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Editor's Notes

The last issue of SACJ, a special issue on IT and Development, was sponsored by a generous grant from the Development Bank of Southern Africa. Unfortunately, confirmation of the sponsorship was only received after the edition had been printed and it was therefore not possible to formally acknowledge the grant at that stage. It is a pleasure to emphatically and gratefully do so now. The fact that the special issue has been very well received, both locally and internationally, is a testimony to the fact that it was money well spent.

The next issue of SACJ will also be a sponsored special issue and deal with the theme of Computer Security. It is being compiled at the initiative of Basie von Solms who will be acting as the edition's guest editor.

This present edition, sandwiched between the two special editions, contains the customary fare of local research contributions. It also contains a guest contribution by Edwin Blake that was initially compiled as a joint response by several leading academics to the recent Green Paper on Science and Technology. It was vitally important to give an IT perspective to this document, and the IT community is indebted to those colleagues who took the initiative to do so. This edition of SACJ also contains the results of a survey taken last year by Judy Bishop on academic IT resources. The figures make for interesting reading. They will no doubt be deployed by every IT department to prove how much worse off they are than everyone else, thereby applying maximal pressure on their respective administrations te get more resources.

Readers will notice that the editorial board of SACJ includes several new names and that three former board members have declined invitations to continue their membership. On behalf of the readers, I would like to thank these former members for their encouragement and services rendered. In the early years, Gerhard Bath provided a delightful survey of neural networks; Steve Schach continually supported the journal with articles and feedback at a time when there was substantial pressure on overseas academics to do otherwise; and Pieter Kritzinger can rightfully claim to be the prime inspirer of many improvements brought about by the journal over the years.

We welcome the new members to a three year term of office and trust that their association with SACJ will be mutually beneficial. SACJ is priveleged to have so many distinguished international names offering such visible support to its efforts in building up IT research in this part of the world.

The new blood in the editorial board highlights the need to replace SACJ's aging editor. Having done the job for several years now, it is clear to me that a fresh approach, bringing new enthusiasm and ideas, is precisely what is needed at this stage. In fact, some might say that a change is rather overdue. The matter is in the hands of the SAICSIT executive committee who is currently seeking a suitable candidate. I will continue with the job until such a person is identified, and I will gladly assist in ensuring a smooth transition. The rest of the editorial team – Lucas Introna as IS subeditor, and Riël Smit as production editor – will remain at their posts to continue their stirling work.

Derrick Kourie
Editor

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Guest Contribution

The Green Paper on Science and Technology

South Africa's Green Paper on Science and Technology was prepared by the Department of Arts, Culture, Science and Technology. It is a consultative document and forms the first step in preparing legislation on Science and Technology Policy for South Africa. It is to be followed by a white paper and then the submission of legislation to parliament. The Green Paper consists of chapters and sections that explains the context of issues facing the country: the issues themselves are phrased as questions with a choice of possible options being proposed.

The Green Paper introduces the "Crisis in South African Science and Technology" and shows that there has been a decline in spending on Science, Engineering and Technology (SET) research and development. Research and development is needed to improve the quality of life for all, improve our international competitiveness and develop a well-educated population. The paper proposes a National System of Innovation that embraces the broad range of activities from high technology to the promotion of incremental technical changes in traditional activities — it covers all domains of innovative activity.

The document itself can be consulted on the web at "http://wn.apc.org/technology/stgreen/".

Information Technology and South Africa's Green Paper on Science and Technology

Collected comments on South Africa's Green Paper on Science and Technology by researchers on the information technology related programmes of the Foundation for Research Development.

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Abstract

If an effective national system of innovation is the main proposal of the green paper then information technology (IT) has to play a very central role in that system. Supporting IT effectively will also mean supporting innovation in IT.

Information technology both enables, and crucially depends on, a national system of innovation. Any white paper on Science and Technology should devote special attention to information technology in view of its crucial and exceptional role in technology innovation.

The IT industry in South Africa, particularly niche applications development, can become a major driver of the economy, both to provide local IT solutions to development needs and to provide export products. It can be a major force in supporting employment in small, medium and micro enterprises (SMME's). The information society makes great demands on human resources. Current deployment of IT is hampered by having far too few people with an ability for innovation in IT. Exploiting the numerous potential benefits of IT will be greatly enhanced by having a more technology literate population.

1 Introduction

Information Technology (IT) is both a leading field of research and development and a profound agent for radical change in our economy and society. It seems set to become the key enabler of scientific, technical and social advance in the coming decades. In this role it may even surpass one of its parent disciplines, mathematics.

We believe that the Green Paper does not recognize the very special and exceptional role that Information Technology plays amongst the research disciplines. The special enabling role of mathematics is recognized, for example, but not that of information technology. (Note: the name information technology is used to indicate a broad range of converging fields encompassing, Computer Science, Informatics, Telematics, etc).

Innovation plays a very central role in computer science. In IT education mere factual knowledge has a partic-

Acknowledgements
The writing of this document was initiated and an outline was discussed at a meeting of information technology researchers convened by the Foundation for Research Development on the 21st February 1996. A working document was produced and substantial contributions (in the form of complete sections) were made by: Prof Peter Clayton (Dept of Computer Science, Rhodes University), Prof Roelf van den Heever (Dept of Computer Science, University of Pretoria), Prof Anthony E Krzesinski (Dept of Computer Science, University of Stellenbosch), Mr Philip Machanick (Dept of Computer Science, University of the Witwatersrand), and Prof Jan Roos (Dept of Computer Science, University of Pretoria).

The document was subsequently circulated to all team leaders of FRD funded information technology research programmes. Comments received have been incorporated into the text. Responsibility for final editing (and the remaining errors) lie with Edwin Blake.
Edwin Blake

ularly and obviously limited life span, the educational goal (once one goes beyond providing basic IT awareness) must be one that fosters independent lifelong learning. Computer programming is a creative activity more open to radical innovation than other engineering disciplines.

While South Africa was ranked very low in a recent World Competitiveness Report its use of the internet, by contrast, is ranked very highly. Although causes have not been investigated one can note that the use of the internet was pioneered by local universities and first established commercially by small local entrepreneurial companies spun off from our universities. This model of using centres of expertise to nurture SMME's in IT has proven very valuable worldwide: it is one of the strategies proposed below.

1.1 Outline of the Document

The next section is a critical overview of the approach adopted towards information technology in the green paper. It identifies a major misunderstanding. Section 2.1 deals with mechanisms for IT development and deals in more detail with the issue of intellectual property rights. A major limiting factor on our effective use of IT is inadequate human resources (Section 2.2).

The next major section (3) considers further comments on the green paper in terms of the issues and questions posed. Information infrastructure (Section 3.1) is followed by research and development in the higher education sector (Section 3.2). The vital role of IT in industrial competitiveness leads to a number of recommendations (Section 3.3), these topics are also related to research and development funding (Section 3.4). The special role of IT in education is next discussed (Section 3.5). The impact of IT on society with a number of illustrative examples is presented in Sections 3.6 and 3.7.

A conclusion listing some policy objectives (Section 4) is followed by appendices on sections of the green paper with passing references to IT and an overview of IT support policy in Australia.

2 Approach to Information Technology in the Green Paper

The green paper addresses itself to an effective national system of innovation (NSI) in Science, Engineering and Technology (SET) — this is the key proposal and the essence of the document. It goes on to motivate the need for innovation:

> A coherent and adequately resourced NSI would form the major instrument to ensure that science, research and technology contribute to the national objectives of:
>
> - an improved quality of life for all
> - improved international competitiveness for South African economic activity
> - a well-educated population capable of participating fully in the new South Africa

Information Technology is mentioned in passing in a number of sections and they are listed in Appendix A. The approach to information technology is mostly rather accepting of a current snapshot of the state of the art: it is taken as a given fact of life. There is little questioning of its role, its future innovations, its future possibilities. Current commercially available advances, the ones that have so transformed science in the eighties and developed societies in the nineties (and certainly the whole world in the dawn of the next millennium) are very properly mentioned: the web, the internet, gigabyte storage on a postage stamp, etc. But this is not seen as a point on an exponential curve of development. It is recognized that IT changes, but dealing with its astonishing rate of change and the profound consequences is little emphasized.

Actually one can say that currently IT is best characterized as unrealized potential. It is *the* key field for innovation! If there is one area a "NSI" cannot ignore it is the innovations needed to make IT useful to our country. Our industrial and commercial competitiveness, our education, health care, "edutainment", public awareness, quality of life, will be crucially determined by our ability to take part in the global information society.

A key area for spending R&D cents must be to make South Africa a beneficiary and not a (marketing) victim of an imported IT industry.

2.1 IT Development

As mentioned above, the green paper does not reflect a deep understanding of the pace of changes in the field of information technology and the consequences of that. It also shows little appreciation of what it will take to have IT develop to fulfil local needs. Section 10.2 of the green paper shows this very well (it is quoted in Section 3.6 below).

That section argues that IT will benefit automatically from government support for the telephone network, radio and television. It is a common mistake to confuse IT with some sort of public utility whose function is to distribute information. Information is not like water or electricity. "Information" as such does not exist. Developing IT content and applications is a complex and creative engineering task. IT is much, much more than the "pipes" for information. IT will never benefit unless there is explicit government support for a development of user orientated information technology.

The section goes on to talk of setting up a long-term government plan to provide equipment countrywide over 10 to 15 years! Could one in 1980 have set in motion any workable plan to provide IT services in 1995? And the rate of change is still accelerating. IT planning must be very different to other types of government planning.

IT planning should revolve around the establishment of centres of excellence and innovation to guide IT developments in desired and continually researched local needs. It should be coupled to national community access centres (see below in Section 3.1) coupled to the proposed Centres of Excellence in IT innovation (Section 3.3).

2.1.1 Intellectual Property Rights

A particularly pressing issue in IT development is that of intellectual property rights (IPR). Section 6.10.1 (of the green paper) deals with "Intellectual property rights". It mentions that "in our haste to conform to GATT and other trade agreements, we [should] evolve a regulatory framework which assists rather than hinders local innovation." This is particularly relevant to IT (along with the life sciences). Developing countries need an intellectual property rights system that encourages innovation and allows fair rewards without stifling competition.

The various IPR systems have an increasingly important economic exchange value beyond being a means of protecting the fruits of innovation. IPR's in the hands of large companies of the three major economic powers (US, Europe, Japan) are becoming a major factor in foreign trade. IPR's allow the conquering of export markets. For such companies extensive holdings of IPR's are a valuable asset. Via cross-licensing agreements these IPR's can allow large companies to proceed with innovation while preventing newcomers, who are not party to such agreements, from entering the field. Thus there is an incentive for such companies and countries to extend the scope and lifetime of IPR systems far beyond what would be required to encourage innovation.

It is possible that IPR's on software are being extended in just such an innovation stifling way. The recognition of patents on algorithms and software (as opposed to using the mechanism of copyright), which is apparently being pressed by the US, may be an attempt to curb the inherent competitive advantage of developing countries in the international software development market. Patents have a relatively long lifetime (20 years is common, and in software this covers 4–5 generations). An algorithm is more an idea underlying an artefact rather than an artefact itself, and traditionally ideas were not considered patentable. In IT, with its high rate of innovation, patents are also a costly protection scheme unsuitable to small businesses.

While further investigation is needed, it should be clear that the wishes of the developed world may not be in the interests of our country, nor in the interests of IT innovation. Legislation is needed to regulate the situation. Unfortunately no concrete recommendation can yet be made on this complex issue, except to note that it needs to be addressed by a interdisciplinary team of legal and IT experts.

2.2 Human Resources for IT

A major issue not addressed by the green paper is the growing need for increased capacity in information technology innovation, particularly in terms of people, but also in terms of research equipment. IT demands will far outstrip the supply of skilled people.

