THE IMPACT OF INFORMATION TECHNOLOGY ON BUSINESS ORGANISATIONS OF THE FUTURE

by

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'There is a theory that states that, if ever anyone discovers exactly what the Universe is for and why it is here, it will instantly disappear and be replaced by something even more bizarre and inexplicable.
There is another theory which states that this has already happened.'

Douglas Adams,1980: 7-8

EXECUTIVE SUMMARY

THE IMPACT OF INFORMATION TECHNOLOGY ON BUSINESS ORGANISATIONS OF THE FUTURE

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The world and society at large are experiencing profound changes that bring about their own challenges and opportunities but also demand of businesses to align their business strategies and processes with their technology strategies, as IT is probably the most significant driving force and enabler of change. Since the evolution of technology is so rapid, this in itself induces and (at the same time) impedes radical change. IT has opened up new opportunities such as presented by evolving digital commerce. Globalisation of business reflects the view that businesses will compete in a borderless environment that demands flexibility and quick response rates. However, evolutionary processes are employed to attain revolutionary change. This anomaly highlights the need for re-engineering existing and past paradigms and methodologies. Re-engineering's successes/failures are measured against the rapidly expanding world of IT.

Newton's linear science and the clock-like machine universe it presupposes, is being replaced by dynamic forces so powerful to change forever the paradigms of the past. Thus, the study of chaos theory and its replacement by the concept of a *chaordic theory*.

The focus in the thesis is Handy's age of unreason, or period of discontinuity, called the "Quantum Era" in which the microchip, technology and information are identified as the main agents of change. The notion of radical change for businesses (and society at large) is explored using Tichy's Revolutionary Change Model, which depicts organisational revolution as a drama in three acts: *The Awakening* (realising the need for change), *The Envisioning* (creating the vision) and *The Re-architecting* (**the birth of a wholly new organisation – the *chaordic enterprise***).

An eclectic strategy was followed drawing from and integrating principles from a vast and varied field of knowledge, covering the natural, social and business sciences and philosophy (e.g. Mathematics, Mathematical Statistics, Quantum theory and the Management Sciences). The thesis adds the following to the existing body of knowledge:

- The proposition of *de-engineering* (and *chaos engineering*) the corporation, following from the principles of self-organisation (-renewal), strange attractors and feedback in chaos theory to rectify re-engineering's deficiencies. Chaordic theory replacing chaos theory in the business sciences.
- *Technology Change Model* whereby organisations can measure the scope of the change (incremental or discontinuous) against (information) technology (existing or new)
- The proposition of
  - appropriate mathematical business models that follow the natural life cycle of any business or idea and
  - the subsequent identification (mathematically and statistically) of the time (pro-active or pre-active) to institute radical change points ('cusps' or 'bifurcations' in chaotic or catastrophic systems).

- Evaluation of IT/IS projects in terms of:
  - an *information delivery matrix* – measuring the direct and indirect consequences and showing evolutionary application of IT
  - the application of the traditional total cost of ownership [TCO] model, the development of a generic TCO-based model for its implementation and possible integration into the supply chain paradigm and
  - a return on investment IT (ROIT) –perspective.

Throughout the thesis, three phenomena become prevalent. These are:

- **The self-organising, self-renewal principles of a chaotic system. Ultimately, some (new) point of equilibrium is reached, introducing the notion of a *chaord* (= cha-os + ord-er).**
- **The inherent cyclical trends prevalent in society and organisations, that, though the needs of society and the environment have shifted into a new paradigm, these trends resemble their predecessors albeit in a mutant form or different Gestalt, similar to Kondratieff's (K-) waves.**
- **The synchronicity of research across a multitude of boundaries.**

In conclusion, the possible effects of the chaordic organisational form and leadership on the broader society and on the macro-level is explored. Although the evolution of this field is so rapid as to make obsolete any proposition of what the future may hold, an attempt is made to identify possible future scenarios.

I hereby submit this thesis as my own and original work. May the reader gain from it the same gratification this researcher did in researching the topic.

