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Half-life syndrome in information.

I Ben-Tahir

HALF-LIFE SYNDROME

IN INFORMATION

BY

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DEDICATION

In the name of God, the Beneficient, the Merciful

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To my father, my natural connection to this ephemeral world, who taught me to value time, t, the persistent variable throughout my thesis and with which we abide our lives; nonetheless, for him time is infinite.

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I. BEN-TAHIR
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LIST OF ABBREVIATIONS

AAA	Automatic anti-aircraft artillery
ABM	Anti-ballistic missile
ACM	Air combat manoeuvre
AEW	Airborne early warning
AI	Artificial intelligence
ALCM	Air-launched cruise missile
AWACS	Airborne warning and control system
BMEWS	Ballistic missile early warning system
BUIC	Back-up intercept control
C^3	Command, control and communications
C^3I	Command, control and communications and information or intelligence
COIN	Counter-insurgency
CONUS	Continental United States
CBM	Confidence-building measures
DEW	Distant early warning (Line)
FEBA	Forward edge of the battle area
FOB	Forward operating base
GNP	Gross national product
GPS	Global positioning system
ICBM	Intercontinental ballistic missile
IRBM	Intermediate-range ballistics missile
JTIDS	Joint tactical information distribution system
LOC	Loss of consciousness (Chapter 2 only)
LOC	Lines of communication
LRCM	Long-range cruise missile
MARV	Manoeuvring re-entry vehicle
M/IRBM	Medium/intermediate-range ballistic missile
MIRV	Multiple independently-targetable re-entry vehicle
MOB	Main operating base
OECD	Organization for Economic Co-operation and Development
RAF	Royal Air Force
RCAF	Royal Canadian Air Force
R&D	Research and Development
ROCC	Region operations control centre
SAC	Strategic Air Command
SAGE	Semi-automated ground environment
SALT	Strategic Arms Limitation Treaty
SAM	Surface-to-air missile
SLBM	Submarine-launched ballistic missile
SLCM	Sea-launched cruise missile
SRAM	Short-range air missile
SRBM	Short-range ballistic missile
SST	Supersonic transport
TDMA	Time-division multiple-access
USAAF	United States Army Air Force
USAF	United States Air Force
USAFSAM	United States Air Force School of Aerospace Medecine
USN	United States Navy
WWMCCS	Worldwide military command and control system (Wimex)

GLOSSARY OF TERMS

Concept/Doctrine	Significance
Adequacy	strategic parity in nuclear weapons by the superpowers (circa 1969-74).
Assured destruction	deterrence of a deliberate nuclear attack upon the US and its allies by maintaining a clear and convincing capability to inflict unacceptable damage on the attacker (circa 1961-68).
Counterforce strategy	in the case of pre-emptive attack, to retain a capability for a second strike against the enemy, viz., long-range bombers with launch capability and sea-based missiles (circa 1961-68).
Controlled response	"no-cities" doctrine or that the US would shun attacking the Soviet cities with nuclear weapons (circa 1962).
Damage limitation	a nebulous concept to limit damage to US population and industrial capabilities in case of a nuclear attack, viz., by thin and thick ABM deployment around such centres (circa 1961-68).
Destabilizing systems	devised to negate the enemy's retaliatory capability without having any bearing on the preservation of a dependable deterrent, viz., offensive weapons programs: warhead accuracy, yield improvement which could provide land- and sea-based missiles with the capability to launch counterforce strike against the enemy ICBM, thus contributing to the breakdown of nuclear deterrence, stimulating even greater enemy strategic weapons programs.
Deterrence	retaliatory force capable of withstanding a surprise attack and inflicting massive destruction on the enemy (circa 1953-60).
Diad	the ability to launch a strategic (nuclear) attack with bombers and SLBM only (circa 1975).
First strike	strategic force's offensive capability/posture (circa 1953-60).

Concept/Doctrine	Significance
Flexible response	limited use of nuclear weapons with emphasis on conventional defence in the initial stages of war (circa 1962).
Fourth arm of deterrence	carrier- and forward-based aircraft in Europe and Asia (circa 1975).
Graduated deterrence	a spectrum of nuclear weapons ranging to the lowest yield (0.5 kt) or improved conventional weapons, or both (circa 1966).
Half-life (classic)	time required for the activity of a given radioactive species to decrease to half of its initial value due to radioactive decay and is independent of the amount or condition of that species.
Half-life (information)	time (actual or expected) within which half the total use of individual items constituting a literature has been or is expected to be made.
	time at which the residual utility of information is 50 per cent.
	time when half of the utility has been consumed.
	time at which half has been depreciated or perished.
Hard-kill targets or Hardened targets	targets which are difficult to destroy either due to their invulnerability to direct nuclear attack or location, viz., subterranean command posts, submarine fleets or movable launchers (MX) (circa 1977).
Incrementalism	a slow and deliberate action to gain and increase military and political power in the area of international strategy, rather than resorting to dramatic technological advances.
Massive retaliation	a deliberately ambiguous concept alluding to a limited use of nuclear weapons to serve as a deterrent to the enemy lest he launches an attack, with a caveat that this doctrine shall not be exercised in any local war against the USSR or China (circa 1953-60).

Concept/Doctrine	Significance
Mutual assured destruction (MAD)	total mutual annihiliation or no chance of damage limitation if deterrence fails through miscalculation, irrational action or an accidental or unauthorized launch by either of the superpowers or even a smaller nation, viz., South Africa, India, etc. (circa 1975).
New look	synonymous to "massive retaliation" (circa 1953-60).
Stabilizing systems	relatively invulnerable weapons and programs designed to enhance survivability, viz., SLBM, hardening of missile silos, dispersion of bomber and fighter bases (MOB, FOB, DOB), missile site ABM defences; also systems without any ability to threaten the enemy's strategic forces (missile penetration aids), MIRV, ASM, ALCM, survivable C^2 and C^3, strategic bombers to guard against inadvertent launches.
Strategic parity	an elusive concept of parity of the superpowers nuclear forces, difficult to define and uncertain in its implications, and upon which are based the doctrines of "adequacy" and "sufficiency". It is also based upon an equivalence of second strike (counterforce) capability from the US viewpoint (circa 1969-74).
Sufficiency	strategic parity in nuclear weapons by the superpowers; synonymous to "adequacy" (circa 1969-74).
Triad	the ability to launch a strategic attack with bomber aircraft, ICBM and SLBM (circa 1975).
Trip-wire strategy	even a low-level conventional conflict in Europe would/could trigger a nuclear response.
Worst-case planning	planning based on estimates of the enemy's greatest potential for destruction and the defenders ability to conduct a defence which allows a second strike (circa 1961-68).

NOTA BENE

A special reference must be made to the contributions of Dr. Barnes, my academic adviser. Since his contributions are so numerous, I have found it difficult to enumerate them or to include his name amongst the references.

Canadian style and usage, a variation from both the British and the American, have been used in this work. Also, whenever possible Canadian examples are illustrated or advanced to show that Canada is not such a technological Siberia after all.

Every possible effort has been made for accuracy, save glitches by the equipment that may have crept in during the final printout.

PREFACE

Mr. Ben-Tahir has asked me to comment, as a preface, on his thesis topic.

When he first proposed the subject area, it struck me as an extremely interesting but difficult one. If Ben-Tahir's perception of the widespread occurrence of the decay phenomenon were correct, it would necessarily involve an extremely broad survey to confirm it. As he remarks, this was indeed the case, and a major difficulty was to whittle the project down to reasonable size.

A second problem was to bridge the gap between the colloquial sense of "information" (meaning, knowledge, etc.), which we all know, and any technically precise sense which could be rigorously studied. In the former sense, we all realize that technology, war, and indeed all human pursuits involve "information." The latter sense has traditionally been restricted to the field of documentation, or else to the statistical "information theory" of Shannon, Hartley, and others. It seems to me that the parallels Ben-Tahir explores suggest that the connections are rich and potentially fruitful.

I have greatly enjoyed the challenge of exploring his ideas with Mr. Ben-Tahir, and hope that they will be a continuing stimulus to him and others.

ABSTRACT

Information decays with respect to time (and its variables) in a technological environment. This may be measured quantitatively in terms of "half-life". This provides a new perspective from which to view the impact of technology on society, and of technological innovations on strategic thinking, or war. The diminishing value of information (rate of decay) in the military environment affects instant decision-making based on highly ephemeral (rapidly perishing) battlefield information; and long-range decision-making for the slowly decaying systems affected by a threat-counterthreat cycle since 1945. The macro-information systems (civilizations and countries) also experience decay of their relative power or their effectiveness to wage wars (in the 1980s and beyond). This information syndrome can be utilized to avert large-scale or total war.

While the earth remaineth, seedtime and harvest, and cold and heat, and summer and winter, and day and night shall not cease.

Genesis VIII:22
The Torah

And the women were given two wings of a great eagle, that she might fly into the wilderness, into her place, where she is nourished for a time, and times, and half a time, from the face of the serpent.

Revelations XII:14
The Bible

And We caused Jesus, son of Mary, to follow in their footsteps, confirming that which was (revealed) before him, and We bestowed on him the Gospel wherein is guidance and a light, confirming that which was (revealed) before it in the Torah -- a guidance and an admonition unto those who ward off (evil).[1]

The Quran V:46

1. Translation by Mohammed Marmaduke Pickthall, my father's professor and mentor (1933-34) who taught him to be an officer and a gentleman.

1. A SPACE IN TIME

All animate and inanimate genera in the universe have a certain life: are born, develop or grow, and die. We observe this phenomenon every day for various species of many of the genera from the elementary protozoam to a star.

The life of a star is a very interesting phenomenon. Since the advent of extremely large telescopes and radio-astronomy, man has been able to observe stars, whose species range from their genesis to their necrosis. In between the two extremes: the birth and the death, lies a spectrum of phases in the life of a star. Each star rises to its prominence, illuminates the universe around itself, like our sun, reaches its epitome and then gradually begins its slow decline and eventual demise. The epitome or the climax, regardless of the time it is reached in the span of the star's life is called the 'half-life' of the star, which does not necessarily mean half of the time it has left in its life, but half of the energy it has expended or has in storage to spend in future.

The classic definition of half-life is the time required for the activity of a given radioactive species to decrease to half of its initial value due to radioactive decay and is independent of the amount or condition of that species.

We have enormous amounts of information on the lives and half-lives of the stars and other radioactive and chemical material, and this information is growing all the time. However, we do not have any information on the information itself, i.e., whether the items of information have any life themselves.

Information is any knowledge gained through communication, research, instruction, observation, etc., and information science is the study of the characteristics of information and how it is transferred. It is concerned with creation, collection, organization, storage and analysis of information in the process of decision-making (6).

In physical sciences there is an empirical ordering of quantities, but information science is relatively a new field of knowledge which is interdisciplinary and multidisciplinary. Information science being multidisciplinary extracts elements from many of the "hard" and "soft" sciences. It is the rationale, the logic and is the intellectual parent of computer and library science, but has arrived, if the theory of relativity could be applied in this instance, only after the birth of its offsprings.

Our quest is to determine if information does have (not that is should or "ought" have) a life: genesis, growth and decay; and if this decay phenomenon plays any part in the process of decision-making, especially at the point where information is at its optimum value or half-life.

Since there is no empirical quantitative ordering of information, half-life can be defined as:

1. the time (actual or expected) within which half the total use of information has been or expected to be made; or

2. the time when 50 per cent of the information is utilized; or

3. the time at which half of the information has depreciated or perished.

We shall also try and examine if the embodiment of science, i.e., technology and its functional use in strategy or war can be viewed in the frame of this "half-life syndrome".

Chapter 2 is a review of the classical themes in the philosophy of technology and we shall see if technology has any relationship to information and the rate at which technology changes or depreciates.

In Chapter 3, we shall discuss the effects of technological embodiment of science on strategy or war and the dialectic relationship, if any, existing between these elements and if either of them have any synonymy with information.

Chapter 4 is the development of the hypothesis of half-life syndrome in information by synthesizing various approaches by information scientists from the US, the UK, Canada, and Australia and determine if a threshold or a discard point for information exists.

In Chapter 5 we examine conflict as an information system. The prescription for both intra- and international war and the ingredients and actors who contribute to the formulae of conflict.

Chapter 6 synergizes all the previous chapters; and we shall determine if the models of information decay developed in Chapters 4 and 5 fit real situations, such as, a rapidly perishing technological battlefield or a slowly developing revolutionary process which could/would have a devastating effect on Western civilization as we know it at present.

Chapter 7 is a summary of the thesis as well as a statement of whether we have been able to establish the fact that information science is inter- and multidisciplinary and whether we are able to conclude and meet the objectives we have stated here.

2. TECHNOLOGY: RUN OF THE MILL [1]

Flight into Realism

(A Science-fiction Sonnet)

I swam ten trillion miles across the sea
To the shoal and ebb of an alien isle
Of murky myth and miry mystery.
And there I stood astill, in daze a while,
Drenched of mortal id, and doused of psyche.
Upon her hushed shores I knelt to admire,
The serene beauty of perpetuity,
Of aeons past, of ageless pyric dire,
Which made me feel and brush eternity
That void like some dark inhuman womb
Restored my lost sense of reality;
And when I returned to this worldly tomb
I craved my anguished mind to relate
But I am compelled to a spellbound fate.

I. Ben-Tahir
In "Refractions 69".

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1. An abridgement of the partial requirement for special topics course CIS 492a: Contemporary Metatechnology taken under Professor S.L. Goldman, B.S., M.A., Ph.D, Andrew W. Mellon distinguished professor in the humanities and director, Humanities Perspectives on Technology program, Lehigh University.

INTRODUCTION

The aerospace technology is the fastest changing technology in the 1980s. Since aircraft and other aerospace vehicles (spacecraft, rockets, missiles, etc.) are heavier-than-air, considerable effort is expended on research and development (R&D) in discovering lighter and more durable metals and alloys to meet both the lightness and stress criteria. The science which is closely associated with this (R&D) is metallurgy. Studies of usage of information generated in the field of metallurgy indicate it as having a relatively short half-life of approximately 3.7 and 3.9 years (25,71,101). Since technology, being a pragmatic discipline, consumes information faster than science can produce it, Redmond (104) estimates the figure of half-life for aerospace technology at 2.5 years (which is borne out by fast turn-over and obsolescence of various aerospace programs such as the cancellations of the supersonic transport (SST) by the US Senate in 1971 and the B-1 bomber by Mr. Carter in 1976).

The ephemerality of information of aerospace technology is no more emphatically illustrated than in the operational role of the fighter aircraft. In the 1960s the US-built F-104 Starfighter[2] was generally conceded as the most advanced fighter in the world (4). In the India-Pakistan war of 1965 this aircraft proved the technological

2. In Canada the aircraft is designated CF104 and was manufactured under license by Canadair Limited as CL-90 (12).

superiority of the Pakistan Air Force against a numerically superior Indian Air Force. However, in the 1971 India-Pakistan affray, which brought about the emergence of a new nation, Bangladesh, almost the entire fleet of F-104 Starfighters was lost to a technologically superior Soviet manufactured MiG-21[3] aircraft and surface-to-air missiles (SAM).

Wars since 1945 between the Third World nations have in part been wars by proxy for the superpowers. These wars have also served as laboratories for active or destructive testing of the superpower arsenals. The 1973 Arab-Israeli war demonstrated (9):

1. the attrition rate of armament in a modern technological battlefield is faster than the efforts of the superpowers to replace the losses by conventional means; and,
2. the F-4 Phantom tactical strike fighter, the mainstay of the Israeli Air Force and which had been tried and tested in the Southeast Asian theatre by the US, was no match for the MiG-21B and MiG-21J[4] air-to-air fighters which operated in the 30-40,000 ft. envelope and at 0.6 to 1.6 Mach numbers[5].

The latter factor jolted the US tactical planners into a recognition of a need for a lightweight fighter to meet the critical

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3. NATO code name for MiG-21 is Fishbed (53).
4. MiG-21B and -J are versions of the same aircraft involved in different operational roles (53).
5. Mach number represents the ratio of the speed of aircraft to the speed of sound in the surrounding atmosphere. It becomes constant at 36,089 ft. altitude and above (100).

air combat manoeuvre (ACM) performance (dogfight) in battle so as to maintain air superiority for the West and its allies. Thus began the technological race for a fighter aircraft to replace the F-4 Phantom, which culminated in the development and manufacture of F-16 and YF-17 (F-18A and F-18L) fighter aircraft (9,46).

The rate of change in technology, specifically in the aerospace-defence environment illustrates certain effects on the subjects directly involved in its use. For instance, recent studies at the United States Air Force School of Aerospace Medicine (USAFSAM) has shown that loss of consciousness (LOC) can be induced in aircrews when their "g"[6] tolerance is exceeded even with additional protective devices such as anti-g suits, straining manoeuvres and tilt-back seats. This is true of most of the advanced air superiority fighters, including the F-15 Eagle[7], which has a high g onset rate of up to 10g/sec (129).

> These levels of increased g forces applied on aviators in modern high performance fighter aircraft are no longer airframe limited but instead are limited to the ability of the human body to withstand the excess g forces. Acutely, the g-limiting symptoms constitute a spectrum of decreasing sensorium ranging from grey-out through black-out to a final loss of consciousness. The threshold for the onset of grey-out, black-out and LOC are variable and are influenced by the rate of onset of g, duration of g, previous g experience, heart rate and blood pressure along with other associated factors (129).

The most important findings at USAFSAM was that several of the aircrews did not believe that they had undergone LOC until instant

6. "g": force exerted on a body at rest by gravity when subjected to acceleration.
7. The technological standard bearer (fighter) for the Western air forces in the early 1980s.

replay review of the videotape recordings. Consequently, it is possible for a pilot of a high performance aircraft such as F-14, F-15, F-16, F-18, etc., who loses consciousness to be unaware that anything had occurred. Subsequent failure to report such an unwitnessed event is quite possible as no significant residual symptoms other than transient amnesia and confusion were manifest in any of the subjects (129).

Another example is a study by the Royal Air Force (RAF) in Britain. A certain period after RAF issued anti-g helmet as a standard equipment to the aircrew to alleviate the problem of restraints in the head movements during high g turns, new shirts with larger neck sizes had to be ordered for the build up of heavier neck muscles due to (93):

1. the distribution or the shift of the g force from the head to the neck; and,
2. the weight of the helmet.

The above examples from USAF and RAF cite the physiological manifestation of technological change; however, these are minimal when compared to the social and psychological effects of technology which are remarked on by different schools of theorists and philosophers of technology.

THEORISTS' APPROACHES TO TECHNOLOGICAL CHANGE

There are several schools of thought on the nature of technology and its impact on mankind. As a whole these theorists discern the effects of technology with views ranging from dispassionate observation through passionate support. Their individual approaches to the effects of technology on man and society depend immensely on the theorist's own background, viz., education, experience, orientation, outlook, etc.

Most of the theoretical views of the effects of technology on society can be classified under four major approaches.

1. The Utopian approach is a universalist or utilitarian one which accepts technology as the panacea for all worldly ills and promises utopia in our time. The doctrine professes that:

   a. technology is intrinsically good and should be pursued for its own sake (82);

   b. technology has made the physical facts of our lives much more tolerable, with such innovations as computers providing opportunities to organize and enrich our lives, and society should adapt to the time of great change (88);

   c. global wealth varies directly with technology in the process of extricating products and energy; moreover, politicians are a hurdle to progress as they do not understand the "metaphysical mastering of the physical" (74); and,

   d. most of the negative comments against technology are deliberately created myths to divert attention from pressing problems (44).

These optimist utopian views are generally held by US thinkers, (e.g., Mesthene, Morison, Fuller, Ferkiss), who are conditioned by the American manifest destiny theme.

2. The Relativist group of theorists emphasize environment, time and space, and they visualize technology as a medium through which time and society are passing. They tend to place time within history rather than the reverse, and see history through form. They are fascinated by the ebb and flow of information systems (74).

   This relativist view is held generally by Canadian thinkers, Innis and McLuhan (74).

3. The Determinist approach is rather a broad spectrum of views ranging from guarded pessimism to apocalyptic fatalism. It elaborates the darkest aspects of technology with all its gargantuan horrors.

   This view is mostly held by European thinkers(74): Giedion (Switzerland), Toynbee (Great Britain), Berdyaev (Russia) and Ellul (France). Certain American theorists: Mumford, Weizenbaum (128) and Wiener (127), who once believed in the great promise of technology have drastically shifted their position sometimes matching the fatalism of Ellul, whose "technique" is a near-diabolic life-force which man is helpless to curb or stop. A disaster so enormous awaits man, he envisions, that blame is a pointless luxury (74). Ellul (41) and Berdyaev (14) are fatalists. Ellul sees himself as diagnosing an ailment and not making judgments. His "technique" transcends the machine: a boundless, limitless, metaphysical force that politics, economics, morality, spiritual values find themselves immersed in; it is "the religion, the ideology and the central force of our society" (41). However, Berdyaev's "technique" is the personification of anti-christ (14).

4. The Ideational approach is expounded by Sorokin, an expatriate-Russian American, who sees the crisis in our time as that of deviation from "ideational" or spiritual values revealed to us by God in opposition to the "sensate" truth revealed by our secular empirical experience or senses. A synthesis of the ideational and sensate truths reached through by our reason, viz., mathematics, syllogisms, etc., he stated is the idealistic truth (114).

Sorokin saw degeneration in the Western culture's music, literature, art, sculpture, architecture, jurisprudence, religion and personal relationships as the effect of the sensate relativistic ethics, i.e., utilitarianism, hedonism and pragmatism, and relates them to the bankruptcy of the technological values and everything associated with this arcane anathema. He proposes the remedy as the return to the ideational values of faith and truth revealed by God as the sole salvation for the Western civilization (114). Sorokin, like Innis, sees the sensate culture through form (74,114) with paintings, sculpture, music, literature, etc., depicting the subsocial stratum of prostitutes, criminals and nudity as the heroes of the time.

The values of the sensate culture Sorokin claims, are utilitarian: "If belief in God is useful, God exists; if not, he does not...". The motto of the sensate value system, everything is relative (114), is echoed by Weizenbaum's criticism of his fellow scientists who believe, "what science has not done, it has not yet done" (128).

The above are the four major approaches of the theorists on the effects of technology on society. There are certain other minor views which are value-free (Wertfrei) and are orientated only towards the understanding of certain technological systems. Anders, Jonas, Jünger, Skolimoski, Rostow, etc. (66,85,106), have contributed significantly towards these objectives.

WHAT HATH TECHNOLOGY WROUGHT?

In 1945 certain extraordinary phenomena transformed the rate of change of technology; since then this accelerated trend has not stopped affecting society as a whole. It was not a single phenomenon: the

Atom bomb blast in New Mexico, the VE- or VJ Day, the advent of the computer or the miracle drugs, but an amalgam of collective events that have triggered a massive increase in technology, and through it, information. The quest is not to ascertain the cause of the critically-massed development of information, demonstrating almost an exponential trend, but to understand its behaviour and try to give information a certain form and thus assist society to comprehend this technological creation.

Technology and information become almost synonymous when one views the mammoth amount of information that technology creates every day. This rampant and runaway trend known as information explosion has been overlooked by most technological theorists. Only certain information processing agencies have shown interest in providing state-of-the-art information separating the chaff from the up-to-date matter; and this they do only from the point of view of economics and commerce with no interest in understanding the phenomenon.

To understand the phenomenon of technology and its consequence, we have to take into account the following factors:

1. sheer population growth since 1945;
2. our adeptness or lack thereof in the deliberate use of technology to achieve our goals; and,
3. the nature and consequences of modern science and technology (82).

Population growth since the Second World War has exceeded the industrial growth and had it not been for the computer, which "arrived just in time" to cope with the enormous bureaucratic workload and complex computational tasks (128), certain societal institutions, such as banks, justice agencies, social agencies, transport and commercial enterprises would have collapsed under the weight of the rapidly growing population. However, it is not the efficiency of the computer nor its diligence that is being questioned, but its use for certain dehumanizing purposes. Weizenbaum contends that computers ought not be asked to perform certain tasks requiring wisdom and raises three rather moralistic issues (128):

1. natural language cannot be taught to a computer as the expressive powers of human words have an unrestricted domain of meanings while a computer is merely a superb symbol manipulator;
2. decision-making should remain in the realm of man so that he could determine his own autonomy rather than rely on computers, which may become embodiments of law instead of merely law abiding machines; and,
3. artificial intelligence (AI) and human intelligence should not be allowed to co-exist as AI is alien to genuine human problems and concerns (in motion picture Space Odyssey 2001, HAL 9000 computer illustrates an example however fictional).

Mesthene (82,83) and Ferkiss (44) suggest that technology creates opportunities which dismiss Berdyaev's "industrial rationalization breeds unemployment, the greatest evil of the day" (14).

THE GENERATION(S) OF TECHNOLOGY

A very different view suggests that technology is not a fixed, static entity which is thrust upon us, but it grows and changes similar to organisms and societies. According to Brooks (22), the evolution of technological knowledge is similar to biological evolution, although technological evolution is millions of times faster than the biological one. The part of genetic inheritance is played by the inherent logic of technological development, whereas the natural selection by the environment is played by social mechanisms of decision-making including the market. Competing technologies form part of the selective environment that determines the evolution of a technology. Technologies demonstrate ecological relationships with one another similar to the species in the biological world (22). The cancellations of the US supersonic transport aircraft and the breeder reactor program are cases of the extinction of endangered species of technology.

The consequent evolution of technology from the first to the next generation is determined by internal and genetic events or logic intrinsic to the technological ecosystem. Just as the number of genetic variations is very large compared with the numbers that are propagated to the next generation as the result of natural selection, so is the number of technological possibilities very large with those that actually survive in the market (22).

In this way, the environment of the technological jungle selects the fittest who survive to the next generation. In technological evolution, what survives forms the knowledge base that again provides the full range of possibilities for the next generation of technology (22). There are, however, cases of retarded evolution. One such example is a RAND Corporation study on dynamic-allocated packet-switching communications for the USAF. The USAF wanted a survivable system containing no central components but the study was shelved for several years after its publication in August, 1964 (105).

However, later on with the computer environment this technology was revived and made the basis for computer-to-computer secure communication. This is an analog of coming to life of a biological entity which had been in the state of suspended animation until the environment was ripe.

TECHNOLOGY AND INFORMATION

Our discourse with technology is not from any philosophical or intellectual point of view. We are neither concerned with technology being the greatest evil of our time and a diabolic force with a momentum of its own; nor a benign power to solve all our national and personal ills. Also we do not see it as an intellectual passage through which time is travelling as if time were a dispassionate spectator watching a momentuous phenomenon. Our point of view is how information science sees technology and how technology is perceived as the generator of information.

New technologies create new information. In 1957 the launching of Sputnik I generated a considerable amount of scientific information about space hitherto unknown to man. Children learned about escape velocity, trajectories and liquid oxygen. Youth showed an immense interest in science. Universities in the West were flooded with students eager to learn and excel in any and every field of science. But over the past 25 years interest in science has faded. University enrolment has dropped. In 1982 with the advent of the Space Shuttle, the reusable technology, a new interest is seen by the youth in technological information. Youth generally do not see science as an avenue for their pursuit as they did a quarter of a century ago when they sought deeper and more cogent indoctrination in the precepts of science. They have turned away from science as being vague, theoretical, elitist, and have turned to technology and perceive it as precise, pragmatic and egalitarian. There are more applications to colleges of technology than to universities. Technology is perceived as the solver of all our problems in the 1980s, not just by youth but also by leaders of Western nations. In the closing speech at the Versailles Conference of the seven most industrialized Western nations, the President of France reiterated that we should look to technology for the answers to our massive economic problems. Hence, technology has become the idol and the deliverer of the fate of the Western civilization. All we can see is that technology delivers information.

New technologies create new opportunities as mentioned above, but they also create new information and every change in technology brings about a change in information. Technology also consumes or uses a lot of information as well as generating it. If new information gathers faster than the old information is used we have a great deal of accumulation of information; if information is generated and consumed at almost the same rate then we would have a stable information store; however, if the information consumption is faster than its accumulation, we have a decay.

Let us examine how changes in technology effect changes in information. If for instance a new external fuel tank, which is considered a very basic and unsophisticated technology in the aerospace field, is installed on an aircraft, it immediately modifies a lot of information about that unit. Besides altering the centre of gravity, it instantly changes the aircraft's:

1. weight:
   a. empty,
   b. fuelled, and
   c. maximum take-off; and

2. performance:
   a. take-off distance or roll,
   b. rate of climb,
   c. time to climb,
   d. service ceiling,
   e. maximum speed,
   f. cruise speed,

g. fuel flow,

h. manoeuvrability,

i. range, etc.

These technological changes in turn generate additional information about the aircraft, generally known as modifications (mod 1,2,3, etc.). Since the previous technical information about aircraft has become redundant or consumed or used, new charts, checklists, graphs, illustrations, tables, etc., have to be created and this information supersedes the previous one, not to mention the learning curve the human subject or the air- and ground crews have to go through to assimilate this new information. This information may again be superseded by either a newer modification of the fuel tank or some other avionic or armament equipment, which can spin still newer and different information.

At some point every technological change becomes information change. When this happens technology becomes almost synonymous with information. Thus the faster the rate of change in technology, the faster the rate of change in information. But since so great is the rate of technological change with supersessions upon supersessions, that ultimately (the redundant or consumed) information begins to deteriorate or decompose. This phenomenon is specifically known as information decay. How fast and how much information decays depends on the rate of change of information with respect to time. But there must be some point up to which the information may still be of use. If we assume this point of consumption or usefulness of information as our threshold, the juncture or cut-off instance, then we can also assume that information from this point onwards in time not to be useful in the technological environment. In the science of physics and chemistry such a decay point is measured in terms of "half-life". However, since information is not measured in the same quantitative scale as physical or natural science, since we have established a quasi-synonymy of information and technology, let us delve deeper into the nature of technology to verify the decay juncture.

3. WAR: STRATEGIC THINKING AND TECHNOLOGICAL INNOVATIONS[1,2]

Concorde

(a technological sonnet for the SST)

Flap, flap, the vile solar wind is too fast,
The sky's edge is curved to a hueless dark,
The condor shivers the breakaway blast,
Its mettle soaring like some swept-winged lark.
Roll, roll, this cold, cloudless air is too rare,
Where the cruel ozone adorns and yaws,
Where the pitch blackbird and the foxbat dare
And fight their battles with bare, blinding claws.
Bank, bank, your trim is far too high to swan,
Your profile belies your frail swinging thing,
That darts and dash's from dawn to dusk to dawn
And breaks with time and sun's flinging cling.
Oh, bird of paradise, you racy dove,
How can one express you his deepest love.

I. Ben-Tahir
October 1976

1. An abridgement of the partial requirement for special topics course CIS 492b: Strategic Thinking and Technological Advances taken under Professors C.B. Joynt, B.A., M.A., Ph.D, and D.J. Hillman, B.A., M.A., M.Litt, 1979-80.
2. Reviewed by Colonel R.K. Buskard, B.A., CD, Director Air Plans, National Defence Headquarters, Ottawa.

INTRODUCTION

Since the end of the Second World War in 1945, the world has experienced numerous wars between nations and also wars within national boundaries, generally known as revolutionary wars or people's wars (36). During the period, 1945-65 there have been 30 inter- and intranational wars (86).

The latest USSR military adventure in Afghanistan in 1980 reinforces the concept that wars occur around the world at a certain frequency and are cyclical regardless of our abhorrence towards such banal carnages (32,37,86,111,120).

A great number of people like war; war excites people and although some express their abhorrence, many are fascinated by it. Unless we understand the phenomenon of war, we cannot comprehend peace (52).

The driving force in the war phenomenon is military technology: innovations that make weapons systems bigger and more destructive, or in some cases smaller and more accurate. History traces a number of persons famous in peaceful fields who were markedly military oriented. Michelangelo, Galileo, di Vinci and Nobel were all military engineers and had no qualms whatsoever in turning their inventions to military purposes (52).

Military technology can neither be wished away nor "deconstructed" (13). It is a reality that we are faced with and is the leading force in the organization and development of (strategic) doctrine (90). US Secretary of State Robert McNamara described military technology as having a momentum of its own; at odds with human capacity to comprehend it; and, out of control (130).

War's primary element, strategy, according to Clausewitz, is the concept of the use of battles to forward the aims of war, in opposition to tactics, or the concept of the use of the armed forces in battle (8). However, Liddell Hart's twentieth century concept of strategy is "the art of distributing and applying military means to fulfil the ends of policy" (59). He considered economic pressures, propaganda, subversion and diplomacy combined with force, 'strategic'.

Another British strategist perceives strategy as having inspired scientists and technologists during wars to achievements they would normally have considered impossible (59). However, Brodie (19), an American political scientist sees "technology falling very short of being the name of the game which is strategy". Regardless of the above perceptions, strategic thinking or doctrine is an autonomous discipline, but is dependent upon technological innovations or advances.

STRATEGIC THINKING

> Strategic thought (in the narrow sense) was concerned first of all with implications of nuclear weapons, and with the gradual awareness of these implications, it came to include diplomacy inasmuch as diplomacy is influenced by arms and, in particular, nuclear arms (8).

Since the explosion of an atomic (fission) device at Alamogordo, New Mexico on 16 July 1945, 'strategic' (in the narrow sense) has become synonymous with 'nuclear'. The use of the word strategic, became current some time after the bombing of Hiroshima and Nagasaki by the USAAF on 6 and 9 August 1945, respectively.

A strategic objective is an objective not based on a geographic location but on a political decision (26). Strategic thinking is very much a product of circumstances, not just technological developments but also domestic and political developments (96). Therefore, strategic thought is not quite separate from political thought (8). An example would be formation and stationing of the USN Fifth Fleet at the mouth of the Persian Gulf in the 1980s. The oil supplies passing through the Strait of Hormuz have strategic implications for the West and the allocation of sea-, land- and air resources to further this aim of assured oil supplies would be part of strategic planning or thinking since oil has domestic and political implications.

Strategic thinking transcends tactical decisions, which are short-lived and serve only a limited purpose in the overall strategic process. There are certain tactical concepts nevertheless, such as guerilla warfare and insurgency (and counter-insurgency (COIN)) operations, which have, since 1948 gained strategic importance in that tactical deployments have crossed over into the strategic realm (36). A good example could be insurgency in the Azores denying the US refuelling capabilities for their long-range contingency operations, thus supplanting a USAF strategic aim.

Strategic thinking in the Communist World, specifically the USSR, differs from Western thinking insofar as the communists have a great difficulty in reconciling technology with their Marxist-Leninist ideology. Capitalist classes and countries will be hostile; and based on their ideological conviction, the socialist countries want peace, the capitalists, war. Therefore, the Communist World must prepare for war (8). However, their pretense for peace does not seem to deter them from repeating the territorial aggrandisement doctrine prevalent in the eighteenth century of invading weak neighbours (viz., Afghanistan).

Chinese and Soviet strategic thinking differ only in dialectic (style and form) and not in substance. They focus chiefly on the destructiveness of nuclear weapons with each accusing the other of understating or overstating the problem (8).

Strategic thinking, therefore, becomes the instrument of a country in its overall achievement of national objectives.

TECHNOLOGICAL INNOVATIONS

> Some technological advances may be so earth-shaking in their consequence that subsequent ones, however more sophisticated individually and impressive in the aggregate, cannot but be of diminished significance relative to the original device (19).

Technological innovation will continue growing exponentially: "there was no hope of trying to stop this 'growling engine of change'"; and, society must learn to adapt to technology (39). Sputnik I launching on 04 October 1957 by the USSR was a triumph (67) in rocketry, missilery and space travel. It heralded not only an era for science (metallurgy) and technology (guidance systems) but also for the military of the superpowers and their allies. Even some Third World countries, however unaffordable it may have been, launched ambitious programs to share the advent of the space age.

The most significant technological innovation since the industrial revolution is the microprocessor invented in 1971. It succeeded because it met the needs of the time using very little energy, raw material and capital. It represents a steady evolution in electronic componentry as valves (tubes in North America) gave way to transistors, which in turn were succeeded by increasingly sophisticated integrated circuits of the semi-conductors (39). At present a new micromini magnetic-bubble technology is under development with manifold capabilities exceeding that of the semi-conductors in the microprocessors (28).

The mounting of a strategic (nuclear) warhead on to the launcher (missile) gave a new dimension to strategic thinking and many traditional concepts revered by strategists were shattered overnight. Even tactical commanders had to review their modus operandi to compensate for technological innovations that became apparent concurrently with the adoption of nuclear option by the military strategists, e.g., blast, radiation, fall-out, etc., that accompany nuclear weapons.

Each technology creates its own particular environment, e.g., the computer has created a supraintelligence milieu in industry and has assumed paramountcy in military technology and doctrine: command, control and communications (C^3).

A PARALLEL DEVELOPMENT

Technology may be said to be driving strategic thinking, insofar as there is a causally significant interaction between technological innovation and doctrinal evolution of strategic thinking (64). This concept of parallel development of technological advances and strategic thinking can best be illustrated by U-2 aircraft overflights to detect the Soviet offensive capabilities, where U-2 technology resulted in the evolution of a strategic doctrine based on advanced electronic reconnaisance and photographic surveillance. In this particular instance both technology and doctrine developed simultaneously; the strategic objective was the foreknowledge of enemy's strategic (nuclear) potential and his ability to launch pre-emptive attack on the continental United States (CONUS) and its Western allies. This supports Buskard's argument that a strategic objective is not based on a geographic location but is a political decision (26).

Technology is not always the driving force; it did partially exist when the US decided to land man on the moon before the end of the decade: the 1960s. Here strategic thinking preceded technology, and every effort was made to create a technology to meet the requirements of the time. Other instances where the doctrine preceded the technological developments are: the cracking of the German dams on 17 May 1943 and the manufacture of Mulberry, a harbour facility for the allies on the French beachead in 1944. But in both these cases the requirements were tactical and not strategic, as the scope of the technological innovations was limited and contributed very little to the strategic objective, the winning of the Second World War (26).

