
Application of Cybernetics System in Management Science and Technology Practices

By

EMMANUEL I. IBORDOR
*Department of Management Science
University of Nigeria,
Nsukka.*

Abstract

This paper is on how cybernetic system of communicate and control is put into practice, based on the application of call centre, VHF and HF electronic facilities to encode and decode information, communicate, control and receive feed back from scene of fire. The case study is the Delta State Fire Service on the use of electronic system (Technical Cybernetic) in the management of fire and other disaster. This paper also explains the use of cybernetic system of control and communicate in business and management organizations, medical, robotic and for the military. It is equally useful in the architectural, engineering and any field of life where communication, control and feedback mechanism is required for effectiveness and efficient performance.

For more effective management of emergence and response – The recommendations includes the need for the Delta State Fire Service to: install robust close circuit television units CCTV in all major cities in Delta State, Nigeria especially, cities and communities like: Warri, Asaba, Ughelli, Bomadi, Sapele, Oghara, Koko, Effurun, Kwale, Aboh, Isselu – Uku and environs. This self-regulation cybernetic will capture and feedback information, to the Fire Service CALL CENTRE for appropriate response. This will reduce detection, call and response time to emergencies, be it intended or emergent situations. Business and management organizations should provide and apply this system particularly in their functional areas. For instance, companies use of virtual conferencing in meetings and stock management. Research should be made on how cybernetic system technique can be applied for the absorption of carbon dioxide (that trap heat back to earth and deplete the ozone layer) and carbon monoxide (that equally deplete the ozone layer) can systematically be absorbed from the atmosphere and applied for other uses.

This paper reviewed some previous works on cybernetic, analyzed and touched in other areas of applications like in the manufacturing, emergency agency, medical, business and management, the military among others and recommended the further extension of the application in the Delta State Fire Service, Nigeria and on research on how to absorb ozone depleting gases from the atmosphere and divert the outcome for other uses.

Cybernetic is based on the principles of *feedback systems and control within these systems*. Cybernetics view information as a cycle common to all mechanism and within its framework, decision making and control are similar and directly linked to managerial activities using the instrument of communication. Cybernetics' is derived from the Greek word *kyberneters- meaning steersman*. Encompassing a diversity of technologies, from solar energy, to robotics, to intelligent manufacturing on international production lines. It is dynamic. It consistently shape our problem solving approach, perceive technological advances and consider the technological, economic and social future of the world.

Historical Context

In 1948 a book entitled 'Cybernetics or control and communication in the Animal and Machine', written by Norbert Weiner, revolutionised people view about the world. Stafford Beer coincidentally at the same time was running an operational research unit inside a steelworks. As a result viewed his company cybernetically, *conceiving a complete management system*. Furthering such thought. Ashbey considered that 'a system is a set of variable, selected by an observer, together with constraints' (Krippendorff 1986:73) Von Forrester, states 'First order cybernetics, is the cybernetics of system that observed from the outside as opposed to the cybernetic system involving the observers' (Krippendorff 1986:31). James Lovelock in his book GAIA (1979) asked and answer 'why does the sea never become too salty or the sun heat the Earth too much? Lovelock considers the *Earth to be an entire cybernetics, self regulating mechanism, at any one time being in a reasonable state of equilibrium*.

Deforestation or sending harmful gases into the atmosphere will merely be compensated for by the earths regulating mechanism, possibly with every little outward change, although distinct, sudden and drastic variation are always a possibility, hence various weather trends like warmer weather severe winters e.t.c

Responses from study in one area are directly related to, and are often analogous to, those obtainable in other disciplines. Technical cybernetic is more concerned with engineering, computing, control and electronics; hence it encompasses manufacturing and production system.

The current state of cybernetics Robots are the first image associated with cybernetics. Cross-over in electronic and biological sciences have offered electrical

circuits that can be 'bolted on' in place of lost or inadequate nerve pathways, allowing the profoundly deaf to hear and those with artificial limbs to feel sensation in the limb. Given that a cybernetic organism (cyborg) basically involves a mixture of human and machine, even people with pace makers or replacement hips are cyborg. Cyborgs open up a new technological future, full of business opportunities. Links between the nervous system of human and computer are now with us. Not only in extra perception a distinct technical possibility, but electronic medicine – electronic signals to alter emotions or the state of the brain are already with us.

Robot assists increase production and often productivity. Not bore down by routine work. Robot is a physical extension of human capabilities, repeating job, accuracy and use of mere strength. Beside 'Menial' task, robot can participate in 'intelligent' decision – making roles. They can shear sheep, play snooker, and create, read and play music. On automation of routine production line, they can virtually check on a situation and respond accordingly, while telepresence is used for visual inspection in hazardous environment such as bomb disposal, the decommissioning of nuclear plants and space exploration. Virtual reality enables experience of an environment without being there.