Human resources are thus the essential factor. Initial training must be complemented by a life-long training system that constantly adapts skills in the face of the ongoing innovation in IT. The pace of IT change will only be acceptable if workers are informed and educated. So another implication of IT innovation is a pressing need for IT skills at all levels. A nationwide system of certification at lower levels is needed to regulate the current plethora of commercial IT "qualifications". At the tertiary level such a national qualifications framework is more problematic given the extremely high rate of innovation in the field — any fixed curriculum is likely to be out of date by the time it is approved.

Industry demands will draw increasing numbers of staff and students away from the higher education sector. The real danger exists that IT education will cease to be effective at our universities. Students will not undertake higher degrees and research staff will leave unless there is a national priority assigned to increasing IT innovation capacity. Without a national IT innovation programme the seeds of South Africa's information society will be consumed before they can bear fruit.

3 Sections and Issues of Special Interest to IT

The green paper generally deals with issues that steer clear of mentioning specific disciplines. However some do refer to IT and some depend crucially on IT. In this next subsections we consider these.

3.1 Information Infrastructure

The first section of special interest to IT is 6.9 (Information Infrastructure for SET Performers). It is currently seen in the context of libraries and the service is seen as complementing and perhaps replacing libraries.

We believe, in line with the universal enabling role of information technology, that this section should really concern itself with universal access by all communities to information technology services. The issue is one of

effectively extending the (telecoms) concept of "Universal Service" in the information age. The "Information Infrastructure" links closely with telecommunications: essentially specifying the bandwidth, quality of service and other requirements of the telecommunications infrastructure. IT itself stretches into all modern processes of society either in a self-contained role or in a network distributed role.

Libraries and library-like services will be a part of that. IT is not an "exciting" technology: it is a *vital* technology. It is a great deal more cost effective than alternatives, *once one stops seeing it as a single application.* A *Community Access Centre* to the Global Information Society is much more than a "capital intensive" library! It is a training centre, an interactive consultation centre with centres of expertise, a multimedia cultural centre, a communications centre, a market price ticker, and so forth.

The issue raised in Section 6.9 is the following:

Issue 6.16:

What are the key elements of a strategy to address the information infrastructure requirements of the SET community and the broader public?

The key element must be a system of public access to a national information technology infrastructure. Such an infrastructure comprises the wires and other links to bring the information to the remotest areas. Much more importantly it comprises relevant and useful content provided by useable applications. The cost of providing such a "Universal Service" would be enormous even if limited access is provided through community centres. What is required, is a well thought through and regularly updated plan for a staged deployment and updating of the Information Infrastructure. The regular revision of any plan in the light of advances in the field of IT is absolutely vital. This plan should be drawn up transparently and also define the role of industry.

Keeping track of changes in IT necessarily implies a system of innovation in that field. Unless such expertise is cultivated one cannot keep abreast of the exponential growth of the field and one is left at the mercy of the global silicon snake oil peddlers.

Single coordinated approach to information provision by government and a government wide IT strategy is supported — it is important to harmonize all Information Infrastructure initiatives. The role of this "single point of co-ordination" will be multi-disciplinary in that role-players from IT and telecommunications will be involved as well as other stakeholders.

A major growth opportunity, that should not be underestimated, is that as many as possible local SA expertise, industry members, etc should be used to design, build and maintain the Information Infrastructure.

There should also be a "single point of co-ordination" for the harmonizing, stimulation, planning, monitoring, etc of general IT development initiatives (applications research and development, data content provision). This group should closely liaise with the "single point of co-ordination" on the Information Infrastructure but it should be a different group.

Although the "single points of co-ordination" are very important to optimize activities, there is a danger that they can become bottle-necks to new development. Therefore their regulatory roles should be minimized. Innovation is easily stifled by regulation and it should be appreciated that many efforts to regulate IT boil down to attempts to regulate research. Such attempts are recipes for obsolete technology. "Harmonizing SET information infrastructure" is not an easy task.

3.2 Research and Development in the Higher Education Sector

Issue 8.2:

What national objectives should determine the main orientation of the R&D activities of the HES?

There are three major objectives which apply particularly in the case of IT: competitiveness, social upliftment and development and long-term growth.

Competitiveness implies not only keeping up with overseas industry, but identifying areas we can be ahead of them. Higher education can address both, through education in the first case, and advanced research in the latter. However, more contact with industry to feed ideas both ways is needed.

Social upliftment and development addresses the problems of the RDP. R&D can support this goal both by providing graduate students of disadvantaged groups with high-end career opportunities and by doing research to support the RDP's objectives.

Long-term growth requires that there be advanced research both in theory (which although not applicable now, may have application later) and in analyzing and understanding industry trends. Understanding trends is especially important where computer technology is concerned, since the rate of improvement in processing power for a given cost is a factor of two every 12 to 18 months.

The general enabling role of IT implies that there is not such a dichotomy between the two options presented as may be expected.

Option 1

The national SET policy must be guided by economic projections of HRD and R&D needs to create a competitive advantage in specific key areas such as agriculture, information technology, and so on.

The specifics noted in Option 1 apply not only directly to computer and related industries, but it should be noted that all other sectors require broad infrastructure. That infrastructure includes computers, networks (especially but not only the internet), telecommunications, transport, etc. For this reason, Computer Science should be seen as an enabling technology for *all* other sectors, and not only in narrow terms.

Option 2

The aim of the HES must be an overall investment in human capacity of a scientific and technical

nature, not targeted too closely at specific capabilities and markets, realizing that such investment in capacity can by itself be a driving force in the economy.

A broad goal in investing in human capacity also requires that infrastructural technologies be available – especially those which are productivity amplifiers. Computers, telecommunications, etc. again are important. However, if we are purely consumers of these technologies, without advanced research to find uses that suit our unique requirements, we will not be realizing the full potential of our human skills in other areas. Example: computer visualization is an area which can vastly improve productivity in sectors such as geology and medicine. However, much original work needs to be done to suit local problems. Another example: safety in manufacturing processes can be enhanced by computer methods (more accurate control of plant, simulation of potential problems).

3.3 Role of IT in Industrial Competitiveness and Reconstruction

Issue 8.7:

What mechanisms must be introduced to promote better correlation between the R&D activities of the HES and the industrial sector?

A first option is to create a database of IT R&D projects that currently or in future may contribute to RSA international competitiveness. The database should contain indications on which projects are considered so worthwhile that industry would be willing to sponsor them.

Option 1

HES-Industry collaboration programmes, such as the DTI-FRD's THRIP programme, should be further developed and financially strengthened. The R&D statutory funding bodies should take responsibility for bringing industry and the HES into negotiations on collaboration.

General incentives, e.g. THRIP programme, tax incentives, and offset arrangements for foreign firms wishing to sell to government, should be developed to encourage co-operation between industry & HES. The current, restrictive, rule governed approach evident in some of these programmes should be replaced by a *delivery orientated approach* which focuses more on facilitating the desired results.

Option 2

The HES must establish special programmes to facilitate the growth of R&D activities in the SMME sector.

A particularly effective technique for stimulating innovative IT SMME enterprises is to establish *Centres of Excellence and Expertise*. This should target identified niche applications fields in order to exploit and develop competencies of researchers. Developers from HES and industry/SMME sector can be supported in collaborative projects.

IT development is a labour intensive activity of itself. Increasing the effectiveness and competitiveness of industry and commerce will further strengthen sustainable job creation prospects.

Channels should be opened up to international, especially USA, venture capital markets. Active development of international IT export markets will act as a stimulus for local IT industry and HES' R&D An environment for more significant co-operation with multinational companies will leverage local skills and further development of such skills and abilities.

The recommendation is thus a combination of government funded initiatives and co-operative projects with multinational companies that invest and transfer technology. Currently IT enabled advances for local industry seem usually induced via their international contacts. Established local companies (with certain exceptions) have a sorry record in IT innovation.

At local government and community level an economic (micro level) atmosphere conducive to such activities should be established. Exact details could be learnt from other similar countries that have succeeded in doing this.

Tertiary institutions themselves do not have the resources to bootstrap the process.

Issue 8.8:

What structures, mechanisms and programmes will reinforce the contribution the HES can make to the reconstruction challenges facing South Africa?

Option 1

The National Research and Technology Audit should show up deficiencies in R&D supporting reconstruction. This should form the basis for a revision of research priorities of universities and technikons to include projects in areas affecting quality of life such as water reticulation, sanitation, energy provision, etc.

Option 2

Universities and technikons should be encouraged, via suitable funding incentives, to establish community interface mechanisms aimed at developing effective outreach programmes

Measures which would contribute to the interfaces:

- creating units to provide an interface with communities
- establishing partnership programmes with CBOs and NGOs
- running community-based extramural programmes
- providing central facilities to facilitate community contact, for example, through an Office of External Affairs or Deputy Vice Chancellor of Community Relations.

As remarked above (Issue 8.7) an internationally proven and effective mechanism for stimulating effective SMME's in IT and related industry is the establishment of centres of excellence and expertise in targeted fields.

A useful measure, given the rate of advance of IT, would be the establishment of an IT "wake-up" think-tank whose brief is to identify key areas where IT technology can be applied for the benefit of South Africa. Such a unit should generate proposals and funding mechanisms that will steer the local IT community to adapt to produce these benefits. It should also identify the paradigm shifts needed of the people that can potentially benefit from such projects. Currently advanced IT resources in SA are very thinly spread — a fact that will have to temper these plans (see also Section 2.2).

3.4 HES Research and Development Funding

Issue 8.12:

How can the funding of R&D in the HES be more suitably organised so as to direct R&D activities towards the needs of economic growth and reconstruction?

Option 1

The statutory funding agencies should be rationalised so as to decrease overhead costs and improve co-ordination and coherence. A model could be to reduce the number of agencies to three:

- one for engineering, the physical, biological, agricultural and geological sciences
- one for the medical sciences
- one for the human and social sciences.

Option 2

The universities and technikons must diversify their research portfolios to facilitate increased spending by the private sector in HES R&D. At the present time the private sector contributes only 10% of the R&D funding in the HES. This is very low by international standards.

Option 3

The R&D component of the GUF[1] should be more directed in its distribution and utilisation, and mechanisms should be developed to monitor the utilisation and outcomes.

Option 1 appears to be unworkable: how could one agency with reasonable staffing and expertise handle "engineering, the physical, biological, agricultural and geological sciences"?

Option 2 goes to the heart of the matter: the semi-colonial and often exploitative nature of many international companies that do business in SA. Particularly in IT they appear to be only interested in selling their products. They offer their local staff sufficient training to sell and maintain (where maintain is in fact replace parts) their products. They are not interested in developing products or technologies in SA. Only government, by means of incentives, can oblige them to do so. In this regard, Australia forms a possible model for SA.

In Appendix B some material is attached on how Australia has attracted major multinational high technology companies into collaborative ventures with Australian universities, and how incentives have been made available to Australian universities to focus their research into product-oriented activities. It also contains a critical evaluation of the Australian experience.

[1] GUF = Government University Fund

3.5 The Role of IT in Education and its Relation to Mathematics

Issue 9.1

What mechanisms should government introduce to improve the teaching and learning of mathematics, science and technical/technological subjects at the pretertiary level?

Use aggressive teacher re-training programmes in holidays. Distance education can play a role here.

Issue 9.2:

Should mathematics and science be compulsory subjects for all pupils for the duration of their pretertiary education? A motivation should be provided for the answer to this question.

No. School children should not be forced but convinced of the importance of mathematics. There are many ways to do this. Although mathematics is important if you want to follow a SET career it is not that critical for all people. A working knowledge of computers is much more valuable to everybody.