In certain instances technology has not responded to strategic needs: the German land mines in the Second World War that nearly stopped the advancing Allied tank forces in Europe and the ad hoc measure of the flail tank contraption was not a technological innovation and did only serve partially the tactical purpose to save the "queen of the battle" (64), hence the technological answer was a partial success. The present problem of radiation hazard at various nuclear power stations, a strategic requirement at a critical time of energy insufficiency, has no possible technological solution in sight.

There are also cases where technology is so far advanced that the strategic requirement lags technology and technology becomes irrelevant. The Canadian CF-105 Arrow fighter aircraft which set several world records during its test flights (98) had to be scuttled on 20 February 1959, being too far ahead of its time as no one was interested in purchasing this advanced technology. HMCS Bras d'Or, a hydrofoil craft which set a world speed record of 70.2 mph as the fastest warship on 17 July 1969 (80), was mothballed for basically the same reason, i.e., being too advanced a technology for integration into strategic doctrine.

The data collected thus far for a parallel development of strategic thinking and technological innovation illustrate that:

1. strategic doctrine may be precursor to technological

innovations;

2. strategic doctrine does not lead technological innovation in most cases;
3. strategic doctrine and technological innovations rarely develop simultaneously;
4. technological innovation may be inadequate to meet strategic requirement; and
5. technological innovation may be too far ahead for adoption in the strategic context.

The parallel approach of strategic thinking versus technological innovation has a very low probability of occurrence and thus is not useful for our study.

A DIALECTIC CONCEPT

The concept of dialectic development in the realm of strategic thinking and technological innovation is one denoting an offsetting arrangement, not so much either doctrine or innovation following the other, but rather an action-reaction sequence with almost an aura of mechanical inevitability, where for every action there is a greater-than-equal reaction (131).

During 1945-50 Soviet defence expenditures declined and the only innovation in their military inventory was a copy of the B-29 Flying Fortress, the Tu-4 bomber, code name: Bull. The second phase in Soviet defence expenditure was the Korean war build-up with MiG-15 and MiG-17 jet fighter aircraft (3). Alternatively, during the same period the US was developing an arsenal of retaliatory armament and was actively testing fission atomic weapons. The US by 1953 had adopted a "first-strike" (offensive) posture fearing a surprise attack by the Soviet bomber fleet and had developed a rather large Strategic Air Command (SAC) fleet of 500 B-47 and some slow and ineffective B-36 pusher-type aircraft (67). The US also had some carrier-based aircraft that could have obliterated the USSR. Neither of the enemy aircraft described above had the speed nor the range to attack CONUS. Half of the $35-billion defence budget was spent on air defence systems against the bomber threat (67), and forward operating bases (FOB) as far as 55°N in Canada, specifically RCAF Station Cold Lake in Alberta, were used to refuel and replenish the USAF SAC fleet dubbed the "chrome dome" for its 'metallic' presence near the North Pole to retaliate against any Soviet aggressive intention.

A string of more than 60 (now 31) radar sites known as the Distant Early Warning (DEW) Line was constructed in the Northwest Territories to detect and intercept the bomber threat. Even if the Soviet had conjured an attack it would have taken the aircraft 10 hours to reach CONUS (67).

To offset the USAF SAC fleet, the USSR developed a strategic doctrine stressing (67):

a. missilery;

b. a powerful nuclear capability against the US allies in Europe with their medium-range bombers; and

c. rhetorics and bluff of their "first-strike" capability.

Although the US weapons technology and strength grew immensely during 1953-60, the US was not sure that they could neutralize all the enemy's strategic forces during a possible first strike (6).

The Soviet advance in missilery evidenced in the successful launch of Sputnik I, spurred the US on an irreversible expenditure spiral of strategic weapons development. It also led to the installation of the ballistic missile early warning system (BMEWS) in Greeenland, Alaska and the UK, as the DEW Line was incapable of detecting objects flying above 100,000 ft. By 1959 the US had 8,000 air defence vehicles (130), 600 B-52 and 1,400 B-47 strategic bombers (67). However, since 1956 the US had known from U-2 overflights that there was no "bomber gap"; and in 1960 they had proof that the estimate of 100 Soviet intercontinental ballistic missiles (ICBM) was in reality only 35 (67). The "missile gap" was a cliché that helped Kennedy win the 1960 presidential election (5).

DEVELOPMENT OF DOCTRINE

In the early 1950s after acquiring an enormous A-arsenal (both fission and fusion weapons) the Dulles' "New Look" doctrine of "massive retaliation" or first-strike capability was unveiled by the US which feared a bomber attack from the USSR (Table 3-1). Massive retaliation, at best, was an ambiguous concept alluding to limited use of nuclear weapons to serve as a deterrent to the enemy lest he launch an attack,

Table 3-1. The development of doctrine-technology dialectic: the US strategic doctrine and weapons technology and USSR response, or in response to USSR response since 1945. (Doctrines are shown in quotes) (1,3,26)

Year	USA	USSR	Year
1945	A-bomb	Tu-4 Bull (B-29 copy) MiG-3	1945
1946		MiG-9 Fargo	1946
1947			1947
1948		MiG-15 Fagot	1948
1949		A-arsenal (49-52)	1949
1950	"Containment" Korean War	M-55 203mm (artillery) IL-28 Beagle; MiG-17	1950
1951			1951
1952	H-bomb; B-36, B-52	MiG-17 Fresco	1952
1953	"New look: massive retaliation; first strike; deterrence." B-47, B-52 chrome dome	H-bomb MiG-19 Farmer	1953
1954	H-arsenal; DEW Line		1954
1955		Tu-15 Badger	1955
1956	U-2; B-52D; IRBM, ICBM, SLBM	Tu-95 Bear; Mya-4 Bison	1956
1957		SS-1 (SRBM); Sputnik I	1957
1958	Minuteman I (ICBM) US space launch	Sputnik II	1958
1959	B-52G/H; BMEWS	SS-4 (M/IRBM); Su-7 Fitter ICBM tested	1959
1960	U-2 downed over USSR	MiG-21 Fishbed C	1960
1961	"assured destruction; counterforce strategy; controlled response or no cities; damage limitation; worst-case planning; graduate deterrence." Hound Dog (ALCM)	Manned space flight H-bomb tests SS-5 (M/IRBM) SS-N-4 (SLBM); AS-3	1961
1962	Manned space flight Titan II (ICBM); Pershing (SRBM); F-4C/D/E; F-4J/N; M-110 AI 203mm (artillery)	SS-N-3 (LRCM, SLCM) AS-4 (ALCM) Tu-22 Blinder	1962
1963	A-6E		1963
1964	Polaris A3 (SLBM)	SS-N-5 (SLBM)	1964

Table 3-1. (continued)

Year	USA	USSR	Year
1965	Vietnam War;	SS-9 (ICBM)	1965
	MIRV		
1966	Minuteman II (ICBM)	SS-1 (ICBM)	1966
	A-7E	MiG-23 Flogger A	
1967	F-111 A/E		1967
1968		SS-13 (ICBM)	1968
1969	Man on the moon	SS-12 (SRBM)	1969
	"Adequacy or sufficiency: strategic parity; trip-wire strategy."	SS-N-6 (SLBM)	
	FB 111A; SR-71 (YF-12A)		
1970	Minuteman III (ICBM, MIRV)	MiG-21 Fishbed K	1970
		MiG-25 Foxbat	
1971	Poseidon C3 (ICBM, MIRV)	MiG-27 Flogger D	1971
1972	ABM Limitation Agreement	ABM Limitation Agreement	1972
	Lance (SRBM)	SS-N-8 (SLBM)	
1973			1973
1974	SALT I	SALT I	1974
		Tu-22M Backfire;	
		Su-17, -20 Fitter C	
		Su-19 Fencer A	
1975	"Diad; triad; fourth arm of deterrence; MAD; hard-kill targets."	SS-17, -18, -19 (ICBM, MIRV)	1975
1976			1976
1977		SS-NX-17 (SLBM, MIRV)	1977
		AS-6 (ALCM); MiG-29;	
		SS-20 (M/IRBM, MIRV)	
1978	MX; ALCM (cruise missile)	SS-NX-18 (SLBM, MIRV)	1978
1979	SALT II?	SALT II?	1979
		SS-21 (SRBM)	
1980	AWACS/ROCC;		1980
	NATO AEW/JTIDS;		
	Beam technology		

with a proviso that the doctrine will not be exercised in any local war against the USSR and China. The "chrome dome" of SAC B-36, B-47 and B-52D aircraft together with the DEW Line, served as counter-threat to the Soviet Tu-4 Bull (B-29 copy) which would have taken 10 hours to reach CONUS if they had had the range (which they did not) giving the US a 4-hour warning (26). If the Soviet aircraft were not detected by the threat-warning system and the counter-threat (SAC), they would have been easy targets for the US air defence vehicles: some 8,000 fighters and BOMARC missiles (130) alerted by Mid-Canada and Pine Tree radar lines.

The emergence of U-2 technology had given the US a clear reconnaisance superiority from 1956 onwards and had assisted them in formulating their doctrine against surprise attack. Eisenhower's "Open Skies" proposal was rejected by the USSR as they were not able to counter the US reconnaisance technology and were wary of demonstrating their strategic weakness and lack of first-strike capability.

Fearing the Soviet first-strike strategic capability, the US during 1961-66 developed a "counterforce" or "second-strike" capability such that if the USSR launched a surprise attack, the US could absorb the damage and yet be able to launch its own counterattack, thus neutralizing any advantage from a pre-emptive assault the Soviets might think they had. The counterforce doctrine was based on the advent of multiple independently-targetable re-entry vehicle (MIRV) technology the successor to a single-warhead manoeuvring re-entry vehicle (MARV) missile. MIRV gave the US the flexibility it was seeking in doctrinal development to offset any gains the USSR may have made during the same period (1961-66). "MIRV changed doctrine, technology and bureaucratic politics" (67).

Based on the fear of pre-emptive attack, the US deployed 1,056 silo-based ICBM, 656 submarine-launched ballistic misslies (SLBM) and 630 B-52 bombers during 1961-66 (67,92). However, in 1964 the Soviet strategic strength was placed at 200 ICBM; in 1969: 1,060; 1979: 1,398 (1). Therefore in 1969 the USSR reached numerical parity or equality with the US in ICBM. The Soviet policy of nothing-less-than-parity was thrust upon by the US during the Cuban missile crisis (1962) when Kennedy informed Khrushchev his strategic weakness known through U-2 overflights since 1956.

By 1969 the SAC fleet was reduced by 62 per cent from 1959 figures (67). The "triad" doctrine or a launch of ICBM, SLBM and strategic bomber force was to offset ICBM parity the USSR had supposedly gained in 1969. This parity also brought about another change in the US thinking with Secretary of Defence Robert McNamara's "controlled response" or "no cities" doctrine of 1962, whereby the US would not target its strategic weapons at Soviet cities, a far cry from Dulles' "massive retaliation". In the 1960s the US would have had a 30-minute warning of a strategic attack to counter it with its own salvo.

McNamara, however, stressed maintenance of a convincing deterrence and in "damage limitation" concept such that in case of a pre-emptive attack the damage is minimal to the US population and industrial centres (67). This strategic doctrine brought about the development of anti-ballistic missile (ABM) technology and its deployment to protect such centres in case of a deliberate nuclear attack by the maintenance of a clear and convincing capability to inflict unacceptable damage on the attacker.

In 1966, four years later, McNamara realized strategic superiority as meaningless once a nation has achieved "assured destruction" capability (59). He observed that comparison of missiles, megatonnage, warheads, etc., bore little significance; and strategic parity, he thought, was an elusive concept, difficult to define and uncertain in its implications. Thus that year (1966) McNamara proposed to Johnson a treaty limiting ABM sites. (The treaty was signed by Nixon in Moscow in 1972).

McNamara saw a thick ABM system as counterproductive: "If an aim is made extremely costly by expected adversary moves, because the threat is large and the advantage all on the other side, the game may not be worth the candle" (131). This is an extreme example of technological dysfunction that stopped a doctrine from nurturing. Also, Drs. Garwin and Bethe had demonstrated how Sentinel (ABM) system could be beaten in an article in the March 1968 issue of Scientific American (19). Even the cancelled B-1 bomber could have penetrated a 10-fold increased ABM network (67). Thus the MIRV/MARV ABM decoy system became just that and the US has developed only one site in North Dakota, and the USSR two around Moscow and Leningrad.

During 1966-69 the Soviets surpassed the worst-case estimates offsetting the advantage the US had enjoyed up until then. This stalemate brought about the doctrine of "sufficiency" or "adequacy": parity in strategic weapons of the superpowers (67). During Nixon's administration it was lauded as the basis for strategic armament limitation treaty (SALT I) talks in search for strategic stability. Also during the 1970s, the duration of a strategic attack was curtailed by another 10 minutes to a 20 minute warning of a pre-emptive launch.

In the period immediately following, i.e., 1969-74, the US and the USSR both made great strides in weapons technology. The US SR-71 (YF-12A) Blackbird reconnaisance/surveillance supersonic aircraft flying at 100,000-ft altitude and 3.0 plus Mach number and its USSR counter-threat MiG-25 Foxbat, whose sole role was to shoot down the Blackbird, were introduced in 1969 and 1970, respectively. Also the threat moved to the manned bomber with the introduction of the Tu-22M Backfire-B intercontinental bomber, a contentious weapon at SALT II talks. Thus the Backfire brought about a revival of the DEW Line and accelerated the development of airborne warning and control system (AWACS) aircraft to direct air defence fighters against the Backfire threat over CONUS and Canada.

The achievement of the "triad" concept by the USSR with its deep-sea force and SLBM has reduced the warning of pre-emptive assault on hard-kill targets to 5 minutes as of 1980 (47).

The MX system of MIRV ICBM on oval rails in the US Southwest and the Trident SLBM are yet other attempts to offset surprise attack by the enemy. One reason for these doctrinal/technological developments was the short-warning attack capability of the enemy SLBM on SAC main operating bases (MOB) reducing the number of B52 strategic bomber deployment to two (1980) from nine (1960) after the receipt of warning. Thus any doctrine to negate the MX or the Trident system will require superior technological innovation by the USSR and even further curtailment of the present 5-minute short-warning threat.

Bertrem (16) considers the doctrinal technological offset as a dilemma: the West discusses new technology long before actually procuring it, but the East assumes the discussions as statement of facts and seeks countering systems long before the West has developed the technology. Buskard (26) contends though, that the West has the technology to neutralize any gains the East may think it has achieved. One such instance is the MiG-25 Foxbat reconnaissance fighter manufactured in 1970 in response to USAF B-70 strategic bomber cancelled in the early 1960s because of technological obsolence (3). Klippenberg (73) reiterates Buskard's stance that the NATO nations have a scientific and technological tradition which would have a decided lead in the offence-defence balance against the Warsaw Pact, e.g., integrated C^3 systems with up-to-the-moment information about Warsaw Pact manoeuvres.

PLATEAUX OF STABILITY

The stalemate or steady-state threat represented by the ABM offset gave birth to McNamara's other doctrines of "graduated deterrence", the development of a spectrum of nuclear weapons ranging from the most powerful to the lowest yield (50 megatons to 0.5 kiloton), or an improved conventional weapons capability, or both (130); and, "flexible response", or the limited use of nuclear weapons with emphasis on conventional defence.

A steady-state or stable balance typically involves:

1. an invulnerable retaliatory force or deterrence;
2. substantial capability of coping with limited aggression;
3. provision for large-scale civil defence in case of war, or damage limitation (59); and
4. a technology offset for each major adverse weapon development (26).

"In short, we are probably reaching a plateau of relative stability in the category of strategic weapons based on their effectiveness, mobility and general invulnerability" (63). An equilibrium is hard to maintain in strategic doctrine or technology, as such balances are short-lived, a specific example is the cancellation of the USAF B-1 strategic bomber in 1976, and the emergence of a manned bomber threat by the Soviet long-range air force Tu-22M Backfire-B in 1978 (although the first prototype was flown in 1974).

STALEMATED DOCTRINE

The "diad" doctrine of deployment of only strategic bombers and SLBM on the lower range of the scale of offensive power, and "triad" doctrine with the "fourth arm of deterrence" deploying carrier-based aircraft becomes insignificant if the enemy uses "incrementalism" or a slow and deliberate action to gain and increase military and political power in the area of international strategy, rather than resorting to dramatic technological advances (Table 3-1). Even "assured destruction" becomes meaningless in the case of the eighteenth century doctrine of territorial aggrandisement by the USSR (Table 3-2) and tactical deployment for strategic gain (Table 3-3).

From Table 3-1 we observe that the strategic doctrine in the beginning followed technological innovations, however, the trends became parallel in the case of U-2 deployment for strategic reconnaissance. Finally the strategic doctrine appeared as a reaction to "worst-case planning" by the US strategists, who overestimated the Soviet strength and thrust the US into an irreversible strategic weapons spiral. This, the Soviets presumed was an offensive doctrine and embarked on an ambitious program to attain strategic superiority (3). Table 3-1 demonstrates that the Soviet incrementalism works for their benefit, since they know full well they do not have to account to their people for defence expenditures (3). Some of the US strategic doctrine developments occur not from their own innovations or as an offshoot of technology but as a reaction to Soviet technology or doctrine. Such doctrines as "mutual assured destruction" (MAD) or total annihilation through miscalculation, irrational action or an accidental or unauthorized launch by either of the superpowers; and "trip-wire strategy", where even a low-scale conventional conflict in

Europe may trigger a nuclear response are not in the domain of the US and her NATO allies but are dependent upon the initiative of the USSR and Warsaw Pact countries. Each of the US technologies and doctrines has been stalemated by USSR incrementalism (Table 3-1).

HOW TACTICS SERVE STRATEGIC DOCTRINE

The empirical data in Table 3-2 demonstrate the Soviet strategic doctrine of territorial aggrandisement as cyclical, that in general, every 12 years the USSR exercises the doctrine successfully, outwitting the West during the intervening years aiming at "peaceful coexistence", "detente" and perhaps, "quiescence" in the future. It is as if to lull the West into a false sense of security and take the time to Sovietize the area as they do not have the ability to provide transportation, communications, etc., to some of their own republics of the USSR.

Table 3-3 shows an even more serious trend, however small. Every second year of her 5-year economic plan, the USSR produces a surplus of armament, which after outfitting (60):

1. her own armed forces and
2. those of her allies
3. is diverted to a Third World nation of the Soviet choice,

to be employed to serve the tactical doctrine of war by proxy in areas which can destabilize the West. The effect is always favourable to the USSR because the area is of her own choosing and serves as an active-test laboratory for her weapons technology. The import of this

Table 3-2. USSR strategic doctrine of territorial aggrandisement* with an implication for 1992.

Year	Event/application
1980	Military take-over of Afghanistan
1968	Military intervention in Czechoslovakia: "Prague Spring"
1956	Military action in Hungary
1944	Annexation of Estonia, Latvia and Lithuania

* Does not take into consideration :
a. neutralization of Finland (1940) and
b. neutralization of East-bloc nations (1945-50) because of Yalta agreement with the West.

Table 3-3. USSR tactical doctrine of proxy action in the Third World (60) with implications for 1982-83, 1987-88 and 1992-93.

Year	Event
1977	Arming of Ethiopia to crush Somalia and the Eritrean cessationist movement
1972	Re-arming of the Egyptian and Syrian armed forces for 1973 action: the Fourth Arab-Israeli war
1967	Arming of Egypt and Syria for the Third Arab-Israeli war.
1962	The Cuban missile crisis

tactical doctrine is strategic in that the USSR is aware that the US will not risk a nuclear war in a limited action and the gain is all on her side (8,19,36,96,126). Also war by proxy is generally fought close to the USSR rather than in areas with long lines of communications (LOC) (26).

DOCTRINE, TECHNOLOGY AND ALLIANCE

For the first 25 years after the Second World War, the world was monopolar with the US as the dominant superpower. The strategic doctrine of the 1950s and -60s was containment of the communist threat to the Third World. The US and her allies encircled the Communist World (Table 3-4). Also the USSR used buffer states to avoid direct contact with the US (26).

The evolution of missile technology and satellite surveillance determined the changes in the US strategic doctrine which affected her allegiance to the allies. The intermediate-range ballistic missile (IRBM) (1,500-mile range) required placement of strategic weapons on foreign soil and the US maintanied air and missile bases around the world. But with the improvement of missile range and accuracy, specifically the deployment of medium-range and intercontinental ballistic missiles (MRBM, ICBM), the US became less and less dependent on her allies and significant cracks began to appear in her alliances due to reliance on technological superiority.

A single event in 1971, the attack by a numerically-superior India on East Pakistan, a member of Southeast Asia Treaty Organization

(SEATO) and the creation of Bangladesh had consequences far beyond the event, in that, SEATO became defunct. Thus the "protocol extending the anti-aggression and economic provisions to South Vietnam, Laos and Cambodia" became impaired (34). The geopolitical gaping hole in the Western alliance drilled by the creation of Bangladesh and the withdrawal of Pakistan from SEATO in 1972 has left the Southeast Asian maritime countries with no cohesive military arrangement, and this may be one of the factors in the abandonment of Taiwan (Formosa) which was called the "unsinkable aircraft carrier" in the Pacific.

Table 3-4 The encirclement of the Communist World by the US and her allies 1945-72 (in west-east or clockwise direction).

Country	Major Alliance	Remarks
Greenland (Denmark)	NATO	
Canada	NATO and NORAD	
Alaska (USA)	NATO and NORAD	
Japan	US orbit	
South Korea	US orbit	
Taiwan	US orbit	
Phillipines	SEATO	Left Seato 1972
Hong Kong	Commonwealth	
South Vietnam	US orbit	Invaded by North Vietnam 1975
Thailand	SEATO	Left SEATO 1972
Malaysia	Commonwealth	
Pakistan	SEATO, CENTO, Commonwealth	Left SEATO and the Commonwealth 1972, CENTO 1979
Iran	CENTO	Left CENTO 1979
Iraq	Baghdad Pact	Left the Pact in 1958 (thus CENTO was formed)
Turkey	CENTO and NATO	Left CENTO 1979
Greece	NATO	
Italy	NATO	
West Germany	NATO	
Denmark	NATO	
Norway	NATO	
Iceland	NATO	No armed forces

The loss of South Vietnam, Cambodia and Laos to the communists, the Chinese and then the Soviet sphere of influence, further eroded any offset strategic gains the US may have had through technological supremacy through ICBM, SLBM, etc.

The 1958 coup d'etat in Iraq ended the Baghdad Pact, but it was not as significant as the 1979 withdrawal of Iran from the Central Treaty Organization (CENTO) the successor to Baghdad Pact. This led to the abandonment of Pakistan for the second time in a decade, and which encouraged the USSR to adventure into Afghanistan. Thus the Western alliance has been adversely affected or is ineffective in the geographical region from east of Turkey to South Korea, and in major part because of heavy reliance on technologically-oriented strategic doctrine deploying ICBM, SLBM and SAC fleet ("triad"). This strategic doctrine has become dysfunctional as the US has lost many strategic objectives without firing even a single shot.

The NATO alliance itself is in danger of disintegrating if Turkey is not technologically, economically, and militarily stabilized. If Turkey withdraws from NATO, the ensuing crisis may cause Greece and Italy to fall into the sphere of the USSR and the whole Mediterranean would become a private lake for the Warsaw Pact. The West will have to re-think and devise a doctrine of "West of Gibraltar"or find offsetting technological innovations to counter the loss.

Furthermore, the West's reliance on the oil resources of the Islamic World cannot be relinquished to doctrines of weapons "sufficiency" or "adequacy" adopted in 1969. This dated doctrine cannot resolve the tactical deployment (with strategic import) of the Soviet forces in Afghanistan and in South Yemen, poised for a pincer attack in the Middle East in the near future. From Table 3-3, the USSR tactical doctrine of proxy action in the second year of each of their 5-year plans indicates the USSR, having achieved tactical superiority in the region, can arm or re-arm any one of the countries to bring about instability in 1982 or 1983 (Table 3-5). Thus the Soviet proxy action in this region is bound to have repercussions for the West, especially for their oil supplies through the Persian Gulf, and no technologically-oriented strategic doctrine will assist unless the West realizes the potential problem and seeks innovative remedies which enjoy popular support in these areas. Confidence building even through the use of television-satellite technology to offset any gains by the communist ideology in this region is essential to Western interests, economy and strategic doctrine. In this case doctrine will have to transcend technology into the realm of "philapsychology".

Any shift in the political structure of Turkey, Jordan, Saudi Arabia, the United Arab Emirates (UAE) or Oman will greatly alter the strategic balance in favour of the USSR (62,122) and against the US and the West. Hence a doctrine utilizing technology to win the hearts and minds of the citizens of these countries, looking for remedies for their economic or political or military problems, is of paramount importance.

Table 3-5. Probable conflicts (wars and coups d'etat) through proxy action by the USSR affecting the West (1982-83, 1987-88, 1992-93).

Region	Third World Nations	
	Adversary I	Adversary II
South Asia	India Afghanistan India and Afghanistan	Pakistan Pakistan Pakistan
West Asia	Iran Iraq and Syria South Yemen South Yemen	Iraq Israel Oman Oman and UAE (Emirates)
	Coup d'etat*	
West Asia	Jordan Saudi Arabia Gulf States (one or more) Turkey	
North Africa	Egypt Morocco	

* According to a former US ambassador (23,24) and a Canadian academic (112) every tactical victory by Israel against its Arab neighbours has led to a strategic loss for the West through radicalization of an Arab state and ouster of a pro-Western monarch.
1948: King Farouk of Egypt (1952).
1956: King Faisal II of Iraq (1958); Syria moved east (1960).
1967: King Idris of Libya (1969).
1973: Stabilization as Arabs considered it a strategic victory.
1982: Probable radicalization of the remaining monarchies, Egypt.

Robert McNamara announced in 1962 his "controlled response" or "no-cities" doctrine, whereby the US would shun attacking the Soviet population centres with strategic weapons (67). This also served as an outstanding gesture on the part of the West as a confidence-building measure (CBM).

Due to lack of technological tradition, the bureaucratization of military-industrial complex and the design lagging the demand (3), the USSR has turned to building conventional weapons far exceeding her military requirement. According to Wohlstetter (131), the philosopher Emmanuel Kant believed that nations undertook wars of aggression to escape the financial burden of maintaining a standing army.

One of the applications of the Soviet tactical doctrine of proxy action in the 5-year cycle is testing of their military technologies (Table 3-5) to determine future strategic doctrine for their own battlefields against NATO.

The battlefield experience of the 1973 Arab-Israeli War has had a profound effect on the strategic doctrine of both the superpowers.

1. The rate of attrition of armament in a modern battlefield far exceeds the conventional logistics employed in classical battles.
2. The battlefield is an active-test laboratory for the perfection of modern weapons ranging from surveillance to target destruction roles (118), specifically, the Early Bird satellite and the Blackbird reconnaissance aircraft which provided Israel with weaknesses on the Egyptian front, and

the use of SAM for destroying tactical aircraft (43) by the Egyptian and Syrian forces.

The doctrines developed in the 1967 and 1973 Arab-Israeli wars changed several battlefield technologies. This had a definite affect on the Soviet operational doctrine in that Warsaw Pact nations learnt that the tactical air force (F-4) can achieve results by destroying the enemy's air power on the ground (1967). To counter this they employed technology in two ways.

1. They started an aircraft shelter program which is twice as large as NATO's.
2. They introduced newer models of tactical aircraft (MiG-21J, -21K, -21L, MiG-23, Su-17 and -19) which bolstered and changed Warsaw Pact air forces from a defensive posture to an offensive one as the air defence role was dedicated to SAM: SA-4, -6, -7, -8, -9 and ZSU-23/4 automatic anti-aircraft artillery (AAA) (1978) (94).

The technological battlefield's most important doctrine is the availability of tactical information. The problem with the sophisticated battlefield is not too little, but too much information for human endurance and assimilation(73). To meet this limitation the latest technological innovation is the integration of surveillance, navigation, communication, etc., into a joint tactical information distribution system (JTIDS), a wide-band, multipath, secure, data-link system processing tactical information for rapid decision-making by commanders (17,57).

JTIDS integrates navigation, communication and identification for aircraft operations into one system and provides only useful information (57). Using dynamically-allocated packet-switching techniques (105) and time-division multiple-access (TDMA) mode (57,105) of addressing through selective, pre-programmed, digital, bit-stream, synchronized transmissions, JTIDS can inform 2 to 98,000 addressees (17,57,68). This integrated system is effective against ECM or jamming by the enemy.

JTIDS when fitted to airborne early warning (AEW) aircraft, such as E-3A Sentry (Boeing 707) or Nimrod Mark I, can serve (by the mid-1980s) as a countermeasure against any short-warning attack the USSR may envisage against NATO; in CONUS it is known as airborne warning and control system (AWACS) aircraft. Thus this technology would thwart the enemy doctrine, if any, of pre-emptive action.

JTIDS fitted on AWACS and region operations control centre (ROCC), shipborne C^3 system and Navstar global positioning system (GPS) will form part of an impregnable, integrated net known as worldwide military command and control system (WWMCCS), which will negate any advantage the USSR may think she has through a pre-emptive attack on CONUS. In the summer of 1980 a false alarm by WWMCCS (commonly known as Wimex) triggered two launches, at least one by Canadian Forces air defence interceptors, sufficient reason for the Soviet defence planners to be nervous henceforth of an accidental all-out attack.

LIFE AND TIME OF DOCTRINE AND TECHNOLOGY

Regardless of the rigidity of each doctrine, it was surpassed by another doctrine with the advent of new technology. We have found stability to be only relative (3), and the doctrinal-technological balance quite tenous. Table 3-1 indicates how technological advances have altered the doctrines several times since 1945 in the following ways.

1. The strategic pre-emptive attack warning time has progressively been curtailed over the past four decades.

Decade	Duration
1950s	4 hours
1960s	30 minutes
1970s	20 minutes
1980s	5 minutes

   thus making C^3 technology an integral part of the doctrine.

2. The threat-counterthreat juxtaposition is cyclical, as it has gone through a complete cycle with the return of the manned bomber and the refurbishing of DEW Line after 20 years.
3. The threat-counterthreat phenomenon demonstrates an effective life for doctrinal-technological changes or adversary moves; the effective life is a function of time (diminishing with each new development).

Even alliances have demonstrated this trend in effective life. Where a treaty or a pact has not succumbed to an external agent, viz., coup d'etat (Baghdad Pact), military action (SEATO) and revolution (CENTO), the deterioration has been internal such as we are seeing in the early 1980s with NATO nations' reluctance in accepting the latest US strategic weapons, the Pershing II missiles.

All weapons systems have degraded with time due to advancing technology. Even complex systems, viz., the F-104 Starfighter of the 1960s, became a linear system in the 1970s when Pakistan lost its entire fleet to the Indian MiG-21 aircraft, SAM and other superior technology which the USSR used as an operational doctrine in a limited war (to be discussed in Chapter 6).

Each new aircraft is introduced as a technologically superior system surpassing all existing technologies, and with it, the innovation introduces a new or novel strategic doctrine. In the 1960s when the F-104 Starfighter arrived on the operational theatre there were renewed tensions in Europe. The erection of the Berlin Wall in 1961 was sufficient to give the F-104 the impetus to become the standard bearer of the Western air forces. Several of the NATO countries, such as Canada, West Germany, the Netherlands, Norway, etc., bought the US-built Starfighter. It was a superior and complex system that fitted the operational requirement as an air superiority fighter and the doctrine to use this technology as a tactical nuclear strike aircraft was formulated by the RCAF. There were no air defence SAM systems to restrict the F-104 in its mission at that time, nor any aircraft in the East-bloc inventory to match it. The F-104 reduced other fighter aircraft to linearity, i.e., if the speed-, manoeuvrability- and altitude curves were to be projected graphically relative to the F-104, they would seemingly look like straight lines.

Since the 1960s there have been great advances in aerospace technology. R&D has brought about aerodynamically agile aircraft: faster, more manoeuvrable systems, that would outfly, outclimb the F-104 air superiority fighter. Also the Warsaw Pact countries have deployed effective SAM air defences to negate the aircraft technology any gain it may have had (through attrition) and the doctrine of using the F-104 as a nuclear option had to be altered also. The role of the F-104 was changed from air-to-air, as an air superiority fighter for defensive counter-air mission deployment, to air-to-surface as a tactical nuclear weapons delivery system for interdiction by refurbishing its wings to withstand stress at supersonic speeds (Mach number 1 and 2) and to retain aerodynamic stability at extremely low-level flights. When Canada opted out of the nuclear arena, the F-104 (CF-104) was delegated to yet another air-to-surface role of close-air support (Appendix "A"). This would be analogous to training a mustang to be a race horse and then using it as a beast to plow fields (4). So the doctrine was put to pasture with the change in technology.

Every time there is a technological change it brings about doctrinal change in the strategic thinking, so much so that doctrine (the theory) becomes a function of technology (the process). The change in technology as we have stated earlier (Chapter 2) is phenomenal according to every philosopher and commentator of technology

(13,14,41,44,48,51,56,64,74,81,82,85,88,104,113,114,127,128,130). They also agree that this rapid growth leads to rapid decay and we have observed changes in doctrine faster and faster since 1945 (Table 3-1) and this change or decay becomes a function of technology, just as doctrine has become a function of technology. Thus it becomes difficult to differentiate between a decaying technological innovation and a decaying strategic doctrine of war, such that doctrine becomes synonymous with technology.

We have argued that technology is quasi-synonymous with information (Chapter 2). Now we have concluded that strategic doctrine is in the same way synonymous with technology. This would imply that war, too, is closely related to information. To comprehend this implication we shall first have to look at information itself.

4. INFORMATION: GENESIS-GROWTH-DECAY

> ...time is essential in all estimates of the
> value of information.
>
> Norbert Wiener
> In "The human use of
> human beings:
> cybernetics and society."

> Prima Donna she may be
> And prime she dons today
> But don wans and wanes away
> And prime is not to stay.
>
> I. Ben-Tahir
> In "Refractions 69.
> L'Ange sans merci."

INTRODUCTION

"In the beginning..." recited the US astronaut, Frank Borman, when he greeted the earth at Christmas 1968 from approximately a quarter of a million miles, while his three-man craft swirled around in space giving the inhabitants of this planet the first, first-hand video-information of their planet's natural satellite, the moon. The astronomical, geological and physical data that followed from this manned mission to the moon and other consequent voyages, were the first-known beginning of astrogeophysical (scientific) information in recorded history. Borman could not have chosen a more appropriate scripture than the Old Testament's first book of Moses, Genesis.

The ensuing lunar landing of 20 July 1969 demonstrated how aerospace technology served science in the accumulation of scientific information. The birth and growth of lunar astrogeophysics banished the previous beliefs held by the philosophers of technology such as Berdyaev and Ellul who had relegated science to the position of charwoman of technology (113) and a handmaiden of technique (74) respectively. Science regained its paramountcy over technology.

Science is knowledge discovered through investigative processes by the recurrence of the same results to within an acceptable level of tolerance. If the same probability is attained in the results by other experimenters reproducing significantly selfsame (exact) results, it lends credence to the process and an ultimate faith to its nature. The collective enterprise of science, i.e., the generation, distribution, maintenance and utilization of information, gives science a broad base of knowledge.

Information is knowledge in a communicative process, generally organized in some logical cognitive manner with time as a variable (70,75). Information science is a scientific discipline that has emerged in the past 15 to 20 years and deals with the characteristics of how information is transferred or handled. This is of enormous importance in the processes of decision-making especially in the military environment for launching fighter-interceptor aircraft in pursuit of an unknown target on the radar.

Approximately 10 million persons in the US alone are concerned with the production and processing of information; 50 per cent of the cost of running the economy is information costs (55). Enormous amounts of information are generated each year creating a mammoth task for the professionals in information science. Their capabilities are stretched to the utmost on qualitative problems of collecting, structuring, organizing, classifying, analyzing, storing, retrieving and disseminating information. This leaves the quantitative problem of the value of information quite unattended at present.

The advent of manned space missions to the moon gave us the genesis of lunar astrogeophysical information. Although we do not know how this scientific information was accumulated due to security of such information and its non-availability for any academic discourse for some time to come, we can assume that this information grew during the period of lunar probes from 1968 and abruptly stopped with the last voyage commanded by Astronaut Eugene Cernan in 1972. Nevertheless, secondary knowledge may still be derived from rock samples and data accumulated during the space voyages prior to 1972.

It would be fascinating to examine how this instant information was: generated when Astronauts Neil Armstrong and Buzz Aldrin stepped on to the lunar surface; distributed upon their return to Earth; maintained as it accumulated for the next three years; and utilized in the process of information handling and transfer.

THE DESIGNS OF GROWTH

"The most critical factor in a society is its communication", theorized Harold Innis, Canadian social historian and philosopher on communication (74). The mentor of Marshall McLuhan, Innis visualized the importance of communication. Since the end of the Second World War in 1945, the rapid growth in world population has increased the need for communication services and this has generated an enormous amount of information. This led the Canadian visionary of the 1960s, the 70s and the 80s, Marshall McLuhan, to establish in his lexicon the term: "Global Village" (74). Had it not been for the technological applications of information science (information or computer technology) to have emerged in time, certain societal institutions in the Western world would have collapsed. Coping with the enormous information overload would have boggled the bureaucracy (52,128) and would have created chaos for the Western civilization (industrialized nations).

That scientific knowledge is cumulative and builds upon previous knowledge is the view of most professionals including a US information scientist, H.J. Hall and a Canadian academic, D.A. Redmond (56,101). Both stress that information generates as a linear function but successive growth(s) superimpose on previous accumulation(s) over a period, demonstrating information piling upon itself (Figure 4-1).

Information can "decay" as well as grow. Generally, decay of information is in fact simply negative growth. With the exception of a few rather long-lived cases, such as the ever increasing publication of the scriptures (as determined by their annual sales figures), the classic case, bell-curve (Figure 4-2) or near-bell-curve (Figure 4-3) and the short-lived or the rapidly perishing model (Figure 4-4) show information decay with respect to time.