Architects find virtual-reality simulations a time-and money-saving option as it allow a preview of building, its location in respect to the environment and the aesthetic and ergonomics of the of the interior. Structural and safety consideration can be implemented even before the ordering of the materials and constructions begin. Virtual reality simulation has been used in the planning of London Heathrow airport fifth terminal used also in 'intelligent home' system. It responds to human premeditated movement or reaction to activate various operations around the home using infra-red technology, distributed control and fuzzy logic. Virtual reality simulation is also used in projects concerned with monitoring of patient's heart beat (electrocardiography) to detect peculiarities associated with specific problems. As a result, an intelligent system can learn the electrocardiographic characteristics of patients exhibiting a particular disease and then non instructively monitor the condition of other patients simply by inspecting their display.

1. **Contribution of Cybernetic System to Communication and Control**

Wiener Norbert assisted by Julian Bigelow developed a mathematical theory for predicting the future based on incomplete information from the past. The assigned problem was tracking and shooting down air craft- to develop a mathematical foundation. This developed mathematical theory revolutionized the whole field of communication engineering and formed the basis of modern statistical communication theory (Heims 1980:184)

In the 1940s, the theory led to the improvement in radar observations of aircraft. Successfully applied in the design of noise filters for radios, telephones and many other devices of common use.

Independently, Claude Shannon was developing his 'Mathematical theory of communication', (Shannon and Wearer 1994). Interesting feature was the anti- aircraft cycle involving feedback: information from radar screen was used to calculate controls to improve accuracy on the target, then the effective observed and communication again via radar. This new information further guide gun objectives etc. The idea that some parallels between engineering device and living organism could be found through mathematical formulation, received extraordinary support from many scientists of diverse background.

Application in Management of Emergency Response Agency: Delta State Fire Service.

The Delta State Fire Service is one of the Delta State Government departments, responsible for management of emergency activities. It came into existence on 27th August, 1991 from the defunct Bendel State Fire Service. It has staff strength of 315 and twenty stations strategically spread among 25 local government areas of Delta State.

A study in 2010 on the use of cybernetic system in management of emergencies indicates as follow:

- i. the service has call centre connected to Starcom communication service network
- ii. the service also has VHF and HF facilities and communication hand sets
- iii. reports are received from the distress caller at the call centre or from the hand sets. The call centre immediately sound the ALARM, present the scene address to the responders and Firemen mount ambulance and fire truck, for the scene of fire as informed. (communication application)
- iv. on getting to the scene, the crew embark on rescue and fire fighting operation as may be applicable. If the fire is serious and assistance required a message will be encoded to the call centre 'Fire serious, assistance required': This is called 'assistant message'. The call centre response to the FEEDBACK and turn out the next truck to the fire scene for the require assistance. If assistance is no more required, a 'stop message' will be sent to the call centre. If unforeseen circumstances develop, like a Fireman dying at fire ground. A message will be sent to the call centre to indicate 'one fireman casualty, on his way to the hospital'.

All messages communicated so far are been heard by all officers with walkie – talkie or in vehicles with mobile communication units.

The operational officer may then give necessary command to the fire ground officer incharge, based on this information. For instance, 'what is the extent of spread of fire, what is the extent of damage, any casualty?'. Instructions like 'use defensive approach strategy, in view of available manpower and equipment'. Among the 110 interviewed across the twenty stations, 105 expressed their observation that the available communication equipment has aided positive response and action. One (1)

expressed the need for a close circuit television unit, to automate detection and encoding of call. The other four did not comment. From my observation, I agree with the man above who expressed the need for a close circuit television unit CCTV, in order to automate detection and encoding of call. This is typically the application of technical cybernetic system in communication, control and feedback, in management of emergencies.

The importance of the technical cybernetic in the context therefore is in the areas of:

- i. timely receipt of call
- ii. quick response to emergency calls
- iii. affective communication to and from disaster scene
- iv. efficient coordination and control

These factors invariably translate wholly, into efficient and effective emergency management.

Application of Cybernetics System in Practical Business and Management Transaction

- In practice, it provides intricate analysis and awareness of system. E.g. stock control in manufacturing firm. Slow stock turn-around can increase warehouse storage costs and component can be superseded or become obsolete, while still in stock. Stock control is a sub-part of a system. With cybernetics analysis, existing system could be modified and improved. Component reservoirs can be correlated to the frequency of their usage, with stock ordering time and quantity adjustment. This reduces the warehousing space requirements using a just-in-time reordering mechanism.