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René Pellissier

June 1999

SAMEVATTING

DIE IMPAK VAN INLIGTINGSTEGNOLOGIE OP DIE BESIGHEIDSORGANISASIES VAN DIE TOEKOMS

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Die wêreld staan in die midde van radikale veranderinge wat hul eie uitdaginge en geleenthede meebring maar terselfdertyd van ondernemings vereis dat hulle hul besigheidstrategieë en -prosesse behoorlik in pas bring met hul inligtingstegnologie strategieë, synde dat laasgenoemde na alle waarskynlikheid die mees beduidende dryfkrag en bemagtigingsagent vir verandering is. Die snelheid waarmee tegnologie verander, bevorder èn inhibeer radikale verandering. Die suksess en mislukkings van herontwerp word dus ondersoek en gekoppel aan inligtingstegnologie.

Die tradisionele Newtoniaanse siening van die wêreld in lineêre terme van oorsaak-en-gevolg waarin gebeure soos die ratte van 'n masjien inmekaarskakel, word toenemend ontoereikend om as analoog te dien vir die tegno-sosiale kragte wat op die moderne samelewing inwerk. Gevestigde paradigmas word onomkeerbaar irrelevant. Die proefskrif fokus dus op chaosteorie, en meer spesfiek word dit vervang met die begrip *chaordiese* teorie.

Die fokus van hierdie proefskif is Handy se tydvlak van arasionaliteit ['*age of unreason*'], of 'tydvlak van diskontinuïteit' ['*period of discontinuity*'], of oorgangsfase, die Kwantum Era, waarin die mikroskyf, tegnologie en inligting geëien word as die hoofdrywers van die verandering. Die idee van radikale verandering van sake-ondernemings (en die breë samelewing) word ondersoek

deur die lens van Tichy se *Revolutionary Change Model*. Tichy karakteriseer organisatoriese rewolusie (en samelewingverandering) as 'n besondere soort drama wat in drie dele ontplooi word: *Die Ontwaking* (die behoefte aan verandering word besef), *Die Vooruitsigstelling* ('n visie word geskep), en *Die Her-argitektering* (ontwerp en opbou van 'n totaal nuwe organisasie).

Deur die wiskundige wetenskappe, die sosiale en die bestuurswetenskappe en die filosofie te integreer (Wiskunde, Wiskundige Statistiek, Kwantumfisika en die Bestuurswetenskappe), lewer hierdie proefskrif 'n besondere bydrae ten opsigte van die volgende:

- Die ontwikkeling van die begrip *de-enginieurswese* (of *chaos-ingenieurswese*) as uitbouing van die beginsels van self-organisasie (-vernuwing), onverwagte en spontane, endogene valensiepatrone, en -iterasies ontleen van chaosteorie en die toepassing daarvan om die tekortkominge van herontwerp aan te spreek.
- *Tegnologieveranderingsmodel* ['Technology Change Model'] waarmee ondernemings die koppeling tussen suksesvolle herontwerp (radikaal of inkrementeel) en toepaslike inligtingstegnologie (nuut of bestaande) kan evalueer.
- Die ontwikkeling van:
  - Wiskundige besigheidsmodelle wat die kromme vir Handy se konstrukte van die lewenssiklusse van idees of ondernemings weergee en
  - Die daaruitvolgende bepaling van die tydstip vir radikale verandering (pro-aktief of pre-aktief) (wiskundig en statisties). Hierdie punte word genoem die 'cusp' of 'bifurcation'-punte in chaos- of katastrofeteorie.

- Die evaluasie van IT/IS-projekte in terme van:
  - 'n *Inligtingsoordragmatriks* waarmee direkte en indirekte gevolge gemeet kan word – veral in terme van die evolusie van inligtingstegnologie-implementerings
  - Die toepassing van die koste van eienaarskap ['Total cost of ownership', TCO]-beginsel op IT-projekte, die ontwikkeling van 'n TCO-gebaseerde

generiese model en die implementering van laasgenoemde op 'supply chain management' en

- 'n 'Return on investment IT' [ROIT] perspektief.

(Inligtings)-tegnologie het baie nuwe sakegeleenthede moontlik gemaak, soos byvoorbeeld die ontluikende digitale besigheidsparadigma. Die globalisering van sakebedrywighede weerspieël die siening dat ondernemings in 'n grenslose omgewing met mekaar moet meeding wat buigsaamheid en vinnige responskoerse sal vereis. Desnieteenstaande maak ondernemings meestal van evolusionêre prosesse gebruik ten einde revolusionêre veranderinge in produkte en dienste te weeg te bring. Hierdie anomalie beklemtoon die behoefte aan de-enginieurswese (chaos ingenieurswese), wat op die grondslae van self-organisering en self-vernuwing (ontleen aan chaosteorie) berus. Te meer nog, dikwels bestaan daar op dieselfde tydstip meerdere heersende bestuursparadigmas, sommige waarvan volkome onversoenbaar is met, en onbestaanbaar is, naas die chaotiese dimensies van die nuwe ondernemingsvorm, naamlik die 'chaordic' onderneming.