Information professionals further agree that as individual items of information become obsolescent and are superseded by new items, the latter process frequently occurs faster than obsolescence. This creates a cumulative effect or exponential growth, which gives information in this particular form a new dimension, known as "information explosion" (Figure 4-5).

Information explosion was a phenomenon of the 1960s, when scientists and engineers realized the amount of scientific and technological information generated and accumulated surpassed the conventional abilities available to them to trap and assimilate information in a systematic manner.

At this point appeared the information scientist: the right person, at the right time, in the right place, to alleviate the problems created by the information explosion. Regardless of their approach to the problems and to the nature of information growth, information professionals are in agreement that the growth of information has been exponential (10,15,20,25,54,55,56,71,72,77,95,101, 107).

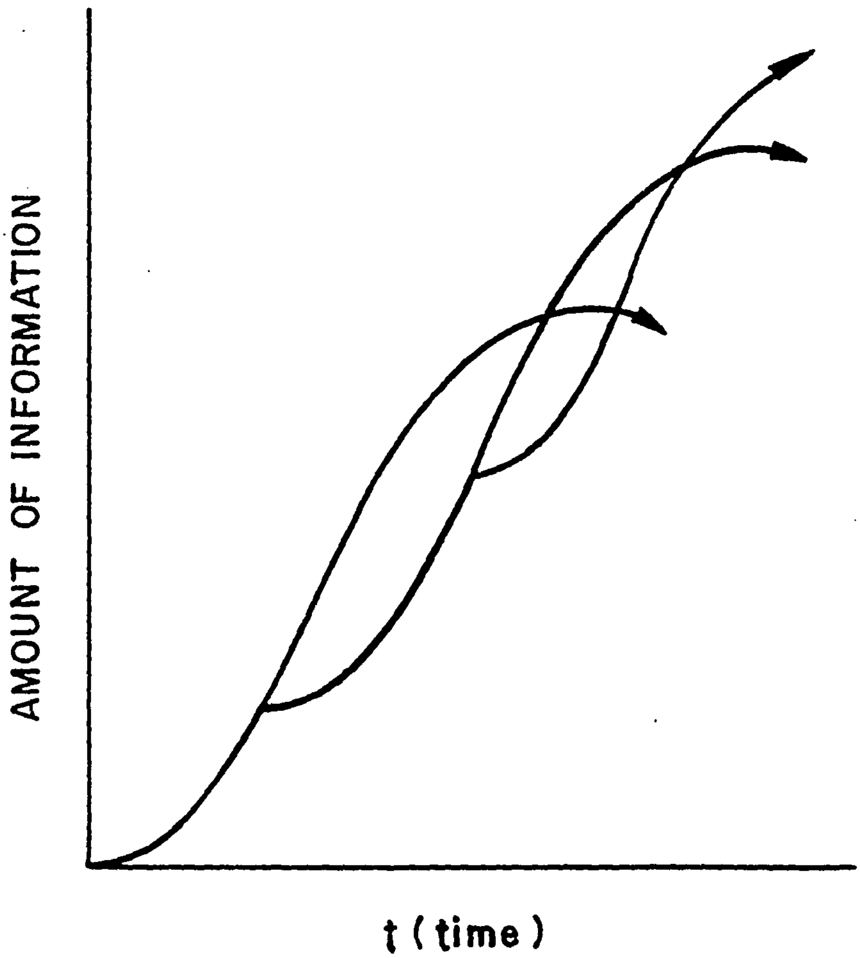


Figure 4-1. Cumulation of knowledge or information (101).

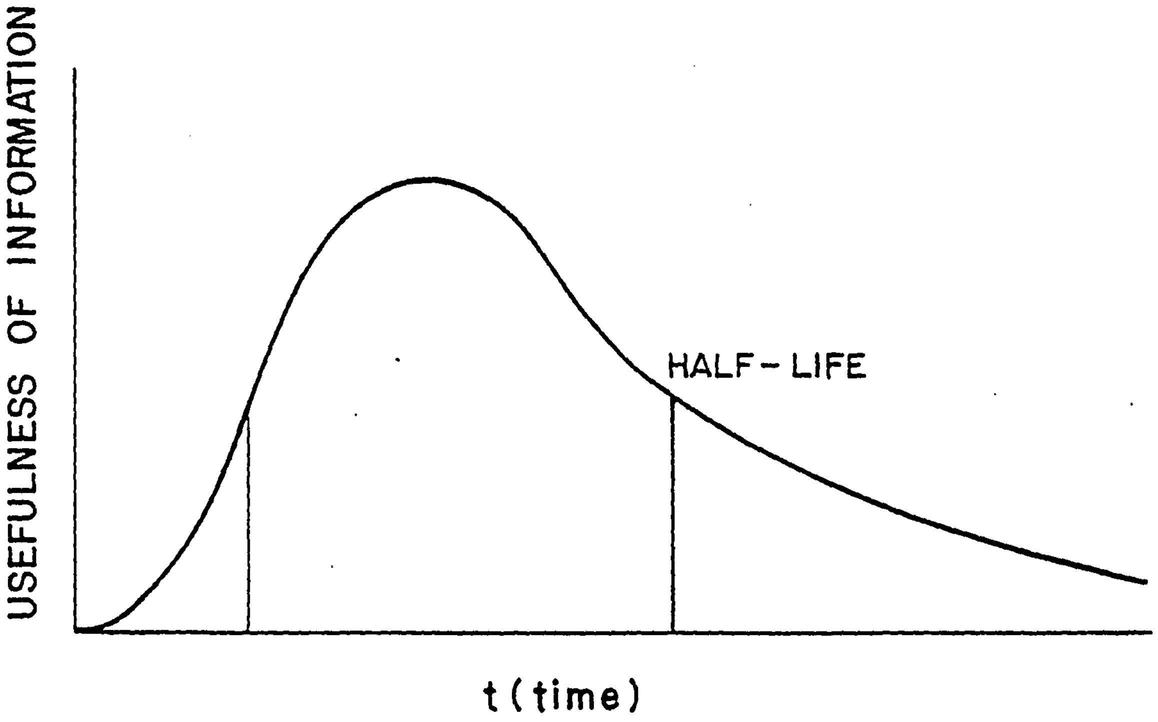


Figure 4-2. Life cycle of a unit of information (101).

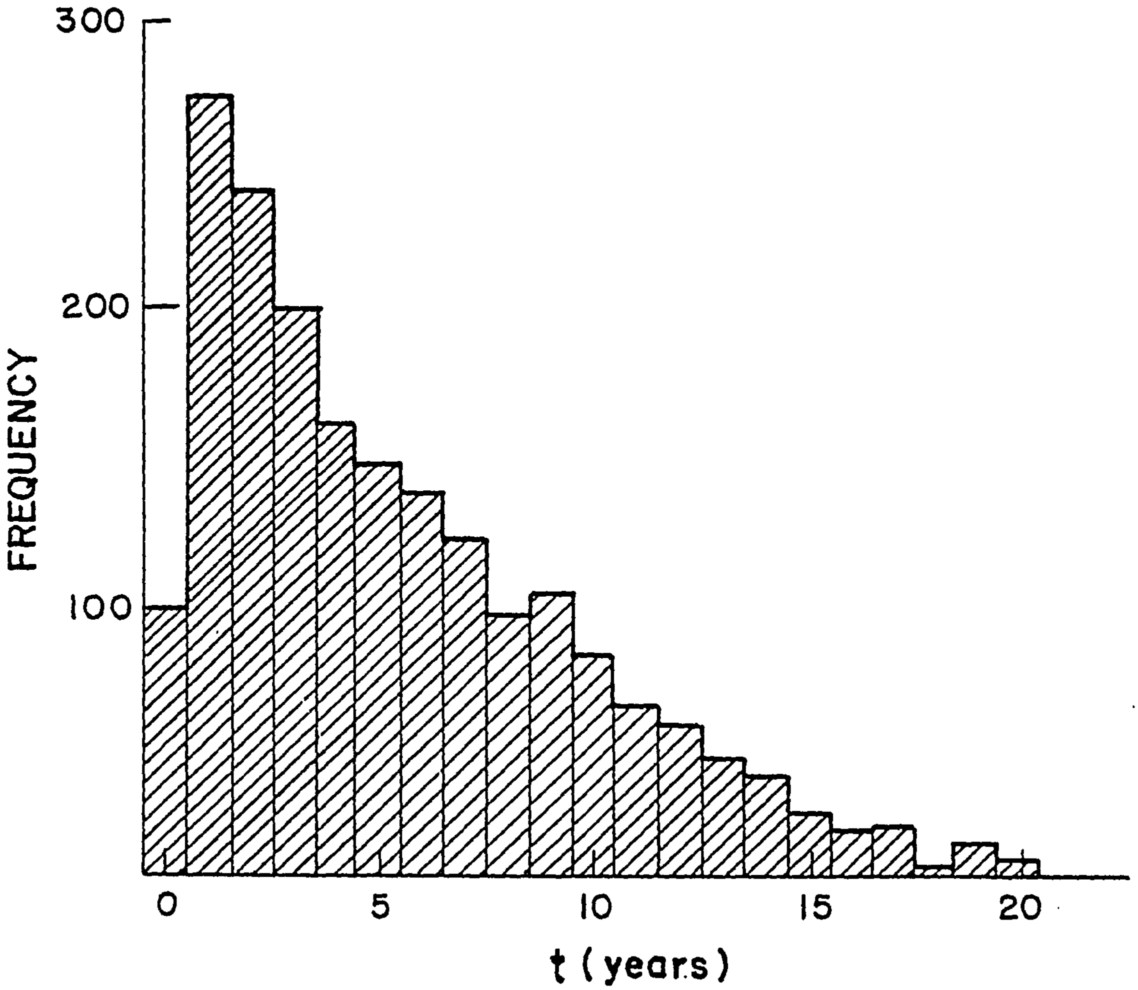


Figure 4-3. Histogram of citations to periodical literature exhibiting a near-bell-curve (20).

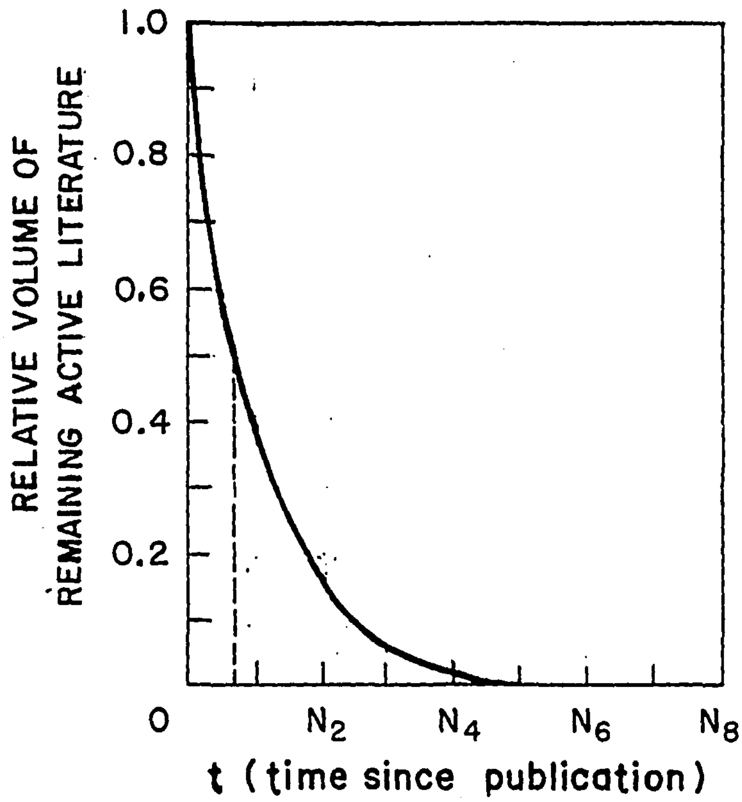


Figure 4-4. A rapidly decaying information curve (25).

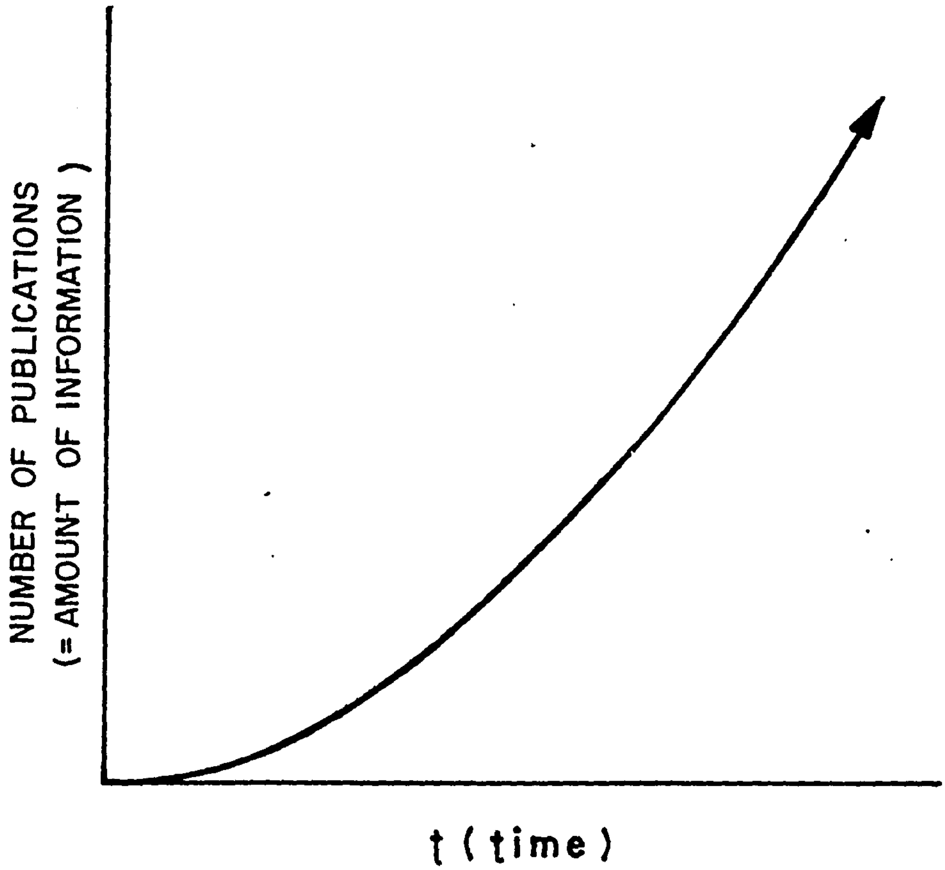


Figure 4-5. Exponential growth: The "information explosion" (101).

In the 1980s the microelectronic information technology has taken the rampant growth of information to a new frontier which has affected the entire society: government, industry (and academia to a lesser extent). These institutions are now grappling with a new force called the information revolution (109).

The "information revolution", according to the Science Council of Canada is:

> ...the use of microelectronics technology in robots, computer-aided design, electronic mail handling systems, electronic funds transfer systems, satellite systems for low-cost communications, improved traffic control systems, and a general and rapid trend in the use of computers in automating the storage, manipulation and retrieval of vast quantities of information. The exploitation of microelectronic technology offers productivity levels never before envisaged (109).

The information revolution has brought about a fundamental structural change in the industrialized countries of the world and is more radical than the industrial revolution. For Japan, France and West Germany, keeping abreast with the massive growth and rapid change in the field of high technology for information capture is a matter of life or death. It is an aggressive policy in these countries to integrate government, industry and academia to research, develop and market these revolutionized information embodiments.

To understand the growth of information we will first have to examine the mathematics of growth itself.

THE MODELS OF GROWTH

In no nation in the world, other than in the US, can one observe such an appetite for unrestrained growth.

The idea that "growth is good" is an item of faith with the Americans. Few people examine the rationale or logical bases for items of faith (10).

The mathematics of growth is the mathematics of the exponential function and natural logarithms. These are usually illustrated by radioactive decay or the oscillation of the current in an R-L-C circuit (10,42).

Exponential growth (and decay) is a consequence that occurs whenever we have a function N which changes in time in such a way that the change ΔN in N during a short time interval Δt varies directly with N and with Δt (10).

$$\Delta N \propto N \Delta t$$

$$\Delta N = kN\Delta t \qquad \text{(Eq. 4-1)}$$

$$\Delta N/\Delta t = kN \qquad \text{(Eq. 4-2)}$$

The time rate of change of the quantity varies directly with the quantity; therefore the greater the value of N, the faster it changes.

$$k = (\Delta N/N)/\Delta t \qquad \text{(Eq. 4-3)}$$

The constant k is then the fractional change ($\Delta N/N$) in N, per unit time, Δt. The dimensions of k are:

$$1/\text{time or } (\text{time})^{-1}$$

If k = +0.0875/yr; then N is increasing at 8.75 per cent per year.
If k = -0.050/yr; then N is decreasing at 5 per cent per year.

We have to determine a mathematic function which has the property that its rate of change is proportional to itself, viz., when function N is plotted against time, t (Equation 4-2), requires a proportional relationship between the slope, $\Delta N/\Delta t$, and N.

We observe that if $N = kt$; kt^2; $k \sin\omega t$; we get a linear function; a quadratic function; and a sine function, respectively. It is easy to show that the rate of change of none of these functions satisfies our condition. Therefore, none of these functions meets our requirement.

Let us examine the properties of the following function:

$$N = N_o A^{kt} \qquad \text{(Eq. 4-4)}$$

where A is a constant. Since N_o and k function as "dimensional constants", we can set both equal to unity without loss of generality. Figure 4-6 is a plot of N versus t for $N_o = 1$ and for $k = 1$ per second. We are thus plotting

$$N = A^t \quad \text{(Eq. 4-5)}$$

for six different values of A ranging from A = 1.0 to A = 3.5.

Comparing the slopes of the curves in Figure 4-6 at the point $t = 0$, for various values of A, shows the value for which the slope is equal to the function itself.

We have determined the value of A when the slope of the function equals the value of the function, at $k = 1$ (10).

Therefore, we have found the function for any value of A for which the slope of the graph of $N = A^t$ at any point as proportional to the value of N at that point (10).

We further determine the value of A, with,

$t = 0$

$k = 1$

$N = 1.000$ ($N = A^t$ (Equation 4-5)), as

$A \approx 2.7$ or $2.71828... = e$

(e, being the base of the system of natural logarithms).

Therefore, the function we sought to obey (Equation 4-4) is:

$$N = N_o e^{kt} \quad \text{(Eq. 4-6)}$$

$k = 0$, $N = N_o$ for all values of t.

Now that we have found the function for growth, our next quest is to determine the time, T_2, required for information to double itself at that rate of accumulation.

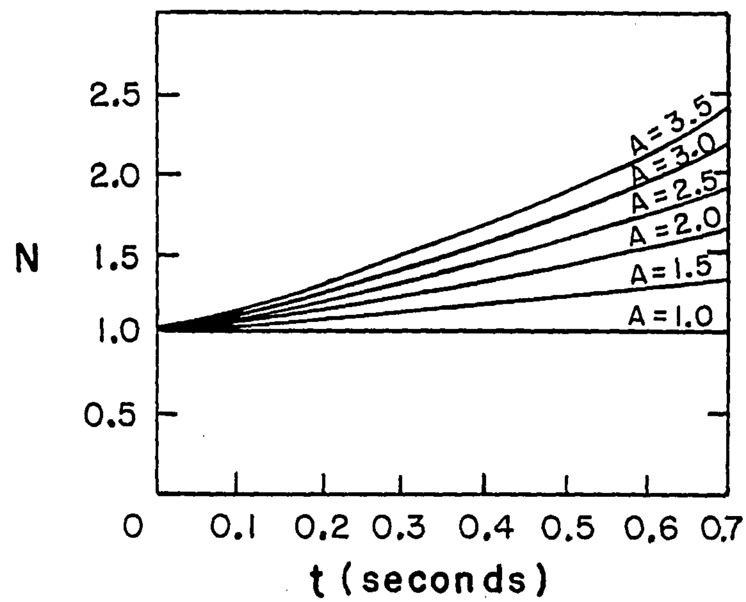


Figure 4-6. The function $N = N_o A^{kt}$ is plotted as a function of time, t, for various values of k for $N_o = 1$ and $k = 1$ (10).

DOUBLING TIME OF GROWTH

"It is useful to think of exponential growth in terms of doubling time, or the time it takes a growing quantity to double in size", stated Meadows, et al., in the Limits to Growth (81), and Bartlett echoed this hypothesis (10).

For positive values of k, Equation 4-6 shows that N increases with time, starting with the value $N = N_o$ at $t = 0$.

Let us find the time, $t = T_c$, required for N to increase by a factor C, from N_o to CN_o, using Equation 4-6.

Therefore, $CN_o = N_o e \exp kT_c$ [1] (Eq. 4-7)

Taking the natural logarithm of both sides, we get

$$\ln C = kT_c \quad \text{(Eq. 4-8)}$$

$$T_c = \ln C/k \quad \text{(Eq. 4-9)}$$

The time T_c for N to grow by a given factor C remains constant.

For N to grow twice its initial value, we let $C = 2$, thus Equation 4-9 becomes:

---

1. To simplify, exponential is expressed as $\exp kT_c$.

$$T_2 = \ln 2/k = 69.3/100k = 69.3/P \qquad \text{(Eq. 4-10)}$$

where P is the per cent growth per unit time.

The constantcy of the doubling time, T_2, is a remarkable feature of the exponential growth (Figure 4-7) (10). We have supposed $k > 0$ and N is increasing but the same holds good for negative values for k where N decreases. In such a case the time required for N to decrease by a given factor C is also constant.

The growth of N with time has a particular simple behaviour. Starting with N_o at $t = 0$, N grows to $2N_o$ at $t = T_2$; it continues to grow to $4N_o$ at $2T_2$; at $3T_2$ it has grown to $8N_o$ and in n doubling times it has grown to 2^nN_o.

Table 4-1. The growth of the exponential function.

T	N
$t = 0$	$N = N_o = 2^0N_o$
$t = T_2$	$= 2N_o = 2^2N_o$
$t = 2T_2$	$= 4N_o = 2^3N_o$
$t = 3T_2$	$= 8N_o = 2^4N_o$
$t = 10T_2$	$= 1024N_o = 2^{10}N_o$
$t = nT_2$	$= 2^nN_o$

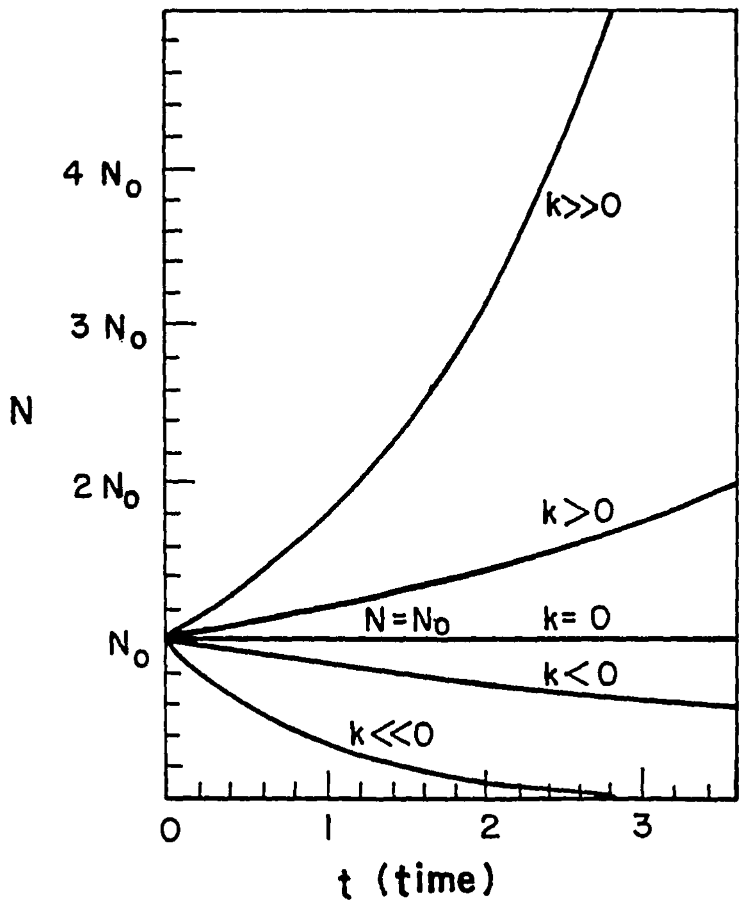


Figure 4-7. A linear plot of the growth or decay of N as a function of time, t, for several different values of the constant, k (10).

In Equation 4-10 we stated that P = 100k and is the ever-constant value of the per cent growth rate per unit time. We know

$$k = (\Delta N/N)/\Delta t \qquad \text{(Eq. 4-3)}$$

and

$$T_2 = 69.3/P \qquad \text{(Eq. 4-10)}$$

Table 4-2 illustrates the important relationship between the doubling time and the percentage time using Equation 4-10.

Table 4-2. Doubling time in years for various annual growth rates (using 69.3 value).

P (% per year)	T (years)
1	69.3
2	34.6
3	23.1
4	17.3
5	13.9
6	11.5
8	8.66
10	6.93
15	4.62
20	3.46
25	2.77
50	1.39
75	0.92
100	0.69

GROWTH AND DECAY

The mathematics of decay is the reverse of the mathematics of growth. If k is negative, then the slope is negative (10).

Exponential decline operates exactly the reverse of exponential growth; there is a constant proportional move (54).

$$k = -(\Delta N/N)/\Delta t \qquad \text{(Eq. 4-11)}$$

For negative k, the quantity N decays from its initial value N_o to its ultimate asymptotic value.

If the value decreases to half its initial value over a certain time, that period is expressed as "half-life" or $T_1/_2$ (54).

Therefore, during one half-life, N decays from N_o to $N_o/2$. In two half-lives N decays to $N_o/2^2$ or $N_o/4$ (Table 4-3).

Table 4-3. Relationship of half-life to decay of N

Half-life	N decay
1	$N_o/2^1 = N_o/2$
2	$N_o/2^2 = N_o/4$
3	$N_o/2^3 = N_o/8$
4	$N_o/2^4 = N_o/16$
n	$N_o/2^n = N_o/2^n$

The amount of decay in the first half-life equals the sum of decays in all the remaining time (half-lives), or

$$T_{1/2} = T_{1/4} + T_{1/8} + T_{1/16} + \dots + T_{1/2^n} \qquad \text{(Eq. 4-12)}$$

THE AGE OF INFORMATION

In physical sciences there is an empirical ordering of quantities to be measured but in information science such a measure is not obvious (125). Redmond (101), a Canadian, has used "number of publications" as a measure for amount of information (Figure 4-5) and US and British information scientists have used "number of citations" as a measure for information (15,20,25,54,71,72,77,95,107).

Sandison, a British librarian, stated the growth of literature at MIT during 1945-68 as 5 to 6 per cent per year and established the doubling time for the information at 11.5 years (16). Using Table 4-2 we see his figures for doubling time, T_2, of 11.5 years correspond to an annual growth of 6 per cent per year (10).

Oliver, another British information scientist, considered the rate of growth to be based on two factors (95):

1. the number of scientific papers published, J; and
2. the number of contributing scientists, C, for each of the years to be considered: 0 and T.

As the numbers of papers grow, the papers age more rapidly being superseded by new ones; as the number of scientists grow the usage of the papers decreases such that it would age more slowly.

However, if the rate of growth of the above two factors are equal, i.e., aging becomes constant.

His theory requires the estimation of:

1. the growth rate, s, of the number of contributing scientists;
2. the growth rate, g, of the number of papers; and
3. the possibly-varying rate of aging or annual aging factor: a_o and a_t for well-defined subjects over a period of T years.

Thus the relation is:

$$1 - a_t = (1 - a_o)e \exp (g - s)T \qquad \text{(Eq. 4-13)}$$

An estimation of the quantities a_o, a_t, g and s requires measurements of: a, J and S for years 0 (1963) and T (1968) (87):

$$g = (1/T)\ln(J_t/J_o) \qquad \text{(Eq. 4-14)}$$

$$s = (1/T)\ln(C_t/C_o) \qquad \text{(Eq. 4-15)}$$

Citation counts were used to estimate a_o and a_t. Approximately 400 citations to published periodical articles only were analyzed for the years stated. Both samples were collected in two batches to determine whether any variations which might occur between them were

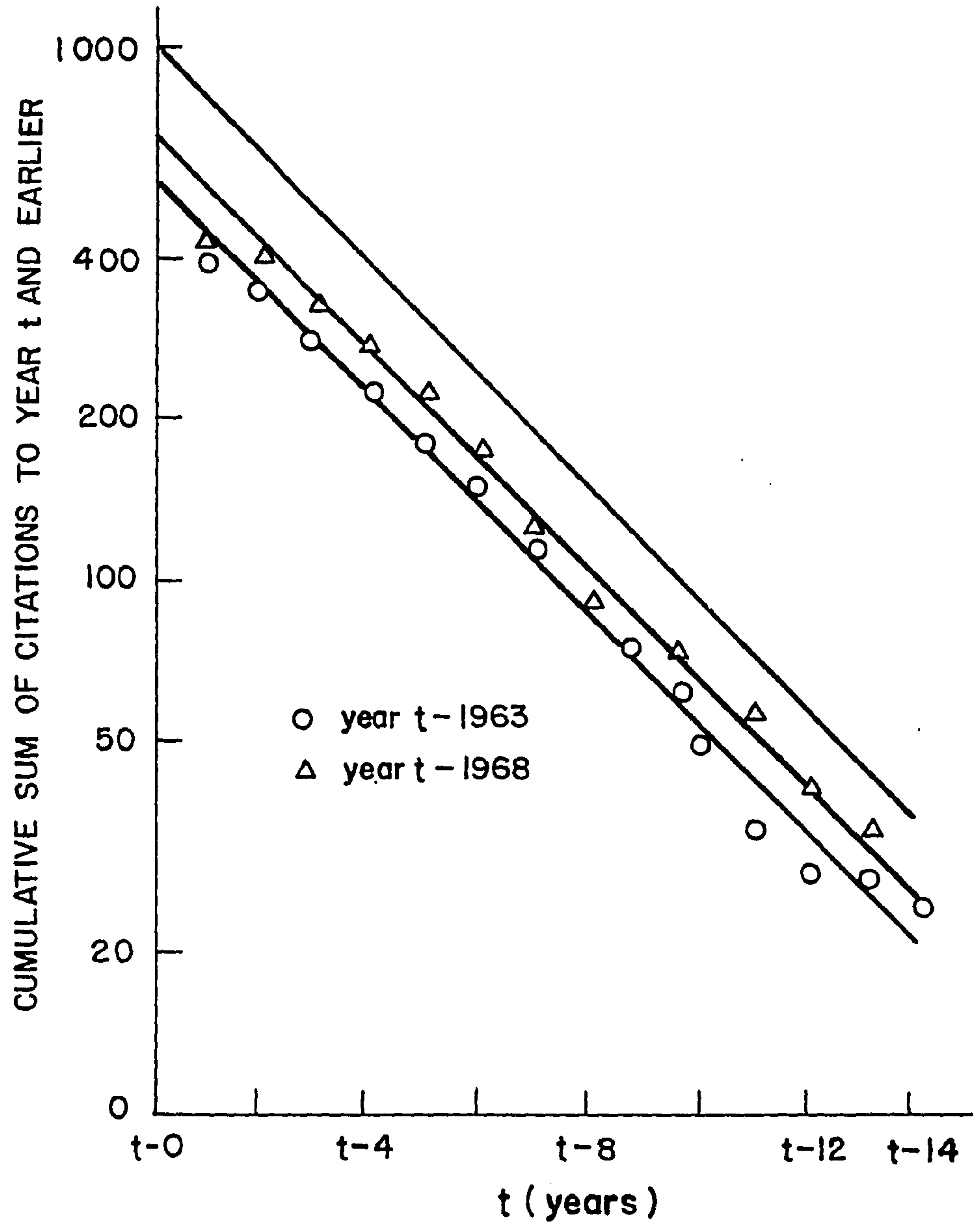


Figure 4-8. Graphical estimation of the annual aging factor (a = 0.79) of semiconductor physics literature (95).

of significance. Figure 4-8 illustrates the plots of the cumulative sums of citations with time; a is calculated graphically.

Brookes (20), another British information scientist, carefully explained the phenomenon of growth of scientific information that Oliver (95) had elaborated. He estimated the doubling time of scientific literature at 10 years and Griffith, et al, at 11.5 years (54). This agrees with Sandison (107).

Brookes' (20) (modified) geometric distribution of growth gives us:

$$p(t) = (1 - a)(1 + a + a^2 + \dots + a^{t-1}) \qquad \text{(Eq. 4-16)}$$

According to this distribution, when a reference (citation) is made to a particular periodical (scientific information journal), the probability that the reference made is to a volume of age t is:

$(1 - a)a^{t-1}$

where a, the annual aging factor is a constant for all values of t and < 1. (When t increases, a increases, but for short periods only (20)).

Figure 4-9 is a graphic illustration of Brookes' geometric distribution demonstrating both continuous negative exponential and discrete geometric approximation.

The series (Equation 4-16) converges to a finite sum, U, when $a < 1$. U is the utility factor.

If

$$1 + a + a^2 + \dots a^{t-1} + \dots = U \qquad \text{(Eq. 4-17)}$$

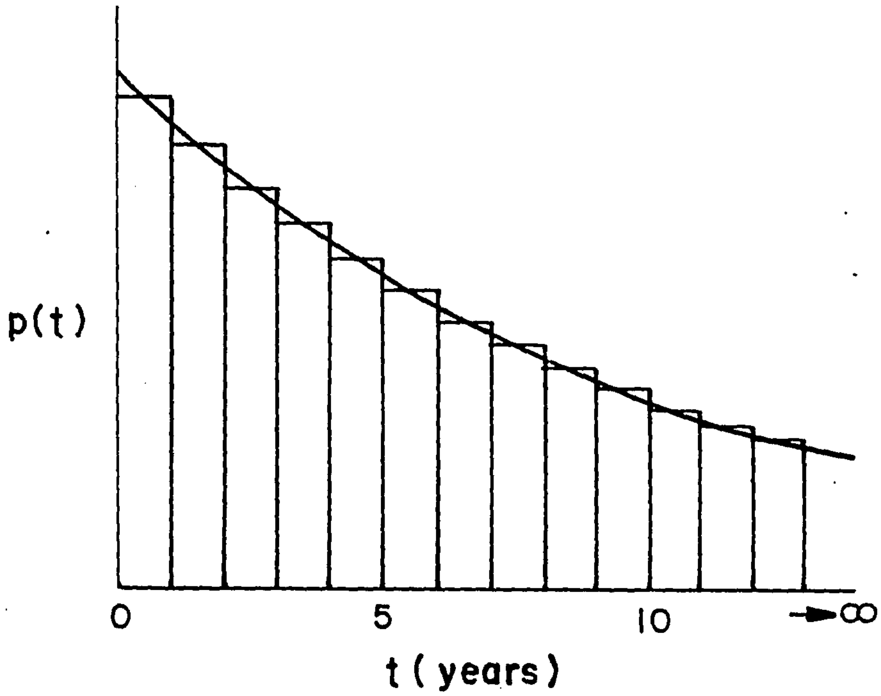


Figure 4-9. The continuous negative exponential and discrete (stepped) geometric approximation (linear scale) (20).

then also

$$1 + a(1 + a + a^2 + \ldots a^{t-1} + \ldots) = U \qquad \text{(Eq. 4-18)}$$

so that

$$1 + aU = U = 1/(1 - a) \qquad \text{(Eq. 4-19)}$$

similarly, if

$$U(t) = a^t + a^{t-1} + a^{t-2} + \ldots \qquad \text{(Eq. 4-20)}$$

$$= a^t (1 + a + a^2 + \ldots \;)$$

$$= a^t U(0)$$

$$U(t)/U(0) = a^t \qquad \text{(Eq. 4-21)}$$

In Figure 4-9, the initial utility U(0) will be the area under the curve; while the residual utility U(t) under the curve from point t to infinity.

If we know the numerical value of a, we can calculate the total sum of the series using Equation 4-22:

$$1 + a + a^2 + \ldots + a^t + \ldots = 1/(1 - a) \qquad \text{(Eq. 4-22)}$$

and any partial sum from Equation 4-23:

$$1 + a + a^2 + \ldots + a^t = (1 - a^{t-1})/(1 - a) \qquad \text{(Eq. 4-23)}$$

If 1,000 references were made to a set of scientific publications with an annual aging rate of 0.875 during its first year after publication, then 875 references would be made during the second year; 1,000 x 0.875^2 for the third year, and so on (95).

Table 4-4 gives the details of aging using a constant factor, 0.875.

Table 4-4. Utility of scientific information using a constant aging factor, a = 0.875.

Year	a^n	Citations
1	(0.875)	1,000
2	0.875	875
3	0.875^2	766
4	0.875^3	670
5	0.875^4	586
6	0.875^5	513*

* half of the citations or 50%

The total number of citations (references) is then:

$$U = 1{,}000/(1 - a) \qquad \text{(from Eq. 4-23)}$$

$$= 1{,}000/(1 - 0.875) = 1{,}000/0.125 = 8{,}000$$

Therefore, 8,000 citations would be made during the entire (infinite) life of the information (publication).

Using Equation 4-21 we can deduce any residual sum of the series, as:

$$a^t = U(t)/U(0) \qquad \text{(Eq. 4-21)}$$

$$t \ln a = \ln U(t) - \ln U(0) \qquad \text{(Eq. 4-24)}$$

Figure 4-10 is a plot of U(t)/U(0) on a log scale, and t on a uniform scale. Any specified value of U(t)/U(0) can be read directly from the graph with sufficient accuracy for all practical purposes (20).

From the graph we can read that for a = 0.875, 50 per cent of the citations were utilized after 5.2 years and that U(t)/U(0) = 0.135 when t = 15 years.