Sales force sub-system. They contact the clients, demonstrate products, make a sale or not and influence the company's profit. If sales decrease and profit fall, the sales force may be reduced to maintain a stable system, one which is self-regulating. Further, a new system may be created to correct the shortfall e.g. performance-related pay scales and bonus schemes are motivational tools for the sales force. Sales target over a specified time period and a financial bonus attached if target is achieved. Continuous improvements attract next level of pay and increase target. Though subsequent financial incentive for staff and/or technological improvement may prove costly- there also lies the secret of sustainable development. Positively, it creates room for analyzing communication, detection modification, adjustment and feedback. Supply and demand are controlled by a pricing mechanism. If supply exceeds demand, price may fall and vice-versa. The desired situation- a stable system is created when supply equals demand. Price segments a market and positions the goods with respect to competition. Highly priced goods create a market niche, may not require significant supply or demand because the percentage profit margin generated is high.

A mass-market goods, such as toothpaste, provisions, garri or sachet water, entails significant supply and demand in terms of volume but not much profit per unit.

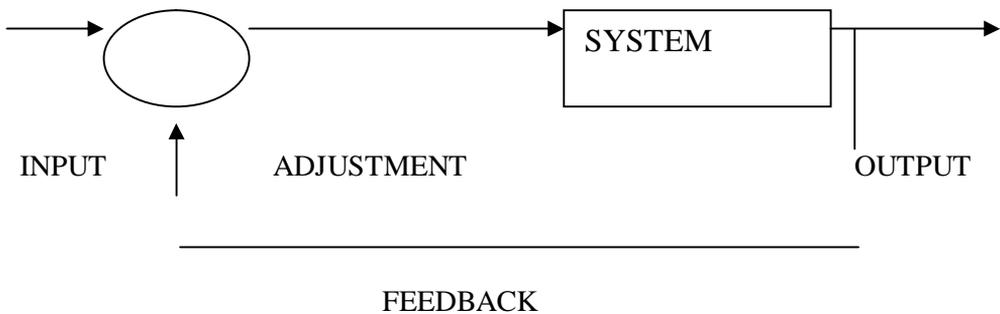
Price must be at a level the market can support. An equilibrium is achieved when the market is stable. The associated constraints are: owing to the influence of other systems and variables such as product innovation and product reposition, stemming from modified market strategies, promotional campaigns and repackaging.

Increased market awareness improves the choice of customer's through customers questionnaires, panels and product- tracking systems, the end user is able to communicate opinions back to the company, thereby influencing the whole system modifications (product colour, aesthetics) and the whole circle will begin again.

In the personal care market, the ecological awareness of customers has forced many companies to rethink their product sourcing strategies. Consumers' feeling has altered the overall system and environmentally friendly 'green' companies. Economies of scale may mean that cost advantage is not passed on to the consumers through the competition pricing of a product, but that the profit margin is increased to the company's benefit.

As for business and management system, the critical insight is that systems can be studied in relation to other systems of completely different types, to considerable advantage.

Decision making are now computerized. A business or marketing exercise can be modeled on a computer in terms of the signals through input information to the process and the value that result at the output – could be profit, turnover or gross income per head. Different strategic can be applied and relationship investigated as to how output values, for example profit, can be fed back to the relevant sector in order to stabilize and maximize: see below figure:



Feedback System

All business must include control mechanism and feedback systems in order to operate effectively. Interestingly, the decision-making and control system does not have to be at one central point.

In about the 1970s, the work in the field of the biology of cognition (Maturana and Varela 1987; forester 1984) that established the platform for development of social cybernetics. This theory, know as 'second-order cybernetics' (Foerster 1979), is a non-objectivistic approach to scientific enquiry that emphasizes the role of the observer in social system. It stresses the autonomy of individuals and studying the continuous processes by which they construct their shared reality, points to a new paradigm in social research which could lead to recalling the title of one of Wiener books- a more 'human use of human beings' (Wiener 1950)

- i) Stafford Beer developed the original idea of Wiener, by modeling a company as a set of interconnected homeostats and using Ashby Ross Law of requisite variety, developed the viable system model (VSM) (Beer 1979, 1981, 1985). Know as management cybernetics has proved to be a useful tool for the diagnosis and even design of complex organizations, ranging from small companies to multinational and from local government to the economy of a whole country (Espejo and Harnden (1989).
- ii) For planning through creative decision process (Beer 1994) and organizational learning (Senge 1992: Espejo et al 1996) have been studied using cybernetics principles of feedback mechanism.