Drie verskynsels word meerdermale vasgelê:

- **Die beginsel van self-ordende en self-vernuwende stelsels ontleen aan chaos- en kompleksiteitsteorie wat daartoe aanleiding gee dat 'n nuwe ewewigspunt bereik word. Die begrip 'chaord' word ingelei.**
- **Die herhalende aard (siklisiteit) van samelewings en ondernemings. Selfs indien die samelewing en die omgewing na 'n nuwe paradigma beweeg, die behoeftes in wese 'n gelyksoortigheid openbaar ten spyte van die paradigmaskuif, soortgelyk aan Kondratieff se K-golwe.**
- **Die sinchronisiteit van navorsing oor meerdere grense.**

Die mate van verandering word bespreek as uitbreiding van die samelewings- en ondernemingsvlak met die kompeterende wapen van inligting en inligtingstegnologie as nuwe medium. Desnieteenstaande uitbreiding in hierdie veld so geweldig is dat dit enige voorstel verouderd stel, word 'n poging aangewend om toekomstige scenarios vir ondernemings daar te stel.

Hiermee word hierdie proefskrif as my eie oorspronklike werk. aangebied Mag die leser daaruit soveel waarde haal as die navorser met die ondersoek van die studie.

DEDICATION

As always, with love to
Jeanri, Mellet and Dominique –
for there is no greater honour than knowing you and no greater pleasure than being your mother.

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I could not have done this without support from:

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- The greatest mathematicians, Isaac Newton, Bertrand Russel and Stephen Hawking – whose discoveries move the frontiers of science and our own thinking.
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- Librarians, Lorraine Grobler and Megan Scheepers, for keeping me up to date on the relevant literature
- Sarie Klopper and Rose Purchase, who took it upon themselves to provide stability and order, where I had chaos

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LIST OF ABBREVIATIONS

4GL	Fourth-Generation Language
ACPA	ABRUPT CHANGE POINT ANALYSIS
AMOC	At most one change point
BPM	Business process management
BPR	Business Process Re-engineering
DB	Database
DBMS	Database Management Systems
DSS	Decision Support Systems
EAM	Enterprise Asset Management
EDI	Electronic Data Interchange
EIS	Executive Information Systems
ERM	Enterprise Resource Management
ERP	Enterprise Resource Planning
ESS	Executive Support System
EVA	Economic Value Added
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
IS	Information Systems
IT	Information Technology
ITT	Information Technology and Telecommunications
JIT	Just in Time Principle
LAN	LOCAL AREA NETWORK
KWS	Knowledge Support System
MIS	Management Information Systems
NPV	Net Present Value
O AND M	Operations and management
OAS	Office Automation System

OCP	Out of context problem
OLAP	Online Architecture Platform
PC	Personal Computer
ROI	Return on Investment
ROIT	Return on Investment Information Technology
SAP	Software Applications Product
SVA	Shareholder value added
SWOT	Strengths, weaknesses, opportunities and threats
TCO	Total Cost of Ownership
TPC MODEL	Technical, political and cultural model
TPS	Transaction Processing System
TQM	Total quality management
VA	Value added
WAN	WIDE-AREA NETWORK
WWW	World Wide Web

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THE PROBLEM

"It must be remembered that there is nothing more difficult to plan, more uncertain of success, nor more dangerous to manage than the creation of a new order of things. For the initiator has the enmity of all who would benefit by the preservation of the old institutions, and merely lukewarm defenders in those who would gain by the new ones."

Machiavelli, The Prince

Since its inception in the early 1990s, much has been written about the notion of re-engineering - first by its creators, Hammer and Champy, and subsequently by those who tried to follow their teachings to attain the successes it promised. Has re-engineering delivered its promise of dramatic improvements in terms of cost, quality, service and speed?