Issue 9.3

Should technology education be part of the compulsory education curriculum? If so, how should it be implemented? Please provide a motivation.

No. School children should not be forced but convinced of the importance of technology. A major component of technology education should be computer literacy. Hands-on lessons will not be possible in all schools but it is extremely important and industry should be encouraged to help. Aggressive teacher training programmes in holidays should be followed to create the teaching staff. A good way of motivating teachers to cooperate is to ensure that adequate facilities are provided and to pay all technology and mathematics teachers and additional allowance. Basic computer literacy can be taught as an interim measure even on obsolete equipment, provided support for such equipment is available.

Issue 9.4:

What mechanisms should be introduced at the local, provincial and national levels to integrate information and communication technologies into the education process to improve the utilisation of the education resources and the quality of learning?

The deployment of IT based distance learning countrywide in schools over the next decade will be limited by the expense. School students should be given access where possible but in the short run the target groups for this technology should be teachers and university students.

It is important to remember that linking education institutions is a very small part of the problem. The major

part involves particularly the production of lesson material, but also end equipment, application software, trained staff and procedures.

Distance learning can and will certainly play an important role in work-force training (they are more motivated and it will be paid for by industry) and in universities / technikons (it is cheaper to link them together). It is also logical to start by linking tertiary education institutions because more can be gained with less investment.

3.6 IT to Support Democracy and Society

Refer to green paper Section 10.2 (Impact of Technology on Democratisation)

While we believe that IT can help to make information available and to exchange information, it is a potentially powerful force to either enable or prevent democracy (Was IT not used by the apartheid regime to control pass books, keep track of exiles, etc?). Unfortunately IT is not a guarantee for a good government, not even a guarantee to democracy.

Issue 10.3:

How can we enhance the role of information technology in making information, needed to exercise public policy options, readily available?

Information technology will benefit automatically from ensuring the technological capacity exists to maintain and extend the telephone network, radio and television to all parts of the country, and also from enhancing the capacity of the local publishing industry. What else could be done?

Option 1

All major national issues, on which public input is required, be set out with the necessary supporting information and made available on the internet or world-wide web servers. This facility could eventually be extended to regional and local issues. Computers linked to the network could be made available at schools or public libraries for ready public access.

The government and various political parties are already using this method to increase access to information. A long-term plan could be put into place to provide the required equipment countrywide over 10 to 15 years. Innovative solutions should be applied such as workstation access to internet via low cost terminals, using the memory of a central server rather than having their own internal memory. Adopting such a plan would stimulate the local electronic and information industry, with major economic and HRD spin-offs, in addition to its benefits of providing modern information technology countrywide in support of the educational development thrust.

The assumptions on the nature of IT development underlying this section are particularly problematic, it is critically analyzed in Section 2.1 above.

Making policy options accessible can be vastly enhanced if there is easy access to the internet. However the goal of participatory democracy is not met if access is restricted to an elite. Work needs to be done in rural telecommunications, strategies for making internet access publicly available (libraries, community centres, etc.).

Funding such development should be pursued by a combination of public funding to seed projects, and finding ways of selling small value added services (publishing on the internet for example), to make development sustainable.

Widespread access to the internet as proposed is a good idea – but some thought should be given to content provision, not merely providing "terminals".

Content should be set up in the form of local encyclopaedias, on-line school text books, discussion forums, etc. Publishing on the internet for the school system should be encouraged; there should be a vast body of free information, and the best should be rewarded by payment, to encourage the best authors to do more.

If a "terminal" policy is used, the terminals should be designed to upgrade to a full computer, for those whose usage warrants it. Otherwise we will see the Beltel phenomenon: a technology that dates fast, with no upgrade path.

Care should be taken to avoid building an assumption of highly centralized servers into the system. This should instead be seen as the initial point, from which growth can occur, once skills become more widespread. A true "information" society includes programmers, and new languages designed for adding functionality in small components, like Java, make entry to the programming market much easier[2]. But highly controlled centralized servers with no local computing power is not an environment that will encourage innovation.

To speak of deployment over 10 to 15 years is not realistic. 15 years ago, there were no windows-based personal computers, and a 5 Mbyte hard drive was an expensive luxury. Even the internet was not in wide use in 1980; the World Wide Web appeared less than 5 years ago. Today, a window-based personal computer faster than a mainframe of 1980 and with a 1 Gbyte disk can be had for about R5000.

Instead, short-term goals should be identified, and a plan for the next 5 years adopted. Even a 5-year plan has to make allowance for major unexpected innovations, and be open-ended in the way goals are specified.

The biggest risk in planning too far ahead is in committing to country-wide infrastructures such as networks, without a clear vision as to what will connect to them – and what people will eventually want to do. If we can decide the functionality, the technology will fall into place (at least to the extent that we can see far enough ahead). We cannot plan based on what we could buy today. The biggest strength of computer technology is the exponential improvement in what you can buy for your money (hyperinflation in reverse); the biggest weakness is the difficulty of upgrading fixed infrastructure such as networks, to keep

[2] To reiterate the obvious: the above is based on today's technology, the only certainty is that tomorrow's "Sumatra" will be orders of magnitude better!

up with general progress in other areas of computer technology.

Here are some examples of potential goals:

- give all schools access to a community centre with internet access by 2001
- aim to move from all centres in a region / province using the same server, to a server per resource centre over 5 years
  - training in server maintenance over that period will be required
  - at the same time, higher-level skills such as web page authoring and programming should become more widespread
- as funds permit, "terminals" should be gradually upgraded to full computer systems to permit local work such as word processing, recording lab experiments and programming
  - a strategy which assumes cheap internet "terminals" will quickly turn out to be too limiting
  - many "analysts" have proposed that there will be a massive market for such "terminals" but it seems likely that users will quickly discover that a fully fledged computer is still necessary
- design the infrastructure so that it is a relatively easy upgrade to improve the network bandwidth to at least HDTV standards, with potential for further upgrades to at least 1 Gbit/s
  - this can be achieved by a fibre optic backbone linking urban resource centres, with cheaper connections wherever the budget doesn't permit the full fibre connectivity
  - the design should allow for upgrading to full fibre incrementally as funds become available (eventually to all urban schools)
  - rural areas will have to use radio or satellite links; the expense will preclude rapid deployment, but a 5-year time-frame may be realistic to cover at least the more populated areas
  - universities should be included in the network, so they become resources for the school system

By 2001, if a plan is adopted around the above goals, most school graduates will be very familiar with current technology, and we will have an infrastructure in place for adopting technologies of the next century. We should even have a base for contributing to innovation, rather than merely being consumers of technology.

3.7 Appropriate and Entrepreneurial Technology

Section 10.5 of the Green paper addresses the appropriate use of technology in marginalized and disadvantaged communities. Urban and rural communities of developing countries will clearly derive benefit from becoming the end users of first world technology and infrastructure, but, without local involvement, communities will become more (rather then less) reliant on foreign expertise, and less (rather than more) able to compete in a world technology market. Information Technology is an area in which a local content and service industry can grow up, hand-in-hand with the installation of new infrastructure. The costs of setting up small enterprises in the Information Technology is much lower than in most other areas of Science and Technology.

Broadening the local content, and including previously marginalized groups, will require the working together of government, business, and institutions of higher education. South Africa is a substantial world market for Information Technology (estimates currently place us somewhere between 17th and 20th), and has considerable customer clout to avoid becoming a dumping ground for foreign technology.

> **Issue 10.6:**
> What should government do to motivate performers of SET to help provide effective solutions to improving the quality of life of the poor and marginalized?
>
> ....
>
> **Option 3**
> Institutional support is given specifically to the development of appropriate technology for community needs. In many cases the most useful methods will employ low or intermediate technology, but in some cases (for example, related to information and communication facilities), even in impoverished areas, high technology may be appropriate.

Collaborative ventures which combine technology transfer with local development require the support of political leaders, as well as entrepreneurs and educators. Forums such as the G7 ISAD conference (and others) are ideal platforms for taking a stand on this issue, and for encouraging foreign involvement in local Information Technology development.

Information Technology is an area in which high technology is often appropriate, even in impoverished areas. Institutional support for the development of appropriate technology is an obvious mechanism for encouraging the development of specific directions.

Section 10.6 of the Green paper addresses unemployment and opportunity. Information Technology is a field of Science and Technology which increasingly underpins other branches of SET, as well as every other field of professional endeavour. Information empowers people in their work place and in their private lives; access to Information Technology is essential in a modern society. IT in any economy must become a "driver" of the economy.

> **Issue 10.9:**
> How can curriculum design and educational strategies be utilised to create a technology-sensitive entrepreneurial culture and diffuse technical skills in the marginalized communities?
>
> This can largely be done through existing educational institutions, provided they develop the appropriate courses in collaboration with local or overseas groups who have expertise in these areas.

Option 1
Existing secondary and tertiary educational institutions and NGOs are encouraged to design courses aimed at developing the required abilities in urban and rural communities. In particular, adult education centres, based in existing institutions or developed from scratch, are set up to provide suitable training, with both a technological and entrepreneurial character, for the unemployed population in the townships.

Information Technology will diffuse naturally into less developed communities if professionals working for private and government institutions in those communities take Information Technology into their work places as a natural means of becoming productive. This requires Information Technology skills to be spread far wider than traditional science and technology programmes, into the educational curricula of all professional directions. Government should accelerate this essential spread of Information Technology by providing incentives to educational institutions to turn out students with appropriate Information Technology skills to complement their chosen profession. At the very least, this would abate the number of graduates in low market related fields who are not readily absorbed into the job market.

In all areas of Science and Technology, but particularly in Information Technology, higher educational programmes would benefit substantially from the increased involvement of industry. Many institutions, including South Africa's technikons, have adopted the cooperative education model, incorporating practical work experience with academic study[3]. This ensures the marketability of graduates, and has a natural market tuning effect on curricula. A greater commitment from industry and educational institutions needs to made in this direction. Government at all levels would play a key role through appropriate incentive schemes.

The only option mentioned in the Green paper under this section (option 1) is currently unsupported by Government. The tertiary educational sector needs to be given support for efforts that attempt to redress past inequalities, and that fall outside of their traditional roles. This is especially urgent for study directions in Science and Technology.

4 Conclusion

The vision of the Green paper is one of preparing South Africa for the 21st century. This vision is one of meeting the needs of individuals and communities through new solutions to problems: powerful solutions that leap-frog old obstacles. Such solutions depend upon innovation, that is, new discoveries that are effectively applied. This is clearly as much a social and economic vision as it is a scientific and technological one.

Legislation which eventually springs from the forthcoming white paper must have an impact beyond the limits of arts, culture, science and technology if it is to be effective. Information technology innovation in particular must impact trade and industry and form an integral part of the strategy for the reconstruction and development of the country. Otherwise the greatest weakness of our science and technology, namely the limited capacity to convert scientific and technological advances into industrial and commercial innovations, will remain unaddressed.

Legislation should involve the implementation of various policies:

1. policy on support for SMMEs, this is broad but includes initiatives mentioned below in terms of community access centres and centres of excellence and expertise.
2. industrial policy to support information technology transfer, including general IT Development Coordination Point — Section 3.1.
3. regional and local IT deployment and IT infrastructure policy (including Community Access Centres, and Telecommunications and IT Infrastructure Coordination Point) — Section 3.1.
4. policy on the establishment of Centres of Expertise and Excellence in IT Innovation to support both SMME's and community access centres — Section 3.3.
5. national priority programme for information technology innovation in HES to support the South African information society, coupled with strategic support for human resources in IT at HES — Section 2.2.
6. coordinated certification for education and training in IT at non-university levels — Section 2.2.
7. competition policy covering intellectual property rights and standardization — Section 2.1.
8. HES–industry collaboration incentives (tax, offset) — Section 3.3.
9. HES–IT multinational cooperation — Section 3.4.