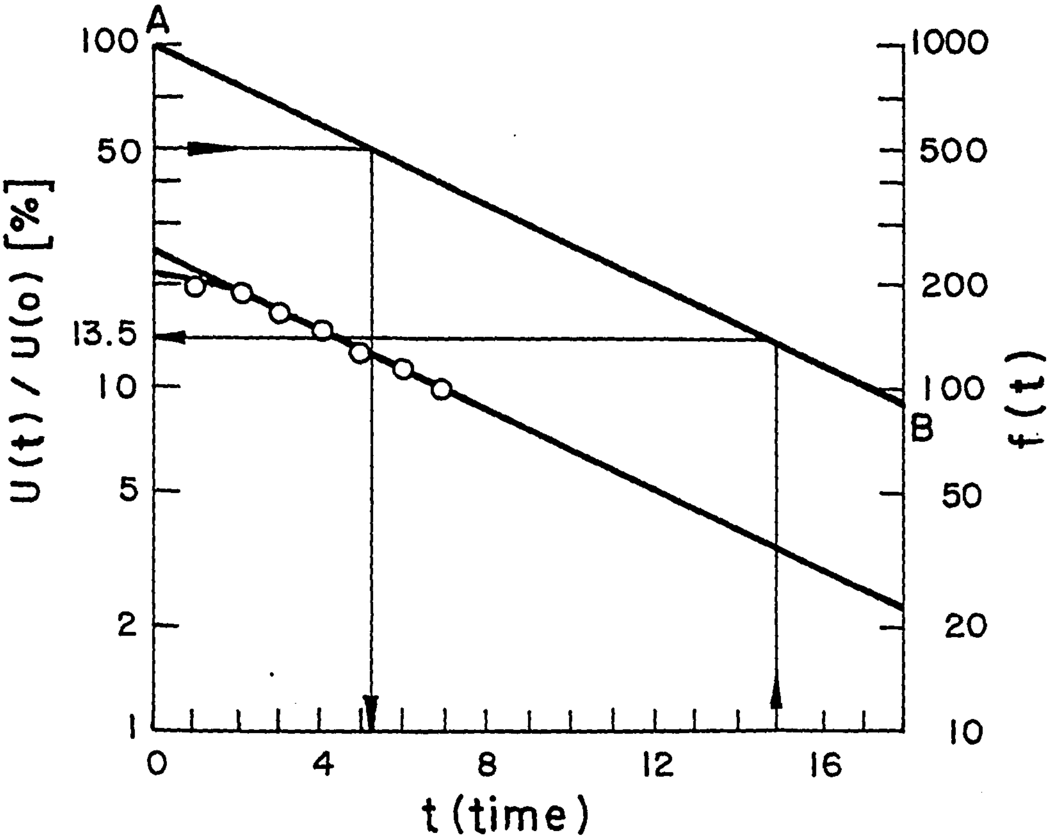


Figure 4-10. The plotted empirical points and constructed graph of U(t)/U(0) (semilog scale) (20).

THE LIMITS OF INFORMATION

Half-life of information was first cited in scientific literature by British professionals: Bernal in 1958 (15) and Burton and Kebler in 1960 (25). The latter observed that the half-life used in nuclear physics and chemistry, a decay function of radioactivity is the time required for the disintegration of one-half of the atoms of a sample of radioactive substance. For a given material any of the half-life periods in physical sciences are of equal duration, i.e., at any given time, the half-life of the remaining material is the same as the half-life of the original mass. In contrast the half-life for information is not definable in precisely the same manner because scientific information remains but becomes unused (25). Line (77) defines "half-life as the time (actual or expected) within which half the total use of individual items constituting a literature has been or is expected to be made." In the similar fashion the point at which the residual utility is 50 per cent is also known as the half-life of information (10,20,25,54,72,77,95,101,107).

The half-life of information varies among sciences. Different physical sciences demonstrate different half-lives (Table 4-5); geology enjoys the longest half-life of 11.8 years and metallurgy a mere 3.9 (25,71,101,103).

> ... growth patterns of a subject field can be described rather well by half-life data. The literature of stable sciences show longer half-lives than those undergoing major changes in content or technique... more theoretical (sciences) may show longer half-lives (25).

In scientific literature the half-life of the subject also changes, viz., transistor literature being superseded by semi-conductor literature in the discipline of microelectronics.

Table 4-5. Age of journal articles at time of use (years) (71).

Field/Subfield	Average age for citations	Half-life for citations	Average age for all uses	Half-life for all uses
Physical Sciences	9.7		2.3	0.2
Physics		4.6		
Chemistry		8.1		
Mathematics	15.0	10.5		
Computer Science	5.9			
Environmental Sciences	8.8			
Geology		11.8		
Engineering	7.4			
Chemical		4.8		
Mechanical		5.2		
Metallurgical		3.9		
Life Sciences	11.2			
Physiology		7.2		
Botany		10.0		
Cancer				0.25
Psychology	10.4			0.9
Social Sciences	11.9			
Other Sciences	12.2			
All Fields	10.8			0.2

The algorithm used by King (71) for Table 4-5 is hereunder described:

> ...to calculate the half-life of citations...for the National Science Foundation...we took a sample of articles that we published in the United States in 1977 in science and technology. We then took a random sample of citations from the sampled articles and determined when they were published. (We also contacted the authors and got information about the citations from them). In this way, we determined if they could not use this data to compute the mean (average age of citations) or the median (half-life). The difference in observed number of citations of articles published each year (1977, 1976, 1975, ...) are attributable to (1) the age of the cited article and (2) the fact that more articles are published in recent years (i.e., there were fewer articles published, say, in 1960 than in 1977). Fortunately, we had estimates of the number of articles that were published back to the 1800's. What we did then was to normalize the number of articles published each year to a common basis by dividing the number of articles published in 1977 by the number published in any given year. We multiplied that ratio times the number of observed citations published in any given year. This yielded an adjusted number of cited articles for each publication year. Then we summed up the total number of adjusted citations over the years. Then we determined what year the half-life occurred by cumulating the adjusted citations up to the year when one-half the total was cumulated. Fractions of years was estimated by linear interpolation (72).

Burton and Kebler in 1960 (25) described the curve for the half-life of a scientific literature as exponential in character:

$$y = 1 - (ae^{-x} + be^{-2x}) \qquad \text{(Eq. 4-25)}$$

where y = cumulative percentage (expressed in decimals); x = time, t, in decades; and (a + b) = 1. Their curve also satisfied the boundary conditions of:

x = 0; y = 0 (excluding references not yet published); and

x = ∞ ; y = 1 (all citations included in all references published).

The curve was then fitted to data and the x-value corresponding to y = 0.5 was calculated, i.e.,

$$y = 1 - (ae^{-x} + be^{-2x}) = 0.5 \quad \text{(Eq. 4-25a)}$$

Burton and Kebler (25) also discussed decay of classic literature versus ephemeral literature; however, Redmond (101) describes the difference between ephemerality and obsolescence as differences in time scale only. Furthermore, Redmond reiterated that all information becomes obsolete sooner or later (102). Grum (55), a US academic and soldier agrees that information perishing is inevitable and the rate of perishing, $\Delta(n)$, is a decreasing function of time.

$$\rho(n) = \Delta(n - 1)/\Delta(n) \text{ for } \Delta(n) \neq 0 \quad \text{(Eq. 4-26)}$$

$$\rho(n) \rightarrow 0 \text{ as } \Delta(n) \rightarrow 0 \quad \text{(Eq. 4-27)}$$

$\Delta(n)$ is a non-increasing function of n which represents the expected future reward of the information of the next n periods; if $\Delta(n) = 0$, n has perished.

Line (77) uses Brookes' series (Equation 4-16) for C, the number of citations to literature published in the last year cited. The total number of citations would be:

$$T = C + CD + CD^2 + CD^3 \ldots CD^n \qquad \text{(Eq. 4-28)}$$

where D is the time or corrected obsolence factor.

The above series can also be expressed as

$$T = C/(1 - D) \qquad \text{(Eq. 4-29)}$$

Half-life then, is the number of terms in the series required to reach the point where half the citations have already been made, i.e.,

$$T/2 = C/2(1 - D) \qquad \text{(Eq. 4-30)}$$

Given a, the obsolescence factor and g, the growth factor, Line defines the corrected half-life, h as:

$$C(1 - D^h)/(1 - D) = C/2(1 - D) \qquad \text{(Eq. 4-31)}$$

$$(1 - D^h)/(1 - D) = 1/2(1 - D) \qquad \text{(Eq. 4-32)}$$

Therefore, $1 - D^h = 1/2$

$$D^h = 1/2 = 0.5 \qquad \text{(Eq. 4-33)}$$

According to Burton and Kebler (25) the half-life is attained when $y = 0.5$; we also have $D^h = 0.5$

$$\text{Therefore, } D^h = y \qquad \text{(Eq. 4-34)}$$

If we wish to determine the value of the half-life itself

$$\ln D = h \ln D = \ln 0.5 \qquad \text{(Eq. 4-35)}$$

$$h = \ln 0.5/\ln D \qquad \text{(Eq. 4-36)}$$

But $D = ag$

$$\text{Therefore, } h = \ln 0.5/(\ln a + \ln g) \qquad \text{(Eq. 4-37)}$$

THE EJECTION OF INFORMATION

"Aging for a specific literature is defined in terms of that literature being cited by other documents..." stated Griffith et al (54), and outlined four distinct cases:

1. All literature cited by all literature.

2. All literature cited by a specific journal.

3. A specific journal cited by all literature.

4. A specific journal cited by a specific journal.

Griffith's algorithm was Brookes' model: cumulating all the citations and then subtracting U(t), utility for each year from U(0), initial utility; then fitting the aging constant a, by eye to the resultant graph. This was done in cases, where:

1. literature aging was:

   a. all literature, or

   b. a journal;

2. the aging was reviewed by:

   a. all literature, or

   b. a specific journal; or

3. it was a possible combination of 1 and 2.

Such visual fit of data was accurate to $\pm$0.01 ($\pm$1 per cent). With experience, they developed another simple mode of fit based on only citations to literature 10 years or older (54).

Griffith found the aging constant a, to be 0.89 (approximately) for scientific information from 1940-75 (54). This is closer to Brookes' estimate of 0.875 or 0.88 (20).

During the First and Second World Wars aging rate slowed down to approximately 0.96, but the contributions were also small (54) and the remainder of the time, a = 0.94, or 6 per cent growth, which is considered well within others estimates (20,95,107).

According to Figure 4-11, two relatively constant aging rates emerged:

a = 0.89: relatively recent scientific information and

a = 0.94: long-term information aging (historical).

Brookes (20) confirmed Line's historic usage of 10 or more half-lives or 99.9 per cent of the total usage (time); however, the usage during different periods for the same scientific subject may be different (Table 4-6).

Griffith, et al (54) agreed with Brookes (20). They reiterate rapid aging as "essential to certain processes in carrying out science", and used Brookes' model for aging.

Brookes was seeking a discard point or a threshold beyond which utility of scientific information had fallen to a minimal level (20). He uses the expended half-lives as cumulative mode for the aging of scientific information, i.e., after two half-lives as one fourth of the initial information remains, three-fourths has been consumed, etc.

To this same end, Griffith (54) assumes an aging rate of 94 per cent for certain scientific information (biomedical literature) (or a = 0.94). This means the growth rate was 6 per cent per year, i.e., each year's publication received 6 per cent more use than those of the prior year. However, Griffith argues, if we know by counting the number of articles that the literature grew by 2 per cent per year, then the adjusted rate of change, everything being equal, is:

6% - 2% = 4%

which establishes the aging factor a, at 0.96.

Table 4-7 displays aging of scientific information revealed through the citations by various journals.

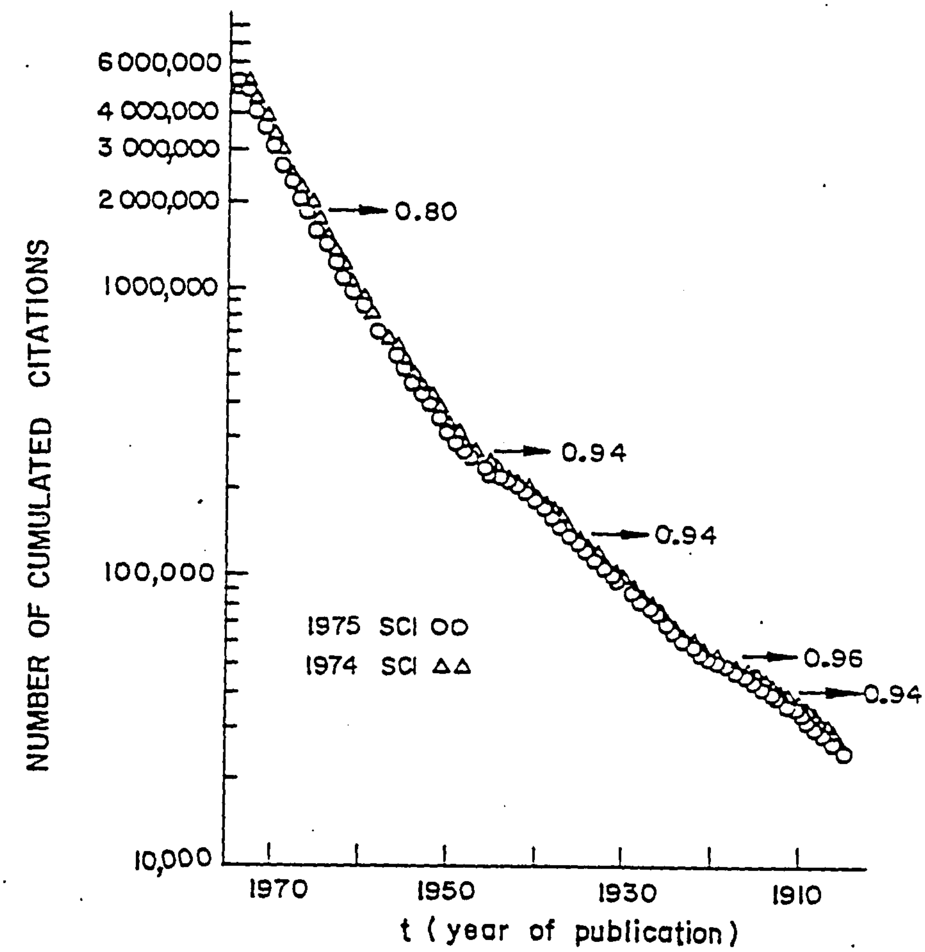


Figure 4-11. Aging of all literature cited in the Science Citation Index (SCI). The number of citations received by all literature from 1974 and 1975 SCI are plotted as described for the Brookes model. Three different aging rates are shown which correspond to: the initial aging phase; the disruptive effects of the Wars; and long-term archival growth (54).

Table 4-6. Cumulative half-lives effect on the usage of information (percentage).

Number of half-lives	Information used (percentage)
1	50
2	75
3	87.5
4	93.75
5	96.9
6	98.4
7	99.2
8	99.6
9	99.8
10	99.9

Table 4-7. Aging of literature as revealed in the citations by various journals (54).

Citing journal	Aging rates (a) for annual compilations of all citations by the journal			Aging rates (a) for annual compilations of only citations by journal to itself			
	1974	1975	1977	1974	1975	1977	
P NAT ACAD SCI	0.80	0.80	0.80	0.74	0.74	0.75	
J MOL BIOL	0.80	0.81	0.81	0.78	0.78	0.81	
LANCET	0.82	0.82	0.82	0.81	0.81	0.79	*
				0.61	0.61	0.61	**
PHYS REV LETT	0.81	0.83	0.83	0.72	0.72	0.76	
BR MED	0.83	0.84	0.84	0.84	0.80	0.85	*
				0.66	0.61	0.55	**
SCIENCE	0.84	0.84	0.84	0.79	0.79	0.82	
BIOCHIM BIOPHYS ACTA	0.84	0.84	0.84	0.78	0.78	0.78	
J CUN INVEST	0.84	0.84	0.84	0.84	0.83	0.83	*
N ENG J MED	0.85	0.83	0.84	0.81	0.77	0.84	**
				0.68	0.71	0.71	
AM J CARD	0.85	0.85	0.85	0.75	0.77	0.75	
CIRCULATION	0.85	0.85	0.85	0.80	0.78	0.78	
J COMP PHYSIOL PSYCH	0.85	0.87	0.88	0.87	0.87	0.87	

* For U(4) - U(10); ** for U(0) - U(3).

Griffith (54) begins with Equation 4-21 of Brookes' model , and proposes to estimate a. The data generated a strong and amiable hypothesis, when:

1. a = 0.88, 50 per cent of the total citedness or information is exhausted within 5 years of publication; and
2. a $\lesssim$ 0.90, more than 90 per cent of the total information was exhausted within 20 years of publication.

These two values should be of assistance to information managers in controlling almost any information explosion (54).

Brookes (20) adheres to a hypothesis expressed in Figures 4-2 and 4-9 that the bulk of the information stays close to one end of the geometric distribution (time) and a steady depreciating tail extends theoretically to infinity. Half or 50 per cent of the used information will be under half the area of the curve Figure 4-9. Redmond (101) agrees that the distribution curve is asymptotic such that the value never reaches zero, i.e., that old information does not die, it simply becomes less and less desirable. Redmond uses 95 per cent usage for certain specified sciences: metallurgy, 17 years; and geology, 50; thus illustrating inherent inertia of a more stable scientific discipline.

Three British information professionals: Brookes (21), Sandison (108) and Urquhart (124) criticize Griffith, et al (54) for their approach to the aging of scientific literature. Although Brookes (21) agrees partially since Griffith uses Brookes' model (20), he objects to the correction factor stating:

> If a literature grows in volume, it is not because the scientists contributing to it work at an ever-increasing rate but because more scientists are attracted to that field. The rate of revision of the earlier literature is thus speeded up; as the rate of growth increases, so does the rate of revision (21).

Sandison (108) is much more critical.

> But the effect of age operates forward through time, so that decay in the reverse direction should not be considered as aging without special explanation... Cumulated population cannot decay: they only grow forward through time (108).

Sandison considers the US approach as naive. Urquhart (124) considers it "a mistake to assume that actual requests for journal volumes dwindle to vanishing point with age".

THE THRESHOLD OF INFORMATION

We have so far seen the birth, life and decline of information. The information revolution created by microelectronic technology has shown us how rampant the growth of information is and how Western industrialized governments are planning national strategy to keep ahead in the war over information. Ministers sit beside industrialists during international trade talks to demonstrate the importance of the information revolution. But what they do not know is the faster the developments in information capture are taking place, the faster is the rate of obsolescence. Information in such sciences as metallurgy demonstrates a relatively short half-life of 3.7 to 3.9 years (25,71,101). It is also true of electronic physics (20) but a 50 per cent decay takes quite a long time for the slower moving sciences of botany, geology and mathematics (71).

The growth of information bewilders most people: it is simply because most people cannot comprehend growth, limitless growth, in the field of information. "The greatest shortcoming of the human race is man's inability to understand the exponential function", said Bartlett (10); but the same is true of the exponential decay.

Information grows and we have demonstrated this cogently, but all the growth is not new. Not all the scientific information generated is new; most of it is re-cycled information along with some newness. Therefore, the information that accumulates is not all "fresh" information, but fresh protected with layers of old information.

We have demonstrated we can quantify information in both its growth and decay. We have seen decay through usage such that new information is used more often than old information. People are interested only in using new information added to a corpus of knowledge. In part this is analogous to the surface mining of outcrops before venturing to subterranean extractions. However, this is only partially true since the raw material to be mined is finite, while information is continually generated.

We know that information is used and used frequently. What we want to know now is the usefulness of the information itself. No one buys yesterday's newspaper unless it is useful to that person. The extent to which this informationis useful is our quest. If we are to put a value to the information, we must also put a limit on this value beyond which the information is of little use to us. Information then would become similar to milk in a carton with an inscription indicating its decay date, after which the milk is useless. Suppose we assume for information a figure of 50 per cent after which the information is of little value to us. Thus we have arrived at the half-way mark, in the usefulness of information, the point at which we may want to discard it. We have mentioned this at various points as the "half-life".

Therefore, the half-life of information then is:

1. the time when half of its utility has been consumed;
2. the time at which 50 per cent is utilized; or
3. the time when half of it is depreciated or perished.

We know that the faster the information is generated, the faster it reaches its half-life, or decays. The bureaucrat, perplexed by the information revolution, should heave a sigh of relief that the information appearing at an exponential rate is disappearing just as fast, being superseded by new and fresher information. It is simple to calculate the half-life of information and then to discard that item of information as irrelevant when the time has elapsed. For instance, the manuals that are generated, or the scientific reports that are written all become useless with time. No one looks at the training manual for the CF100 Canuck aircraft, nor the Kinsey report (because both are now defunct).

We have established half-life of various sciences, and also we have established that such a syndrome exists for information. Let us examine if this applies to other information systems: to technology and to war, as we have established them to be separately analogous to information. We shall observe whether technology and war, both, demonstrate decay, and whether the rate of decay of information is fast in a rapidly perishing information system, such as a technological war, or slow such as in the case of a slow national upheaval or revolution. This should give us an idea to understand peace, a more stable information system or how to attain and maintain it.

One of the most peaceful human endeavors has been man's voyage to the moon. It captivated the imagination of the human race. It also captured a considerable amount of information about the other world of our world.

We as a civilization observed the genesis of lunar astrogeophysical information with the US astronaut Frank Borman in December 1968; the growth of such information with man's first lunar landing with Neil Armstrong in July 1969; and the abrupt termination of information culminating to instant start of decay with the departure of Eugene Cernan from the moon in December 1972. We saw the entire span of a new science, information science, without even realizing its impact on our civilization. Had Neil Armstrong known it, or as we see in retrospect, his first utterance on the moon should have been:

"One small step for man, one giant step for information science."

5. CONFLICT: THE FIGHTING INFORMATION SYSTEM

There is no such thing as an ultimate weapon.

- Captain James Beadling, USAF
  Assistant Professor of Aerospace Science
  Otterbein College, Westerville, Ohio
  1959

Information is the ultimate weapon.

- I. Ben-Tahir
  1982

INTRODUCTION

In the previous chapter we have observed how information is generated, grows and eventually decays with respect to time; and that the rate of information perishing is a decreasing function of time (55). In Chapter 2 we described how information changes rapidly in the defence environment, specifically the ephemerality of technology in the aerospace field. Every slight change in technology effects change in information to a point that technology becomes almost synonymous with information. In Chapter 3 we established that technology is the driving force behind strategic thinking and war, and every technological innovation has brought about a change in the doctrine of war or strategic thinking so much so that it becomes synonymous with technology. But since we have also stated that technology is analogous or almost synonymous with information, this implies that war too is synonymous with information.

We have established the decay or the "half-life syndrome" as an important point in the information phenomenon. In this chapter we shall examine if there are other systems which exhibit the features we have reviewed in Chapter 4. This would mean the development of mathematical models which would give us an understanding of these information systems as well as enable us to demonstrate the models as applications.

THE LIMITS OF WAR

Since the Second World War ended with the nuclear bombing of Hiroshima and Nagasaki in August, 1945, the world powers have realized the awesome or awful destructive capacity of strategic weapons.

Therefore, since 1945, to avoid a nuclear holocaust of the Third World War, a new concept of limited war has emerged (96). The doctrine was developed as a response to the Korean War (1950-53) and had a two-fold implication (96):

1. to mitigate the danger of an all-out nuclear war; and
2. to support the policy of containment of communism.

Limited war has become a fact of our time (126). The war for the Falkland Islands was a principal example of a limited war where the conflict was limited to a geographical area of 200 miles radius around the islands. From 1948 onwards, people's revolutionary wars have gained momentum and strategic importance (36) thus outflanking the second part of the above doctrine established by the US, the containment of communism.

Che Guevara added a corollary to the doctrine of the limited war which stated that in order to create victory for the proletariate, conditions for communism do not have to be ripe, but war or anarchy can create the necessary conditions (36).

It was the concept of limited war that got the US involved in Vietnam (19). A monopolar world had emerged after the Second World War, with the US on top, prior to Vietnam. The US wanted to teach Vietnam a lesson using the most sophisticated technological innovations (96). But the US learned three very fundamental precepts.

1. Victory does not usually come to the strongest party in a limited war (contrary to the doctrine) (8).
2. Technologically superior force can be a dysfunction in a limited war (the USAF and USN air fleets competed with each other to produce high sortie rates and tonnage dropped with no significant conquests, winning "data" but no "territory") (19)
3. No regime which cannot assist itself against a revolution or subversion can be helped through the intervention by a powerful ally (96).

But what is not understandable is the reason why the US got involved in the limited war after having learnt in Korea that it is not easy to fight an ideologically-enthused enemy on the Asian mainland. Even though the US had a school of "never again" generals who were adamantly against any US involvement in Vietnam, the bureaucracy was able to tilt in favour of the involvement. Perhaps these officers were dismissed as 'generals fight the last war; academics the next'.

The answer to this puzzling question lies in a very mundane area. The US was aware that Vietnam was extremely rich in a certain strategic element, Wolfram, commonly known as tungsten. It is used in aerospace technology and the military-industrial-scientific complex (MISC) was quite aware of its significance.

"Vietnam, and the whole of Southeast Asia is extremely rich in tin and tungsten; and it was a long-recognized US movement in this area for the mineral resources", stated Tupper, an economic geologist (122). Other geologists agree with this statement as the best-known most-kept secret of the Vietnam war (58,117).

The US is six per cent of the world population but uses 33 per cent of the world's minerals and to guarantee its economic growth and technological well-being, the US must retain its mineral resource sources (122).

The US was engaged in an undeclared and unpopular war to contain communism and to restore freedom and democracy according to most historical documents, and there has never been any hint of US intentions on South Vietnamese tungsten deposits.

It is ironic that after such a debacle, the largest deposits of Wolfram (tungsten) were discovered in Canada at the border of Yukon and Northwest Territories (122).

The USSR too has had its share of limited war experience for precisely the same reasons in Afghanistan. Prior to the armed intervention in that country the USSR had conducted an extensive geological survey of Afghanistan and informed that government that there were no significant deposits of any minerals of consequence. However, in the Tadzikh Soviet Socialist Republic, a few miles from where the USSR-Afghan-Pakistan-Chinese borders converge, the Soviets have the biggest open-pit gold mine in the world. If the Soviet have a gold mine in proximity to Afghanistan, it can be inferred that their diagnoses were intentionally deceptive.

The UK as well was not fighting for just the territorial integrity of a colony of 1,800 people, 8,000 miles away in the South Atlantic. The Malvinas Basin between the Falkland Islands and Argentina is supposed to contain a significant quantity of oil, approximately 500 million to five billion barrels. However, the British do not just claim the Falkland Islands and its dependency, South Georgia, but also the South Sandwich Islands, the South Orkney Islands, the South Shetland Islands extending all the way to the Antarctic continental shelf known as the Palmer Land. This is the surface of a very large submerged archipelago (99). (British troops invaded the South Sandwich Islands on 20 June 1982 and took prisoner 20 Argentine scientists manning a weather station since 1976 (with the acquiescence of the British since 1977) (89)).

If Argentina were to own the Falkland Islands when the Law of the Sea comes into effect, it could lay claim to the entire archipelago and would have energy for its future needs for up to more than 100 years (This is the claim of a Canadian petrologist commissioned by the Argentine government to survey the area up till 1981 (84)). If the

British were fighting for the rights of their subjects who wanted to remain loyal to the Crown, why did the UK relinquish reign in 1981 over Belize, a Central American colony (population 144,857 (1980)) which wanted to remain as such? An even more interesting case is that of Hyderabad Deccan, which the British abandoned in 1948 (Appendix B). In both cases, these countries did not serve British interests.

In the above three cases which have involved the top three powers in the world, each power had the same motive to conduct a limited war: to gain or regain natural resources. In the case of the US, they had insufficient information about the resources, as proven by the Canadian geological community (58,117,122). In the case of the USSR only fragmentary information is available. Until they stabilize the Afghan rebellion, which may take years, we will not know the outcome of that information (The British fought three Afghan Wars, (1838-42; 1879-81; 1902 (86)) but had to withdraw from the country after tactical battlefield victories, due to continued harassment, extreme resistance and uncontrolled insurrection). The UK had potentially good information (84,99) to launch a limited war against Argentina in the Falklands.

Thus we deduce that the limited wars fought by the big powers are not to uphold the rights and the freedom of the people who would otherwise be oppressed by a lesser power, right or left, but for what they could gain by applying the doctrine of limited war. As Sorokin (104) said: "...wars and revolutions were not disappearing but would grow in the twentieth century to an absolute unprecedented height."

The war between equal powers such as the one fought by Iraq-Iran

(1980-82) showed a gross miscalculation by Iraq. Had Iraq waited until 1982 to launch its attack, the outcome would have been different (Table 3-5) with the USSR supplying its excess latest weapons to its client state. Apparently Syria is the recepient of Soviet armament after its losses in the 1982 Israel-Lebanese war.

There is an addendum to the doctrine of limited war: "If a total war is ever to break out it is most likely to be the result of an escalation of a limited war" (126); and that total war will be fought most probably in Europe (8).

THE PRESCRIPTION FOR WAR

> Under ideal conditions, war is fought with surpluses of energy and resources, such as the Allies waged in World War II. A more risky proposition is to fight to secure the enemy's energy and resources in the hope of continuing the war with them -- this was the idea behind Wehrmacht's drive for the Caucasian oil fields in 1941. The message of the 1973 oil crisis was therefore as simple as it was ominous: the era of abundant energy is over...the seriousness of this threat to our collective security now looms so large that it cannot be ignored, for without the output of the oil fields and industry, our forces will be no more than inert masses (78).

A historical example of the above thesis is why the Ardennes counter-offensive by the German forces, generally known as the Battle of the Bulge, was abruptly terminated in December 1944. The Germans:

1. could not capture the Allied fuel storage as per their schedule; and
2. ran out of fuel on the battlefield as a consequence.

The German ability to conduct war was seriously curtailed by the immense numerical superiority of the Allied forces. They did not match the German technological superiority either in weapons development (rocket-powered vengeance weapons V-2, the precursor to the modern missile and jet fighter aircraft) or in innovative technology, such as petroleum fuel produced from coal.

The only country at present which uses this process is South Africa, which has an abundant supply of coal amongst other strategic minerals on which the West is utterly dependent for its economic growth and strategic stability (discussed in detail in Chapter 6).

We have observed the motivation of the big powers (US, USSR, UK) to apply the doctrine of limited war when a key ingredient is a strategic resource of significance for their technological well-being. The denial of such a resource could not just bring about economic hardship, but reduce the strategic capability considerably , perhaps to the zero point. The example of the Ardennes counter-offensive and the worriscme revelation of Leitch (78) indicates the vulnerability of Western military forces.

Perhaps one of the reasons for limited actions in the past was the low cost of fuel and materiél, but this has changed immensely since the 1973 Arab-Israeli war, the consequent oil embargo and the formation of the oil cartel, spiralling energy costs to exceed materiél cost for the first time since the industrial revolution. An example of such a cost can be seen from the British action in the Falkland Islands. The estimates for the loss of ships alone puts it at $1 billion (with the number of ships lost exceeding the D-Day figure). The cost of other materiél losses and subsequent expenditures is put at $5 billion (40). This demonstrates:

1. that the attrition rate is greater than anticipated by defence planners; and
2. that even a power with minor relative capability can inflict enormous damage to a big power using technology as its doctrine, e.g., the Exocet stand-off missile.

The theory of relative capability dynamics and extensive war emerged from examining hegemonic behaviour of major powers since 1450 (37). Doran (37) observes that as a nation grows in power relative to other nations its capacity to influence events and to exercise leadership grows; and when this capacity wanes the nation's ability to influence international politics diminishes. This political development of a major power is manifest in a cyclic pattern, and he defines the cycle as "a period of time during which something is established, reaches a peak, and declines."

This theory argues that relative capability is composed of two dimensions (37).

1. Size of a nation which is often indexed by:
   a. gross national product (GNP),
   b. territory or area,
   c. armed forces,
   d. military spending and
   e. population.

2. <u>Development</u> of a power which includes variables such as:

a. per capita income,

b. urbanization and

c. technological sophistication.

Relative capability follows a cyclic dynamics with the upper limits pre-ordained by:

1. territory,

2. initial capital and

3. natural resources endowment,

which affect the length of the period, and the height of the ascendancy.

Figure 5-1 is a graphic illustration of relative capability of a state under ideal conditions.

> The focal points are the two inflection points b and d and the two turning points a and c... It is at these points the government is most vulnerable to overreaction, misperception, or aggravated use of force which may generate massive war (37)

The points a and c are clearly important, however a nation does not perceive itself as beginning to decay until after the process is set in. Likewise, a nation does not know that it has reached its abyss until later. The points b and d are exceedingly difficult to perceive, nevertheless the idea of cyclic growth and decline of power is important.

Toynbee (48) argued that all powers follow a similar cyclical

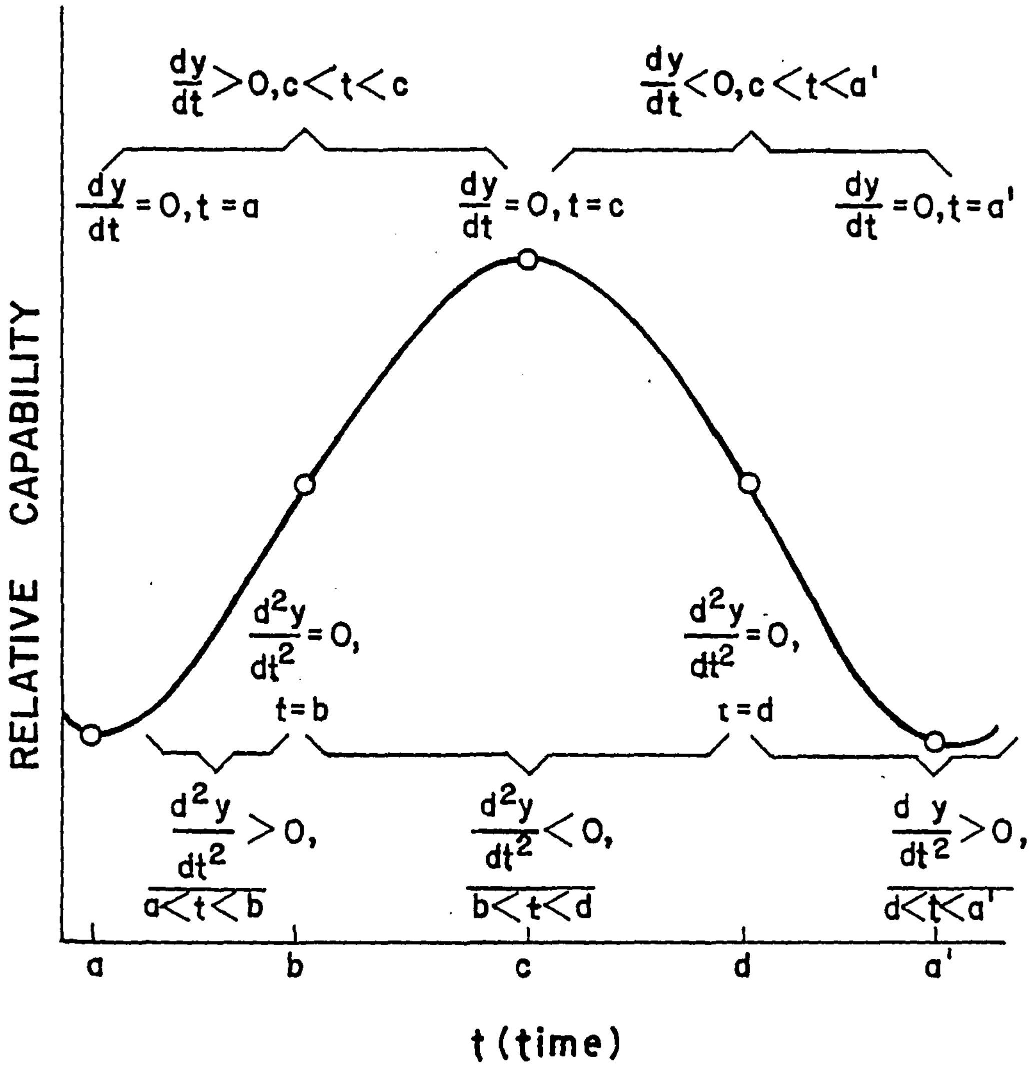


Figure 5-1. Generalized curve of relative capability. a,b,c,d,a', are critical points; t = time; dy/dt = rate of change (velocity) in relative capability over time; and d^2y/dt^2 = rate of change of change (acceleration) in relative capability over time (37).

dynamics; only in his discourse he dealt with civilizations, which in contemporary terms can be called states. He postulated that each civilization undergoes the same phases or dynamics.

1. Genesis: the birth of a nation by overcoming obstacles.
2. Growth: the "etherealization" of a nation-state into a power.
3. Decay: the breakdown from within resulting from the shortcomings not decreed by law but human failure; a few effete individuals gain a stranglehold over power, thus becoming nemeses to creativity, and finally bring about the disintegration and dissolution of the state.

Toynbee (48) suggested that the decay phase of a power can extend over years: tens, hundreds and even thousands. He put the decay of Egyptian civilization to be from 1600 BC to 500 AD, or 2,100 years.

During this cycle of relative capability, the state which meets all the imperatives of ascendancy(37) or is in the growth phase (48) influences international decisions and wages wars.

THE GENESIS OF POWER

To understand relative capability, we must examine the mathematics of the basis of this power. Figure 5-1 illustrates a curvolinear graph, which if scrutinized closely may be able to unravel the cycle.

Figure 5-2 illustrates a point y, a variable, which may be in arbitrary units. Let y be dependent on time, t, that has elapsed from some agreed fixed instant. If we let the value of the variable y at time t and $y + \Delta y$ at time $t + \Delta t$, then the average change in the variable per unit of time during the interval Δt is:

$$\Delta y/\Delta t$$

This ratio gives us a measure of how fast the value of y is changing over the interval Δt; the smaller Δt is, the nearer we get to a measure of how fast the value is changing at the time t. In fact, by taking Δt small enough we can make the ratio $\Delta y/\Delta t$ differ as little as possible from the differential coefficient, also known as the first derivative:

$$dy/dt$$

which is the limit of the ratio as $\Delta t \rightarrow 0$ (45).