The answer to this, is two-fold. Firstly, it concerns the inherent flaws in Hammer and Champy's own definition of re-engineering proposed in 1990. It has even been claimed to have Marxist (revolutionary) origins. They [Hammer and Champy] themselves have seen fit to change the original definition, claiming that the concept was largely deemed to be a cost cutting methodology as opposed to one for strategic sustainable change – a re-engineering of re-engineering. Thus it is necessary to study the definition and consequences of re-engineering itself. Secondly, with rapidly advancing technology, re-engineering is largely driven by a new force, that of information and IT. Organisations that are getting the mix right between re-engineering their business processes and implementing the (sometimes costly) appropriate technologies to do so, have been successful. Organisations which have not achieved this, are bearing the costs of re-engineering without enjoying its advantages. For them (and it seems as if the vast majority of organisations that embark on re-engineering, fall into this category) there is a period of cleaning up after re-engineering.

This thesis will study the effect of advancing (information) technology on changing the organisation, its structures and its values, and the ways that it is doing business. Because technology changes the very nature of work, it changes the workers and it changes leadership and structures within organisations. More and more organisations are finding themselves re-engineering their ways of doing business more than re-engineering the processes – because technology is forcing them to do so. The challenge for organisations is to get this right and to know when it is time to implement radical change.

RESEARCH STRATEGY DEPLOYED

Since no research has meaning without proper validation, use is made throughout of a hybrid case study approach. The case study has long been stereotyped as a weak sibling among social science research methodologies. However, this inherently qualitative method has some distinct advantages, even to a mathematical statistician like oneself. To this researcher, the greatest advantage is the fact that it provides the opportunity to explore uninhibitedly, all dimensions of organisational life and IT's uses and abuses without the constraints that structured data modelling would have imposed.

Possible research strategies depend upon:

- The type of research question,
- the control over actual events by the researcher, and
- the focus on contemporary as opposed to historical phenomena.

These are summarised below - in no order of preference [Yin, 1989: 17].

Table 1: Summary of different research methodologies, indicating their usage

strategy	Form of research question	Requires control over behavioural events	Focuses on contemporary events
Experiment	How, Why	Yes	Yes
Survey	Who, What, Where, How many, How much	No	Yes
Archival analysis	Who, What, Where, How many, How much	No	Yes/No
History	How, Why	No	No
Case study	How, Why	No	Yes

Yin [1989: 23] defines the case study as

' *.. an empirical inquiry that*

- *investigates a contemporary phenomenon within its real-life context;*

- *when the boundaries between phenomenon and context are not clearly evident; and*
- *multiple sources of evidence are used.'*

In answering *'how?'* and *'why?'* questions, the case study strategy deals with operational links needing to be traced over time, rather than mere frequency or incidents. In the case of the current research, organisations are asked 'how' and 'why' questions in order to determine their use of relevant information technology and its relevance on radical change. In examining contemporary events, it is preferable to add two sources of evidence not generally included in the historian's repertoire. These are:

- Direct observation and
- systematic interviewing.

In this context, the case study's unique strength lies in its ability to deal with the full range of evidence – documents, artefacts, interviews and observations [Yin, 1989].

It is acknowledged that the case study has many disadvantages and may be deemed questionable by the pure scientist. It is suggested that this is largely due to bias on the part of the investigator, but, since it is also possible to introduce bias in designing questionnaires, it is contended that this will not detract from this research. Secondly, since there is no necessity for proper design of the experiment and a proper random sample is not necessary, generalisation may be questionable. This is even truer of the single case methodology. The answer to this is that case studies are generalisable to theoretical propositions and not to populations. Hence the case study, like an experiment, does not represent a statistical sample and the goal of the research is not to enumerate frequencies, but to expand and generalise theories. Thirdly, case studies may take too long and generate massive documentation. It is suggested here that this need not necessarily be the case, provided that the research remains structured and focused.

Use will be made in this thesis of multiple case studies rather than single case study methodology, the former being analogous to multiple experiments. Previously developed theory is used as a template from which to compare the empirical results from the case. If two or more cases support the same theory, replication may be claimed. Evidence from multiple cases is often considered more compelling and the overall study is thus regarded as being more robust [Yin, 1989]. There is no danger of the unusual or rare case becoming the norm. It should be noted that the full variety of qualitative and quantitative empirical sources of evidence is available. These sources of evidence include the following [Yin, 1989: 20]:

- Documentation,
- archival records,
- interviews,
- direct (and indirect) observation and
- participant observation.

By adopting the chosen research strategy, it was possible to validate (but not prove) the proposed Technology Change Model and information delivery matrix which form the core of this thesis and address the research problem.