The white paper will have to identify and formulate the necessary measures which will develop the capacity for innovation in South Africa. The 21st century will be the century of the global information society. A substantial chapter of such proposals will have to deal with information technology and South Africa's preparation for the information age. The objective will be to see that IT will be enabled to provide better living conditions for all people more efficiently. Another objective must be to avoid a further deterioration of South Africa's competitive position in the face of increasing worldwide reliance on knowledge and IT for market advantage.

Appendix A Sections of the Green Paper with Passing References to IT

2.3 Policy Context

[3] Waterloo University in Canada has become world famous for this.

3.1 The Changing Role of Government in Support of the National System of Innovation
3.4 Toward the 21st Century
6.1 The International Experience
6.9 Information Infrastructure for SET Performers
7.8 The Regional and International Dimensions of Innovation
8.1 The Research and Development Orientation
9.3 The Appropriate Role of Technology in the Process of Learning Mathematics and Science at the Pretertiary Level
10.1 Technology and Public Choice: Sustainable Development and Ethical Issues
10.2 Impact of Technology on Democratisation
10.5 The Appropriate Use of Technology in Marginalized or Disadvantaged Communities

Appendix B Information Technology (IT) Policy in Australia

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This appendix follows on from points raised earlier in Section 3.4.

IT products and services currently account for 20 percent of world trade and are growing at 10 percent per annum. The overall growth in world trade is 6 percent per annum: IT is an industry that no nation can afford to neglect.

The dynamic growth of the Asia/Pacific Region has lead many corporations to re-focus their long-term strategies for the Region and for Australia. The mutual benefits are enormous: Australian firms provide specialized skills and techniques to help international companies win new niche markets, and in return international companies provide new markets for Australian products and services.

Corporations are encouraged to benefit from Australian innovations and advances in IT — Australia compares very favourably with other countries in the Region as a source of specialized IT skills, products and services. International companies bring the markets of the world to Australia's doorstep. They help Australian firms establish or expand their overseas markets through proven marketing and support networks. They provide immediate cost effective access to new technologies, innovative product development and improved economies of scale.

B.1 Partnerships for Development

Because of its geographic isolation from IT centres of the world, Australia was one of the first nations to become aware of the need to capture future IT opportunities. The Federal Government operates two schemes which encourage international companies to expand their strategic global activities in Australia and to seek out Australian products, services and skills with international prospects and mutually beneficial returns. These schemes are Partnerships for Development (PFD) and Fixed Term Arrangement (FTA) Programs.

PFD Program Partners agree to implement within 7 years strategic business plans to commercialize Australia's competitive strengths in the IT and communication industries. FTA Partners agree to a 4 year program. Partners only undertake activities that make commercial sense. The activities must be strategic and should be commercially sustainable after the Partnership expires.

Many of the world's leading IT companies participate in the programme. PFD Partners are: Alcatel, Amdahl, Apple, Bull, Cincom, DEC, Ericsson, Fijitsu, HP, IBM, Microsoft, NEC, Nokia, NorTel, Oracle, Pyramid, Siemens Nixdorf, Sun Microsystems, Tandem, Unisys and Wang. FTA Partners are: Acer, Canon, Compaq, Fuji Xerox, GPT, Hitachi Data Systems, Ingres, Oki Electric, Storage Technology, Toshiba and NCR. Some 300 Australian companies benefit from the PFD and FTA Programmes.

The policy is working. In 1987 Australia exported AU$650 million of IT products and services. In 1991 this figure rose to AU$1.5 billion, and by 1995 will have exceeded AU$3 billion. By the year 2000 the IT industry is to become Australia's biggest employment and export sector.

B.2 Incentives to Collaboration

International companies with annual IT sales to government of between AU$10–AU$40 million are encouraged to enter into a FTA program. International companies with annual IT sales to government in excess of AU$40 million are encouraged to enter into a PFD program. In practice this means that an international company that qualifies for PFD/FTA membership must allocate 15 percent of its sales to support the PFD/FTA program otherwise it cannot sell to government.

When entering into a PFD/FTA, the company undertakes to maintain a specified level of R&D and exports over a 7/4 year time frame. A business plan is drawn up in collaboration with the Commonwealth Department of Industry, Trade and Regional Development to determine how the PFD/FTA strategic activities complement the parent company's global business strategies, to identify potential local partners and to specify projects, activities and annual milestones.

The agreements are formalized in a Memorandum of Understanding between the Australian government, the international company's head office and the local subsidiary. Companies report annually on their progress as to how they have achieved the milestones specified in the business plan.

Australian companies are encouraged to become PFD/FTA partners by providing products, skills and services to international IT companies. Local companies must identify international IT partners, identify a mutually beneficial area of collaboration, understand the contractual arrangements required by the international partner, provide a detailed business, financial and marketing plan and investigate the international company's standards, quality control, volume, delivery and pricing procedures.

An external auditor provides an ongoing and consistent review of the effectiveness of the program. Partners are audited every two years at government expense and an

annual report is published by the auditors summarizing the effectiveness of the program.

B.3 Collaborative Research Centres

The Federal and State Governments encourage research collaboration between universities and industry. Government grants are available to develop Collaborative Research Centres (CRC's) to facilitate collaborations. After an initial period (usually 3 years) of government support, CRC's must be self funding from revenue raised from industry contracts. CRC's have ambitious goals and some of them already attract funding in excess of the competitive research funding available from the government.

As an example, the Centre for Information Technology Research Institute (CITRI) was established in 1990 by the Victorian State Government, the Royal Melbourne Institute of Technology (RMIT) and the University of Melbourne. CITRI hosts ±100 researchers (faculty members of the hosting institutions who double up as part-time associates in CITRI) and in 1993 earned AU$7.3 million from industry contracts. CITRI hosts research groups which are active in telecommunications, database design, multimedia and neural networks. CITRI provides applications development, strategic research, consulting and training courses to industry. CITRI forms strategic alliances with large corporations to perform long term research in selected areas. For example, CITRI has an alliance with Ericsson Australia to develop a Software Engineering Research Centre (AU$2 million over 5 years) focusing on performance analysis of Telecommunications Information Networking Architecture (TINA) and telecommunications software. CITRI has a successful track record in winning competitive research grants, developing generic research technologies and commercializing products. CITRI's education services include a Postgraduate Certificate in software engineering as well as courses designed for major engineering organizations. CITRI provides facilities for postgraduate student training in its host departments of computer science and engineering.

B.4 Some Critical Remarks

Industry-university collaboration involves 3 partners: government, local and international companies and the universities. Government provides the legislative and financial incentives for industry and university to collaborate. This involves substantial expense in terms of the grants allocated to start up the many CRC's. On the other hand, university research funding has been reduced since Australian universities are expected to meet 40 percent of their budgets from outside sources that are facilitated by the CRC mechanism. Industry is collaborating: many international IT companies are members of the Partnerships for Development Programme. However, PFD membership often involves equipment discounts and donations of previous generation equipment rather than hard currency. Thus government and industry have met their obligations in terms of the PFD programme. It is essentially up to the universities to provide the manpower and skills to make the PFD programme work. However, few new university staff are appointed - academics are expected to maintain their current levels of teaching, research and administration and in addition to function as CRC associates. This may be possible: government may be of the opinion that Australian academics are not overworked and that they can become more productive.

It can be argued that the CRC mechanism is inconsistent with the university ethos and that the university's right to chose its areas of academic investigation was being restricted. Universities do not necessarily have the managerial and financial acumen to make a success of the CRC.

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The Evaluation of Business Process Reengineering Projects in South Africa

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Abstract

While much has been written describing the necessity for and effects of Business Process Reengineering (BPR), little research has been conducted into the evaluation of BPR projects. This paper describes the result of a study aimed at identifying current practice in the evaluation of BPR success in South African organisations. Evidence was gathered by interviewing 18 respondents from organisations which were or had been involved in BPR projects. A framework for the evaluation of BPR projects developed by the author was evaluated against this evidence and guidelines for management which can be applied in the evaluation of BPR projects derived

Keywords: *Business Process Reengineering, Evaluation, Benefits, Measurement*
Computing Review Categories: *K6*

1 Introduction

Business Process Reengineering (BPR) is a managerial initiative which combines the transforming power of Information Technology with a process-based view of the organisation to radically redesign business processes.

World-wide, companies are spending millions on BPR. Andersen Consulting alone billed $700 million dollars in BPR revenues in 1992 [16]. BPR promises enormous benefits, which if realised should outweigh the considerable costs described above by a factor of between 5 and 40:1 [1]. However, there is a growing realisation that the implementation of a BPR project is very difficult in practice, as changing from a functional hierarchy into a process-based organisation involves many complex organisational, structural, interpersonal and information systems issues [10].

Although surveys show that reengineering is a top priority for as many as three quarters of Information Systems managers [5] and that the number of BPR projects has increased substantially in the last two years [7], many CIO's feel that the expected benefits of BPR have not been realised [7]. Results such as this have led many managers to be sceptical of BPR, particularly in the UK, where management "tends to view innovation reluctantly" [17].

However, while there is much literature of a descriptive nature on BPR in general, the issue of how to measure results is not clearly defined. As Preece and Peppard [11] point out, there is a clear message that new metrics of process measurement are needed. There are, however, few authors who have investigated what metrics are actually being used. Yet it is difficult, perhaps even impossible, to judge the success of any initiative without proper measurement of the benefits it is expected to provide. Before one can conclude that reengineering does or does not work, one must first determine how success is evaluated.

This paper describes the result of a study aimed at identifying current practice in the evaluation of BPR projects in South African organisations. Section 2 describes the research methodology employed, Section 3 describes a framework for the evaluation of BPR projects developed by the author, Section 4 analyses the evidence gathered and Section 5 evaluates the framework against this evidence. Section 6 provides guidelines for management which can be applied in the evaluation of BPR projects.

2 Research Methodology

The research project was undertaken in 1994 and involved passive observation, by means of semi-structured interviews, of firms who had attempted or were attempting BPR.

Procedural Framework of the Research

The procedural framework most suited to passive observation is that of developing a theoretical conjecture to be tested [14]. The first step in this framework is for the researcher to conduct a review of the literature related to the subject being studied. The researcher then develops a theoretical conjecture in which he/she asserts various ideas about the area of study, based on the underlying theory found in the literature.

The theoretical conjecture is then used to develop empirical generalisations, or clear statements which can be verified against further evidence. This empirical evidence is then gathered from an appropriate sample and analysed with the aim of confirming or rejecting the theory, or developing a more refined theory.

The theoretical conjecture and diagrammatic framework developed by the author are described in Section 3 below.

The Data Collection Strategy

BPR is primarily involved with organisational structure and behaviour. Much of the data to be obtained in this regard may be said to be "soft", that is, related to human ideas and perceptions, rather than "hard" or related to facts and figures. It was therefore decided to adopt a primarily non-positivist, phenomenological approach.

The phenomenological point of view assumes that reality is not concrete and exterior, but socially constructed and given meaning by the people who experience it [6]. Phenomenologists hold that reality is socially constructed rather than objective, and that the task of the social scientist is to try and understand reality through sensation, inference and induction from data, rather than the gathering and measurement of facts [4].

Phenomenological research is primarily concerned with concepts, and therefore makes use of qualitative methods of gathering data. It was decided that the semi-structured interview approach would be most effective in gathering data on BPR, as this would allow for a greater in-depth understanding of the subject matter than a questionnaire. An interview schedule was thus constructed as appears in Figure 1. Once the interview had been conducted the interview content was analysed using interpretive analysis. This enabled the researcher to identify the central concepts which emerged from the interviews, confirming, rejecting or providing further insight into the theoretical conjecture.

