it is necessary to get South African industry involved. I am unaware of any South African electronics or computer company spending anything near the level of their turnover on their research and development programmes, which is regarded to be necessary to maintain technological leadership. This level is presently regarded to be 15% of turnover in the electronics and computer industries!

However, South African industry still regards R & D as primarily the duty of the state. This fact is proved by recent statistics, which indicate that of all the R & D executed in the RSA, only 37% is undertaken by the private sector - the rest by the State. This is in shrill contrast to a level of 60% of all R & D undertaken by the private sectors in countries such as Japan, France, Italy and the UK, and 70% in countries such as the USA and West-Germany. I believe that Government should be convinced that tax incentives in this regard would be by far the best investment in long term growth, and the creation of wealth and job opportunities in South Africa. According to the Nobel prize winner, Solow, the contribution of the growth in capital contributed 11% of the GNP of the USA; this is in

contrast to the contribution of 38% by the in the increase in labour, and a massive contribution of 57% resulting from an increase in the level of technology as a result of R & D. In most developed countries between 40% and 60% of the growth in the GNP is technology-based.

## Computer Science courses

Lastly, alow me some thoughts on the education of computer scientists and computer engineers at our universities. My personal impression is that the demands made on departments of computer science in South Africa are unrealistic. The spectrum of students to be taught by such departments is extremely wide, and includes three distinct groups:

a) Business Science and Administration students, requiring a knowledge of business systems.
b) Science students, ie those studying numerical-mathematical subjects such as Mathematics, Applied Mathematics, Physics, Chemistry, Statistics, etc.
c) Students in "theoretical" computer sciences, interested in (inter alia) computer architecture.

The academic requirements of these three distinct groups of students seem to me to be widely differing as far as computer science is concerned. From my personal association with students at the University of Stellenbosch, I get the impression as that it is difficult, if not impossible, to give *relevant* problems to computer science students, due to their differences in background, specifically as regards their mathematics / physics / statistics knowledge. This requires our departments of computer science to be all things to all men - an unattainable goal in any university department, and one which does not serve the academic cause. Such a situation could lead to problem regarding the motivation of not only students, but also of their lecturers. Instead of teaching them the basis of computer science founded on real problems, they have to be content with writing a programme of a doggie crossing the street. Specialist courses, even at first year level, seem to be advisable.

I personally believe that all students in engineering should take at least an introductory course in computer science. Apart from the problems of an already over-full syllabus, they should however - due to the problems I have just indicated - require a special service course in computer science so that *relevant* examples could be studied and given as homework tasks. This has lead to the situation where Faculties of Engineering the world over seem to prefer to "roll their own" courses in computer programming.

Ek glo dat universiteite, dmv voldoende doseer-personeelvoorsiening, in staat gestel moet word om te kan differensieër binne Departemente van Rekenaarwetenskap. Dit sou beteken dat BSc Rekenaarwetenskapstudente, dws. dié wat spesialiseer in "teoretiese" rekenaarwetenskap (of bepaald dan rekenaarstelsel-argitektuur as die A-groep hanteer word. Afsonderlike of dienskursusse, gedoseer deur dosente in Rekenaarwetenskap, vir studente in bv die handelswetenskappe, ingenieurswese, ens. is dan nodig vir ander studentegroepe wat nie in hierdie kader val nie, en wie se behoeftes heeltemal verskillend is. Dit is my mening dat kursusse vir hierdie kader van studente verkieslik geïntegreer moet word met die relevante rekenaarprogrammering, databasisse, stelselontwerp (toepassingsprogramme) ens. binne die betrokke vakdissiplines.

Dit beteken inderdaad dat die huidige Departemente van Rekenaarwetenskap sal verdeel in toepassingsgerigte onderafdelings vir die volgende vier gebiede:

1) Computer science with specialisation-target 'true' computer science theory (automate, queueing theory, determination theory, expert systems, etc.) I firmly believe that there should be a maximum of four to six departments of Computer Science in South Africa specialising in these areas, so as to create real centres of excellence. This would be in accordance with the rationalisation plans of the Department of National Education.
2) Business systems for students in Faculties of Business Science and Administration - the "need-to-do" group. These students would study data bases, networks, fourth generation languages, programming systems design, etc.
3) Numerical techniques for students in Applied Mathematics and Numerical Mathematics: with specialist areas such as parallel programming, discrete systems of equations, simulation (modelling) of physical systems. etc.
4) Hard realtime and imbedded systems for students in Electronic Engineering: areas studies would include software and hardware considerations/compromises to comply with *real* requirements.

I regard the existence of 20 Departments of Computer Science at South African universities to be an oversupply, even at those universities where the emphasis is purely on service courses in computer science. Perhaps we should start to get our act together and start rationalising, before it is done for us.

## NOTES FOR CONTRIBUTORS

The prime purpose of the journal is to publish original research papers in the fields of Computer Science and Information Systems. However, non-refereed review and exploratory articles of interest to the journal's readers will be considered for publication under sections marked as a Communications or Viewpoints. While English is the preferred language of the journal papers in Afrikaans will also be accepted. Typed manuscripts for review should be submitted **in triplicate** to the editor.

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  - author's initials and surname;
  - author's affiliation and address;
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  - a list of relevant Computing Review Categories.
- Tables and figures should be on separate sheets of A4 paper, and should be numbered and titled. Figures should be submitted as original line drawings, and not photocopies.
- Mathematical and other symbols may be either handwritten or typed. Greek letters and unusual symbols should be identified in the margin. Distinguish clearly between such cases as:
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  - the letter O and zero;
  - the letter I and the number one; and
  - the letter K and kappa.
- References should be listed at the end of the text **in alphabetic order** of the (first) author's surname, and should be cited in the text in square brackets. References should thus take the following form:

  [1] E Ashcroft and Z Manna, [1972], The translation of 'GOTO' programs to 'WHILE' programs, *Proceedings of IFIP Congress 71*, North-Holland, Amsterdam, 250-255.

  [2] C Bohm and G Jacopini, [1966], Flow diagrams, Turing machines and languages with only two formation rules, *Comm. ACM*, **9**, 366-371.

  [3] S Ginsburg, [1966], *Mathematical theory of context free languages,* McGraw Hill, New York.

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