It should be pointed out that, throughout this research, the author has endeavoured to put IT/IS-related issues in *strategic* (as opposed to *operational*) perspective. The researcher has found a culture of this nature to be lacking in the current literature and the business environment and can only hope that this thesis will enable business leaders to grasp the real strategic value of BPR and IT that are emerging.

In his exposition of scientific theory, Hawking [1988: 9] suggests that any good theory should satisfy the following two requirements. These are:

1. It must accurately describe a large class of observations on the basis of a model that contains only few arbitrary elements and
2. It must make definite predictions about the results of future observations.

According to him (Hawking) any physical theory is always provisional in the sense that it is only a hypothesis – one can never prove it. Thus, no matter how many times the results of subsequent experiments agree with the theory, one cannot predict whether the next time, the result may not contradict the theory. On the other hand, to disprove a theory, one only has to find a single observation contradicting the theory. Thus, a new theory really is an extension of the previous theory. In practice, a new theory may be devised following upon add-ons to the previous theory, through modifications or even abandonments. An example of such is that of Newton's laws of gravity, which in essence, have been proved not correct by Einstein's predictions. However, since Newton's laws are simple and the difference between its predictions and those of general relativity is very small, Newton's work stands. (In this thesis too, Newton's laws are used to prove a point and subsequently questioned as to their continued relevance in a changing world). The point here is that, although this researcher, in no way equates the propositions, definitions and models in this thesis to those of the great physicists, these (the propositions, definitions and models) generally also follow the principles of a good theory as postulated by Hawking, thus having (and adding) scientific value – and to which, until they are proven not appropriate through the intervention of a single contradiction, the theory may be extended and built upon by the reader.

Due to the extent of the research subject (i.e. the evolution of IT and its re-engineering of all levels of society) which is almost chaotic in nature, it is possible that parts of this research may initially seem without focus or intent. The researcher, however, feels that from the models derived (Module V) and the findings and conclusions in the Epilogue, it can be stated that, within such a complex system as this, there is order out of chaos and that the terms 'chaordic' (= chaos + order) used in Module II and the 'de-engineering' (the self-organising principle following from the aftermath of re-engineering) in Module V, have relevance in this research. The reader will also find that this researcher has deviated from the accustomed linear research methodologies in accordance with Newton's now (limitedly) flawed cause and effect thinking.

To return to Newton's case mentioned above, Russel [1992] points out that the traditional cause and effect model (that is the traditional Newtonian linear framework) described in Modules II and III is fundamentally erroneous, requiring to be replaced by a different notion, namely those of the laws of change. Much of modern business science (also in this thesis) are derived from the laws of nature – these, according to Russel, apparently being in a state of continuous change. Russel proposes an interesting scenario whereby cause and effect may be used, but both shortened indefinitely, resulting in, as embodiment of the causal law, a certain direction of change at each moment (Russel likens this to differential equations embodying causal laws). Since it is not possible to observe infinitesimals in time or in space

'.. rough empirical generalisations (in this thesis) have a definite place in science, in spite of not being exact or universal. They are the data for more exact laws, and the grounds for believing that they are usually true are usually stronger than the grounds for believing that the more exact laws are always true.'

Russel, 1992: 312

Russel [1992: 634] concludes

'..it is plausible to suppose that every apparent law of nature which strikes us as reasonable, is not really a law of nature, but a concealed convention, plastered on to nature by our love of what we, in our arrogance, choose to consider rational.'

In embarking upon the above venture, one has deviated from one's accustomed paths - the experience has been enriching. After years spent in statistical consultations, one has reached a stage whereby one questions the subject's (Mathematical Statistics') ability to handle open-ended research and have started to realise that the subject, although obviously scientific by nature, lacks a certain open-endedness in that it generally focuses on strengths of some proposition *already known*, thus limiting the research to ask the how and why questions that

this researcher thinks should form the basis of any research. The follow-up of this work, will certainly entail many fruitful quantitative research topics – some of which this researcher's students have already embarked upon. To this researcher, the chosen methodology proved stimulating and rewarding and follows the route suggested by Hawking and by Russel on the worth of any scientific theory.

It is hoped that the reader will find in this work something as valuable and challenging as the research strategy deployed was to the author, for whom as a former mathematical statistician, the greatest learning experience was probably this:

That there is knowledge to be gained and lessons to be learnt, and the source of it is nature and the human mind ... And that there is only one way of proving them wrong – and that is after the fact.