1. Could you briefly describe the reengineering project?
2. Have you established success criteria for the project and what are they?
3. When where these criteria established?
4. Do you have measusers for these criteria and what are they?
5. Are there different types of measures, i.e. "inside" and "outside" of the process?
6. Who uses the measures?
7. Has the project been a success or failure?

Figure 1. The interview schedule

At the beginning of each interview the research question was described to the respondent. The respondent was then initially asked to provide a brief description of the project in order to provide a context for the specific questions, as there are different forms of BPR which are undertaken.

In many cases the respondent answered some of the research questions as shown in Figure 1 in his/her general description of the project, in which case only the remaining unanswered questions were specifically asked. If a respondent alluded to an interesting issue, which was not specifically addressed by the questions, then other follow-up questions may have been asked. Thus the interview was semi-structured, as opposed to completely structured in advance. This approach was taken in order to try and gain a deeper understanding of the organisational experience of BPR, rather than allowing the pre-determined interview schedule to determine entirely, in a positivist manner, the data which could be obtained.

Of the 18 interviews, 17 were tape recorded and in some instances additional notes, particularly of diagrams drawn by the respondents, were taken. The average length of an interview was 45 minutes, although some ranged up to an hour and a half. All the interviews were transcribed, resulting in 6 pages of single spaced typed transcript on average.

The Data Analysis Strategy

At the conclusion of the data collection phase of this research, eighteen interviews had been conducted in eighteen different firms. These tape recorded interviews were transcribed into one hundred and ten pages of text. This text provided the researcher with a primary narrative from which a higher order narrative could be extracted and used to examine the validity of the theoretical conjecture.

There were two objectives to be achieved in this analysis. The first was to determine the validity of the empirical generalisations derived from the theoretical conjecture. The second was to extract any further insights into the subject matter provided by the interviews. These would be insights which, although not specifically addressed by the theoretical conjecture, could nonetheless be used to refine the conjecture further, so as to provide a more complete explanation of the phenomenon under study.

These objectives meant that two approaches had to be taken to the analysis of the data. In the first place, all the data was examined within the context of the primary narrative, and required interpretation and inference to be synthesised into the overall theoretical conjecture. A phenomenological method of interpretive analysis was thus first adopted in respect of the data.

Interpretive analysis is derived from the hermeneutic or interpretive tradition and ultimately enables the researcher to abstract the "essences" from the text. This is described by Lacity and Hirscheim [9] as follows:

> *Essences are wholly subjective gestalts of the lessons learned from studying the phenomenon. The abstraction of these essences requires creativity, intuition and reflection. Here the unit of analysis transcends the actual study to make insightful comments for academics and practitioners. The researcher no longer asks "What do the participants think about the phenomenon?", but rather "What do I think? What lessons have I learned about the phenomenon?"*

In addition, the empirical generalisations provided a paradigmatic framework within which to examine the data. This meant that for this purpose, a quantitative technique such as content analysis was appropriate. Content analysis is defined by Berelson [2] as

> *"A research technique for the objective, systematic and quantitative description of the manifest content of communications."*

This technique was used in this case, to support the interpretive analysis by assessing the frequency with which each of the empirical generalisations was supported or rejected. This approach may be seen as halfway between a positivist approach and a more phenomenological approach, and is thus suitable for the analysis of data in a paradigmatic framework.

The content analysis was thus used to support the more general lessons learned in the interpretive analysis, and

these were used to refine the theoretical conjecture.

In summary this research methodology is a qualitative, interpretive one in the phenomenological tradition. The analysis of the text data cannot be said to "prove" the theory in any quantitative or statistical manner, but should instead provide a more interpretive knowledge of the validity of the theoretical conjecture. The validity of the interpretation rests on the self-validation of those insights which are communicated clearly and completely in the analysis of the data. If what is communicated adds meaning about the evaluation of BPR projects, then knowledge has been gained and the process of inquiry has been successful. This concept is described by Daft [3]:

> *"Ultimate proof of an idea or theory is its acceptability to common sense. An important test of validity is liking an idea, feeling right about it, being able to use it to throw light on a previously hidden aspect of organisation. Objective proof seldom will exist somewhere outside one's self that will demonstrate correctiveness or validity. No statistical test will do this for us; no amount of replication will make acceptable an idea that does not square with experience."*

3 A Framework for The Evaluation of BPR

The theoretical conjecture was based on the literature review, discussions with practitioners and consultants, and a framework developed by the author to describe the application of different types of metrics by different groups in the organisation.

The framework as shown in Figure 2 is in the form of a grid in which the types of measures to be used are considered in relation to who is using them. The grid suggests that process measures are appropriate for the process teams themselves, while results measures are appropriate for management. Appropriate process measures will enable the self-managing process team to manage the process effectively(A). However, inappropriate results measures(B) will not tell team members what they must do to improve their performance, and will therefore lead to ineffective process management. Results measures are more appropriate to management, who need an overall view of what the organisation is achieving(C). Such measures will enable management to manage the firm from a strategic viewpoint. If, however, management adopts inappropriate process measures(D), focusing on what occurs inside the process, then they will soon find themselves reverting to the command and control style of management, which may be suitable in a hierarchical situation, but which undermines cross-functional self-managing teams.

Using this framework as a basis the following theoretical conjecture was made:

Business Process Reengineering projects do not frequently lend themselves to evaluation in terms of simple financial measures such as payback, ROI or NPV, although some aspects of these types of calculation are required if the BPR project is to be cost-justified in advance, or if the major purpose of the BPR project was cost reduction. BPR projects are generally more effectively evaluated by using multiple metrics which include the measurement of time, quality and service. In terms of the multi-metric approach to the evaluation of BPR projects it is essential for a clear distinction to be made between the evaluation appropriate for the process team and the evaluation appropriate for the management of the organisation as a whole. Evaluation measures which are appropriate for the process team are those which measure the activities inside the process itself. For the management of the organisation as a whole, measures which are appropriate are high-level results measures such as increased profit or improved customer service.

Table 1. Empirical generalisations

1. BPR projects are not frequently evaluated in terms of simple financial measures unless the purpose of the project was cost reduction or measures are required for the purpose of cost-justification of the project.
2. BPR projects are generally evaluated by using multiple metrics which include the measurement of time, quality and service.
3. A clear distinction should be made between the evaluation appropriate for the process team and the evaluation appropriate for the management of the organisation.
4. Evaluation measures which are appropriate for the process team are those which measure the activities inside the process itself.
5. Evaluation measures which are appropriate for the management of the organisation are results measures of what the process has achieved.

The theoretical conjecture is essentially narrative, providing a "consistent story that describes the essential features of the problem under investigation"[13]. However, for the theory to be operationalised in a practical and useful way, paradigmatic thinking is needed. That is to say, a set of logical conjectures on which to predict and explain the observations is required. Thus the theoretical conjecture is used to produce a series of clear statements which will be testable against further evidence [13].

These statements are known as empirical generalisations. A set of empirical generalisations as shown in Table 1 was developed from the above theoretical conjecture.

4 Analysis of the Evidence

The theoretical conjecture and empirical generalisations were then evaluated by interviewing practitioners and analysing the resulting data.

Analysing the Interview Data

There were three distinct groups of respondents. Most of the respondents were or had been involved in a BPR project (BPR Project Respondents). There were however

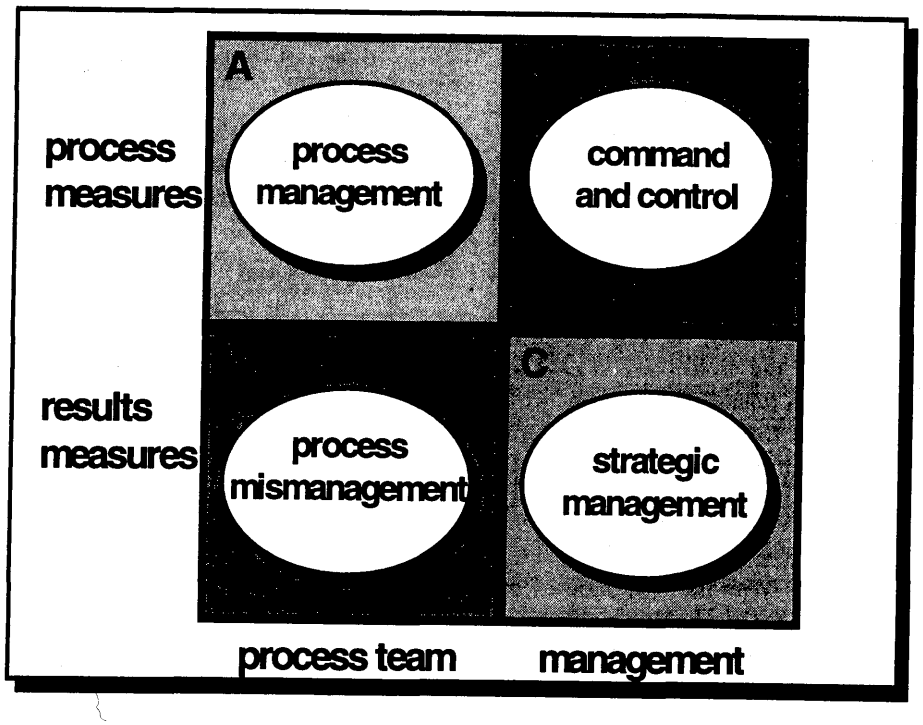

Figure 2. A Framework for BPR Evaluation Measures

two respondents who had been in projects which never materialised (no-BPR Respondents), and two who spoke more generally about BPR in their capacities as consultants. Since each of these groups provided very different perspectives and varying amounts of detail, it was decided that it would be more appropriate to analyse them separately.

The analysis which follows is therefore divided into three sections, one for each group of respondents.

Results of the Analysis for BPR Project Respondents
Of the eighteen respondents interviewed, fourteen discussed projects which were in progress or had been completed. Of these projects, one was in the initial conceptualisation phase, four were in the design phase, four were being implemented and five were complete. All of the respondents who had completed projects mentioned that the change was ongoing to a greater or lesser degree.

Four main areas arose in which respondents discussed issues relating to the project. These were:

1. the project itself
2. measuring in the context of the project
3. IT issues in BPR, and
4. BPR in South Africa

The Project Itself
Various aspects of the actual projects were described by the respondents as follows.

Naming the Project Not all the respondents referred to the activities being undertaken as BPR. Of the fourteen respondents, only two explicitly referred to the projects as BPR. Several used the term "reengineering" and one respondent used the term "transformation", a word specifically used by the consulting firm involved in the project. Several other respondents simply referred to the project as "the project" or "the change". There was some anxiety amongst respondents as to the use of the term "BPR" or even "reengineering". They felt that these terms had negative connotations, both in terms of the failure rate ascribed to BPR, and in terms of headcount reduction and the effect this might have on employee morale, or even industrial relations. A respondent whose firm had completed a most successful reengineering project said that the term had been banned from the organisation because "there is too much pain associated with it now".

There was also some discussion relating to the differences between process reengineering, business reengineering and business process reengineering. Some respondents felt that it was most important to differentiate between these, and even that process reengineering could not properly be termed reengineering at all. A distinction between "radical" and "creeping" BPR has however been drawn by Remenyi and Whittaker [12], and it is felt that process reengineering, business reengineering and business process reengineering all fall within the scope of the concept on which this research is based.

Scope of the Project Seven companies were involved in projects which aimed to reengineer an entire business unit. This is generally known as "radical BPR". Three were attempting to reengineer the IT division. In all these cases IT was a profit centre which could also, in theory at least, serve clients outside of the immediate organisation. Two organisations were reengineering the processes around a particular product. The other two firms were both manufacturing firms who were reengineering the support functions at the Head Office so that they could more effec-

tively support the manufacturing process. The other seven cases are examples of "creeping BPR".