Therefore we assume that the rate of change of y at the time t is defined to be the value at that time of dy/dt, the differential coefficient of y with respect to time, t. This is the rate of change of y then, commonly called the velocity of y.

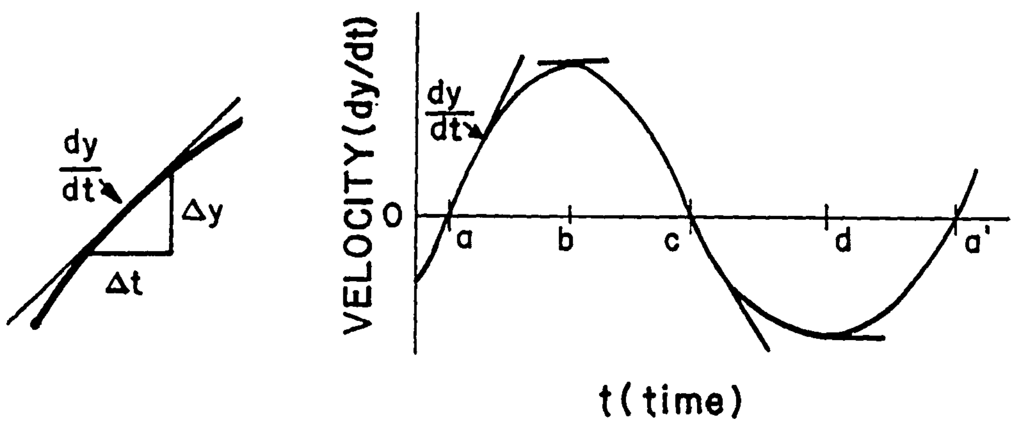


Figure 5-2. The rate of change (first derivative) for each point on the curve; with positive rate of change signifies a rise in the level of relative capability; and negative rate of change indicates a decline. The rate of change is non-linear and non-monotonic, rising or falling to different degrees (with differing slopes over time). (The inset to the left is a conceptualized, magnified version of where the tangent meets the slope) (37).

However if we wish to discover the rate at which the the rate of change is changing, we will have to take many points of dy/dt such that we form a curve of these values. The derivate of that curve is:

$$d/dt(dy/dt) = d^2y/dt^2 \qquad \text{(Eq. 5-1)}$$

Figure 5-3 is a graphic representation of this rate of change, which we commonly call acceleration or the second derivative.

When the acceleration is positive

$$d^2y/dt^2 > 0 \qquad \text{(Eq. 5-1a)}$$

and the velocity is increasing.

When the acceleration is negative

$$d^2y/dt^2 < 0 \qquad \text{(Eq. 5-1b)}$$

and the velocity is decreasing.

But when it is neither positive nor negative, then

$$d^2y/dt^2 = 0 \qquad \text{(Eq. 5-1c)}$$

and the velocity is a constant.

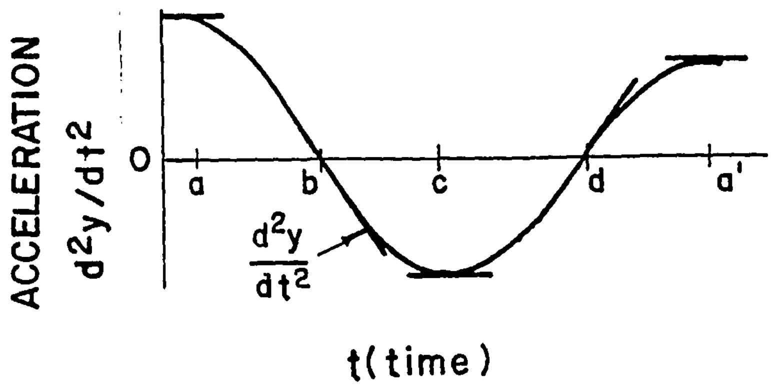


Figure 5-3. The rate of change of change (second derivative), the changing slopes of the tangent lines of the velocity curve; acceleration is neither constant, linear, monotone, nor always positive (37).

THE STRUGGLE FOR POWER

To appreciate how a state generates power we will have to observe the infrastructure or the components that make up the cohesive force which gives the state the relative capability (32). Chi (32) has developed mathematical models which represent internal conflict in a system.

Let us assume a one-dimensional issue continuum in a three-actor system, S, with A_1, A_2, and A_3 as the actors. Let us assume the zero point to be any convenient point on the continuum, as it will not affect the generality of our discussion. We can easily change our equation by adding an appropriate constant, to reflect the actual value of an equilibrium position of a particular system. We shall represent this as a line where points are value of the variable Y. The poles are a graphic convention to avoid possible confusion (Figure 5-4).

To make the three-actor system work, we have to make the basic assumptions of: rationality, unimodality and additivity.

1. Assumption of rationality. Suppose A_2 tries to have its political goal adopted as the policy for the political system or the government, and tries to move S to the right. Contrarily, A_1 tries the same towards his position. Since the resources available to the actors A_1 and A_2 are limited, they have to act rationally to mobilize support for their positions. In support of this goal we assume three strategy principles for every actor (32).

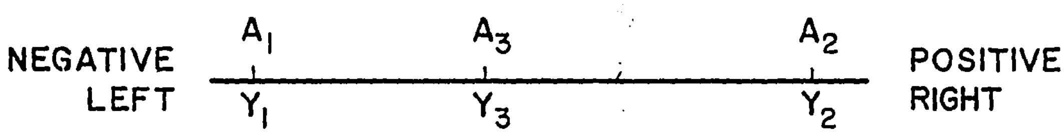


Figure 5-4. An issue continuum of a three-actor system: A_1, A_2 and A_3 (32).

a. Equal efficiency. Every actor is equally efficient in transforming his mobilized resources into political power in support of his political action.

b. Parsimony. Every actor tries to minimize the spending of his resources while trying to maximize the attainment of his political goal.

c. Proportionality. The amount of resources to be mobilized by the actor is proportional to the threat against the attainment of his political goal.

2. Assumption of unimodality again takes three forms:

a. each actor prefers only one policy position with respect to the given issue;

b. actor A_i is optimally satisfied only if his policy position Y_i coincides with the policy adopted by the system, i.e., $Y_i = y$; and

c. the greater the discrepancy between the actor's policy position and any policy adopted by the system, (represented by the position y), the greater the dissatisfaction, d_i.

Therefore, $d_i = |Y_i - y|$ (Eq. 5-2)

The quantity d_i is also the threat faced by the actor A_i; thus the larger the value of d_i, the greater the urgency for A_i to try to redress the situation.

3. Assumption of additivity. Given political pressures P_1, P_2 ... P_i from actors A_1, A_2 ... A_i, the resultant pressure P, then is:

$$P = P_1 + P_2 + \ldots P_i \qquad \text{(Eq. 5-3)}$$

(This also leads to a method of issue reduction for the system to handle several issues simultaneously as if only one issue were dominating the system S (Figure 5-5)).

We already have established that every political action creates a pressure P which affects the system S along the Y issue continuum (Figure 5-4) at a given time t. However, all possible states of S at various points in time constitute the range of the political process (32) or the growth of the internal power.

The political process has three major attributes:

1. current state of the process;
2. rate of the process or the rate of change (first derivative); and
3. modification in the rate of the process or rate of change of change (second derivative) (38,45).

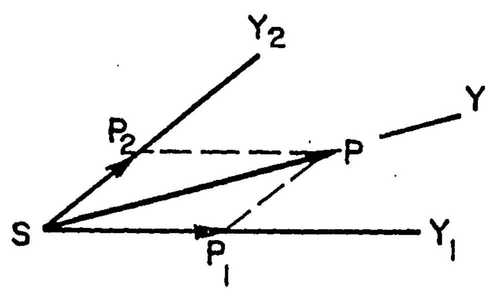


Figure 5-5. The method of issue reduction in the case of two issues. The angle Y_1SY_2 has a cosine equivalent to the correlation between two variables associated with two issues under study. P_1, the action vector is the direction of the pressure desired/created by A_1; the length represents the level of pressure A_1 wants to exert on S (32).

Table 5-1 The effects of the major attributes on the political process

Attribute	Effect
Current state of the process	
Under pressure P, S moves either to the right (positive) or left (negative); the direction of the process is the same as the direction of P.	when $P = 0$; S is immobile " $P > 0$; S moves right (+) " $P < 0$; S moves left (−)
Rate of the process	
Let y be the current state of S on the issue continuum. Under pressure P, S moves in either direction. If y is the position as a function of time, then the rate of change of the process is dy/dt.	when $dy/dt = 0$; S is immobile; y constant " $dy/dt > 0$; S moves right (+) y increases " $dy/dt < 0$; S moves left (−)
Modification in the rate of the process	
Under pressure P, S moves along Y; however, the rate of the process is not assumed to remain constant, i.e., it may be accelerating or decelerating: its change is d^2y/dt^2.	when $d^2y/dt^2 = 0$; S is immobile or moving at a constant velocity, or $dy/dt = k$ " $d^2y/dt^2 > 0$; S changes direction from left to right or moves to the right faster and faster " $d^2y/dt^2 < 0$; S changes direction from right to left or moves to the left faster and faster

We suppose the system begins in a state of equilibrium ($dy/dt = 0$; $d^2y/dt^2 = 0$) with the system in position y. The proposing of a new policy amounts to the establishment of new desired position, Y_p. If Y_p is to the right of y, then A_1 has two choices:

1. slow down the process of implementation; or
2. attempt to move the policy to the left.

1. Slowing down would not need any action or application of pressure P by A_1 on the system S as long as the condition stays stagnant or the policy is proposed but not implemented or $dy/dt = 0$ (constant); therefore, $P = 0$.

   If $P = 0$, then $d^2y/dt^2 = 0$

2. To move the policy to the left, some action by A_1 to generate pressure P would be needed:

   $P \propto d^2y/dt^2$, or

   $$P = a(d^2y/dt^2) \qquad \text{(Eq. 5-4)}$$

   where a is a positive constant. Using the assumption of additivity we can use this for a multi-actor scenario, with pressures P_1, P_2, P_3 ... P_i.

The greater the P on the system, the greater is:

$$|d^2y/dt^2| \quad \text{(absolute value)}$$

or the more revolutionary the process. If the absolute value of the second derivative (acceleration of the process) is an indicator of the level of change in S, then this depends upon:

a. the level of pressure P, and

b. the value of a (the positive constant or the system attribute which indicates level of resistance to change or a measure of political inertia, cultural factor particular to each system. The greater the value of a, the larger the P is needed to induce change).

THE DECAY OF POWER

The political actors are not always the undifferentiated government at one pole and the apathetic public at the other, but are categorized by their actions as (27): bureaucrat, politician, anarchist, excited citizen and external agent.

We will have to view the actions of all of these actors to ascertain the final outcome and its eventual consequence on Western technological society in the following chapter.

The *bureaucrat* is assumed to have a political goal and a certain capability in mobilizing his resources for goal attainment in the most efficient and rational manner. He implements policy formulated by the politicians: seemingly apolitical, neutral on any issue, and unconcerned with the policy position assumed by his masters. He wants stability for himself and his organization, prefers job security, shuns transfers or changes in his organization and does everything he can to slow down the rate of change, which threatens his well-being. The bureaucrat does not have to be an individual; it could be an institution, organization or even another state, which is capable of dampening: the direction, the rate of change and the rate of change of change, viz., the superpowers, whose fear of nuclear holocaust helps them dampen any escalation of international tensions. The bureaucrat is happiest when:

$$dy/dt = 0 \qquad \text{(Eq. 5-5)}$$

and any change in its value, negative or positive, worries him. Being a rational actor he uses the proportionality principle to prevent change:

$$P_1 \propto dy/dt$$

$$\text{Therefore, } P_1 = -b(dy/dt) \qquad \text{(Eq. 5-6)}$$

where b is a positive constant; and the negative sign implies that the pressure is being applied in the opposite direction. If $b = 0$, the bureaucrat is incapable of mobilizing resources, hence impotent or incompetent.

The goal of the bureaucrat is to stop any political change by applying pressure.

$$\text{Therefore, } P = P_1 \qquad \text{(Eq. 5-7)}$$

where P is the resultant pressure to counter the action of the system.

$$\text{Therefore, } a(d^2y/dt^2) = -b(dy/dt)$$

$$\text{or } a(d^2y/dt^2) + b(dy/dt) = 0 \qquad \text{(Eq. 5-8)}$$

The solution of the above equation describes the state of S as a function of time, t.

$$\text{Therefore, } y = k_1e^{-mt} + k_2 \qquad \text{(Eq. 5-9)}$$

where the exponent coefficient $m = b/a$; m thus varies directly with b, or the political capability of the bureaucrat, and inversely with a. The bigger the m, the faster the system S, reaches equilibrium.

Therefore it appears from the second-order differential Equation 5-8, that the bureaucratic process is one of exponential decay (32).

Figure 5-6 illustrates the exponential decay of bureaucratic action when $k_1 > 0$, or positive. At initial time, $t = 0$, S is at $y_o = k_1 + k_2$ and moving gradually to a position of stable equilibrium $y_e = k_2$. If we assume the position of equilibrium as the zero point, then:

$y = k_1 e^{-mt} + k_2$, becomes

$$y = ke^{-mt} \qquad \text{(Eq. 5-10)}$$

The politician is more interested in his policy position with respect to his political goal and least interested in the stability of the system, S. Let the politician's position be represented at zero on the issue continuum. He applies his pressure, P_2, to move y in either direction to bring it closer to his position on the issue continuum. The greater the absolute value of y, the greater is the threat to his policy position,

Therefore, $P_2 \propto |y|$

$$\text{or } P_2 = -cy \qquad \text{(Eq. 5-11)}$$

where c is a positive constant.

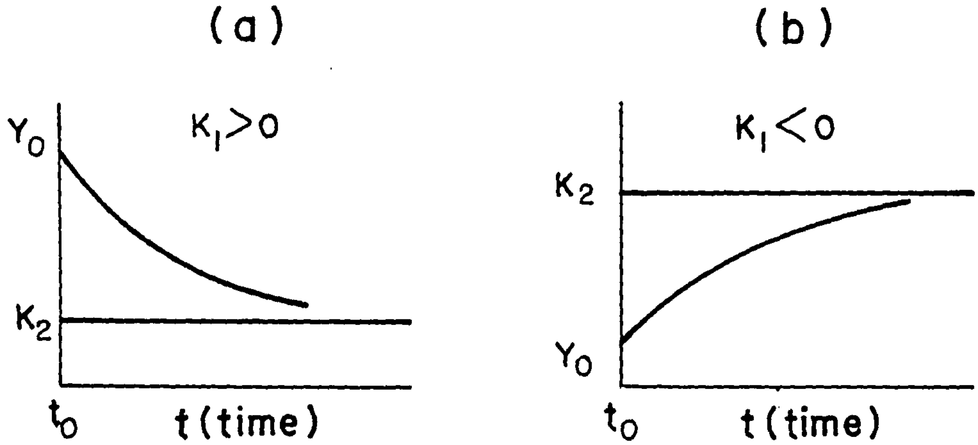


Figure 5-6. Bureaucratic process along time, t. When the constant k_1 is positive, the process decays exponentially. k_2 is the level of saturation (32).

Therefore, $P = P_2$

$$a(d^2y/dt^2) + cy = 0 \quad \text{(Eq. 5-12)}$$

When the above Equation 5-12 is solved, we get the state of the system as a function of time.

$$y = k_1\cos(u.t) + k_2\sin(u.t) \quad \text{(Eq. 5-13)}$$

where $u = (c/a) \exp 0.5$

The effect of the politician's action creates an oscillatory process which makes the system S move back and forth around his policy position called the unstable equilibrium position (32). This is why the bureaucrat considers the politician as a baseless vase (Figure 5-7).

The process has a cycle, T

$$T = 2\pi((a/c) \exp 0.5)$$

and an amplitude, R

$$R = (k_1^2 + k_2^2) \exp 0.5$$

The <u>anarchist's</u> political goal is opposite to the bureaucrat and he cannot stand any form of organization. His goal: destruction; his

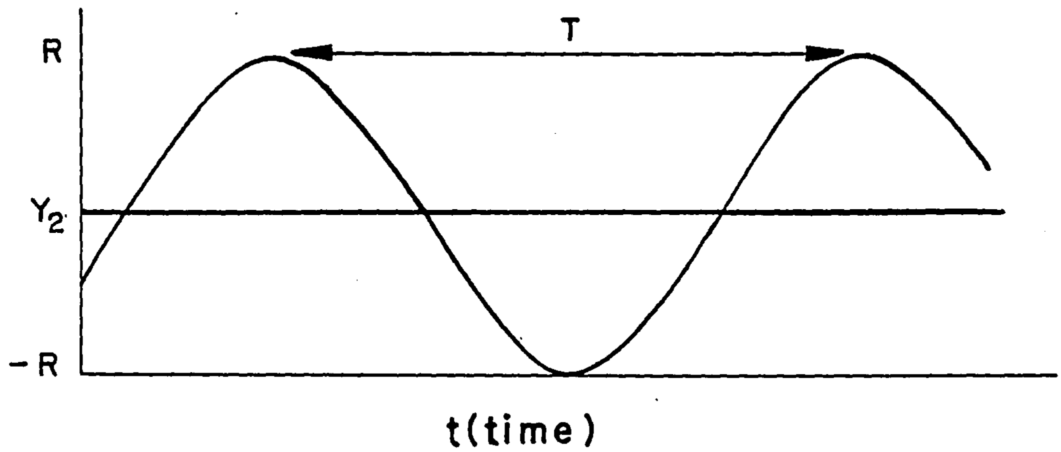


Figure 5-7. The political process in a system where the politician is the only actor. $Y_2 = 0$ is the policy position of the politician. The process has a cycle T, and an amplitude R (32).

strategy: change of the system as fast as possible to prevent any routinization. The anarchist is mostly active during revolutionary periods (32). However, Ben-Dor (11) equates anarchism to terrorism: "an act designed to influence political behaviour by extra-normal means by generating fear, uncertainty, anxiety, insecurity; the actual use of threat of violence."

If the system is moving to the right, i.e., there is a rightist movement in progress, the anarchist will push it to the right and vice versa.

$$P_3 = g(dy/dt) \qquad \text{(Eq. 5-14)}$$

where g is a positive constant.

Therefore, $P = P_3$, and

$$a(d^2y/dt^2) = g(dy/dt)$$

$$\text{Therefore, } a(d^2y/dt^2) - g(dy/dt) = 0 \qquad \text{(Eq. 5-15)}$$

The solution of the above differential equation describes the state of S under the pressure of the anarchist as the only actor.

$$y = k_1e^{jt} + k_2 \qquad \text{(Eq. 5-16)}$$

where $j = g/a$.

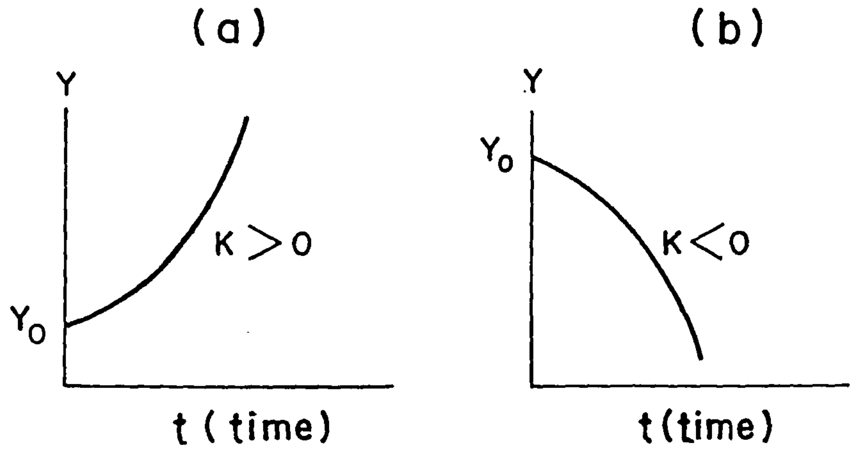


Figure 5-8. The exploding process of political change generated by the action of the anarchist: (a) the rightist revolution; (b) leftist. At $t = 0$, S is at $Y_0 = (k_1 + k_2)$ (32).

The system undergoes a process of exponential growth/decay without any limit; how fast it reaches the point of collapse depends on the exponent jt, since j and g are Anarchist's capabilities and

$$j \propto 1/a$$

as illustrated in Figure 5-8.

This brings us to the frustrated but excited citizen who does not understand the policy proposed by the politician to be implemented by the bureaucrat, and who, in turn has his hands full with the anarchist trying to undo his status quo. This person known as the excited citizen, or charismatic follower usually causes the emergence of a charismatic leader, eg., Germans supported Hitler; Chinese cultural revolutionaries hoisted Mao; Iranian revolutionaries recalled Khomeini, etc.

The excited citizen applies P to move the system, S, away from the status quo, (y = 0).

$$P_4 = hy$$

where h is a positive constant.

Therefore, $P = P_4$

or $a(d^2y/dt^2) = hy$

Therefore, $a(d^2y/dt^2) - hy = 0$ (Eq. 5-17)

Solving this differential equation gives us

$y = k_1e^{rt} + k_2e^{-rt}$ (Eq. 5-18)

where $r = (h/a) \exp 0.5$

as t increases, k_2e^{-rt} approaches zero; and y k_1e^{rt}, an exponential growth.

In both cases of the anarchist and the excited citizen the system collapses if there is no intervention (32) Iran is a perfect example.

Politician and the excited citizen are policy-oriented actors, while bureaucrat and anarchist are process-oriented. Politician and the excited citizen have opposite signs and bureaucrat and anarchist have opposite signs.

Therefore, $P_{2,4} = P_2 + P_4 = -cy + hy$ (Eq. 5-19)

$= (h - c)y$

$= C.y$ (Eq. 5-19a)

Therefore, $P_{1,3} = P_1 + P_3 = -b(dy/dt) + g(dy/dt)$ (Eq. 5-20)

$$= (g-b)dy/dt$$

$$= B.(dy/dt)$$ (Eq. 5-20a)

Coefficients B and C may be positive, negative or zero, depending on the results of the balance of power between the bureaucrat and the anarchist (32).

An <u>external agent</u> is any other influence which affects the system in a way unlike the four political actors. The political pressure P_5 of the agent is expressed as a function of time.

$$P_5 = f(t)$$ (Eq. 5-21)

Table 5-2 describes succintly the various pressures the external agent can exert.

Table 5-2. <u>The external agent and his pressure</u>

Type of pressure	Effect
$P_5 = s$	a constant external pressure to move the system to the right ($S > 0$) and left ($S < 0$)
$P_5 = st$	an escalating pressure, e.g. the price of a natural resource
$P_5 = se^{nt}$	an exploding pressure
$P_5 = s\cos(nt + q)$	a cyclical pressure, such as business cycles

If the national policy is detrimental to the well-being of the majority population, the anarchist may join the excited citizen, i.e.,

$$P = P_3 + P_4$$

$$a(d^2y/dt^2) = g(dy/dt) + hy$$

$$\text{Therefore, } a(d^2y/dt^2) - g(dy/dt) - hy = 0 \qquad \text{(Eq. 5-22)}$$

$$\text{or } y = k_1(e \exp (v+s)t) + k_2(e \exp -((v-s)t)) \qquad \text{(Eq. 5-23)}$$

where $s = g/2a$ and $v = ((g^2 + 4ah) \exp 0.5)/2a$

Thus both the anarchist and the excited citizen contribute to the development of a dangerous situation since the exponential coefficients s and v are increasing functions of g: the capability of the anarchist, and h: the capability of the excited citizen. The system inertia, a, can slow down the decay or the exponential process but cannot stop it from its ultimate collapse.

The curve demonstrates a combined growth and decay and whosoever is dominant, i.e., the anarchist (decay) and the excited citizen (growth) shall indicate cumulated decay or growth in the consequent period to the collapse. In more complicated systems all five actors may demonstrate their relative strength; a complicated pattern may emerge such as Lebanon after Israeli invasion of June 1982.

In our particular case the pattern does not develop into a stability situation because the decay never counterbalances the growth similar to post-Shah Iran.

We have demonstrated intra-state conflict using mathematical models. In case the system becomes unstable when either the anarchist or the excited citizen, or both, bring their force(s) against the bureaucrat (military and civilian) and the status quo politician (legislators appointed by the executive or a parliament elected by a few, including rigged elections). Such examples have been found in the 1970s:

1. the fall of South Vietnam (1975); and
2. the fall of the Shahinshah of Iran (1979).

In the former case the anarchist pushed the system as fast as he could causing eventual collapse; and in the latter the excited citizen pushed the system towards his policy goal until the decay oscillated in his favour.

Let us examine if such a conflict situation can develop in any other area of the world which bears strategic significance to the Western interests.

In Chapter 6 we shall examine just such a state and try to understand the implications for the West and the policy that the West could initiate if it desires to prevent such a negative situation from developing.

6. SYNCRISIS: INFORMATION, TECHNOLOGY AND WAR

> Considering how many fools can calculate, it is surprising that it should be thought either a difficult or a tedious task for any other fool to learn how to master the same trick... What a fool can do, another can.
>
> Silvanus P. Thompson

> Woe to those nations who made their billions in oil and invested them in Western banks; for them time shall draw no interest.
>
> Anonymous

INTRODUCTION

In Chapter 4 we demonstrated how information generates, grows and decays. The decay point after which the value of information depreciated beyond its usefulness was of special interest to us and we called this point the "half-life" of information. Similarly in Chapter 5 we established certain mathematical models for intra-state conflict between warring factions, whom we classed by their attitudes, goals and behaviours. We saw also how their individual or collective pressures on the state can bring about equilibrium or collapse of the system.

In this chapter we shall view certain cyclic or recurring patterns of information, which if understood can be of great benefit to the technological societies of the West. The underdeveloped or developing societies do not have a technological base. With their extremely high agrarian component, they do not/will not suffer as much from the down-trends as a technologically sophisticated society does. Nevertheless, the sufferings of the latter nations should not be discounted because they do suffer from factors such as droughts, famines, floods, chronic unemployment, diseases, etc., and since they do not have such privileges as "talk shows" or "hot lines" to vent their frustration, they do exhibit certain aggression toward the minority in power, the politician and the bureaucrat.

The aggressiveness of the people in these societies, or the Third World, is demonstrated by the severity of the above factors which may be cyclical due to natural causes (which are cyclical).

TYPHOONS AND ANTI-CYCLONES

When Comrade Nikolai Kondratiev, a Soviet economist, wrote an article in 1926 for an obscure German magazine predicting that the Western capitalist economies lived out a 50- to 60-year cycle, thus contradicting the Marxist credo that they would crumble under their own weight, Stalin gave Comrade Kondratiev a short shift in the salt mines. Western economists were prepared to recognize 4-,5-,9-,16- and

22-year cycles, but a 50- to 60-year cycle was out of the question; and followers of Kondratiev were viewed as UFOlogists of economics (110).

Perhaps it was a self-fulfilling prophecy that after more than 50 years in intellectual Siberia, Comrade Kondratiev has found rehabilitation and respectability in no place other than at the Mayfair. The Society for Long Range Planners met at their headquarters in Belgrave Square, London, on 18 September 1981, to resurrect the long-wave theory of Kondratiev, and its measure of respectability can be gauged only by the staid British corporations' interest to establish long-term planning to analyze the effect of this cycle (Figure 6-1).

There are other cycles: sunspot, housing, marriage/divorce, fertility, etc., but they are too mundane for any interest at this juncture. However, there are cycles which demonstrate certain profundity towards the conduct of war or relative capability which arouse our interest (32,37).

THE CYCLE OF WAR

Doran stated a cycle of national power as a period during which something is established, reaches its peak and declines (37). During this time the nation-state is powerful enough to wage wars.

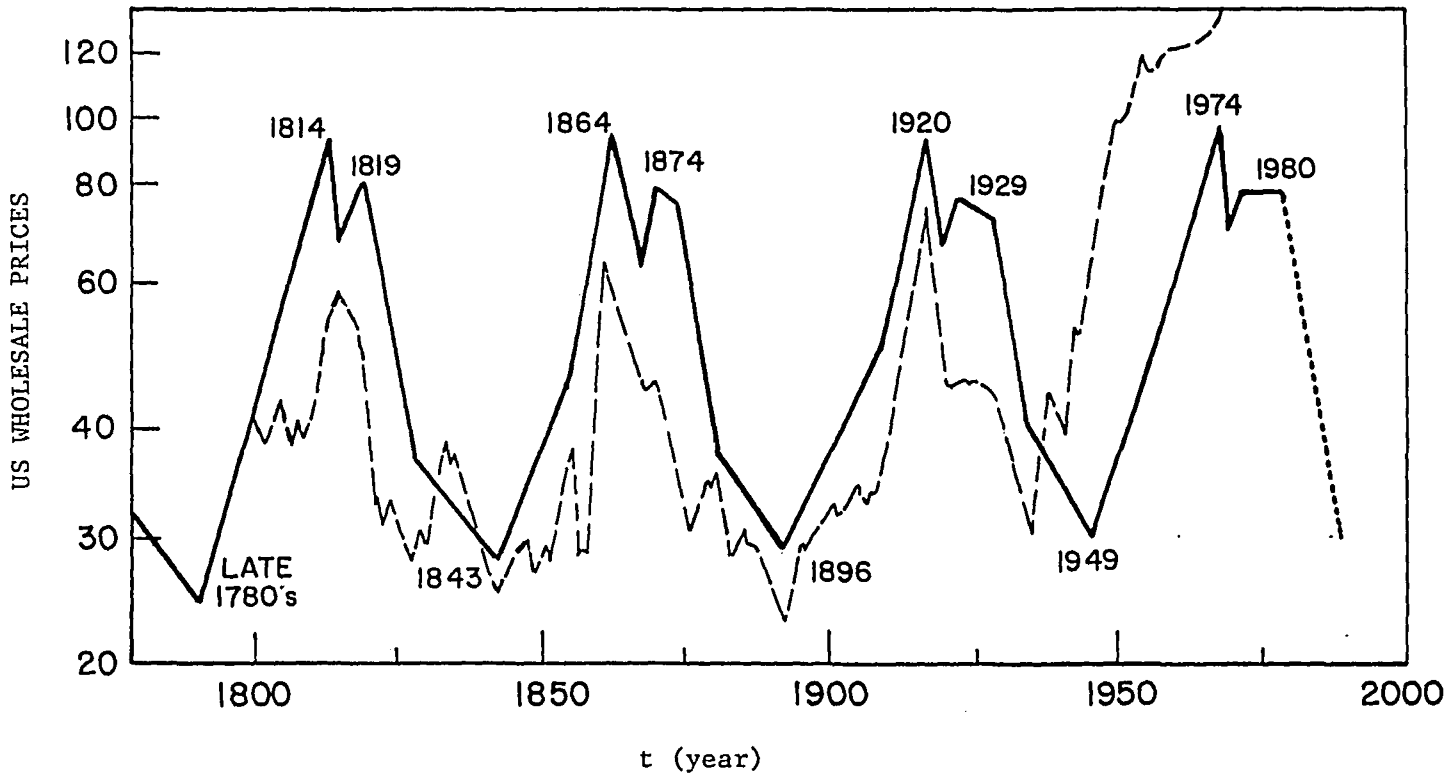


Figure 6-1. Kondratiev's idealized long-wave superimposed on a chart of US wholesale prices, reflects the ever-recurring cycle of inflation and deflation, or credit expansion and debt liquidation (110).

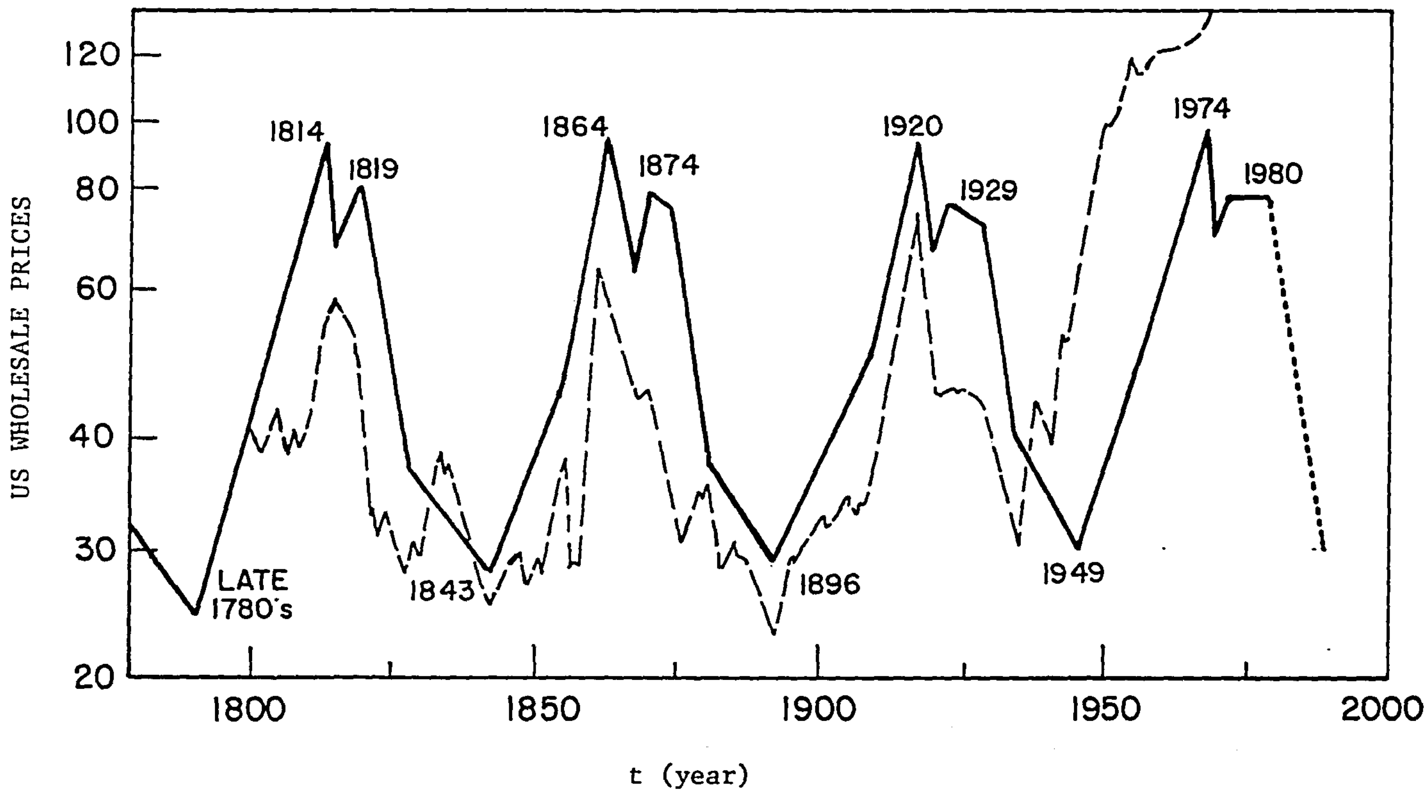


Figure 6-1. Kondratiev's idealized long-wave superimposed on a chart of US wholesale prices, reflects the ever-recurring cycle of inflation and deflation, or credit expansion and debt liquidation (110).

> As the cycles evolve and role changes, significant adjustments are required of the government and the society. The theory further asserts the trauma of the role change is most severe for state leaders at each of the four critical points (Figure 5-1) on the cycle where an abrupt and ineluctable inversion occurs within the dynamics. The critical points are the two inflection points b and d and the two turning points a and c. It is at these points according to the theory that the government is most vulnerable to over-reaction, misperception, or aggravated use of force which may generate massive war (37).

Figures 6-2 and 6-3 are graphic representations of relative capability of nine nations (1815-1975). The fitted curve gives the historic and the potential strength of each nation. With the exception of Japan all Western nations demonstrate decline in their relative capability. Each of the empirically determined relative power curves is supported by the historical record from 1815 through 1970 (37). (Some scores during the last decade appear counter-intuitive; for instance, the USSR apparently enjoyed 24.9 of the system's power, China 24.7 and the US 20.0).

New updated indicators were developed because technology: microelectronics and nuclear, has rendered old ones ineffective. New indicators were defence spending <u>vice</u> armed forces, and GNP per capita vice urbanization (37).