'Execution is the chariot of genius'

William Blake

PROLOGUE

"Press on. Nothing in the world can take the place of persistence.
Talent will not - nothing in the world is more common than unsuccessful men with talent. Genius will not - unrewarded genius is a proverb.
Education will not - the world is full of educated derelicts.
Persistence and determination alone are omnipotent."

Calvin Coolidge

This thesis focuses on *radical (*or *revolutionary) change* – radical change through re-engineering the processes of the business (or the business itself) or radical change through the evolution of technology, especially IT. This being the case, the researcher chose to deploy Tichy's Revolutionary Change Model as a road map through the thesis (Figure 1).

According to Tichy [1993: 52]:

'The course of revolution is predictable ..
and its different phases can be understood.'

He (Tichy) maintains that an organisational revolution is a particular type of drama with protagonists, antagonists, dramatic themes and a gripping and deep plot played out in three acts: **The Awakening** (*when the need for change is realised*), **The Envisioning** (*when a vision is created and workers are mobilised*) and **The Re-architecting** (*which entails the design and construction of a wholly new organisation*). The protagonists of this drama are the people who seek to change and set the revolutionary plot in motion. The end of the transformation is exhilarating and leads to a feeling of rebirth, after which the process begins anew.

The Awakening phase focuses on the need for change, which is the most wrenching part of the revolution. The protagonists have to shatter the status quo and release the emotional energy needed for the revolution. This phase also deals with

resistance to change (mainly technical, political and cultural). During the envisioning phase, the purpose of the revolution comes into focus. This process is creative but often chaotic. The Envisioning process should address three fundamental building blocks of the organisation, namely the technical (organising people, capital, information and technology to produce goods and services), political (power and rewards) and cultural (shared values and beliefs) aspects. The Re-architecting phase captures the art and challenge of creative redesign. It involves redesigning and rebuilding the organisation in order that it should become 'boundaryless' in that there is a free flow of information from where it is created to where it is needed. This notion of boundarylessness creates new organisational structures.

Tichy's model describes the process of organisational change in terms of several modules, set within these three Acts, pertaining to the different constituents of the change (Figure1) and according to which the chapter or module headings for the thesis were set. According to Tichy, there should be recognition of a need for change – this is studied in **Module I** (*Setting the scene*) in which an age of transition is assessed according to the new driving force behind change, in this instance, the advent of the microchip as the critical mass for change. Mention is made of the repetitive nature of phenomena, since this notion becomes critical in the Epilogue at the end. Thereafter, **Module II** (*Facing the reality*) studies the current realities of chaos and catastrophe and endeavours to identify, mathematically and statistically, that point in time, the cusp, where the change would still have pro-active (or pre-active or reactive) meaning.

With the advent of the New Age of information, and the subsequent move from the Industrial to the Digital Era, there is a need for new organisational structures and forms. Some of the organisational forms described in **Module III** (*The awakening*), may not be new, but their implementation certainly is. The notions of a 'chaord' and a 'chaordic enterprise' (following from the original contention of the 'quantum organisation') are suggested to handle the complexities identified in Module II. The principle of self-organisation as a consequence of the chaos studied in Module II, is

derived. **Module IV** (*Envisioning*) touches on the organisation's new resources, namely information (and technology), business knowledge or business intelligence. Ways of acquiring these resources and creating and maintaining competitive advantage out of the intangible and dynamic medium they constitute, are explored. IT is defined from an evolutionary point of view rather than seen as a fixed state. IS and IT as (respectively) the demand and supply sides of information are discussed. Information delivery systems are identified and explored and a model for the classification of information delivery systems proposed. Since the main focus of attention in the thesis is the issue of re-engineering the business, the author has refrained from delving too deeply into the interesting phenomenon of knowledge management.

The thesis then progresses to the issue of re-engineering the business (or its processes) which is dealt with in **Module V** (*Re-architecting*). The focus is on the failures of re-engineering, rather than its successes and the possible reasons for these failures. They are, in part, ascribed to a lack of a culture of technology innovation, a lack of appreciation of the value of information and the evolution (from back room, cost cutting to strategic relevance) and cost of IT. It is contended that re-engineering is inextricably bound to the implementation of information delivery systems. A model studying the links between the two is proposed. Two methods for measuring the cost of IT are suggested, these being return on investment (ROIT) and total cost of ownership (TCO). Re-engineering as a business performance improvement tool is questioned, especially since the fathers of the concept of re-engineering, Hammer and Champy themselves, have, since its inception, concluded that there may have been good reason for its many failures – one possibly the advancement and rapid deployment of technology itself. A model (the Technology Change Model) integrating IT and BPR is proposed. The final focus in this Module is on the consequences of re-engineering, what this author terms, '*de-engineering* the corporation'.