A Process Focus As discussed in chapter one, most important to the concept of BPR is the focus on processes. Of the fourteen firms involved in projects, twelve explicitly stated that they were focusing on process, or used the word "process" to describe the business being altered. Of the remaining two firms, one of them did not appear to have a clear process focus at all, and in this case the project seemed to be floundering somewhat, the respondent expressing doubt as to whether the project would have any effect. The other firm was a manufacturing firm, which already had a strong process focus in the manufacturing environment. Here the project was aimed at reengineering the support functions at Head Office to complement the manufacturing process itself.

The Source of the Project With the exception of one project, all the projects were identified at top management level. In 21% of the cases it was stated that the project was personally motivated by an individual, and here it was felt that this was probably so that the individual concerned could "make his/her mark" as well as benefiting the company. 29% of the companies undertook the project as a direct result of changes in the environment, i.e. external drivers both political and economic, while only 7% (one company) had undertaken reengineering because of a pressing need to change completely the IT architecture and systems. The other 43% saw BPR as an opportunity to improve the business in terms of financial performance and/or service to the customer.

The Objectives of the Project This research is aimed at discovering what, if any, criteria are set by management for the success of the project. When this question was asked, respondents generally answered in terms of the objectives which had been set for the project. They felt that meeting the objective or objectives of the project was the criterion for success.

In general these objectives fell into four areas: financial, operational, customer and cultural. Financial objectives included profit improvement, cost reduction and revenue enhancement. Although cost reduction and revenue enhancement together determine profit improvement, these are specified separately because respondents were inclined to mention them in this manner. In other words, some companies want to improve profit through both cost reduction and revenue enhancement, while other are looking at just one or the other.

Operational improvements include increased productivity, better turnaround time, using IT to maximum advantage and improved structure. These were sometimes, but not always, seen as being linked to financial gains. Many respondents spoke of cultural objectives such as multiskilling the workforce, creating an "initiative culture", and "ownership culture" or improving employee morale. Where these issues were mentioned they were generally not directly linked to financial gains.

Table 2. Content Analysis of Criteria for Success

Area	Criterion	Freq
Financial		
	profit improvement	2
	cost reduction	6
	revenue enhancement	1
	Total	**9**
Operational		
	increased productivity	1
	better turnaround time	5
	using IT to maximum advantage	2
	improved structure	2
	Total	**10**
Cultural		
	multiskilling the workforce	1
	creating an "initiative culture"	1
	creating an "ownership culture"	4
	improving employee morale	2
	Total	**8**
Customer		
	improving customer service	5
	increasing customer satisfaction	5
	being the "market leader"	4
	Total	**14**
Survival		
	survival of the company	1
	Total	**1**

Objectives based on customer perceptions such as improving customer service, increasing customer satisfaction or being the "market leader" were also set in several cases. One respondent said that the primary objective of the project was survival of the company. All of these objectives were mentioned by various respondents as being primary (rather than secondary or implicit) objectives of the BPR project.

Since the objectives, or success criteria, for BPR projects are related to the empirical generalisations, a content analysis was performed on the data in relation to this issue, counting the number of times a particular criterion was mentioned. Table 2 provides a list of criteria, grouped according to the areas specified above. Column one contains the area of improvement, while column two contains the criterion. The frequency with which the criterion was mentioned is shown in column three. The total number of mentions exceeds the total number of respondents because most respondents mentioned more than one objective.

Most of the respondents indicated that the objectives for the project had been set at the start of the project, and only 21% of the companies did not have explicit objectives for the project.

However, several respondents indicated that they found it was very difficult to quantify the objectives. One respondent expressed this as follows:

"Now what is amazing is that when we started the project, we could not quantify our goals. Because

at the time we had no ... measurements in place, and the first thing we had to do was to develop a measurement".

This point of view contrasts with that of another respondent who stressed the importance of setting measurable, and therefore quantifiable goals:

"Setting very measurable objectives was critical to that success. Even though at the time, unattainable. And that's what's key to the whole thing."

This company, however, was only able to set these measurable objectives after the conclusion of a successful pilot project. It thus appears as if the setting of quantifiable goals is a difficult issue, particularly if no pilot study is conducted, as is often the case.

Use of "Outsiders" Many of the companies used "outsiders" in the form of consultants or persons from other companies who had done BPR, for advice or assistance with the project work. It was felt that a neutral perspective or, more importantly, one which was perceived by members of the organisation to be neutral, was very important to the success of the project. At the same time, however, several respondents stressed the importance of not allowing the consultants to take charge, and of ensuring that there was at least joint ownership of the project. One respondent at a large parastatal organisation which has engaged a consulting firm for assistance on the reengineering project describes this as follows:

"We said – we're the owners, you're here to help us with certain methodologies that we don't fully understand. But at the end of the day it's our project. We've said what we want them to do, and they must do it."

Another respondent stressed that she considered it very important for the organisation to implement the reengineering, rather than the consultants. This was being done to place the responsibility for the ultimate success of the project with the organisation itself.

Success of the Project Only one of the respondents whose firm had completed the project said that the project had failed, based on the fact that there had been no change in the bottom line, where profit improvement was the basic objective of the project. The other respondents, however, all claimed to have had great success. The successes mentioned included R30 million off the R120 million rand cost structure of a life assurer, 51% profit improvement at another life assurer, and having "put the competition in disarray" at a heavy equipment dealership. All of the respondents who were still implementing the project stated that the project was, so far, on target and expected to achieve the required objectives. Respondents who described projects in the conceptualisation or design phases were not asked about the success of the project, as it would have been too early for an assessment to be made.

In general, of those respondents able to make an assertion regarding the success or failure of the project, 89% regarded the project as having been successful thus far. This appears to contradict recent findings in the US, which placed the success rate of BPR at 30% of projects and even lower. This may be due to the fact that many of the projects are still in progress, while the others have only recently been completed, making it difficult for the respondents to judge accurately the projects' success or failure. In fact, the respondent at a company which finished its project 10 months ago stated that his perception of the success of the project had diminished somewhat since its completion. One might expect that some of the other respondents may have different responses to this question at a later time.

The findings published in the US which are referred to above do not explicitly define what constitutes "failure" of a project. This issue was raised by several respondents who felt that achieving the objectives set by a BPR project in the short term does not necessarily guarantee the sustainability of the project, and that "failure" may in fact manifest itself at a later stage. This is due to the "elasticity of organisational behaviour" which causes an organisation to move back (like a piece of elastic) to the pre-BPR configuration and culture once the project is over.

Thus a project might succeed in terms of the success criteria formulated in advance, but nonetheless create conflict or undesirable behaviour in unforeseen areas, particularly those relating to the people in the organisation. For example, one respondent noted that while the project had been enormously successful in terms of the predetermined financial criteria, several members of the management team had experienced what was termed "burnout" as a result of the project. These managers had felt overworked and overly stressed by the project and had consequently left the company. This had a negative effect on employee morale and on the organisation as a whole.

Another respondent described how behaviour in the organisation was unexpectedly following the old hierarchical patterns. The project thus "failed" in terms of implicitly expected cultural change, even though it had achieved all its explicitly stated objectives. This was described as follows: "Hierarchy is not what you draw up with boxes and lines. It is in the mind. Unless you break people's hierarchical approach to the way they manage and the way they do their jobs, you will never deal properly with hierarchies. We're still having to deal with that."

Thus, in effect, people can be quite uncomfortable when they are expected to work outside the traditional hierarchical corporate society, and this can have a negative effect on the success of the BPR project.

Measurement in the Context of a BPR Project

Most of the respondents considered measurement to be most important in establishing the success of the project. This was considered to be determined by the performance of the reengineered processes after the completion of the project, generally in comparison to performance prior to the project. This did however provide some difficulties in that the process itself may not have been measured before the project was undertaken. In many projects, therefore, part of the first phase of the project is to establish process-based measures, and then measure these as a basis for comparison.

Table 3. Content Analysis of Types of Measures and Their Uses

Type of Measure	Use of Measure	Freq.
Results		
	for management	14
	for process teams	7
Process		
	for management	0
	for project only	1
	for project & teams	3
	for teams	8

Some respondents felt that this had to be done even before measures could be set for the objectives. Measuring thus became a specific activity in the project, and continued as the project progressed.

Types of Measures It is most important to establish, in terms of the empirical generalisations, the types of measures which are used in assessing the BPR project, and who uses each type of measure.

As in the case of the objectives of the projects, this issue has been analysed by counting the occurrences of the different types of measures used, results measures or process measures as defined in chapter two. Table 3 provides a list of the types of measures, and the frequency with which each was mentioned as being used in a particular context. Column one names the type of measure, while column two names the use of the measure. The frequency with which the type of measure was mentioned is shown in column three. The total number of mentions exceeds the total number of respondents because most respondents mentioned more than one type of measure as being required.

All the respondents agreed that top management would ultimately require results measures of the highest level in assessing the project. These were generally financial or customer-focused measures, such as improvement in profit, overall cost savings, customer satisfaction or improvement in customer service. Customer service was generally measured in terms of time. A measure of success which was not anticipated in the theoretical conjecture was a change in the culture of the organisation. This was seen as measurable, and in many cases an important criterion for the success of the project.

None of the respondents felt that top management would need to see measures of activity in the process itself, either in order to judge the success of the project, or to manage the process afterwards.

However, 89% of the respondents were convinced of the need for additional measures at a lower level which would track the activity in the process itself. This was seen to be related to the BPR project in various ways. Of these, 8% (one respondent) felt that process measures were needed only for the duration of the project, in order to improve the process, and see where problems existed. This respondent believed that lower level process measures would be dropped as soon as the project was completed, because of the expense involved in collecting the measures. A further 25% of the respondents agreed that process measures were needed in the project, but thought that the process teams would need these measures to manage the process afterwards as well.

Of the 89% of respondents who saw a need for process measures, 66% were of the opinion that these were not needed in the design of the new process, but only to judge its success, and manage the process after completion. This was because the process should not be improved on the basis of existing bottlenecks, but completely reengineered. Appropriate process measures would emerge for the new process.

At the lower levels this can create difficulties because the new measures cannot be compared with those of the previous process. This was a concern raised by several respondents. Where a redesign creates measures which cannot properly be compared with the old measures, process measures are less useful than high level results measures in assessing the success of the project, although they are vital for the ongoing management of the process.

Of the respondents who saw a need for process teams to have appropriate process measures, 58% felt that these teams should also be aware of the overall measurable objective, to provide them with an overall target towards which to work. There were however respondents who felt that communicating overall objectives to the organisation as a whole could create conflict and fear:

> *"If you say to people that you're going to take R20 million out of your cost structure, they immediately think of the loss of people."*

In general, overall objectives should probably be communicated to the organisation where these are non-financial, that is customer- or time-based or cultural.

Non-Financial Measures Non-financial measures were said to be used at both the results and the process level. Where non-financial high level objectives were measured, this was generally done in respect of culture change and customer service and satisfaction. Specific culture surveys were conducted to establish whether the culture of the organisation had indeed changed. Customer service and satisfaction were measured in terms of turnaround time and specific customer satisfaction surveys respectively.

Within the process, most measures are non-financial and operational by nature. These include measures such as time to process a claim, number of claims processed, number of sales calls made and so on. Generally these measures are used by members of the process teams or their direct superiors.