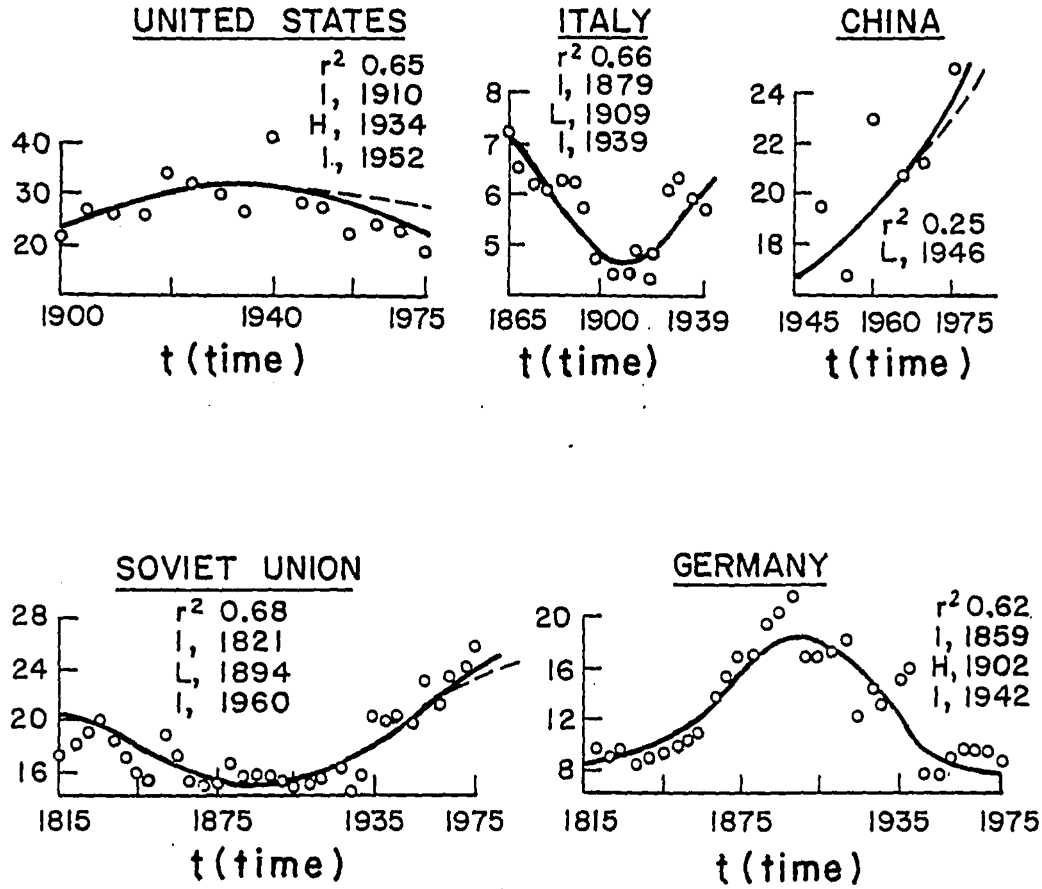


Figure 6-2. Relative power curves for major powers with data points and fitted curves: 1815-1975 (37).

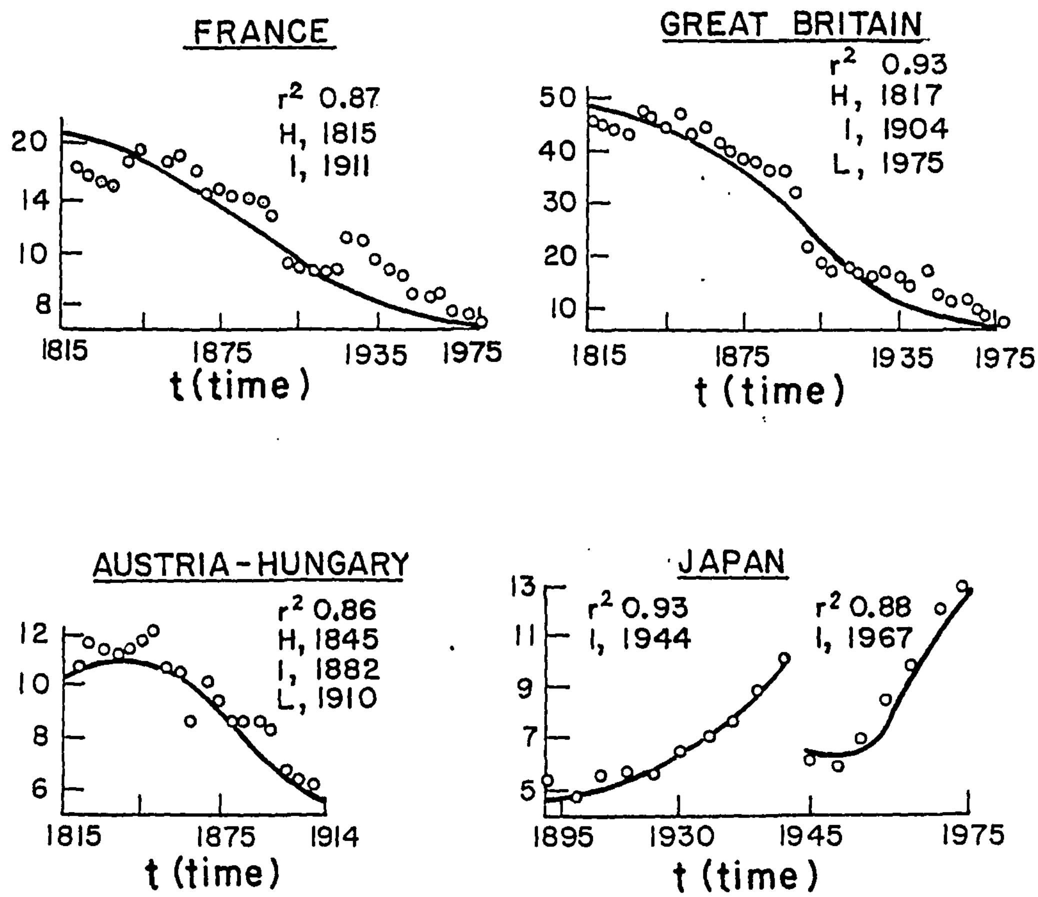


Figure 6-3. Relative power curves for major powers with data points and fitted curves: 1815-1975 (37).

Comparison of the indices for China (PRC), the USSR and the US revealed important facts about relative power dynamics (Figure 6-4).

1. US relative capability as measured by new data increases compared to the old while the Soviet and Chinese capability shows downward change.
2. However, the new data do not change the pattern of relative capability: US trends downwards while both Soviet and Chinese relative capability increase gradually.

THE TURBOCYCLES OF VIOLENCE

Chi (32) states that political violence is a normal method of conflict resolution in the Third World nations, where the "haves" do not wish to give up their power and privileges and the "have-nots" cannot induce change through peaceful means. He expresses violence as a spectrum ranging from denial of basic rights such as a decent living to brutal elimination of the opponents. The extreme and visible form of violence is assassination, "the deliberate extra-legal killing of an individual for political purposes". He cites assassination as his empirical quantifier for violence, exclusive of all other forms of political violence. The information was collected by searching the data bases of:

1. The New York Times,
2. Times of London,
3. Le Monde,

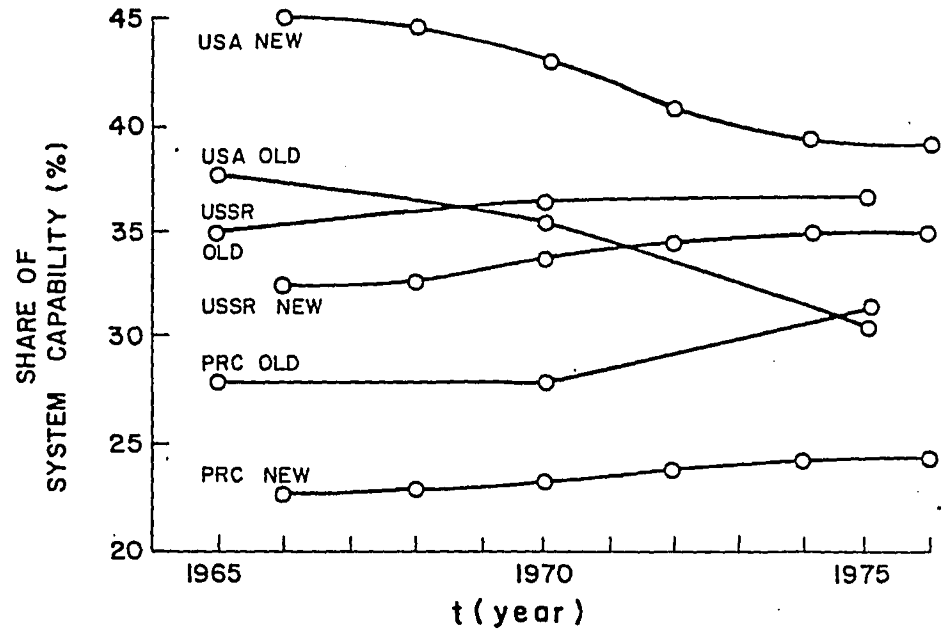


Figure 6-4. Relative power curves for the USA, USSR and PRC: 1965-76 (inclusive). (Source: Handbook of military and social indicators, IISS, 1976).

4. Facts on file and

5. Deadline Data.

The targets of assassinations were limited to:

1. heads of state or government,

2. cabinet ministers and legislators and

3. ranking bureaucrats: judges, generals, top civil servants.

The number of political assassinations is counted for every country in Latin America, then annually aggregated to obtain an annual index for the whole region. To reduce the "contagion effect" of political violence, the moving average Y_i for every two-year period was calculated:

$$Y_i = (Y_i + Y_{i+1})/2 \qquad \text{(Eq. 6-1)}$$

where 1,2,3...i = 1918, 1919, 1920...

and Y_i the number of assassinations in the ith year.

From the above Chi (32) derives the following equation:

$$Y = M_1 + M_2 + M_3\cos(u.t) + M_4\sin(u.t) \qquad \text{(Eq. 6-2)}$$

He assumes the possible presence of the following political actors and their influences on the system.

Actor	Factor
Politician	Oscillation
Bureaucrat	Dampening
Anarchist	Exploding
External agent	Escalation/de-escalation

Coups d'etat in Latin America have fulfilled the same process as elections in Western democracies (Figure 6-5). It seems that there are regular trends in violence followed by periods of tranquility; the oscillatory period (Figure 5-7) is approximately 17 years.

By simulating various values of T (from 16 to 18 with the increment of 0.01), T turns out to be 16.76 years or 16 years 9 months.

Figure 6-5 gives us the last revolutionary upsurges in Latin America in 1959 and 1976: Cuban and Chilean, respectively. A probable revolution is expected then in 1993. But we have to account for the fact there have been no inter-state wars, i.e., between Latin American countries themselves or with an outside power since the end of the First World War (32) or since the end of the Second World War until the outbreak of hostilities during the Falkland Islands crisis. "As a result of a number of treaties in the Western hemisphere there were never any declared wars between Latin American states in the twentieth century" (91). However, this trend may change after 1982 Falklands War, which may trigger a ripple effect.

This raises a very interesting issue. The external agent, the US in this case, served as the damping factor (i.e. was the bureaucrat).

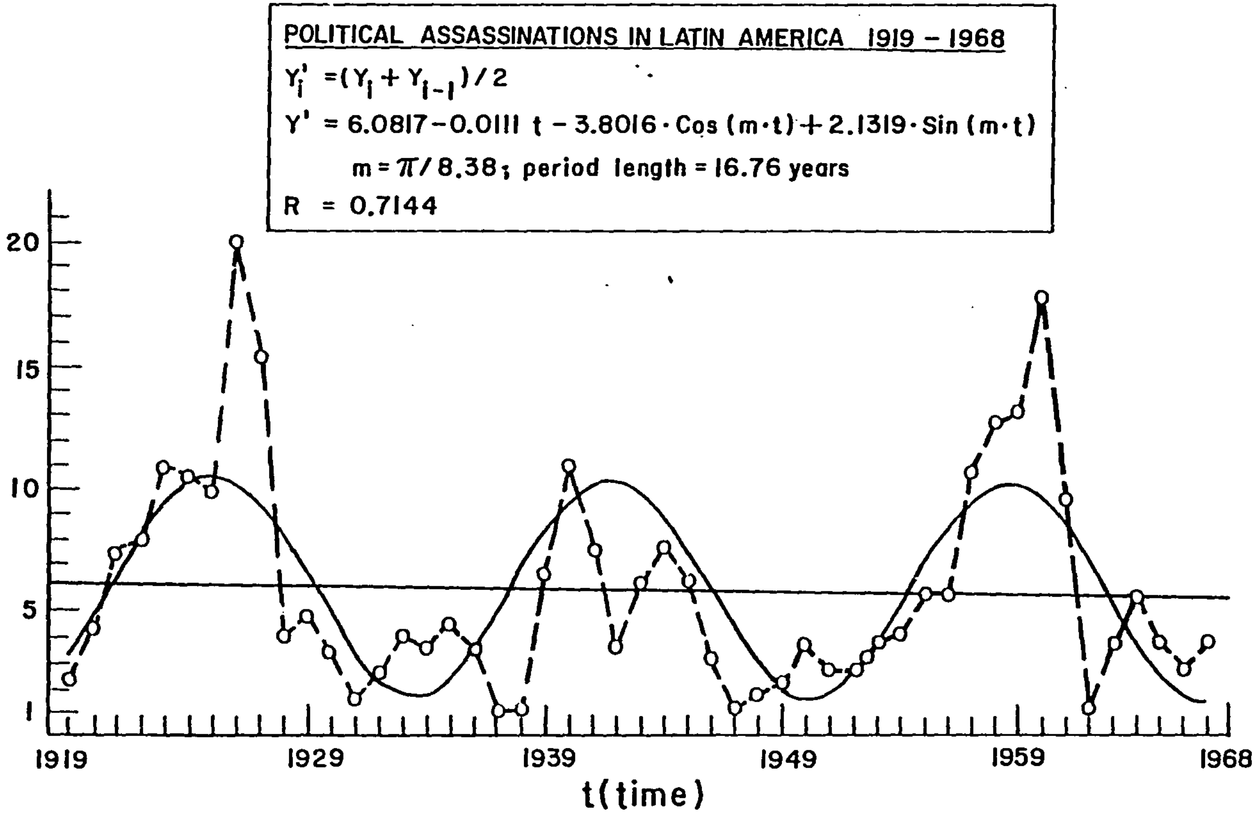


Figure 6-5. The cyclical occurrence of violence in Latin America: 1919-68 (32).

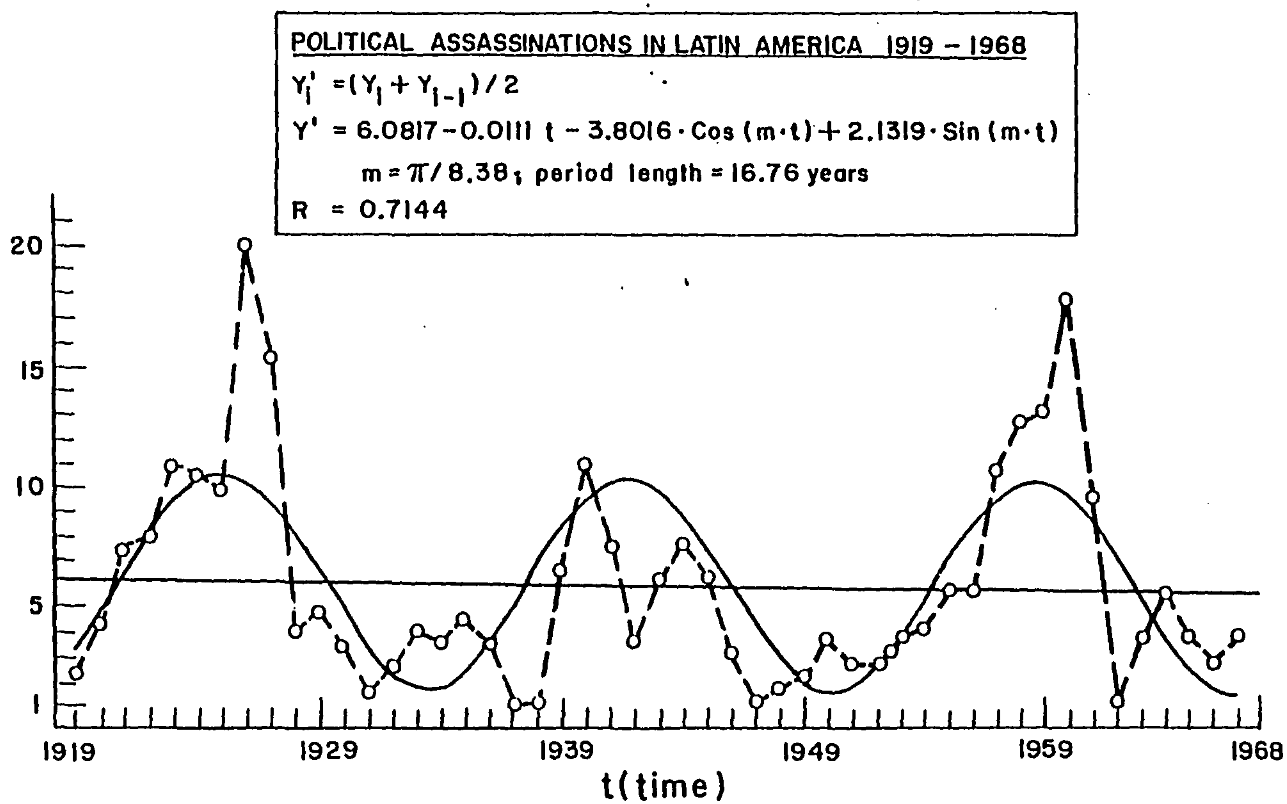


Figure 6-5. The cyclical occurrence of violence in Latin America: 1919-68 (32).

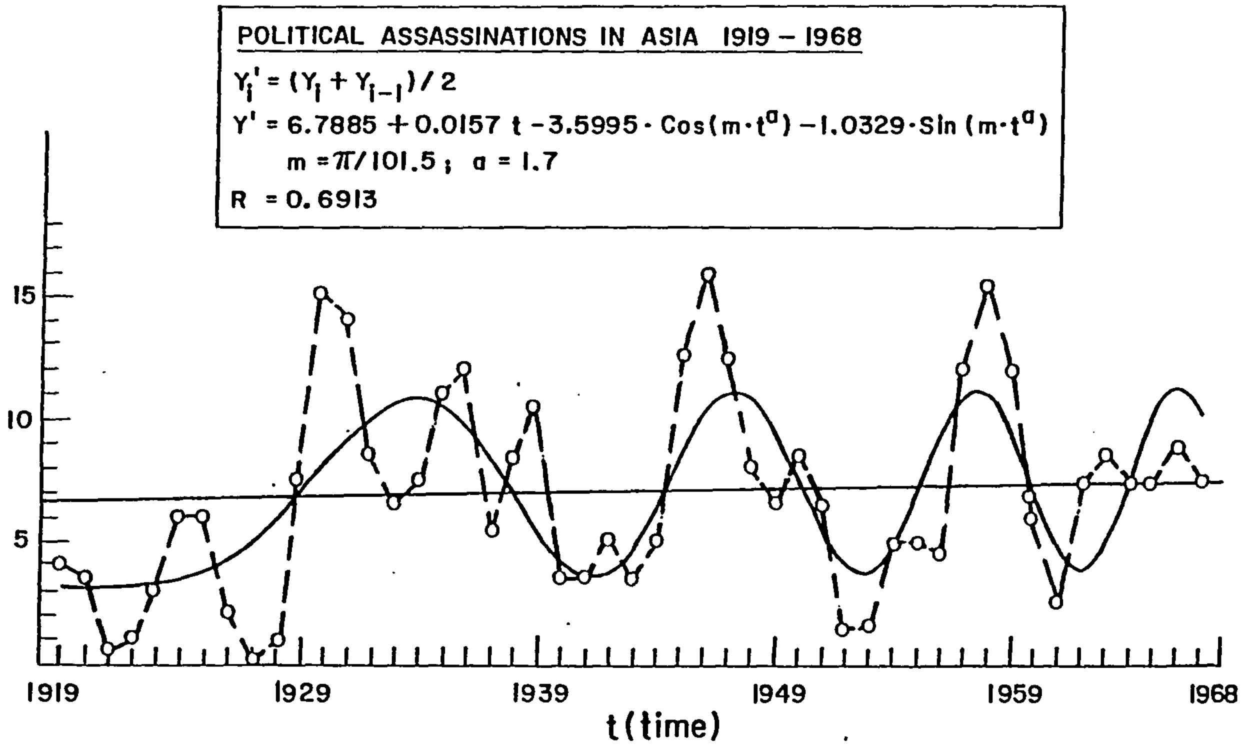
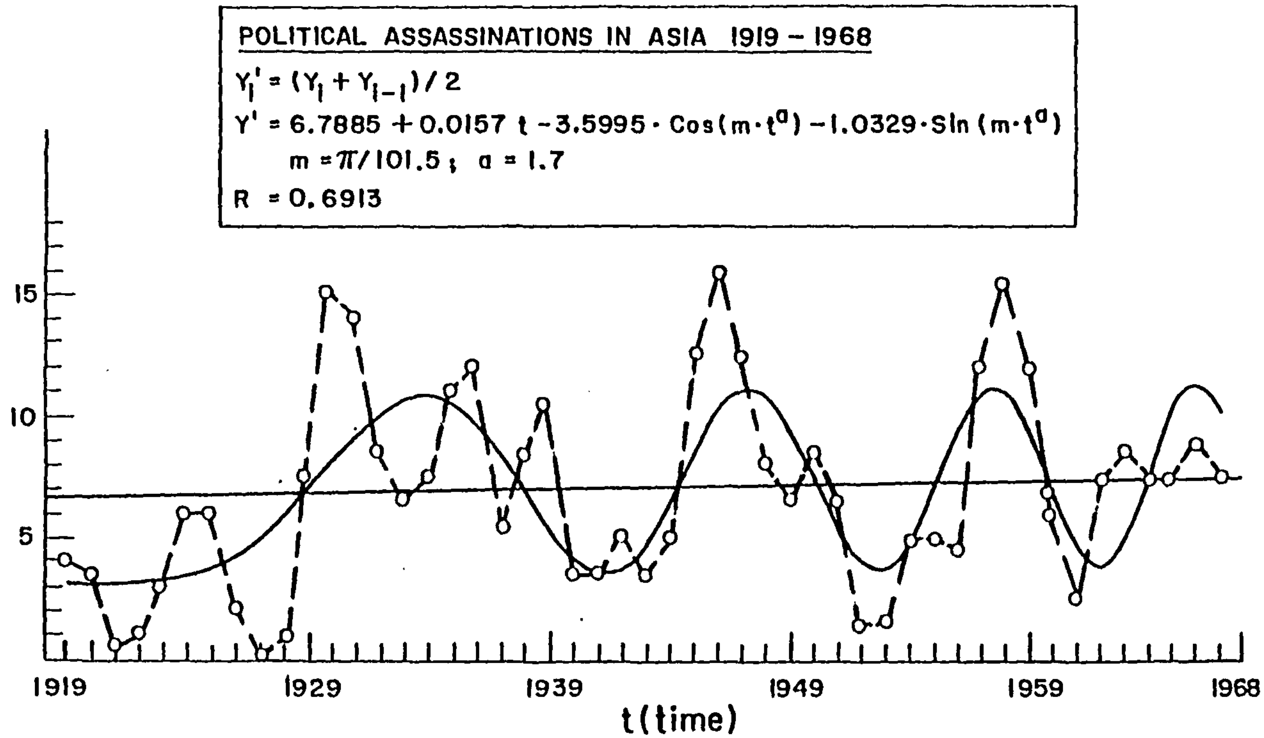


Figure 6-6. The cyclical occurrence of violence in Asia indicates a shortening of the oscillatory period with each cycle: 1918-68 (32).



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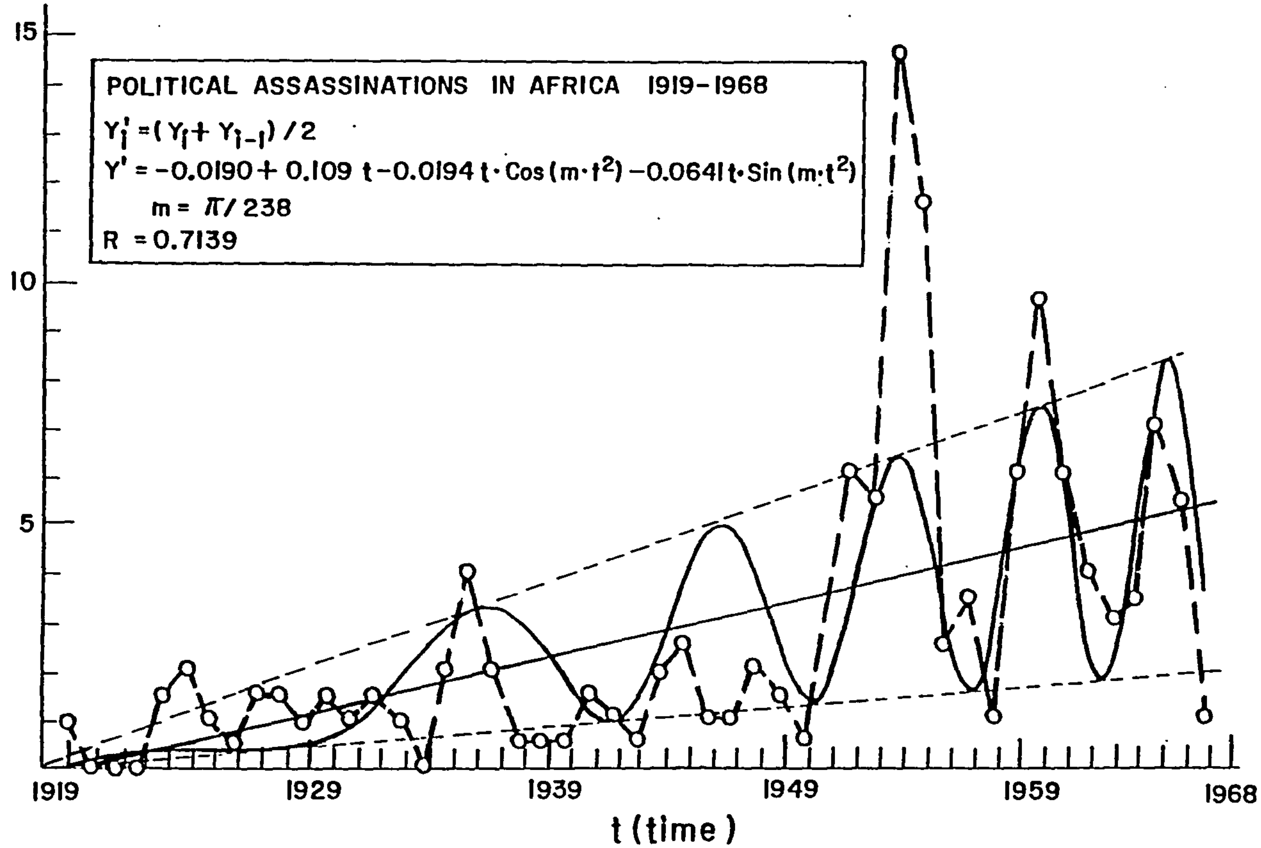

Figure 6-7. The cyclical occurrence of violence in Africa indicates a shortening of the oscillatory period as well as an increase in the range of violence with each cycle: 1919-68 (32).

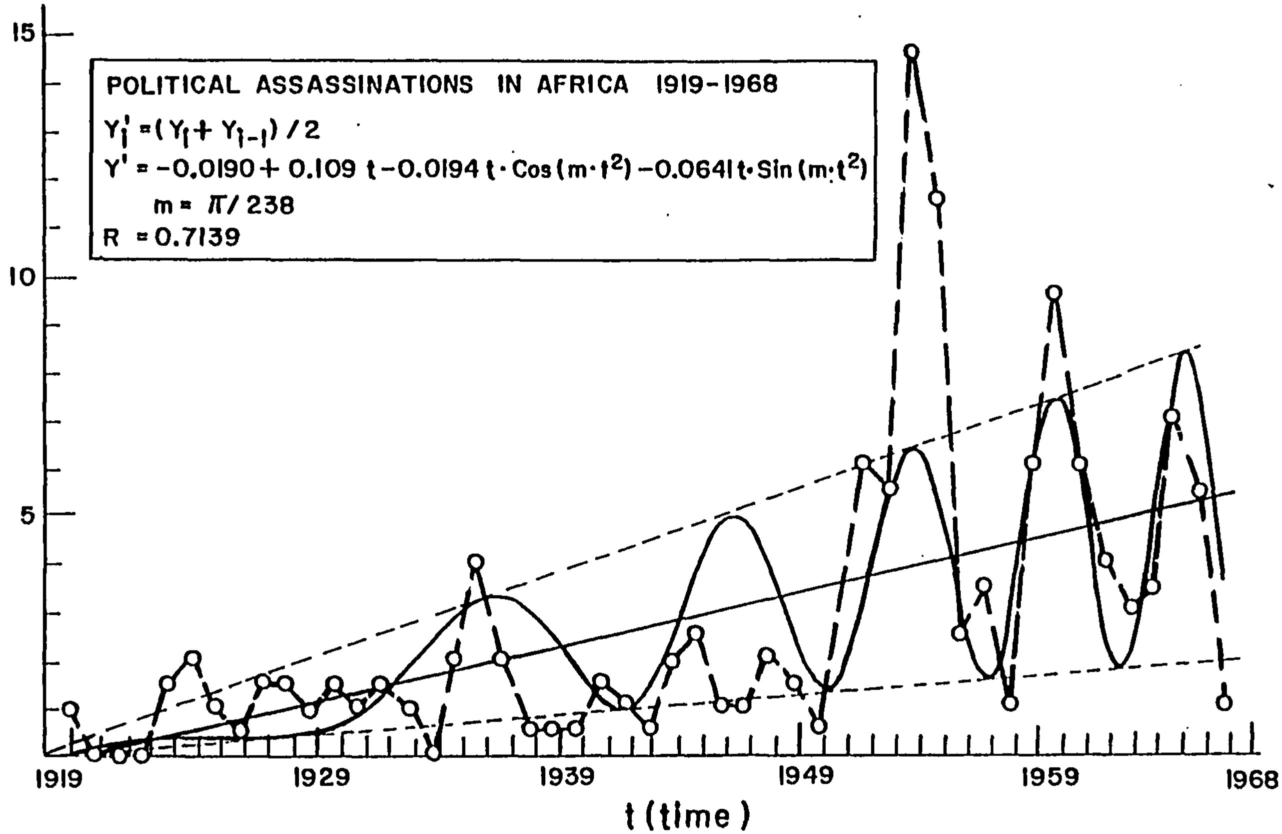

Figure 6-7. The cyclical occurrence of violence in Africa indicates a shortening of the oscillatory period as well as an increase in the range of violence with each cycle: 1919-68 (32).

The inhibitory effect of the US was felt throughout Latin America regardless of the size of the state. The US was the neutral power exerting great influence in the guarantee of the territorial integrity of her southern neighbours. But with the US openly announcing support for the British during the Falkland Islands, the humiliating defeat and surrender suffered by Argentina on 15 June 1982 has added new imponderables. Every Latin American state is now in the process of refurbishing its arms inventories. Although this is being proclaimed as a requirement for Latin American solidarity, in reality it will lead to several inter-state boundary disputes specifically between:

1. Guatemala-Belize
2. Venezuela-Guyana
3. Ecuador-Peru
4. Chile-Argentina

The entire violence equation in Latin America may have to be remodelled in the 1980s, with the oscillatory period, T, altered and shortened.

Similarly, Chi (32) again has demonstrated cycles of political violence in Asia and Africa (Figures 6-6 and 6-7) as he considers parameter u in the equation (Figure 6-5) not constant, but a function of time.

Although in Asia the oscillatory period shortens during each cycle, the range of violence remains constant as in Latin America. But in Africa both the cycles are being shortened and the range of violence is increasing from one cycle to the other. Table 6-1 gives us the difference in the solving of the differential Equation 6-1.

$$Y = M_1 + M_2 t + M_3 \cos(u.t) + M_4 \sin(u.t) \qquad \text{(Eq. 6-1)}$$

Table 6-1. <u>The cycles of violence in Latin America, Asia and Africa</u>

Latin America	Asia	Africa	Effect on
M_3: constant	M_3: constant	$M_3 = m_3 t$	Range
M_4: constant	M_4: constant	$M_4 = m_4 t$	Range
u: constant	$u = m.t^{s}$*	$u = mt^{s}$	Cycle length t

* s is estimated by using the simulation method to find a value which maximizes the best-fit between models and the observed reality. s for Africa = 1.00; Asia = 0.70.

We must, therefore, conclude that the escalation of violence in Africa is highly probable which may push the continent or parts thereof into a radical systemic change. This buttresses the hypothesis to be advanced in this chapter that South Africa may become the probable area of conflict between its black majority and the white minority in power. Also this is the last remaining country (with the exception of Namibia (South West Africa) which is under South African control) where the natives have no rights of expression for political change through democratic means (votes and elections) nor other basic rights such as

Table 6-2. Countries that have moved away from the Western sphere of influence since 1945 (by continental region) (27,30,91,112)

Decade/year	Latin America	Asia	Africa
1940/1949		China	
1950/1951	Guatemala (51-54)		
1954		North Vietnam	
1955			Egypt (55-77)
1958		Iraq	
1959	Cuba		
1960/1960			Guinea
1962		Tibet	Algeria
1963		Syria	
1964			Congo, Mali
1967			Tanzania
1969			Libya
			Somalia (69-77)
1970/1970	Chile (70-73)		
1971			Sudan (71-71)
			Uganda
1972			Madagascar
1974		South Yemen	Benin
1975		South Vietnam	Sao Tome and Principe
		Cambodia	
		Laos	
1976			Angola
			Equatorial Guinea
			Cape Verde
			Guinea-Bissau
			Mozambique
1977			Ethiopia
1979	Nicaragua	Iran	
1980/1980		Afghanistan	
1982			Mauritius

The point of departure from the Western sphere is determined when either the nation sought ties with the Communists: USSR-Cuba or China; or when the US broke ties with that country.
Parenthetical dates indicate when a nation returned to the Western sphere due to:

(a) destabilization by the US in Latin America; or,
(b) economic or military pressures by the Communists in Africa.

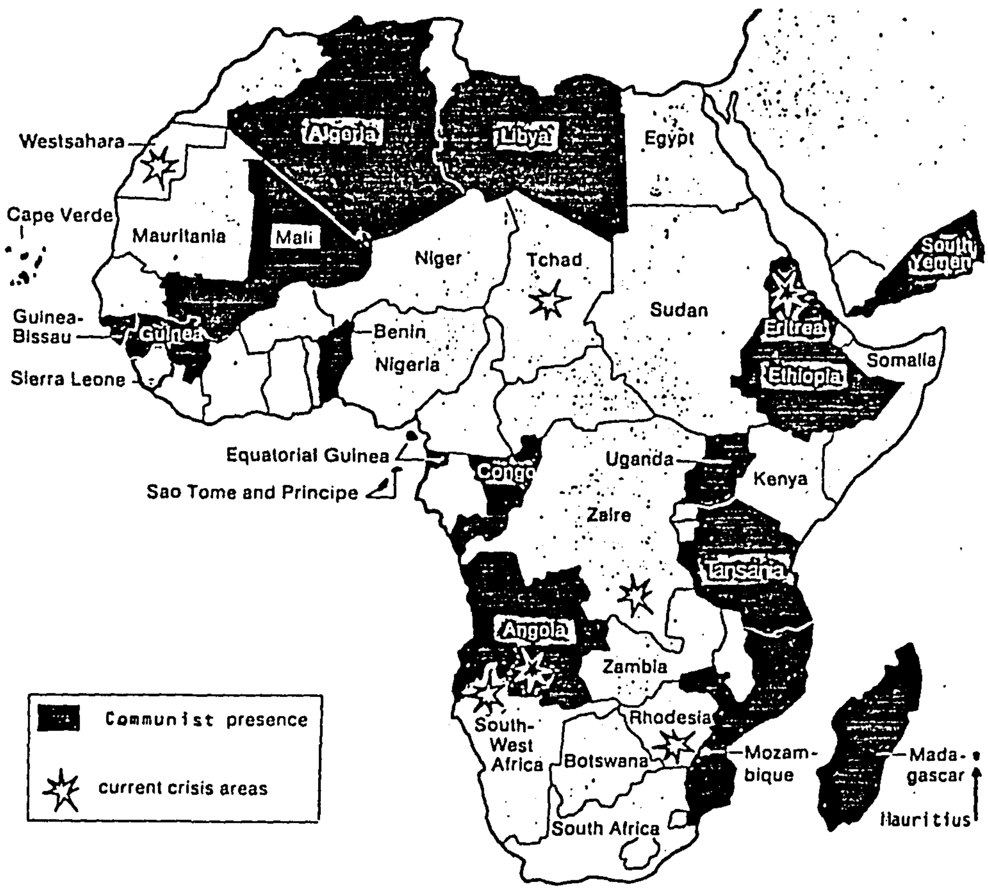

Figure 6-8. African countries which have moved away from Western sphere of influence since 1945, specifically since 1960 with the emergence of new, independent nations (7,27,30,91,112).

decent living and humane treatment: respect of the individual, freedom of movement, freedom of expression, etc.

The Latin American region will definitely pose a serious problem for the West, specifically for the US, where the US has lost the leverage and credibility in 1982.

THE EYE OF A HURRICANE

It is hard to keep down the man in the salt mine. Such reputable institutions as the MIT Alfred Sloan School of Management has recently come to the defence of Kondratiev's long-wave theory. Kondratiev demonstrated working backwards to the eighteenth century and charting British, French and US wholesale prices that showed three peaks in 1814, 1873 and 1920. Also he found similar waves for interest rates. In 1968, Harvard's Professor Dewey found a 54-year cycle in British wheat prices going back to the thirteenth century. Curiously, investigation of Arizona tree rings dating back to 1050 AD suggested a cycle of exactly the same length (110)

> The Kondratiev cycle is recognized to have peaked in 1920. Within 10 years the subsequent "secondary prosperity" had run its course: bankers were throwing themselves out of windows and deflation and depression were the order of the day...(110).

> The implication is that present recession is about to become miserable depression. Inflation could become deflation in the true sense, with prices falling on negligible demand and non-existent credit... Interest rates will decline, which should be good for Consols and other gilts, but share prices will disappear below ground. Given past cycles the depression could last 10 years or more (110).[1]

The chairman of a trust company appeared on 10 June 1982 before the Canadian House of Commons finance committee investigating bank profits and his testimony appeared on the front page of a national newspaper (97).

> Alan Marchment, chairman of the Guaranty Trust Company of Canada and chairman of the association (of Canadian trust companies), told the committee that a Depression-style calamity could overtake the country's economy "in six months or less" (97).
>
> Donald Miller, vice president of The Canada Trust Company, estimated a collapse could come in "under six months" (97).