Module VI focuses on the learning organisation, without which any change is meaningless, and studies new kinds of leadership, termed 'chaordic leadership' in accordance with the earlier themes.

The last **Module** (*Epilogue*) fittingly addresses the cyclical nature of society and the economic waves through which the world as we know it, has progressed. It questions the unexpected proposition that there might be few things new. That is, it questions the repetitive nature of the world despite the continuous advent of new technologies. It continues to explore the ideal state mentioned in **Module I** and originally conceived by the Greek philosopher, Plato. It also addresses the disappearance of national and ethnic boundaries, reminding one strongly of the way in which the concept of digital business has crossed the normal boundaries and barriers of current businesses in and between organisations.

In this author's view, this aspect best highlights the radicality of the changes needed in our (business) society – that, from Toffler's and Kondratieff's waves and Imperato and Harari's epochs (which will be explained in Module I), nothing can remain the same and that the world as we know it, is on the verge of another jump onto a curve, of which the dependent variable may be known, but the independent variables of the new function are too complex to properly and quantitatively identify.

Using Tichy's model, one has tried to determine these, each Module identifying and describing an independent variable from that new curve, but not even having the power, as yet, to weigh these in terms of relative importance. According to the theory, a system that is in a state of chaos is bound to reach some new point of equilibrium, but the time and format are unknown. Thus, Tichy's model serves only as a road map for a course, and the world may possibly as yet only have an inkling of its outcome. Moreover, *where* (and *what*) that point of equilibrium will be, we simply do not know. More interestingly, how *long* that equilibrium will last, is also unknown – especially if we take cognisance of the fact that Toffler's first wave lasted more than 8000 years, whereas the second lasted a mere 300 years...

The choice of Tichy's model is deemed appropriate in the light of the fact that re-engineering is revolutionary in nature (see the reflections on re-engineering and Marxism in **Module V**) and IT is generally revolutionising the ways in which organisations are competing through information and knowledge.