Cost-benefit analysis 42% of the respondents explicitly stated that the company had performed a cost-benefit analysis. Of these, 33% said that the cost-benefit analysis was done as an exercise, but did not solely determine whether or not the project was undertaken. These respondents said this would have happened anyway, and one said that the MD knew that the project was "a bit of a gamble". Apart

from this statement which indicates an awareness of the risks involved in the project, no other mention was made of risk, or risk analysis in relation to BPR projects. 83% of the companies which did cost benefit analyses had set financial objectives for the project.

15% of the respondents explicitly stated that they believe that it is impossible to cost-justify a BPR project. This was expressed by one as follows:

> *"I will defy anybody in any business reengineering project to cost justify what they do – to say 'we'll spend so much, we'll save so much'. If you do it properly, the momentum that gathers speed creates opportunities and ideas that you would never have thought of. There's a natural belief to say 'find the guy who knows what to do, and he must go and do it'. But if it's done properly, nobody knows what to do. You cannot."*

Another respondent similarly pointed out that it is possible to cost-justify individual initiatives, such as a new IT system, in the project as they arise, but that the overall project cannot be justified in advance because you don't know what these initiatives will be.

The conflict between needing to cost-justify project activities and the difficulty in predicting what will be needed in the long term was expressed by one respondent as the difference between "tactical" and "strategic" reengineering. Tactical reengineering is the initial project done to establish processes and activities for further change, while strategic reengineering encompasses the "ideas and opportunities that you would never have thought of".

> *"..with the tactical reengineering we want to see benefits within the lifetime of the project. And normally those benefits will phase in over three years and reach maximum in the third, that's typical of tactical reengineering. The strategic reengineering will overlap that and will phase in typically in about the second year. It's all the stuff you can accomplish with things that take a long time to put in place, like the IT systems or whatever. And the benefits of a strategic program will probably only start being realised in year three onwards."*

Cost-benefit analysis thus appears to be appropriate for a tactical reengineering project, at the start of the project. For a strategic reengineering project it should be done individually for each initiative in the project. For example, at one organisation the reengineering team decided that a national phone-in centre should be established. This initiative was part of the strategic reengineering effort, and could not have been foreseen before the start of the project. It therefore had to be cost-justified as an independent initiative.

Where the reengineering as a whole is seen to be essential, i.e. strategic, it is likely that a cost-benefit analysis will either not be done at all, or will only form part of the criteria on which the decision to proceed with the project is based. Strategic investments traditionally bypass evaluation procedures as routine as cost-benefit analysis.

Setting of Measures It was generally agreed that the overall objectives of the project, and the measures associated with these, should be set by top management, or by a combination of top management and the project team. However, when it came to the process measures, some respondents said that these should be set by the project team, while others said that the people who work in the process and use the measures should be the ones to determine the appropriate measures. One respondent even felt that the teams should have the power to change the measures as they see fit. Whether or not the respondent felt it appropriate for the team to set their own measures seemed to depend on the degree of empowerment and autonomy which the BPR project had afforded the team.

Only one respondent mentioned the idea of getting the customer to determine what the output measure of success for the process should be. This had not, however, been done in the firm concerned, although the respondent thought it was a good idea.

Benchmarking Benchmarking in the sense of looking outside the company for standards and processes was being used by almost half of the companies surveyed. The extent to which benchmarking was utilised, however, differed remarkably. In some cases benchmarking is seen as purely quantitative, in terms of time and money per activity, while in others it is seen as establishing whether the form of processes, data models and activities has been found suitable elsewhere. In addition the amount of information which can be obtained with respect to benchmarks can vary considerably:

> *"Benchmarking ranges from a telephone call to establish one indicator to a project in itself. And that depends entirely on the [business's] appetite for those sort of benchmarks."*

In general, however, the notion of looking outside the business when undertaking BPR, is accepted as being important to the success of the project.

Remuneration Several firms indicated that they intended basing remuneration in future on performance measured in terms of the measures established in the BPR project. Two respondents stated that this was in fact crucial to the success of the project, as without incentives it would be very difficult to create the culture change necessary for the sustained improvement sought.

However, the reservation was expressed by other respondents that it could be difficult to do this, and that it would be very important that the measures on which performance was assessed could be influenced only by the person being assessed.

Other Measuring Issues Other issues relating to measuring which arose included the notion of a project being self-funding, and of building the measures to be used into the systems supporting the process. Self-funding generally becomes an issue where consultants are involved in the project. The consulting firm provides a business case to prove that the project can, in the first year, cover at least the consultant's fee. One respondent did specify that all costs relating to the project, including stationery and man-

agement time, were costed in determining whether or not the project could fund itself.

Several respondents indicated that systems being built as part of the BPR project would include measurement of the process itself. In one case this has even been built into the user interface so that users can, by means of an icon, establish their own process performance for the month to date, up to the last fifteen minutes.

IT Issues in BPR

In general it was agreed that some degree of change to existing IT systems is needed in a BPR project. Respondents did, however, differ as to the degree of change necessary and the manner in which this change should influence the project. Less than half of the companies had found it necessary to alter fundamentally the IT systems for the purpose of the particular project under discussion. The others did not mention IT, or were only planning change in the future.

Generally there was a distinction drawn between IT as an enabler, and IT as a driver, of BPR. While some respondents felt that the project should on no account be technology-driven, others felt that the true benefits of a project could not be realised in the long term without fundamental IT change.

One case in particular, however, demonstrates the danger of allowing IT to drive the change process. The business in question decided to undertake BPR, specifically because it were being forced (by the vendor) to change its IT platform. A full IT architecture design has been the basis of the project, and all process changes are being built into the new system design. The new business processes are thus dependant on the new systems and the business must wait for these systems to be introduced - a process which the respondent indicated could take up to 10 years, owing to the size and complexity of the system. Thus the BPR project itself can only be rolled out over this 10 year period, starting in a year's time when the first systems are delivered. The project has been running for 3 years already.

Another business in the same industry has decided to make process changes before the new systems are developed, making the necessary changes to the existing systems as a temporary measure. This business began the project this year and will start to realise benefits early next year, well before the business which is allowing itself to be entirely driven by IT.

It is thus important that IT is seen as an enabler of BPR, and as a tool which can be used to make long-term strategic changes. However, IT should not be either the driver of the sole enabler of the BPR project, as this could delay the project beyond the point at which it loses the capacity to provide competitive advantage.

It appears as if the degree to which IT is used in the project may be affected by the consulting firm which is used. Each consulting firm has its own process for change, whether that be strategy development, IT integration, change management or pure BPR. Companies should be aware of this when selecting a consulting firm, as a firm which is based in IT development may very well wish to emphasise the IT aspect of BPR more than the client feels is required.

BPR in South Africa

The South African environment appeared to affect the manner in which BPR is applied in two ways: with regard to retrenchment and empowerment.

BPR and Retrenchment Retrenchment appears to be a particularly sensitive issue in South Africa. Some firms will not use the terms "reengineering" or "BPR" simply because they imply retrenchment, and more than one respondent described the terms as "dangerous" because of this. While several business units have significantly reduced their headcount and flattened their organisation structures as a result of the BPR project, respondents were anxious to emphasise that this was achieved without large scale retrenchment, either by moving individuals within the larger organisation, or through natural attrition or "early retirement".

Respondents from firms who were in the early stages of BPR generally expressed reluctance to retrench, and one respondent indicated that the organisation had specifically committed itself to not retrenching staff, as it was felt that this would not be appropriate given the prevailing socio-economic conditions. This was expressed as follows:

> *"I came out very strongly against 'reengineering' in the South African context. I think in South Africa it is a dangerous term to use in the socio-political environment. I think process orientation and alignment to achieve certain targets is fine, but unfortunately all the articles we read are coming out of the States saying 'we reduced costs by 50%'. We're not in that competitive market in South Africa. We theoretically should be, but there's no way I can stand up in [my organisation] and say I'm going to reduce 16000 people to 10000. The program would not even move one metre."*

In this case, the organisation has been able to gain the full co-operation of the unions in the BPR project by undertaking not to lay off staff.

Whether the full benefits of BPR can be gained without reducing headcount is debatable. If large-scale growth is anticipated, as it is in the case quoted above, then it may very well be feasible to re-deploy staff who are displaced from their existing positions. If however, BPR which requires retrenchment to be effective is seen as essential for the survival of the business in a competitive industry, then the business may have no choice but to retrench people. The degree of retrenchment necessary can obviously be reduced with foresight if the firm does not fill posts which are empty before the BPR project itself starts.

One respondent claimed that the amount of retrenchment had been minimised by hiring staff on a contract basis for a full year before the project began. This is of course technically correct, but nonetheless people who had had work found themselves unemployed, in whatever form, as a result of the project.

Empowerment of Self-Managing Teams Although much of the American and European literature proposes the idea of "self-managing" teams as being suitable for reengineered organisations, this concept does not appear to be in use in South Africa. Only one respondent said that self-managing teams would form part of the structure of the reengineered firm. All the other respondents who spoke of team work were reluctant to apply the term "self-managing". These teams generally have managers or supervisors who are accountable for the performance of the team.

Nonetheless it is considered that the members of these teams have far more independence and responsibility than was the case in the pre-BPR organisation. In one firm, the members of the team were able to select the team leader from a choice of four applicants screened by management. In this case the respondent said that the teams were "self-controlling" rather than "self-managing".

There appears to be a perceived need to limit the empowerment granted to teams, and to specify that limit very clearly. The reason for this was not alluded to by any of the respondents, except to say that they did not think it was "suitable" in the organisational context.

Results of the Analysis for No-BPR Project Respondents

While most respondents had completed or were still engaged in BPR projects, two of the respondents described situations in which BPR had been proposed and investigated, but never actually undertaken. In both of these cases the respondents had invested a great deal of time and energy in the proposed project. One respondent had even been relieved of his regular duties by the organisation so that he could head up the reengineering effort. In both cases, however, the proposed BPR projects have since been abandoned in favour of small-scale improvement within departments, without any process focus at all. This was described as "fiddling with the plumbing".

In spite of the fact that the BPR projects were in these cases never actually begun, there are some lessons to be learned by those who are involved in BPR. These are specifically related to the ambiguity of failure in relation to BPR projects, and the importance of establishing success criteria for the project.

The Ambiguity of Failure in Relation to BPR Projects

Both of the No-BPR Respondents were involved in cases which might possibly be described as BPR "failures", since little improvement has been realised by the activity which was undertaken. However, BPR was never actually undertaken at all, and the type of small-scale improvement described does not even fall within the definition of "creeping" BPR, as there is no process focus to the activity. One respondent felt that the activity could not be described as BPR, since there has been no change, dramatic or otherwise, in "what the customer sees".

This leads to the conclusion that reports of the large proportion of BPR failures must be treated with caution, as it is difficult to know whether the projects were in fact BPR projects at all. There is a great deal of ambiguity surrounding the issue of BPR failure, not only in this respect, but also in respect of how "failure" is defined even when there is a BPR project involved. It is thus very important to determine success criteria for a BPR project, by which its success or failure can be properly judged.

Criteria for and Measurement of BPR Projects

No overall criteria for success, or means of measuring this, had been set by either organisation when the BPR projects were abandoned. One organisation had no measures at all, while the other had set measures of process performance in terms of the objective of each individual process. These, however, were generally process measures of "what would lead to customer satisfaction, i.e. the internal standards of the process." The respondent in this case stressed that this type of measurement was focused on process performance as opposed to gaining "some kind of vision of where the company was to be positioned as a whole."

Thus in both cases, without criteria for success – i.e. "a vision" of where the organisation could get through BPR – management had no real means of assessing the desirability of the project. This may have contributed to the abandonment of the projects before they had even begun.