If this is the advice of trusted officials of the banking industry of a Western nation, then we will have to take another look at Kondratiev's theory. The Canadian dollar fell to 76.82 cents US on 23 June 1982. This value was lower than the Depression low of 80.08 cents (record low) of December 1931 (Figure 6-9) (29). The prime lending

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1. This curiously may take us to 1993, the year we expect revolutionary action in Latin America using the model prior to Falklands war of 1982. Also the Soviet 12-year strategic occupation cycle and the 5-year proxy action doctrines coincide in 1992-93 (Tables 3-2 and 3-3, respectively).

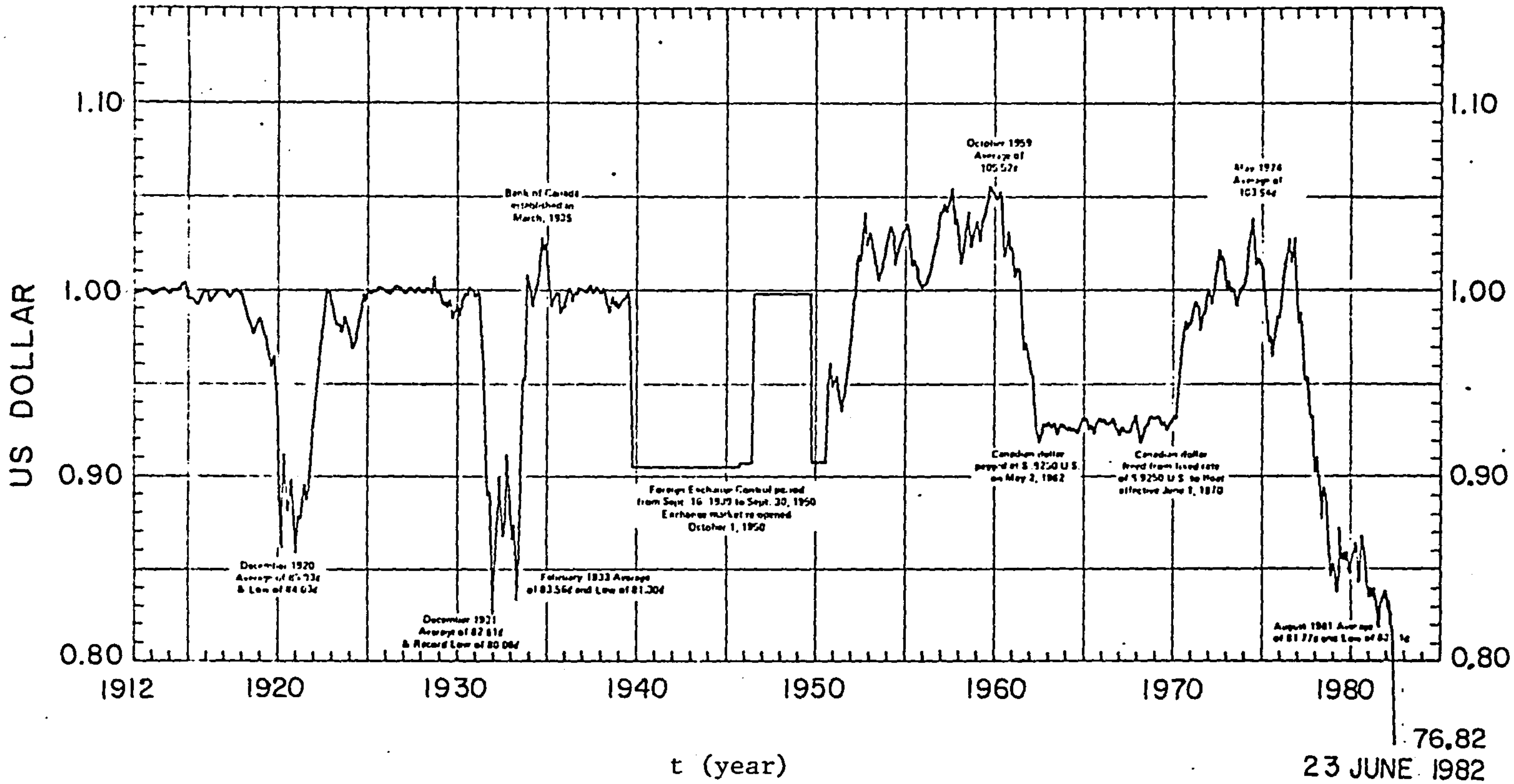

Figure 6-9. The Canadian dollar (1912-1982): monthly average exchange rate in US currency (29). (The breakthrough is ours).

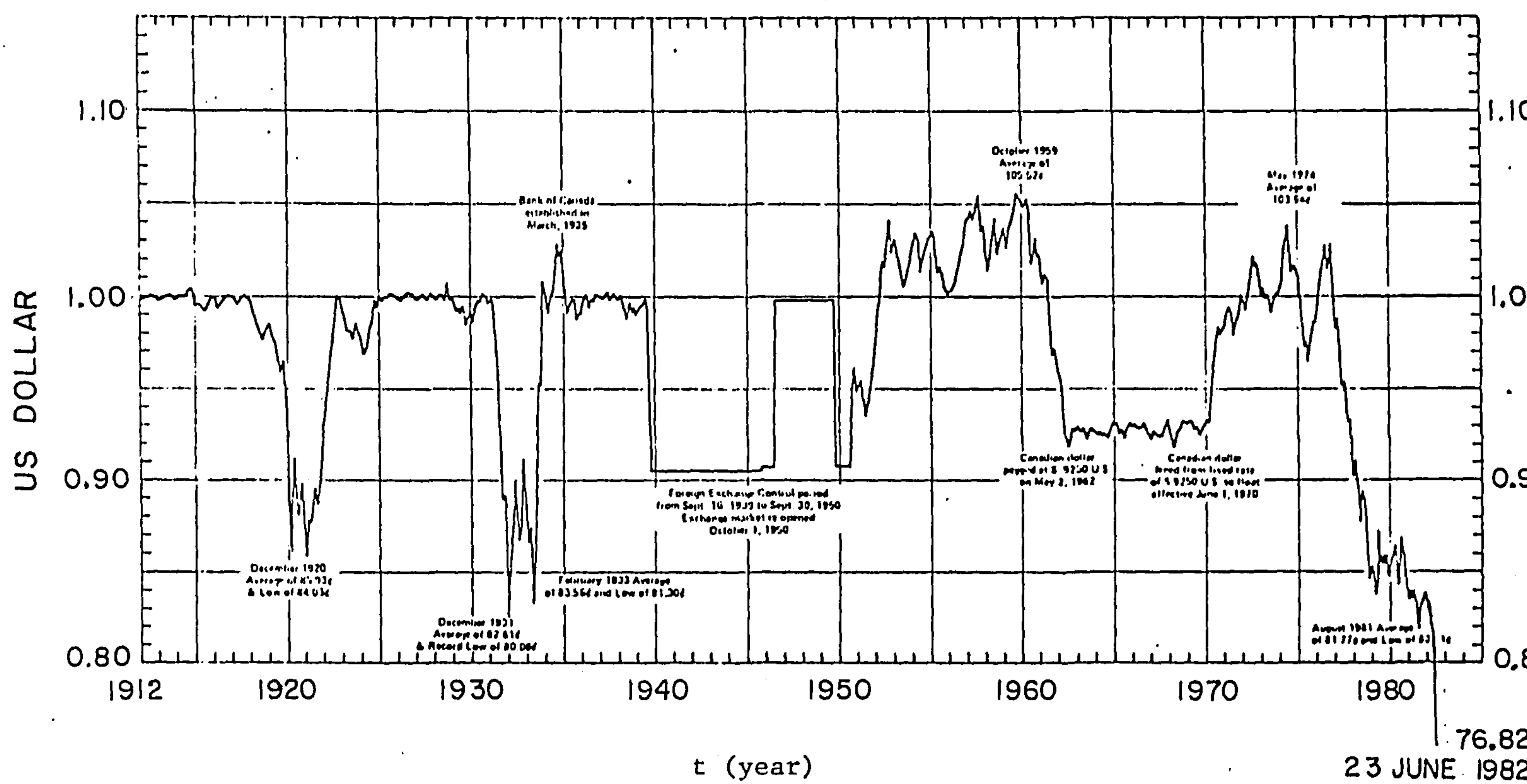

Figure 6-9. The Canadian dollar (1912-1982): monthly average exchange rate in US currency (29). (The breakthrough is ours).

interest rate skyrocketed to 22.75 per cent on 06 August 1981. Business bankruptcies caused by exorbitant interest rates are phenomenally high (1,000 per month). With 65 per cent of the cash flow being paid as interest payment even large corporations may declare insolvencies thus creating an economic cataclysm. If his 54-year cycle is true then the repeat of 1929 is quite probable in 1983. All it will take for this phenomenon to become global from a local Canadian one, is for a debt-ridden cobalt-producing country such as Zaire (discussed later) or the politically-marred Poland to file for bankruptcy. This would also trigger a ripple effect through the Western banking system, creditors to these countries, and their interwoven, incestuous relationships may cause irreversible damage to the economy of the West as a whole. If other debt-ridden countries follow suit and decide to escape their financial obligations the world may see a colossal paraxysm.

THE RAPIDLY PERISHING INFORMATION SYSTEM

We have seen rather well-established trends in long-lived cyclical information systems: a single phase of 2,100 years for the decay of the Egyptian civilization or a relatively short 54-year cycle for the Western economies with a down turn for as much as 10 years, variously called recession and depression. However, we have seen that after each down turn the West, especially, after the worst depression of 1929-39 recoiled and regained its economic strength through the process of war (1939-45).

We have mentioned before that the origin of a total war, which can only be fought in a technological environment, i.e., Europe, may be an escalation of a limited war. Such a war is possible if the economic situation becomes intolerable with energy shortages and a stranglehold over resources by the USSR.

The economic threat would be so great and the civil authority so weak that has made one Canadian military officer to state:

> There are defence planners who suggest that deterrence will only be a secondary consideration to internal conditions when our motorized industrial (technological) society collapses...it will be military who will have priority on mobility: first, to defend against external threat, and second, to maintain the rule of law internally until optional approaches (for alternate fuels) are developed, found effective, and adopted (78).

When a threshold of tolerance is reached, the West will have to decide whether it would accept an economic catastrophe: devalued dollar, shambled economy, fuel shortages, electric brown-outs/black-outs, factory shutdowns and urban disorders; or to take the USSR to task. It could very well be that the USSR may decide to take advantage of a weakened US to assert itself in Europe, an industrial base for its semi-industrialized economy. In any case an outbreak of hostilities is possible and even probable in Europe where the two superpowers have poised themselves against each other for almost four decades.

The European battlefield will be a technological tit-for-tat. If we consider the borders of East and West Germany as the forward edge of the battle area (FEBA), majority of the concentrated targets would be within 90 km (55 miles) and more important ones within 275 km (170 miles) from FEBA. A pre-emptive attack by the NATO forces could neutralize the Warsaw Pact (118). Similarly, 30 per cent of industry, 25 per cent of the population of West Germany is 100 km (62 miles) from FEBA (119).

A British scholar (94) puts the targets in Central Europe much closer, but he is only discussing land targets in a tank battle.

Distance (km)		Target (%)
less than 1		50
1-2		30
more than 2		20
	Total	90

Another British general, Farrar-Hockley (43) envisions surface forces with sufficient launchers which could neutralize tactical air forces in a few days. The Canadian view is that such neutralization can only happen in an electronic countermeasure (ECM) free environment(26). This point has been well proven in the Falklands with the Royal Navy and the British Army destroying a considerable number of Argentine tactical fighters and propeller-driven counter-insurgency (COIN) Pucara aircraft in a relatively ECM-free area.

The destructive power and accuracy of modern weapons make it imperative for the adversaries to develop ECM and electronic counter-countermeasures (ECCM) capability to negate any advantage the enemy may think he has by launching a short-warning pre-emptive attack. A good example was a flight over the Baltic Sea in 1968 of a lone Soviet aircraft which created a cloud to baffle NATO ECM; and soon thereafter the entire Warsaw Pact theatre was hidden from the NATO radar network. When a second such incident occurred in August, 1968, the Soviet armed forces invaded Czechoslovakia, without an inkling to the West of a massive military movement.

INFORMATION WARFARE ON THE TECHNOLOGICAL BATTLEFIELD

The Charge of the Light Brigade, the Battle of Waterloo, the naval engagement off Jutland, the Argentine attack on Falklands, etc., are examples of poor C^3I. Such errors frustrate battlefield or tactical commanders and can lead to the loss of the battle itself. But all this has changed due to scientific research in information transfer and technological developments, and their operational or war application on the battlefield.

Detection is synonymous with destruction, states a Canadian officer (78). With fire-and-forget surface-to-surface missiles working on thermal-signature or heat-seeking mode, remaining hidden on the battlefield becomes more and more difficult. If there is a war in Europe the technological attrition will be immense with all the systems and countersystems prevalent on the battlefield. It will be difficult to determine the victor from the vanquished.

Appendix C discusses the West's capability to control and disseminate information on the battlefield. Let us see if the USSR has such technology. We discussed in Chapters 2 and 3, the F-104 Starfighter being the most superior aircraft in the world in the 1960s. We also mentioned that it was the mainstay of the Pakistan Air Force in the wars with India in 1965 and 1971. Although it proved its technological superiority in the 1965 Indo-Pakistan war, something else happened to this technology in 1971.

> During the last Indo-Pakistan war in December 1971, Indian strike aircraft repeatedly succeeded in making low-level penetration of up to 160 km (100 miles) into Pakistani air space. Flying at night, they repeatedly located and attacked their targets with great precision. In addition to aircraft specially (sic) suited to this strike role such as Su-7s and Canberras, the Inadian Air Force also used An-12 military transport aircraft converted into bombers which dropped palletized bomb loads of up to 16t from their rear loading ramps haphazardly over populated areas. These aircraft generally took off from their base at Chandigarh, 230 km (140 miles) north of Delhi, to attack targets in the Sialkot, Gujranwala, Lahore, Lyallpur, and Multan areas (31).

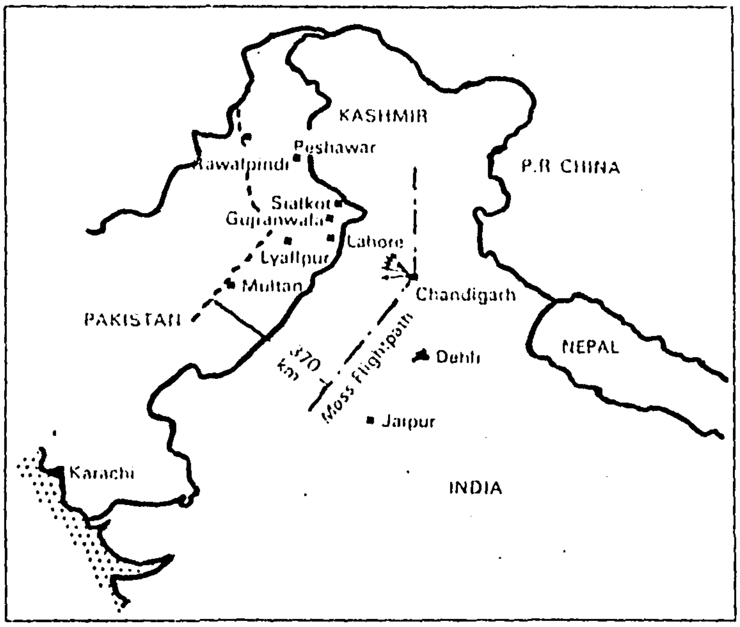

Figure 6-10. As early as 1971, during the Indo-Pakistan war, a Moss aircraft flown by a Soviet crew served as the Indian early-warning and control centre. Strike aircraft of the Indian Air Force were guided by Tu-114 Moss to targets up to 185 km behind Pakistani lines. The Moss itself remained a safe distance away from the Pakistani border, over Indian territory at an altitude of 6000 m and under the cover of Indian SAM defences. The strike aircraft (in addition to Canberra and Su-7 included An-12 Cup transport converted into bombers) operated from their base at Chandigarh, 230 km north of Delhi (31).

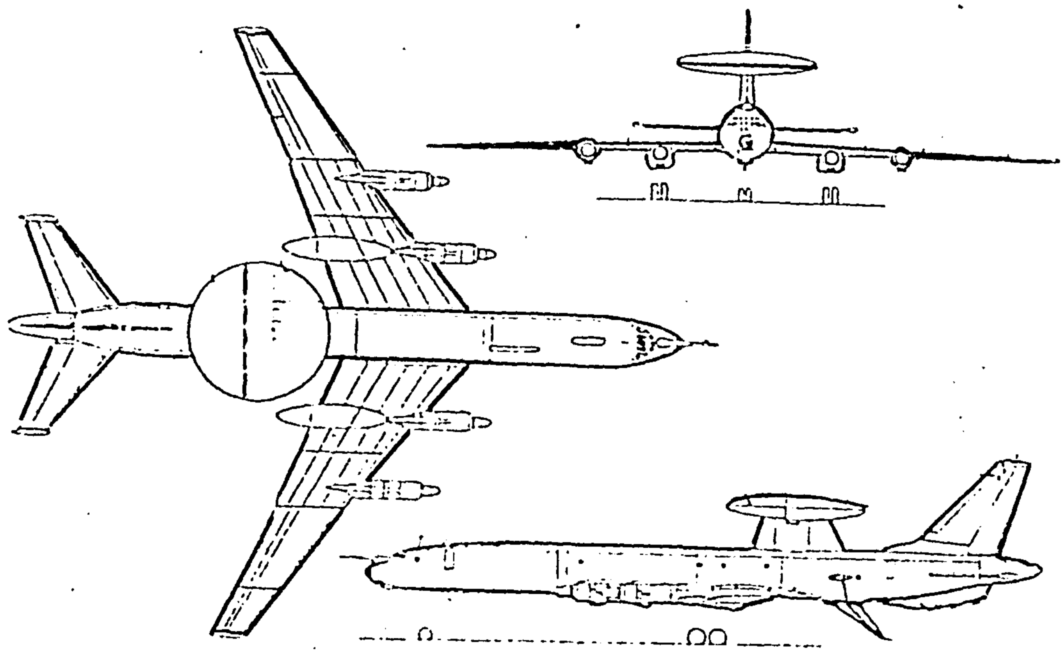

Figure 6-11. Tu-114 Moss, the Soviet early-warning aircraft operationally tested by the USSR in the India-Pakistan war of 1971, a decade ahead of its counter-threat, the US E-2C's active test during the Israeli-Syrian air battles in Lebanon in 1982 (31).

> The Pakistani air defence...could not manage to effectively counter these repeated night penetrations by the Indian aircraft. They did, however, confirm the presence during each of these attacks of a lone aircraft flying at an altitude of 6,000 m (20,000 ft) always a safe distance from the Pakistan border, under the cover of Indian SAM defenses, and this was eventually given the designation Spider. Pakistani communications intelligence (COMINT) staff claimed that all the operators on board the aircraft, including the Indian radio officer, spoke Russian. The Pakistanis also confirmed the extremely effective ECM of this single aircraft. At this point, it should have become clear to Western observers that the Russians counterpart of the American AWACS had successfully passed its operational evaluation under combat conditions (31) (Figure 6-10).

The initial phase of the Israel-Syrian-Lebanese affray was a test of information science, technology and war. The Israelis using the E-2C Hawkeye aircraft (Appendix C) were able to engage both the Syrian aircraft in dogfights as well as evade, retrieve and destroy Syrian interlocking SAM network in Lebanon's Bekaa Valley.

> Israel's success in tank and air battles against Soviet-made weapons during the fighting in Lebanon has major implications for Warsaw Pact and NATO planners, military sources said yesterday.
>
> During the five days of fierce clashes last week, both the Israelis and Syrians tested new weapons and new technology for the first time in battle conditions.
>
> The Israeli Air Force was guided by Hawkeye radar surveillance aircraft, which were said to be capable of tracking 250 planes simultaneously...(49).

So the Pakistani Air Force US-built F-104 became the target of a superior Soviet technology (the threat) and the Syrian Soviet-built MiG aircraft to the US computer-technology (the counterthreat) and the dialectics of technological innovations and the strategic thinking we discussed in Chapter 3 prevailed.

The crux of technological change lies in the technologies of information, interacting with and amplifying the effectiveness of other technologies. In Chapter 3 we had discussed the Joint Tactical Information Distribution System (JTIDS) and its instant information transfer capability to provide the tactical commander up-to-the-moment information. (The development of the system is detailed in Appendix "C"). In Chapter 4 we established the information decay models. Now we would like to see if these models apply in a real situation. Succintly the epoch of (JTIDS) information on a battlefield is 12.8 minutes, and the half-life of such information is much less as the information starts decaying as the threat becomes ominously large with every passing second. The half-life of such information then is two minutes (Figure 6-12). This signifies that the tactical commander has less than that to negate the threat, by launching his counterthreat. Let us hope that men of vision foresee events before the threats and counterthreats become so large that lest someone will say "may the best information system win."

The rapidly perishing information on the technological battlefield (Figure 6-12) demonstrates a curious similarity to the information decay upon publication (Figure 4-4) such that in both cases information value perishes rather quickly. In the case of battlefield information Figure 6-12 only projects a single item of information. However, myriads of such items of information are being generated in each 7.8125 milliseconds-time-slot and each of these may last a 12

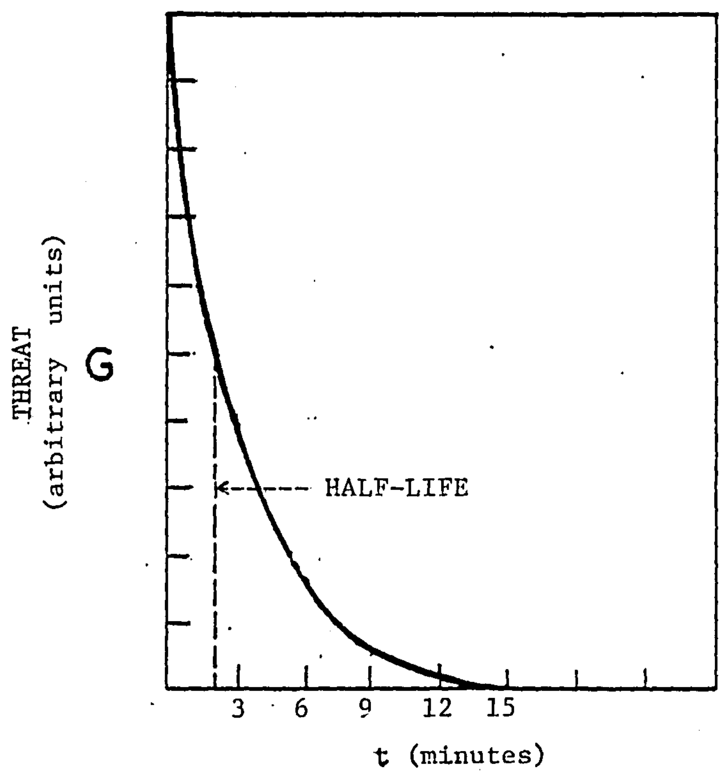

Figure 6-12. Rapidly decaying information during a technological air battle.

second cycle or 12.8-minute epoch. This brings us to an interesting point of supersession of information (Figures 4-1, 6-5, 6-6, and 6-7). In the first figure we see information mounting in a single phase. The latter figures demonstrate cycles of repetition or waves, similar to air battles where a threat appears in waves (or force) and decays when challenged by counterthreat.

Thus we have established that battlefield information behaves in the same manner as the scientific information or information collected during peace time. The only difference in these two cases is that decay is compressed by the environment variable, time, during war.

Consider an information source that broadcasts once every epoch. The storage channel receives the message and stores it until it is updated at the corresponding point in the next epoch. This is similar to Grum's idea of periodic replenishment of information (55). In terms of the storage channel which holds the message perhaps for up to 12.8 minutes, we can explicitly apply the notion of half-life or 50 per cent usage of the information. However, in these cases of life-critical but exceedingly ephemeral information we can extend the discard point to more than one half-life, which we have established at 2 minutes. If we use two half-lives, we expend 75 per cent of information (Table 4-6). In Table 6-3 we elaborate this usage.

Table 6-3. Half-lives versus information utility

Number of half-lives	Time (minutes)	Information decay (%)	Remaining information (%)
1	2	50	50
2	4	75	25
3	6	87.5	12.5
4	8	93.75	6.25

After 8 minutes the information has been degraded 93.75 per cent. Since the storage channel retains this information for 12.8 minutes, i.e. 6.25 per cent of information for one-third of the period, it suggests that this time is being wasted on information that is already consumed or whose youthfulness has been expended. In a fast changing environment having no information is maybe better than having misleading information.

If old information is unreliable one is fooling oneself by maintaining it: "You don't know, but you don't know, that you don't know."

The storage channel can be more effectively utilized by dropping the information and storing other material. In fact if we have three channels by staggering them by two half-lives, i.e., every four minutes, one channel is not utilized one-third of the time. This gives us the equivalent of one additional channel, or four channels for the price of three. If six channels are to be established then the turnover of information can be six-fold, the present storage channel. This suggestion should be researched in the ever-expanding information world.

APART SKIN, APART HIDE

In Chapter 5 we discussed in detail the multi-actor scenario and their orientation towards equilibrium or destabilization of a state; and the rationale for limited war by the big powers. Let us see if the rationale and models apply in a real situation.

Suppose we examine a state which has a multi-actor scenario and the ingredients which could create an environment for a conflict situation or may already have reached that state without our apparent (public) knowledge. Also we have to assume this state is of crucial or strategic importance to the West such that the West would not hesitate to apply the doctrine of limited warfare should the situation warrant.

Let us assume the state to be the Republic of South Africa. The reason for choosing South Africa is important not because it is an isolated technologically-oriented state, but because the West's (specifically the US) dependence on the raw material and natural resources it produces. According to various South African public documents (115,116) that country is the largest producer of strategic minerals listed in Table 6-4.

Table 6-4. South African strategic minerals* (partial list)

Mineral	World reserves (%)	Rank	West's reserves (%)	Rank
Manganese	78	1	93	1
Chromium	81	1	84	1
Platinum	75	1	89	1
Gold	51	1	64	1
Cobalt	4	6	6	5

* Figures vary when obtained from different South African institutions because of secret trades and trade secrets.

According to Canadian economic geologist, W.N. Tupper, the US created a stockpile of strategic minerals after the Second World War. But if imports of strategic minerals from South Africa were to be terminated, the US would be in serious trouble within 3 to 5 years.

South Africa has technical problems in the transportation of its raw materials as well. In 1981 South Africa produced a record crop of maize (corn). Of the 7 million tons earmarked for export, the railways could only move 3 million tons. If the railways deteriorate by 20 per cent, it could pose a serious threat to the long-range technological well-being of the West (122). The minerals the US is most dependent upon from South Africa are: chromite, manganese and platinum. (Cobalt comes from Zaire, a country which has serious financial problems).

Chromite is used in variable quantities up to 40 per cent in the manufacture of steel, primarily to give it (122):

1. toughness: the ability to withstand impact;
2. strength: the ability to withstand load; and
3. resistance: the abiltity to inhibit corrosion.

Manganese is also used in the manufacture of steel: 20-22 lb of manganese is used as a scavenger per ton of steel to give it strength and remove brittleness (122). Platinum is used for processing ultra-caustic acids: sulphuric, hydrochloric, hydrofluoric (122), and phosphoric (2). Platinum can also be used as a catalyst in the electrolysis process to produce hydrogen (from water) as a fuel, a trend away from hydrocarbons. There are still other uses under research for platinum, depending upon its continued availability (2). Gold has no strategic value insofar as defence is concerned, but whosoever controls this noble metal can surely bankrupt the West in a very short period. After all the US was the country which had based its economy on cheap gold ($35.00 per ounce) and cheaper oil until 1971 and 1973, respectively.

South Africa is also the only country in the world which transforms coal into oil, a process perfected by Hitler's Germany. It has two plants in operation, SASOL I and II, 120 miles from Johannesburg, and SASOL III is being constructed nearby by the US. All three plants are close together near the coal mines (122).

We have information provided by science on South Africa's potential as a supplier of strategic minerals to the US and the Western nations.

Let us assume that South Africa is a state with three-actor scenario:

A_1 = black majority

A_2 = white minority in power; and

A_3 = coloured (mixed) race, Asians and individuals of moderate views.

Let us also assume that A_2, the white South African government, due to logic intrinsic to itself proposes a policy of universal sterilization of the majority black, A_1, or some other reprehensive and unpopular scheme to radicalize black position. The black citizenry assumes a policy position Y_1 on the extreme left of the issue continuum (Figure 5-1) and opposes the rightist policy at Y_2.

The politician asks the bureaucrat to implement the policy. The citizen becomes excited and is joined by the anarchist whose only aim is to destabilize the system and push it out of equilibrium. Internal strife becomes an intra-state war with the alignment of the forces of the bureaucrat and the politician P_1 and P_2 and those of the anarchist and the excited citizen P_3 and P_4 since the blacks have no experience in politics or bureaucracy due to white minority policy.

We have P_3 and P_4 together as

$$y = k_1 e \exp((v+s)t) + k_2 e \exp -((v-s)t) \qquad \text{(Eq. 5-23)}$$

where $s = g/a$; $v = ((g^2 + 4ah) \exp 0.5))/2a$

The government of the unpopular white minority may collapse, such as that of the Shahinshah of Iran, when it implemented the policy to curtail the traditional salary to the religious leaders (the mullahs). They in turn excited the citizens and Khomeini emerged as a charismatic leader. Similarly, the combined forces of the excited citizen and the anarchist can bring down the system. According to information cycles, (Figure 6-7), the violence in Africa is increasing with both the oscillatory period and the range of violence becoming shorter and more intense respectively (Table 6-1).

We have both the cyclical information about Africa and the information about the dynamic forces within South Africa, which are diametrically opposed to each others' views. In an environment like this, when colonialism has disappeared from the world in general and Africa in particular, South Africa becomes an anomaly and an anachronism.

In the case of South Africa information science can save the day, if the West realizes that the decay can be arrested before it gains momentum. From Toynbee's work (48) and Doran's relative power curves (Figures 6-2 and 6-3) we know that once the decay process begins the capability of the state never returns to its former zenith. Historically we have seen Egyptian, Greek, Roman empires collapse. In the twentieth century the Ottoman (Turkish), British and the French empires have crumbled and the superpowers have emerged. So it is quite feasible for South Africa to become the next Vietnam, Crimean war or the Waterloo, Dienbienphu, Bangladesh for the West.

If the West persists in ignoring the aspirations of the black majority of South Africa, it will have to wake up to the realities of the day, the hour, the moment. The West must reinforce the forces which will bring progressive change and establish equilibrium in South Africa to guarantee a continued supply of strategic minerals for its technological well-being and to maintain its relative capability.

If the South African minority white government collapses by the combined actions of the anarchist and the excited citizen, the US will have two choices, both quite unfavourable.

1. Invoke the third precept learned by the US in the implementation of the doctrine of limited warfare, i.e., no regime which cannot defend itself against a revolution or subversion can be helped through intervention (96) and lose South Africa as it did Iran, which would mean the US would lose its only source for strategic minerals.
2. Defend the South African government to negate the combined actions of the anarchist and the excited citizen which can have two outcomes:

a. A win for South Africa would give the US a breathing spell, such as the one for 27 years in Iran after reinstalling the overthrown Shah in 1952.

b. A loss under this circumstance would mean a total write-off of strategic minerals to a nation which can either be:

(i) hostile, non-aligned and heedless to international pressures, or

(ii) hostile, aligned with the USSR similar to Cuba, Ethiopia, Libya, determined to undo the US at all costs.

If the latter occurs (i.e., 2.b.(ii)) we come to a new set of choices.

1. Accept the loss gracefully of the source of natural resources and look for new technology to provide for the deficiency. The geological adage "what is ore today may not be ore tomorrow and vice versa", can have many interpretations.

a. <u>Substitution technology</u>, or where technology has prevailed in finding replacements for many strategic minerals (122):

(i) artificial diamonds for industrial use;

(ii) silica-carbide (carborundum) for cutting steel and concrete;

(iii) artificial cryolite as flux in the electrolysis process for the manufacture of aluminum vice the real mineral only found in Greenland; and

(iv) nepoleine _vice_ feldspar as raw material for the manufacture of whiteware,

may prevail again in finding new and better substitutions for future uses.

b. _Advancing technology_, or when low grade material can be mined profitably such as (122):

(i) copper being mined from material with less than 0.4 per cent cupric content, same is true of molybdenum; and

(ii) nickel being mined with 100 per cent increase in extraction from Latrite or nickel-bearing soil (1.2 per cent) instead of nickel sulphide (0.6 per cent) since 1977.

c. _Developing technology_, such as new methods of extracting fuels and minerals (122):

(i) petroleum from shale and oil sands; and

(ii) marine mining as there are sufficient manganese nodules on the ocean floor (the reason why Law of the Sea is essential).

2. If the West does not wish to accept the loss of South Africa to a hostile populace with the Soviet backing, then the choice is to fight the USSR or the Soviet policy would further destabilize the economy of the West in general and the US in particular.

If the economic situation is considered bad after the 1982 Versailles summit of the seven most industrialized nations of the world, with 30 million unemployed in the OECD countries, what would the scenario be without the availability of strategic minerals for the West and in particular the US?

The prospects for one giant step to the moon, or even Io, may be the means to the end of a rainbow.

7. "PER ARDUA AD ASTRA"[1]

HIGH FLIGHT

Oh! I have slipped the surly bonds of earth
And danced the skies on laughter-silvered wings;
Sunward I've climbed, and joined the tumbling mirth
Of sun-split clouds - and done a hundred things
You have not dreamed of - wheeled and soared and swung
High in the sunlit silence. Hov'ring there
I've chased the shouting wind along, and flung
My eager craft through footless halls of air.

Up, up the long, delicious, burning blue
I've topped the windswept heights with easy grace
Where never lark, nor even eagle flew -
And, while with silent lifting mind I've trod
The high untrespassed sanctity of space
Put out my hand and touched the face of God.

Pilot Officer John J. McGee, Jr.[2]
Royal Canadian Air Force

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1. "Through difficulties to the stars", motto of the RCAF 01 April 1924 to 31 January 1968 and the Canadian Forces Air Operations Branch (air force) since December 1972. Also the motto of RAF, RAAF, RNZAF, etc.
2. A US citizen, born in China, educated in Britain, terminated his studies at Yale to serve as a Spitfire pilot; composed the sonnet in September 1941. The sonnet was scribbled on the back of an envelope addressed to his mother and was found after he was killed on active service 11 December 1941.

The complexity in attaining the objectives of this thesis was considerable as information science is a relatively new discipline and this is the first known effort to see the ephemerality of information in the fields of technology and war. In that respect a novel approach dissecting several hard and soft sciences as well as history, and mathematics was necessary. In a roundabout way, we have thus proven that information science is both inter- and multidisciplinary.

Our research involved such physical sciences as physics, chemistry and geology; and social sciences: sociology, economics, international relations, political science, etc., with syncretic elements from various other fields. Data had to be collected and retrieved from sundry sources as data bases themselves do not indicate any storage on half-life of information. The construction of the thesis was even more difficult especially in trying to coalesce various discrete elements.

We have concluded that technology is changing rapidly, affecting information to an extent that every change in technology becomes a change in information such that technology becomes, in a sense, information itself. Also we have found that technological innovation is the driving force in moulding strategic thinking or war. The relationship between technology and war we concluded is so close that every change in technology brings about a change in strategic doctrine of war. Thus technology becomes synonymous with war and through implication, with information.

Our major conclusion has been that information perishing or decay is inevitable and is a depreciating function of time; and that information perishes at different rates in different fields and the faster the rate of information growth, the speedier is the decay of such information. The decay differs from radioactive decay only in the fact that information becomes unused and not unusable.

We established a threshold of information usefulness as the point when 50 per cent of the information is utilized; or when half of the total information has depreciated or perished; or when half of the total use of information has been made. And we stated this point to be the half-life of information.

We applied the decay syndrome to other information systems to test its application. Empirical research showed us systems with decay ranging from 2,100 years for ancient civilizations to less than 2 minutes for not very civilized action in a technological war. We also found long-range decay of political systems and the effect such a decay would have on the Western civilization if corrective actions are not implemented. As a by-product of the research we also discovered patterns in other systems which can be understood as the subtle workings of cyclic occurrences on global scale, especially the imminent economic cataclysm expected in 1983.

Finally, and most importantly, we have established that information science provides a novel, new and different approach to many of the problems facing the world. The role of the information scientist is as a theorist for the decision-maker, not just to "examine the way scientists use scientific information" (35).

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Appendix 'A'

FIGHTER AIRCRAFT ROLES AND MISSIONS

This is a short description of the various types of missions in air-to-air and air-to-surface operational roles undertaken by fighter aircraft (38,123)

AIR-TO-AIR

1. Air Intercept. The rapid dispatching ("scrambling") of interceptor aircraft in all-weather, day-night conditions under the direction of ground control radars to within a range from an airborne intruder from which the interceptor can assume control and approach, identify and when necessary destroy the intruder. The approach, identification and manoeuvre to within the launch envelope of onboard weapons is performed by means of the interceptor's multi-mode radar, the infra-red search-and-track system as well as other onboard sensors. To permit the interceptor a degree of freedom to employ a variety of tactics, the aircraft radar must have long-range capability to sweep a large airspace. To take advantage of long-range detection of hostile targets the aircraft must carry long- or medium-range air-to-air armaments and, to engage targets detected by shorter-range sensors, additional short-range air-to-air weapons (missiles and rapid-fire cannon) must be available. The interceptor must be capable of quick reaction, high maximum airspeed at altitude and a radius of action which would enable interception of hostile aircraft while still within surveillance radar coverage.