Computers are linked to a global communication network, the internet is an effective, powerful distribution and promotional tool for products and services on international scale. Internet provides a good powerful search engine and trading. This encourages continuous new product develop, constant external and internal analysis and customers awareness. The internet is therefore a powerful part of a complex feedback loop. It enable the financial sector to utilize neutral- network technology, as do many other sectors. Based on the principles of the functioning of the brain, artificial neural networks are able to map patterns and trends in data, often taking into account many external influences: stock market prediction, trading trend and customer purchasing patterns, are fruitful areas for such machine intelligence computers which are able to map human thought patterns.

Application of Cybernetic System in Science and Technology

In the vehicle manufacturing firm's, safety and security have become crucial, hence the provision of air bags, side impact bars and anti-lock braking systems.

On 8 March, 1946, MACY FOUNDATION- a philanthropic medical foundation sponsored 21 scientists in a New York hotel, to talk about these ideas. The principle of a new science were formulated: CYBERNETICS. This 'cybernetics group' met regularly from 1946-1953. (Heims 1991) Great mathematicians like John Von Newmann, the Neuropsychiatrist Warren Mc Culloch, the social scientist Bateson and the anthropologist Margaret Mead, Arturo Rosen blueth and Wiener himself etc met regularly.

In his classic book: *Cybernetics: or control and communication in the Animal and the Machines* (1948), Wiener named and presented the foundation of cybernetics. Etymologically, the name is of Greek origin, meaning ‘Steerman’. This is because, the first significant paper on FEEDBACK mechanisms was an article on governors, written by CLERK MAXWELL in 1868 and ‘governor’ is derived from Latin corruption of ‘gubernatur’. Plato had used this terms to describe the science of the Steering of ships. In the 19th century, the French scientist Ampere borrowed the word as a science of government.

Cybernetics disproved the philosophical controversy between vitalism and mechanism, which had claimed that biological and physical systems were naturally distinct. Cybernetics is complex (cannot be described in a precise and detail fashion) and probabilistic (as opposed to deterministic) systems. (Beer 1959:18)

Conclusion

Cybernetic creates connections between wartime science and post-war social science by developing a non-causalistic and ecological view of systems, both physical and biological. Wiener showed the existence of invariants in the communication and control mechanisms that are observed in both animal and machine.

Cybernetic principles have provided basic principle for the design of many sorts of machines such as radar, communication networks, computers and artificial limbs, and on the other hand, fundamental insights to the study of animal characteristics like learning, memory and intelligence, management science and sociological context. Therefore, management at all level should embrace and implement cybernetic system application for effective success in business operation

Recommendation

The evolution and development of the cybernetics has added a more critical use of the system in complex situations. It is hereby recommended that research should be carried out using mathematical model, to solve the present critical situation of climate change.

This research should focus on how the principle of technical cybernetic could be used to develop instrument or machine, that can absorb carbon dioxide (CO₂) gas (this gas trap heat back to the earth and also deplete the ozone layer). Also, instrument or machine that absorbs carbon – monoxide (CO) gas (this gas also help in depleting the ozone layer of the atmosphere). The products so absorbed could then be applied for other uses as may be advised by experts.

References

- Ashby, R. (1956). *Introduction to cybernetic*. London. Chapman and Hill
- Beer, S. (1967). *Cybernetic and Magt*, London. English University Press

- Britannica Concise Encyclopedia (2006). *Cybernetics*. 2nd Ed. Peru. Merriam Webster Incorporated.
- Donald A. et al (2004). Don't Travel – Use Cybernetic (In *International Business. The challenge of global competition*) 9th Ed. New York. McGraw – Hill/Irwin
- Krippendorff, K. (1986). *Dictionary of cybernetic*. Philadelphia, P. A. University of Pennsylvania Press
- Maturvana, H. & Varela, F. (1987). *The tree of knowledge the biological root of human understanding*, Boston M. A Shambhala
- Shannon, C. (1949). Communication theory of secrecy system. *Bell System Technical Journal* 28:65-715
- Stredrick, John (2006). *Human resource management*. 2nd Ed. Oxford. Charon Tec. Ltd, India. pp. 374
- The 21st Century. Webster's International Encyclopedia (2005). *Cybernetics*. 2nd Ed. Columbia. Richard Fischer/Master file
- Waewick, K. (1994). Cybernetic – the modern Science of System *Kyberntex* 23 (6/7) 76-85
- Wiener, N. (1948). *Cybernetic or control and communication in animal and the machine*, New York.