One respondent stated that the project was not undertaken because BPR was seen as "too painful" and "too radical" for the organisation. The observation that the project was perceived as "too painful" begs the question "what is too painful?". Does the implication of a degree of pain suggest that pain can be relative? If so, would appropriate criteria and means of measuring these have altered the scale on which the pain was to be measured, and therefore have changed the decision to abandon the project? Certainly, without criteria for success, there would have been no means to establish the success or failure of the projects, even if they had proceeded.

Although these respondents provided only 2 examples of BPR projects which "failed" before they even began, they do illustrate the importance of creating a "vision" of what the project is attempting to achieve, by setting objectives or criteria for the success of the project at the very beginning. This must be done so that the project desirability can be properly evaluated, and also so that the success or failure of the project can later be determined.

Results of the Analysis for the Consultants

Two consultants were interviewed about BPR in general. They were asked to describe what, if any, success criteria they typically use for a BPR project, and how these are measured.

Success criteria for BPR

Both consultants spoke of success criteria for BPR in strictly quantifiable terms. Examples of these included market share, profitability, production targets or product lifecycle time. This emphasis on quantifiable gains is related to the fact that the consultants need to be able to justify their fees to the client. This was expressed by one of the consultants

as follows:

> *"Before we ask our clients to buy we have a benefits case. Why would you do it? What's the bottom line? What's the bottom line for the stakeholders? The stakeholders typically include the shareholders, so there's a profit motive. ... So there'll be a benefits case which is typically 3 to 5 times our fees – that kind of money - sometimes 10 times – depends what is inside this oyster that we open up. So if you're talking about where we measure success, we absolutely measure it against the benefits case. And we do a break-even against our fees as well, we work towards delivering cash as well as profit. So there're the two driving forces behind what we do – business reason and business goal in terms of numeric goal."*

The other consultant, however, expressed reservations that these criteria might be focused on areas of improvement which were too narrow, in order to achieve specific money returns to justify the consultant's fees. This he felt was dangerous in the effect it could have on the organisation as a whole:

> *"we could deliver 500% improvements within one process, but it's a dynamic sort of system, so the minute you influence that, things start going haywire everywhere else."*

It is therefore very important to ensure that the measures which form the primary success criteria are high-level, results-based measures which assess the effect of the entire project, and not just a single process.

It is also important not to forget the "softer" organisation issues in the search for financial gains. One consultant said that his firm found it necessary to keep going back to organisations they had reengineered because

> *"it's like a piece of fudge. The organisation just keeps on melting back to where it used to be."*

This problem with sustainability is related to the organisational resistance to change, and indicates that more explicit management of organisational and cultural issues may be needed. The consultant indicated that his firm had never had a project fail in terms of the financial criteria set, but that if failure was going to occur, it would be because criteria in terms of organisational change were not specifically addressed. This supports the observations made by some BPR Project Respondents who had encountered unexpected organisational issues which were affecting the success of their projects.

Both consultants indicated that providing a cost-benefit analysis of the project in advance was critical to obtaining the work.

Different Types of Measures

The consultant who claimed to have had only success with BPR emphasised the importance of using different types of measures at different levels of the organisation.

> *"We see them as a tree of measures. Key Performance Indicators we call them, but they work down to grassroots level. You could come down to the number of invoices processed by an invoice clerk.... It's a cascade all the way down the process, and it's fundamental to our business"*

It was also felt by this consultant that at the lower levels it is very important that people choose their own measures. These measures will be used to assess the success of the project, and then afterwards for the ongoing management of the process.

> *"Each morning the teams meet to discuss the issues. They take care of measuring the job that they did yesterday, and then tackle the issues of the day."*

In contrast to this, the other consultant spoke of measurement only in terms of the criteria set to justify the consultants' fees. As described above, he expressed reservations about the sole use of these measures, and said that he believed broader measures should be used. He did not discuss measures which teams could use in the ongoing assessment and sustaining of the reengineered process. He also did not think that the clients with whom he had worked had felt that the projects were successful. He expressed some confusion as to the overall failure:

> *"I don't know why it falls to pieces, on paper it's really easy."*

It would appear as if, when selecting a consulting firm, organisations should take particular care that the consultants have a defined strategy for measuring, and that the criteria which are set by the consultant are in fact those on which the organisation intends to judge the process. It is also very important that cultural and organisational change issues are not neglected in the search for financial benefits.

Summary of Analysis

The analysis of the findings revealed that success criteria and the measurement thereof are very important in BPR projects. These issues were often discussed by respondents even before the related questions had been asked by the interviewer. In addition there were many other issues raised, which were believed to impact on the success of the project.

5 Refinement of the Framework and Theoretical Conjecture

As a result of the analysis described above, the validity of the empirical generalisations as presented in Table 1 may be assessed.

First Empirical Generalisation

There was strong support for the first generalisation as less than 25% of the stated objectives were measured in simple financial terms. Of the simple financial measures used, 89% were in the evaluation of projects which had as objectives either just cost reduction, or profit improvement through cost reduction and revenue enhancement.

In addition to this, 56% of those companies which used financial measures did so as part of a cost justification

of the project. In general, however, there was not much emphasis placed on cost justification by the respondents. Even amongst those companies which did such an analysis it was stated that the results of the cost-benefit analysis would not solely determine whether or not the project was undertaken.

Second Empirical Generalisation

There was strong support for the second generalisation. Respondents indicated that there were on average 3 different types of objectives which were being measured. Improvements in time and service were explicitly mentioned as objectives. Improvements in quality were not explicitly mentioned, but would be a by-product of other objectives which were mentioned, such as creating an ownership culture amongst the workforce or becoming the market leader.

The measures specified in this empirical generalisation are customer-focused. This view should be broadened to include the process, and the employees and shareholders of the organisation as well.

Third Empirical Generalisation

There was strong support for the third generalisation as 86% of the respondents felt that different levels of measures were required, and that these would be used for different purposes. The purposes for which these measures are required are discussed further in the next two sections.

Fourth Empirical Generalisation

There was some support for this statement as it stands. 92% of the respondents who saw a need for process measures believed that these should be used by the process team. However, this statement needs to be altered to reflect the fact that the process teams should also be aware of the overall results measures, particularly where these are non-financial, that is customer- or time-based or cultural.

The purpose of the evaluation needs also to be stated more explicitly. Process teams will use process-level evaluation measures to manage the process on an ongoing basis, and overall results measures as a goal towards which to work. Process-level measures will not be used to judge the success or failure of the project. This is for two reasons. The first is that it is not the process teams who judge the project for the organisation, but upper management, and upper management does not use process level measures. The second is that where the process has been radically altered, the measures too will have changed. In such cases the new process measures will not be comparable with the old, if these existed at all, and the reengineered process cannot be compared with the old process, except at a results level.

Fifth Empirical Generalisation

There was unqualified support for this statement. All the respondents agreed that top management would require results measures. These included improvements in profits, customer service, customer satisfaction and organisational culture. Top management want to know that the company has changed for the better in the eyes of its stakeholders.

Table 4. Support for the Empirical Generalisations

Empirical Generalisation	Total Agreement	Strong Support	Some Support
First		√	
Second		√	
Third		√	
Fourth			√
Fifth	√		

Summary of the Support for the Empirical Generalisations

The evidence collected suggests that all the empirical generalisations were supported to a greater or lesser degree by the respondents, as shown in Table 4. However, the second and fourth generalisations, while not incorrect as they stand, need to be extended in order to be more useful.

In general the theoretical conjecture was supported, but should be amended for greater accuracy and usefulness.

Refinement of the Theoretical Conjecture

It is possible to use the concepts generated by the analysis of the evidence collected to present a modified theoretical conjecture as follows:

Business Process Reengineering projects do not frequently lend themselves to evaluation in terms of simple financial measures such as payback, ROI or NPV, although some aspects of these types of calculation are required if the major purpose of the BPR project is cost reduction, or if the BPR project is to be cost-justified in advance. Ex-ante cost justification is not often done.

BPR projects are generally more effectively evaluated by using multiple metrics which include the measurement of time, quality and service. In terms of the multi-metric approach to the evaluation of BPR projects it is essential for a clear distinction to be made between the evaluation appropriate for the process team and the evaluation appropriate for the management of the organisation as a whole.

Evaluation measures which are appropriate for the process team are those which measure the activities inside the process itself. These are used for the effective ongoing management of the process. The process team should also be aware of overall results measures, particularly where these are non-financial. These measures serve as a goal towards which the teams can work.

For the management of the organisation as a whole, measures which are appropriate for the ongoing management of the organisation and for the evaluation of the BPR project, are high-level results measures such as increased profit, improved customer service or change in organisational culture.

The modified theoretical conjecture gives rise to a revised version of the Framework for BPR Evaluation Measures model shown in Figure 2. This revised model is shown here as Figure 3.

The revised grid suggests that process measures will

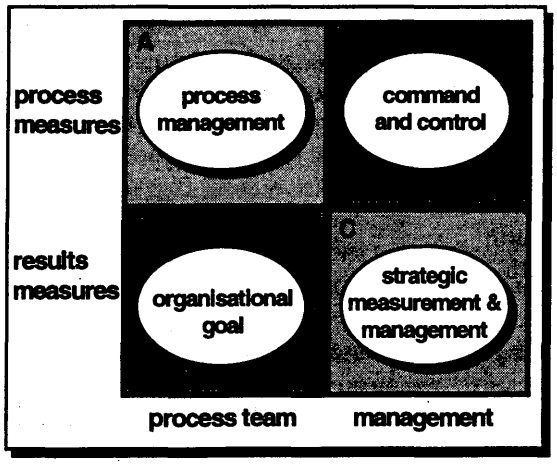

Figure 3. Revised Framework for BPR Evaluation Measures

enable the process team to manage the process effectively (A), while results measures (B), although they will not tell team members what they must do to improve their performance, will provide an overall goal towards which the team can work. Results measures are also appropriate to management, who need an overall view of what the organisation is achieving (C). Such measures will enable management to manage the firm from a strategic viewpoint, and to assess the success or failure of the BPR project. If, however, management adopts inappropriate process measures (D), focusing on what occurs inside the process, then they will soon find themselves reverting to the command and control style of management, which may be suitable in a hierarchical situation, but which undermines the teams.

6 Management Guidelines

As with any management research, the ultimate aim of this research was to provide guidelines for management. The following guidelines may be useful to management engaged in, or contemplating, BPR:

- It is particularly important to set broad success criteria for the BPR project at the start of the project. These criteria should create a "vision" of what the reengineered company will look like.
- Success criteria should preferably be quantified, but they need not be financial. Indeed it is very important not to neglect cultural issues in the search for financial benefits, and changes in the organisational culture should themselves form part of the "vision" for the reengineered organisation.
- It is very often not possible to foresee exactly how the reengineered company will work, or how the project will proceed. Initiatives which arise during the course of the project should be seen in light of the overall strategic initiative, and assessed for their ability to facilitate the reengineering as a whole.
- Radical IT change is often fundamental to the reengineering effort. However, IT should not be allowed to drive the effort, but rather used to enable it.
- Consultants can provide an important external perspective and valuable skills. However, they should not be allowed to own the project, and the financial criteria which they are likely to set should not be the sole criteria used in assessing the project. The organisation should ensure the BPR project is driven by the needs of the organisation, and not the skills of the consultants.
- Process-level measures should be used by the process teams to manage the reengineered processes. Management should concern itself with results measures for the organisation as a whole. These measures should also be visible to everyone in the organisation, both during the project and afterwards, as they provide a goal towards which everyone can work.
- Reengineering can work and achieve substantial benefits. However, it requires clear objectives which are set at the start; careful evaluation of the process activities, results and organisational culture; and ongoing management of these issues to ensure sustainability of the benefits gained

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- Tables and figures should be numbered and titled.
- 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 [1–3]. References should take the form shown at the end of these notes.

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