2. Defensive Counter-air. Conducted to destroy or neutralize the enemy's offensive air capabilities, thereby permitting the effective use of the air by friendly forces while denying it to the enemy. Defensive operations are conducted at the initiative of the enemy and include the engagement of hostile aircraft penetrating friendly airspace and the defence of friendly surface targets of any type against attack by enemy air resources. Agility in air combat, usually expressed in terms of excess energy and manoeuvrability under given parameters of altitude, airspeed and "g" force, are measurements of an aircraft's capability in defensive counter-air operations. To engage enemy aircraft the tactical fighter must have a suitable air-to-air radar and other target acquisition aids in order to utilize its long-, medium- and short-range missiles and its rapid-fire cannon. Suitable threat-warning equipment is also required.

AIR-TO-SURFACE

1. Interdiction. An offensive air support mission carried out against enemy surface targets to isolate or seal off an area, denying the use of a route or approach, or destroying and neutralizing the enemy's military potential at a distance behind the forward edge of the

battle area (FEBA). Battlefield Interdiction, a relatively new term, is an interdiction mission carried out within 50 miles of FEBA. These tactical aircraft normally carry a maximum of air-to-ground munitions: either bombs, guided bombs, rockets or guided missiles or all of the above, and if attacked they are extremely vulnerable due to the weight-and-drag penalties of these weapons. Therefore, adequate threat-warning systems are required to alert of possible attack by enemy aircraft or ground-based air defence systems. After cruising at high level for fuel economy to FEBA, high-speed penetration to the target area is at high-, medium-, or low-level depending on the type of enemy defences anticipated. In case of attack by enemy aircraft, the interdiction aircraft must also be equipped with defensive armament such as a rapid-fire cannon and air-to-air missiles.

2. Close-air Support. The application for airborne weapons against hostile targets which are in close proximity to friendly land forces, and requires the detailed integration of each air mission with the firepower and movement plans of those forces. As this mission is normally in support of friendly forces in contact with the enemy, to be fully effective maximum ordnance must be brought to bear as accurately as possible in minimum time. Thus the tactical aircraft must carry a large weapons payload, react quickly, cruise at high speed to the target area, have adequate target acquisition aids to permit rapid and accurate location of the target and have the ability to accurately deliver either unguided or guided weapons. In support of pre-planned friendly land offensive, the tactical fighter must be capable of loitering short of the target area so that its firepower can be immediately brought to bear at the most advantageous time. Moreover, when operating in such close proximity to ground-based air defence systems, adequate warning and countermeasures systems must be carried.

3. Offensive Counter-air. Conducted to destroy or neutralize the enemy's offensive and defensive air capabilities thereby permitting the effective use of the air by friendly forces while denying it to the enemy. Offensive operations are conducted at the initiative of friendly forces and include the attack on airfields, aircraft on the ground or in the air and the associated support and logistics of enemy air operations. These targets could be located deep within enemy territory thereby requiring the tactical aircraft to possess the inherent capability to penetrate these distances at high speeds and low altitudes. To penetrate enemy airspace the tactical fighter must carry, in addition to its offensive weapons payload of bombs, rockets and air-to-ground missiles, threat-warning systems so as to be alerted of possible attack by enemy air defence missiles and aircraft, and sufficient defence in the form of rapid-fire cannon and air-to-air missiles, should such an attack occur.

4. Defence Suppression. Suppressing enemy's counter-air system to degrade, neutralize, or destroy enemy's surface air defences and command, control and communications (C^3) systems, so that friendly air

forces can operate with greater flexibility and reduced losses. The aircraft with such a capability (F-4 Phantom) is known as a "wild weasel".

5. Anti-maritime Surface. Operations extending beyond the land mass to the limit of the territorial waters. When necessary, the effective application of firepower against maritime surface targets, whether to enforce control or destroy, can best be carried out by tactical aircraft because of their quick reaction capabilities and their capability to carry a variety of armaments. From on-shore bases, the tactical fighter can dash at high altitude and speed before descending to the target area. A radius of action sufficient to allow protection of all territorial waters when operating from main or dispersed operating bases is a measure of the effectiveness of the aircraft in this mission. The latest generation of long-range pulse doppler look-down radars permits early target acquisition, while guided air-to-surface missiles provide an attack capability outside the lethal zone of ship defence systems. However, to remain clear or warn of penetration of this zone, the attacking aircraft must also be equipped with the appropriate threat-warning systems. When flown in conjunction with naval task force the mission is called tactical air support maritime operation (TASMO).

6. Surveillance and Reconnaissance. Employment of tactical aircraft carrying one or more types of sensors to acquire intelligence information on enemy targets or territories for offensive or defensive planning or post-operation assessment of attack effectiveness. To provide the high resolution data and thus the detailed information necessary, aircraft normally penetrate the enemy airspace at altitudes of less than 500 feet above ground level (AGL). Low altitudes and high speeds combined with onboard warning systems and defensive armaments are necessary to enhance survivability when operating in close proximity to enemy's air defence system. The aircraft must have sufficient radius of action to enable a high-speed penetration from FEBA deep into enemy territory.

Appendix 'B'

BRITISH ABANDONMENT OF HYDERABAD DECCAN (1947-48)

The Dominion of Hyderabad Deccan (Figure B-1), a suzerain nation, (Crown under a Crown) with a population of 17 million[1] and an area of 82,700 square miles[2], was abandoned by Britain in 1947-48 in spite of a "Perpetual and General Defensive Alliance" of 1800 (65). In 1766 the Nizam had ceded the coastal districts of Northern Circars (33) and in 1853 the province of Berar was assigned to the British (on their own behest) for stationing troops in Hyderabad and the area was ceded to British rule in 1902 (33). Several attempts to regain control over Berar were dismissed by Britain, including court proceedings, which the British government did not allow citing that a suzerain nation cannot sue a sovereign nation.

In August 1947, when the British granted independence to India and Pakistan, Hyderabad Deccan opted for independence within the British Commonwealth of Nations. The letters of the king of Hyderabad Deccan, Nizam VII, the richest man in the world at that time, to King George VI, were never transmitted by the Viceroy and Governor-General of India, Lord Louis Mountbatten (69). Nine months later Mountbatten replied to the Nizam:

> I have investigated the matter, and it appears that the reason why a further reply was not sent lay in an error of staff work in the political department here...(69).

The Nizam of Hyderabad Deccan, who had assisted the British in the two World Wars with men, money and material, and on whom they had bestowed the title of His Exalted Highness, the Faithful Ally, was abandoned to the Indian economic blockade and military pressure (79). While Hyderabad Deccan fought its case before the UN in 1948, Indian forces advanced on the state from 20 different fronts and Hyderabad armed forces capitulated on 17 September 1948 (65).

About this, a former British Resident (Crown's representative) at Hyderabad Deccan, Sir Arthur Cunningham Lothian has written (79):

> No person of British origin who knows the facts can read this dignified and loyal statement (of Nizam) without the feeling of shame at our tacit abandonment of Hyderabad to pressure of every sort from India... The parallel between recent events in Hyderabad and what happened in Czecho-Slovakia (sic) before the last War must surely have occurred to everyone acquainted with what has transpired (79).

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1. Canada had a population of 12.9 million in 1948 (24.6 in 1982 (Statistics Canada)).
2. Twice the size of Ireland; half that of France (69,79).

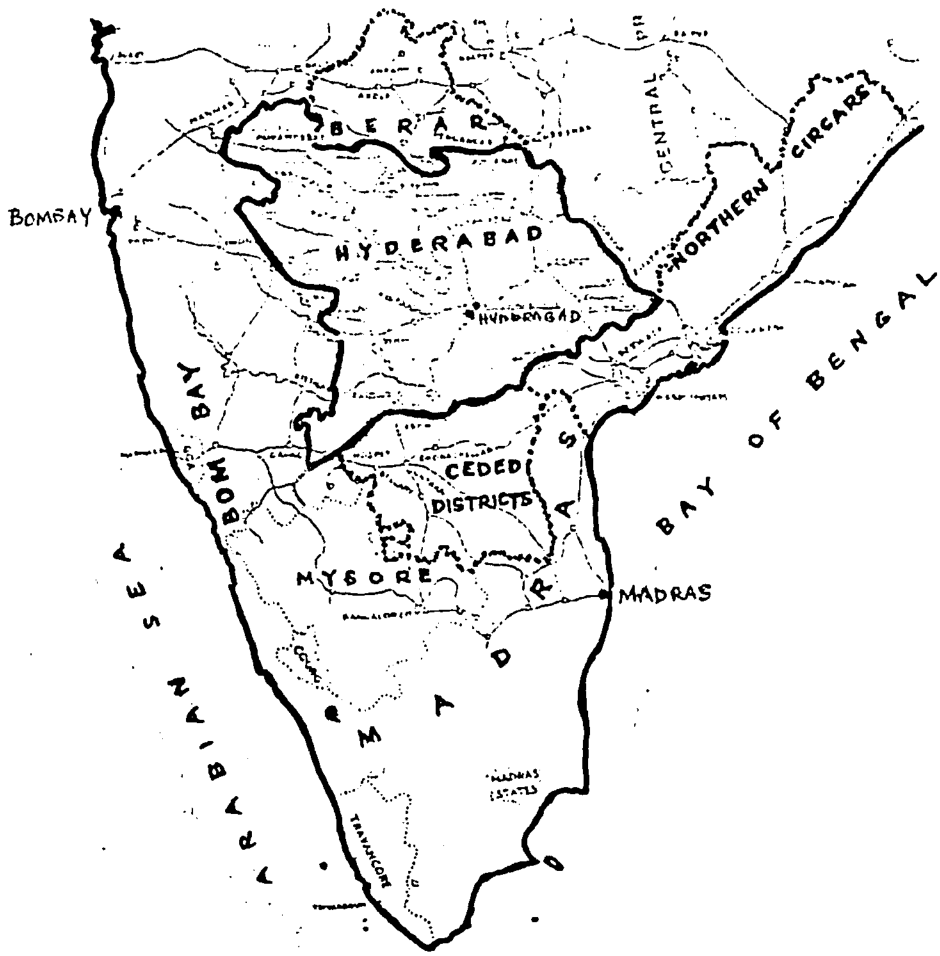


Figure B-1. His Exalted Highness the Nizam's Dominion of Hyderabad Deccan: population 17 million; area 82,700 square miles; own currency; railways; airline; armed forces. Abandoned by the British in 1947-48 to Indian economic blockade and consequent military invasion, while the country was fighting before the UN for the return of the territory taken away by Britain in lieu of protection, which never came when it was needed (65).

The Nizam, in his last letter to Mountbatten, wrote:

> To break faith with the weak causes perhaps less immediate disadvantage than to break faith with the strong, but assuredly it brings its retribution (69).

He never received any reply. About 850,000 people were killed, millions became destitute, homeless refugees. No British flotilla came to the aid of their faithful ally, for he had stopped serving their majestic interests.

SCIENCE, TECHNOLOGY AND BATTLEFIELD INFORMATION: AN HISTORICAL PERSPECTIVE

Alexander Graham Bell, a Canadian, inventor of the telephone, made his first analog transmission in 1874 using circuit-switched network with fixed bandwidth pre-allocated for the duration of the call. Prior to the 1960s pre-allocation was considered an "in" thing (105).

Some time in the 1960s the USAF commissioned the RAND Corporation to study the possibility of a survivable communications system containing no central components. In August 1964 the report was submitted to the USAF, which shelved the study for several years. RAND Corporation proposed something which had been known for some time, but considered uneconomical. Dynamic-allocated concept never attempts to schedule a bandwidth over the entire source-to-destination path. There is a space after each link of the message or packet. Thus packet-switching was born. It divides the input into minute segments (packets) at immense speed and is three to 100 times more efficient than a pre-allocated system (105) which the enemy is able to intercept (messages from the front).

Computer professionals re-discovered packet-switching in response to communicating data from computer-to-computer. Licklider, in the mid-1960s developed the time-sharing computer system called ARPA I at MIT. In 1968 ARPANET packet-switching network was given the go-ahead (105). Since then there has been no looking back on the system (science) and its applications (technology).

Packet radio using one wide-band channel was developed transmitting short bursts when there was data to transmit. Voice transmission via packet-switching is being developed and digitized voice can be compressed 15 times (105) thus making the "scrambler" used in military communications, redundant.

There are several other uses of packet-switched information networks but the most significant are those used by ARPANET for world climate study, the Space Shuttle and command, control and communication (C^3) for the worldwide military command and communications system (WWMCCS) (76) and broadcast communications satellites with a unique potential to support packet communication efficiently even with the limitation of 0.25-second round-trip to the geostationary satellites (61) approximately 23 million miles away in space.

Since there are several subscribers or users to a system, they share it in a unique time-division multiple-access (TDMA) manner, with data from each station segmented into bursts of time shared at specified moments (61). The University of Hawaii's Project Aloha in the 1970s indicated the utilization of packet radio to be feasible and effective. The primary objective of such an information network was the support of interactive communications between the computer resource (host) connected to the network and user terminal (terminal-host, host-host, terminal-terminal) (68) thus maintaining integrity even if one component is destroyed.

The wide-band spread spectrum, although desirable, is not a priori requirement. Coded-slotted information transfer can provide an effective ECCM capability with a very low probability of intercept (68) as the enemy would not know which bandwidth is being used at a specific instant.

This information system can be used in airborne, seaborne, ground or space environment. The science's technological embodiment came when the information system was fitted into an aircraft, and the war embodiment, when the aircraft was used as a surveillance/C^3 system to control tactical fighters in their air-to-air and air-to-surface roles (Appendix A).

Joint tactical information distribution system (JTIDS) operates a single secure communications channel that is divided into 128 time slots per second. Each participant is alloted enough time slots to meet his needs. An E-2C Hawkeye (Figure C-1) or E-3A Sentry (Figure C-2) aircraft are given slots to report the position, speed, heading, identity, etc., of all aircraft they are capable of tracking (17).

> Participant communication capacity and reporting rates can be traded off to determine the overall system performance. Individual access to the system may be as infrequent as once each 12.8 minutes or as often as once each 8 milliseconds. The number of participants in a single JTIDS network may range from 2 to 98,000...(17).

The system works by sending first a synchronization burst followed by a message containing several hundred bits of digital information. A guard period follows allowing the information to propagate throughout the environment. This "time-slot" lasts 7.8125 milliseconds, and 1,536 time-slots make a "cycle"; and 64 such frames constitute an "epoch". At this point, the time-slots are renumbered and a new epoch begins (17) (Figure C-3).

An E-3A Sentry aircraft (Figure C-2) for airborne warning and control system (AWACS) or airborne early warning (AEW) for European theatre has sophisticated radars to detect and track low-flying hostile aircraft and can vector interceptors to engage the intruders before conventional radars can pick them up. It can also monitor the marshalling of aircraft at enemy bases behind enemy lines and command friendly aircraft in a pre-emptive attack (17).

The E-3A can provide information to ground and naval tactical commanders and assist these forces from detection by enemy radar over a large area (Figure C-4) through timely information from their evasive action period. NATO has ordered 18 E-3A Sentry aircraft; UK has 11 AEW Nimrod aircraft to supplement their NATO commitment (53). Saudi Arabia will receive five such aircraft in the mid-1980s. The Soviet counterpart, Tu-114 Moss is illustrated in Figure 6-11 (31).

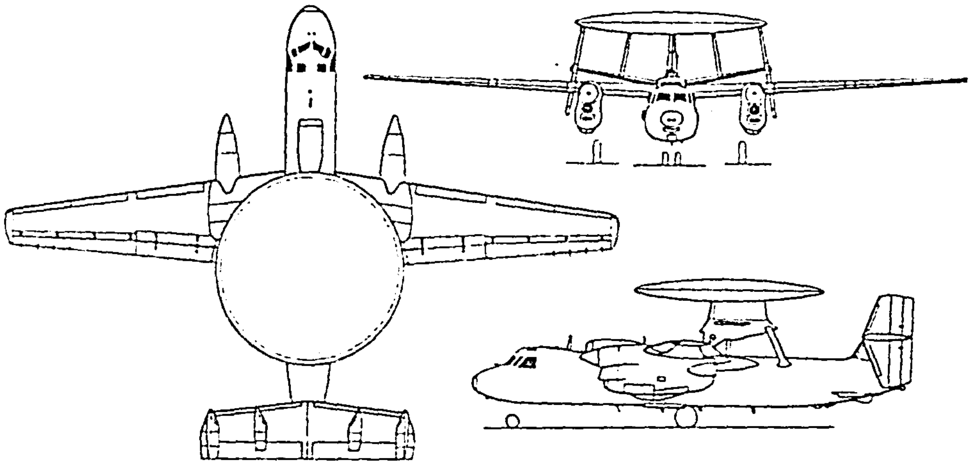
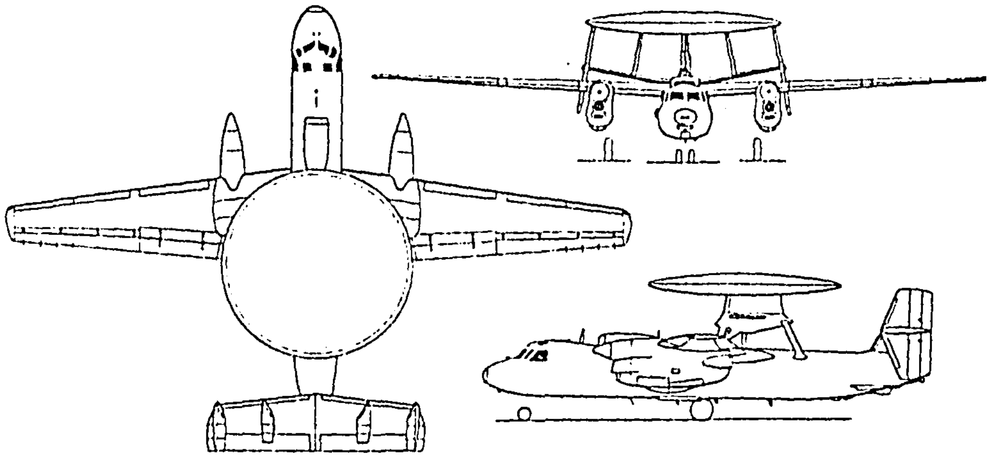


Figure C-1. E-2C Hawkeye all-weather carrier-borne early-warning aircraft. Also suitable for land-based operations with a detection range of 260 nm (300 miles) at 30,000 ft. In service with the USN and the Israeli Air Force. Eight aircraft ordered for Japan (1982-85) and four will be delivered to Egypt.



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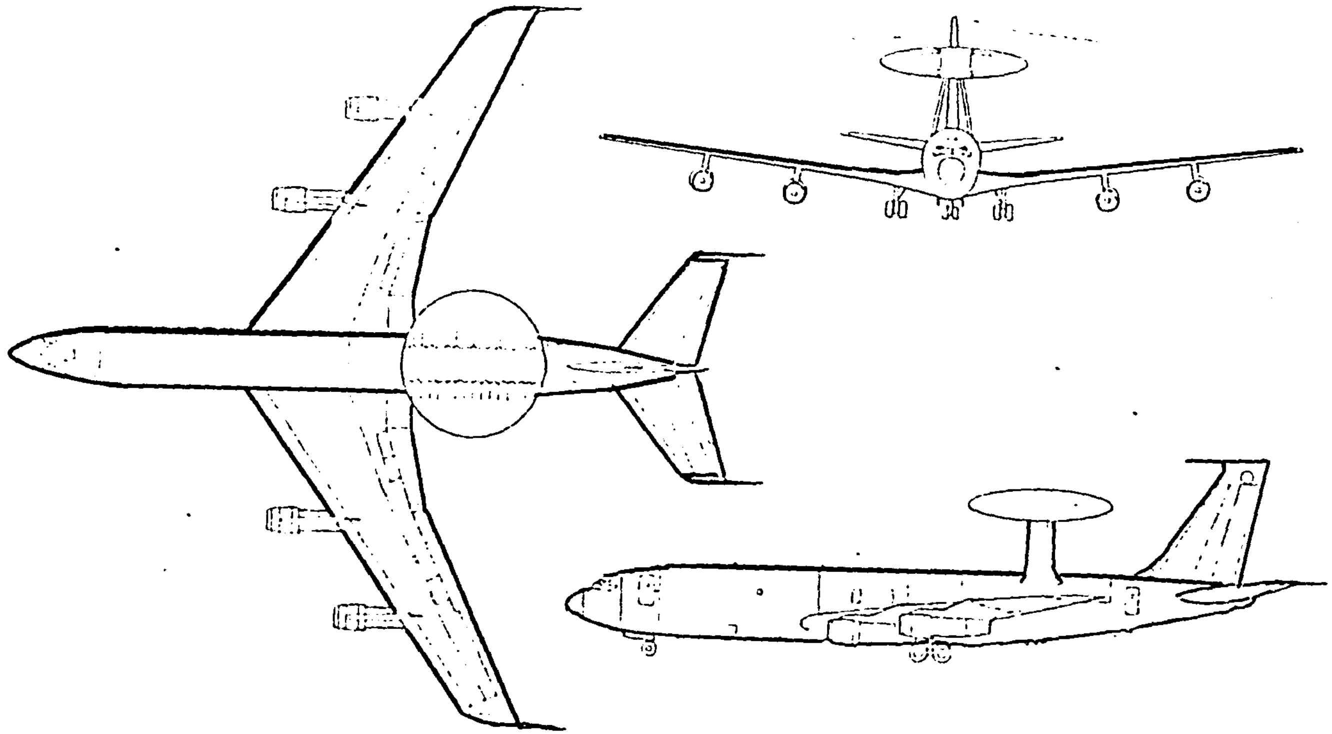
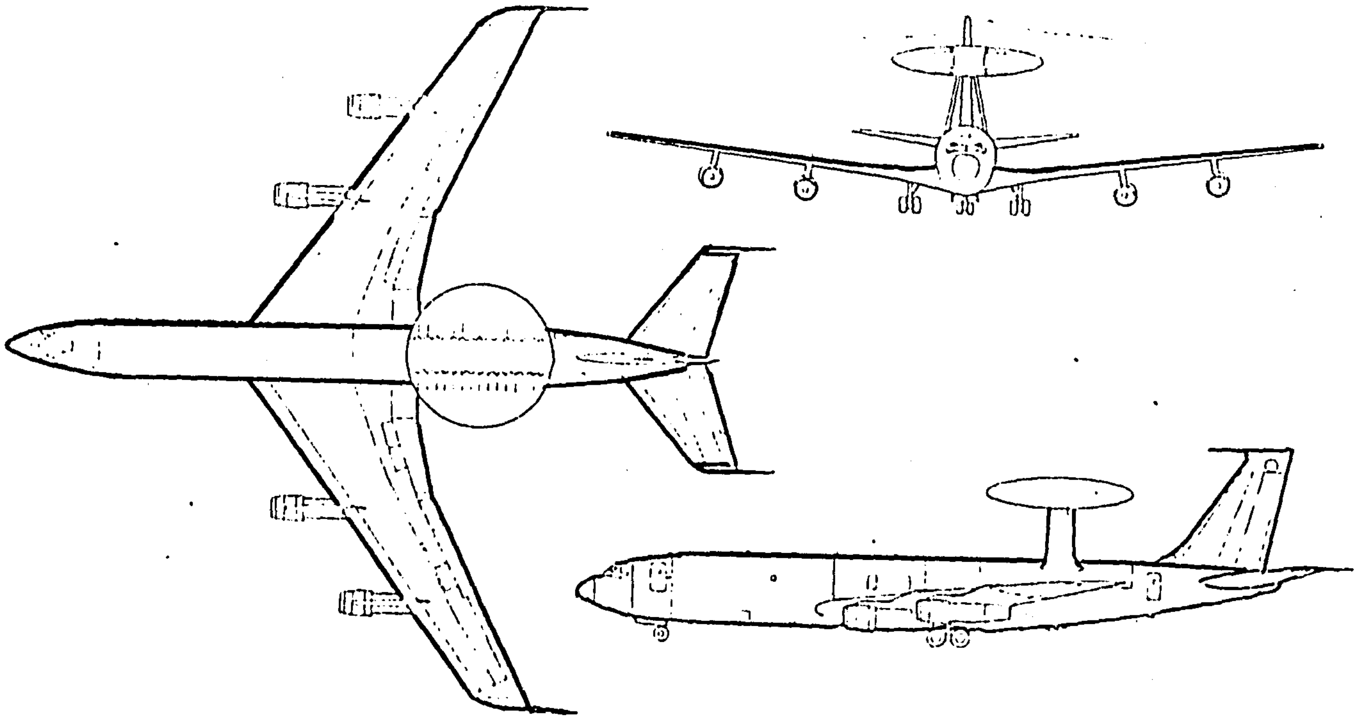


Figure C-2. E-3A Sentry (Boeing 707) airborne warning and control system (AWACS) aircraft for CONUS and Canada; and airborne early-warning (AEW) aircraft for NATO. A total of 31 aircraft are planned for continental air defence and 18 for Europe; 5 will be delivered to Saudi Arabia (7 were scheduled for Iran in 1979-80) (53).



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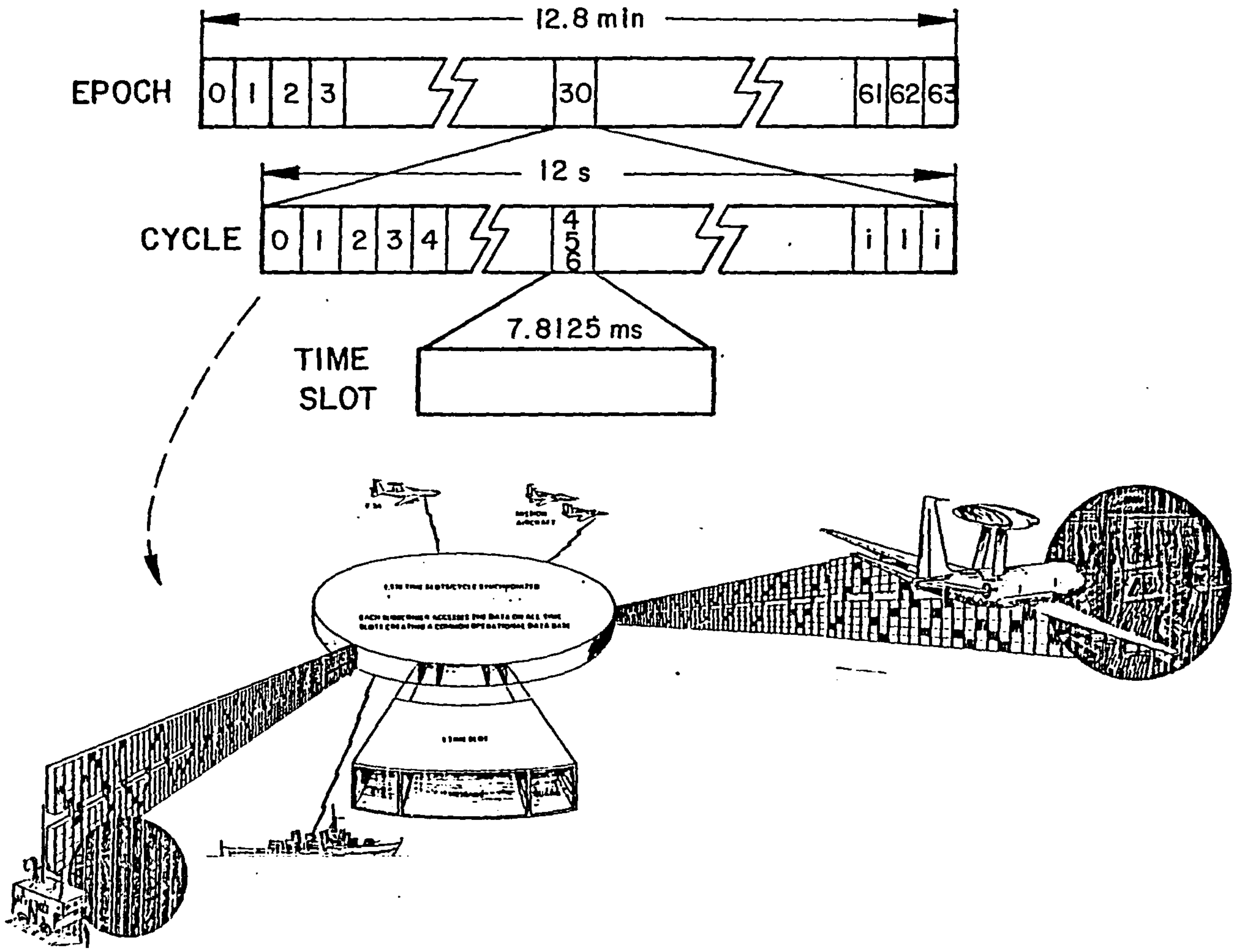
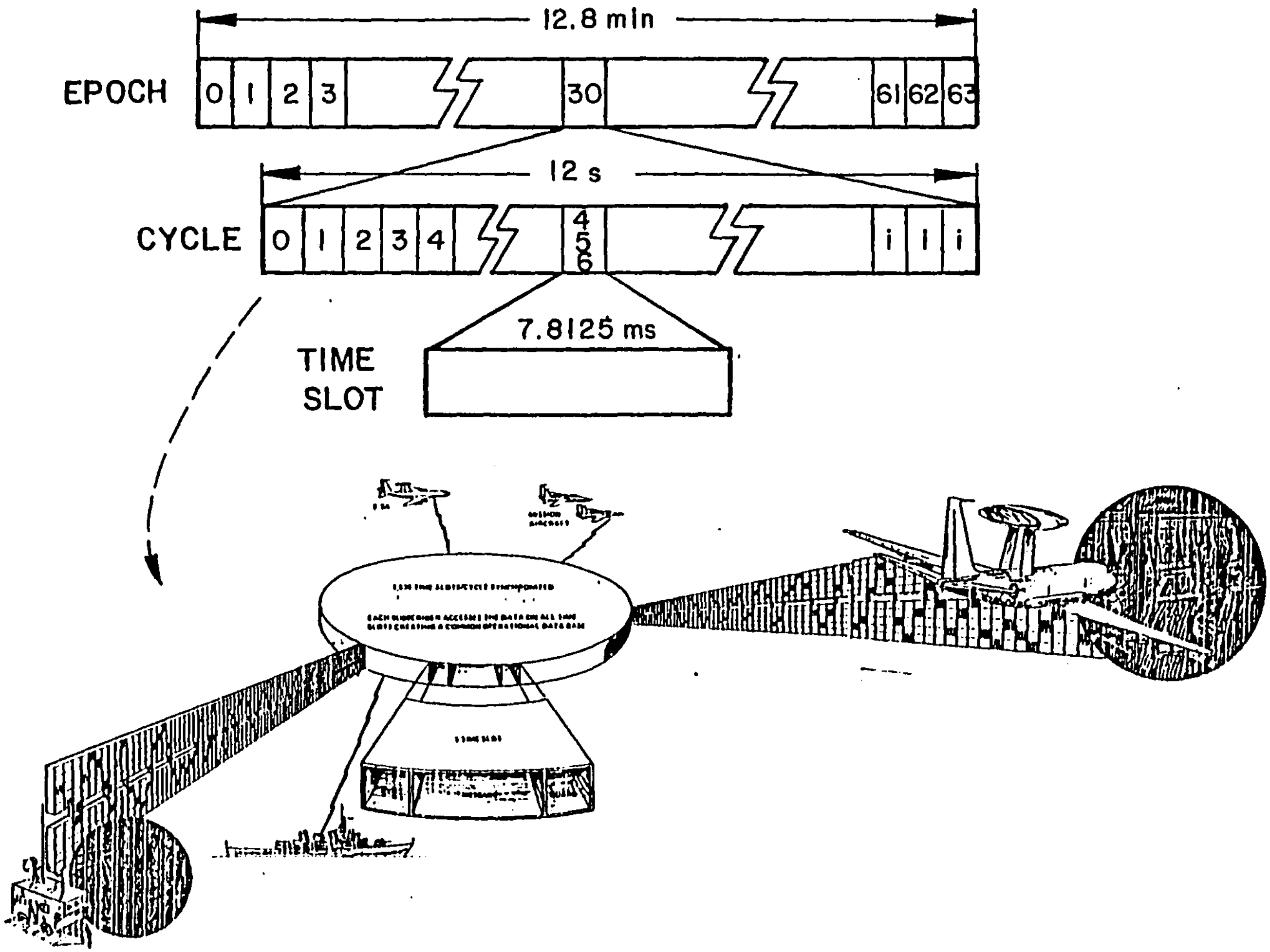


Figure C-3. An integrated tactical information system with AWACS and mission aircraft and ground and seaborne input and relays.



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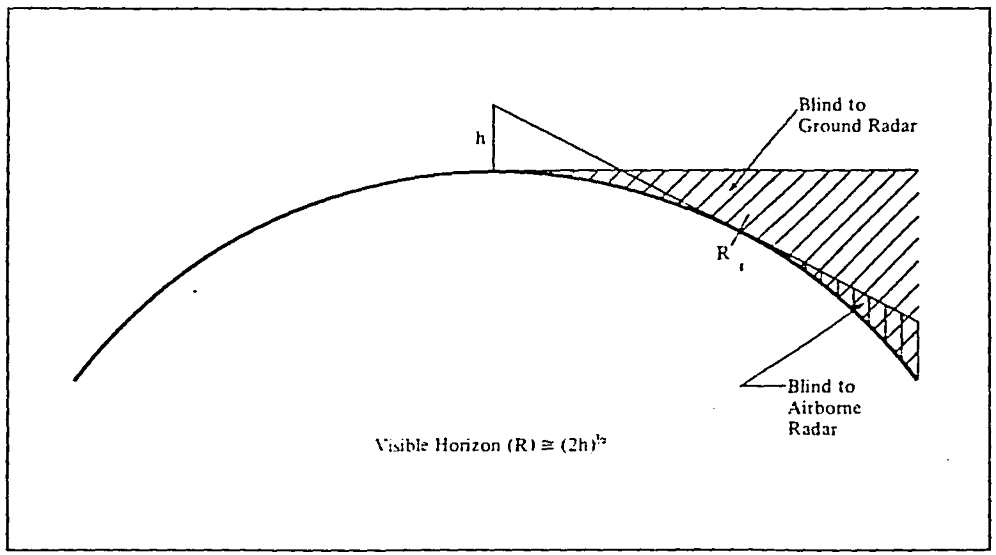

Figure C-4. The horizon for ultra-high-frequency airborne radar is approximately the visible horizon. Thus at a radar altitude (h) of 30,000 feet, the range (R) to the horizon is about 245 miles.

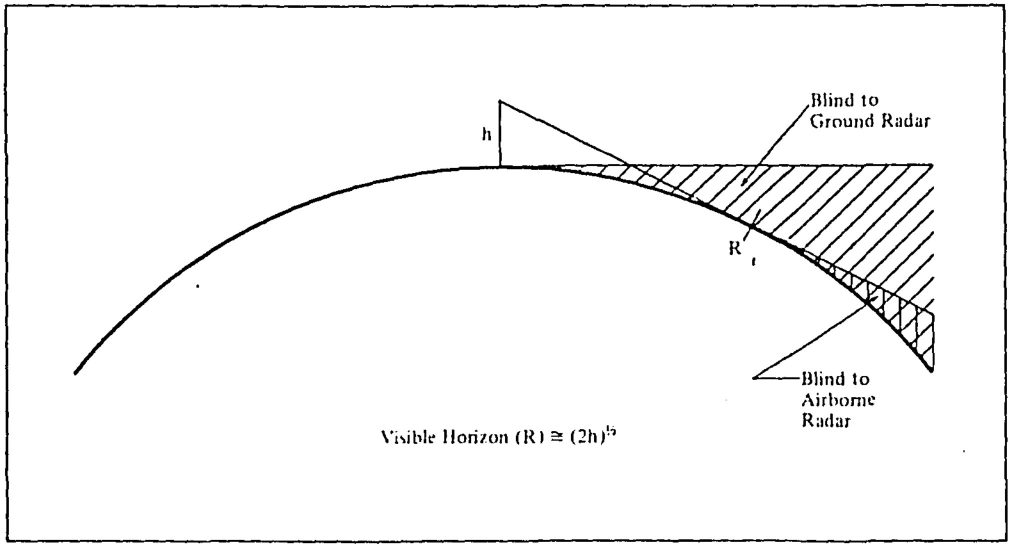

Figure C-4. The horizon for ultra-high-frequency airborne radar is approximately the visible horizon. Thus at a radar altitude (h) of 30,000 feet, the range (R) to the horizon is about 245 miles.

VITA

Idris Ben-Tahir is a Canadian, who was born on 26 June 1939 in Hyderabad Deccan, a landlock suzerain country, which was militarily occupied in 1948 by the then newly independent India. He attended St. George's Grammar School in Hyderabad Deccan until 1949, and completed his School Certificate (General Certificate of Education 'O' level) of the University of Cambridge, U.K., from St. Francis' Grammar School, Quetta, Pakistan in 1956-57.

He has studied at Otterbein College, Ohio (1958-60) and is the only known 'alien' to have served as a member of the USAF Reserve Officer Training Corps. He is a graduate of the University of Ottawa, and has attended Queen's University, Kingston; University of Wales Institute of Science and Technology, Cardiff; City of Westminster College, London; and Université de la Sorbonne, Paris on various Canadian Forces sponsored courses.

Ben-Tahir has served as an officer with the Royal Canadian Air Force (Reserves) (1963-67); and some of his appointments as a Canadian federal public servant since 1967, include: scientific editor with a research laboratory; staff officer in charge of publications and technical editor with the Canadian Forces Air Transport Command Headquarters at Trenton, Ontario; senior technical editor with the Aerospace Engineering Test Establishment at Cold Lake, Alberta, and assistant program officer with the Directorate of Air Requirements of the Air Doctrine and Operations Branch, National Defence Headquarters in Ottawa.

He has been active with various community organizations and in 1980 was a candidate for Member of Parliament during the 32nd general election for the Canadian House of Commons.

Ben-Tahir is a bachelor and is the eldest son of the late Mohammed Tahir Siddiqui, Secretary of Labour and Resettlement in the Nizam's Government of Hyderabad Deccan (until 1948) and managing director of a chromite mining corporation in Baluchistan province of Pakistan (until 1961), and Ahmedi Begum Siddiqui, at present living in Karachi, Pakistan.