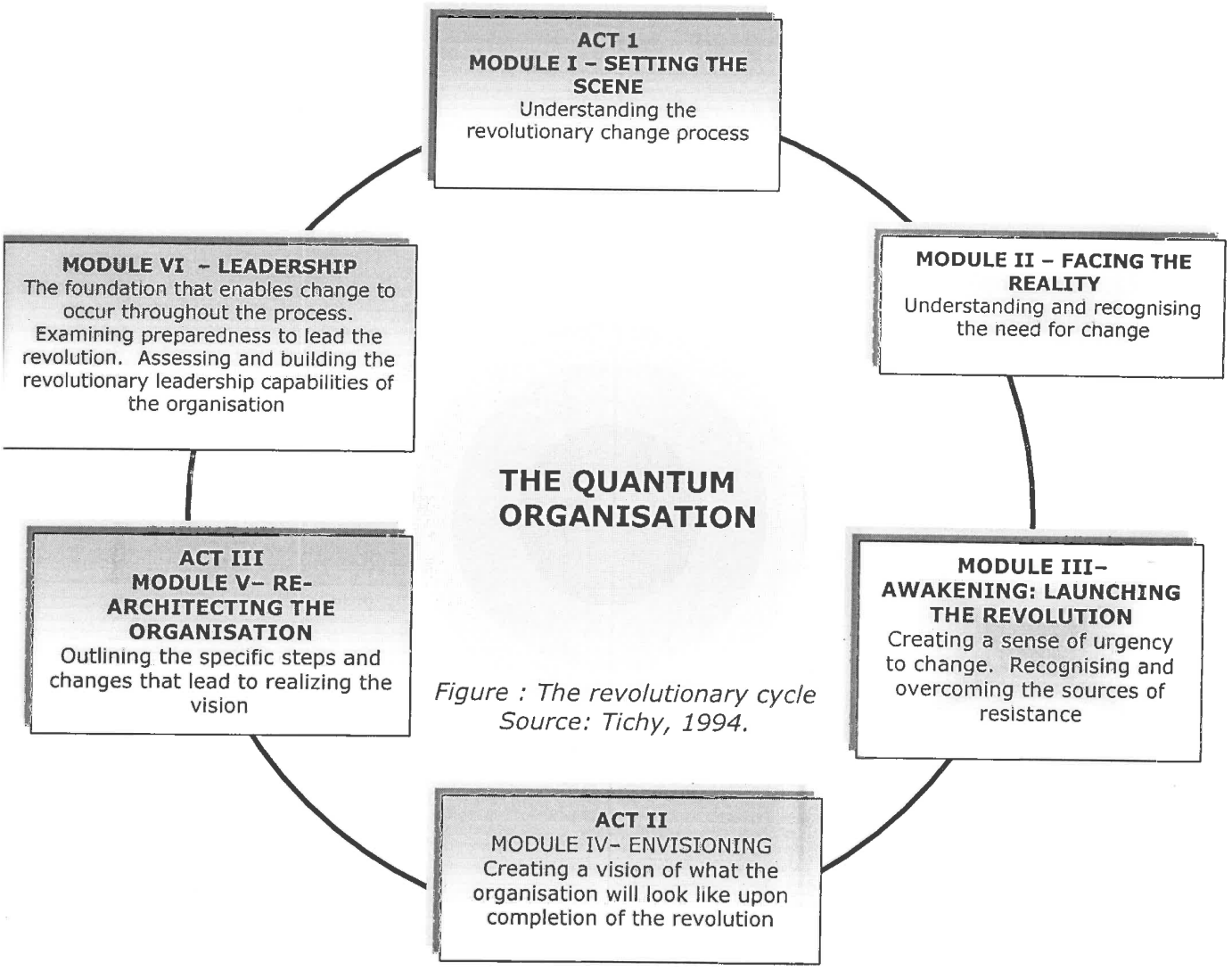

Figure : The revolutionary cycle
Source: Tichy, 1994.

Figure 1: Use of Tichy's model as a road map through the thesis
After Tichy, 1993

The reader will (rightly) question the references used in the thesis, finding some 'dated', even more so within the field under review, namely information and IT. The reality is that the evolution of our knowledge on organisations with respect to the emerging technologies is expanding so rapidly that few publications, and even fewer text books, are up to date in this field. It has been this author's challenge and pleasure to use and update the present knowledge base and present or change it in such a way as to make it applicable within this dynamic new world. As a consequence, most definitions, graphical presentations and tables summarising concepts, have no formal references as these simply do not exist – yet. One has to borrow and derive concepts from the fields of organisational strategy and systems theory, from traditional Industrial Engineering and from Economics – all of which lend themselves fairly well to describing the new power of information. A good example of this is that of the definition of IT which this author subsequently elected to link to its evolution rather than remain with rigid definitions on their own.

Another example is that of the concept of re-engineering presented by Hammer and Champy themselves. Since its inception in 1990, this subject itself has undergone major re-engineering (even more so, in terms of Hammer and Champy's glib reference to IT 'as an enabler'). What IT was in 1990 when they opted to use it as an enabler and what IT is today (or could possibly become in the future), are simply not comparable at all – and probably justify and support the re-engineering failures cited in literature.

Moreover, it is this author's contention that, to any business problem two parallel and (arguably) equally important solutions exist, one being a short-term (operational solution) and the other a long-term (strategic) one. The short-term one is necessary to sustain the organisation while the more strategic solution takes time to have its effect on the organisation's survival. One has purposely elected the more strategic one as it is this author's belief that IT has and should have that effect for the organisation of the future to survive.

The underlying principle of all society's endeavours is the creation of a (perceived) ideal state. Whether this takes the form of value creation or stakeholder value for organisations, this principle is universal to human nature. For this reason, it is felt that Plato's *The Republic*, has relevance to any academic work of this kind, hence the quotations introducing every Module and also the final quotation at the end. The fact that Plato's driving force was the death of his friend and mentor, Socrates and the way in which this was orchestrated, has parallels in the current dissatisfaction with the world and the driving force of technology taking us into a digital era – what this author likes to call the 'Quantum Age', after Max Planck's quantum hypothesis, whereby *'a quantum may disturb a particle and change its velocity in a way that cannot be predicted'* [Hawking, 1988: 54], giving credence to the central notion of chaos theory as foundation in this thesis. Plato's work (and its hypothetised relevance) also enhances the notion made here that there is evidence of repetition in our drive for competitiveness.